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Food Consumption and It's Economic Availability in Rural Population

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ABSTRACT

The economic affordability of food is an important factor in the country's food security. In this study, the main problems in the availability and consumption of food at the level of rural households were identified. A comparative analysis of expenditures, incomes, and consumption of basic foodstuffs in rural and urban residents has been carried out, and positive and negative trends identified. As a result, the average daily caloric intake in rural households was 2757 Kcal, which is 11% more than in urban ones. However, an objective assessment requires additional analysis of indicators by age, gender, intensity of physical activity, etc. Unfortunately, official data on them is freely available.

KEY WORDS: Economic Availability; Food Consumption, Rural Population, Agriculture.

INTRODUCTION

Agriculture is the foundation of food supply in Russia, and the goals of food industry have changed in this country over time. For example, in the first half of the 20th century, the problem in the fight against hunger was identified. Interruptions in the supply of bread in 1917 led to mass riots and finally the revolution. In the early 1920s with the introduction of a new economic policy in Russia, the possibility of restoring agriculture appeared, which was practically destroyed by the First World War and the Civil War.

In the late 1920s, collectivization, which was supposed to increase agricultural production for the country's urban population, and meet needs of industry for raw materials, turned into a new famine. In 1946, the food supply situation was critical after the war. Crop failure in 1963–1964 again aggravated this problem, which was solved by importing supplies of grain from the USA, Canada and other states. Only at the beginning of the XXI century, Russia achieved a positive trade balance in the grain. It can be argued that the problem of hunger has been resolved since about the end of the 1960s. The development and implementation of programs for the development of agriculture have improved the nutritional structure of the population.

The Food Program of the USSR (1982) was tasked with fully meeting the needs of not only bread, but also other types of food in accordance with scientifically based standards. In the late 1980s, there was a tendency for growing the consumption, which was close to rational norms (Semin and Karpov 2014). However, with the transition to market relations and a radical change in the existing economic system in the 1990s, the problem of food security became acute again. The main reason was not so much a shortage of food as a sharp decline in real incomes of the population, especially in rural areas.

A large-scale import of cheap products from abroad began,

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while Russian agricultural enterprises could not compete in the market and were forced to cease their activities. As a result, the rural population, which was previously engaged in agricultural production, abandoned their work without basic income. The process of degradation of the village and agricultural lands was launched. In the period from 2000 to 2005, a recovery period began, which predetermined the significance of large industrial agrarian formations. Meanwhile, there was not incentives and funds to invest on the low level of technical development in the industry (Karadağ et al. 2018; Khairullina 2017; Khairullina 2018; Skalnaya 2018).

With the introduction of the law on the development of agriculture in 2006, and then the priority national agricultural development project, it was possible to partially

prevent massive land degradation and the outflow of the rural population to the city. However, the rural population decreased by 2.4 million people (6%) and reached to 37.7 million people from 1995 to 2017. There is a population migration from the village to the city every year. The degradation of rural areas continues in conditions unattractive for the population.

The importance of the problem at the state level and its solution mechanisms are reflected in the Federal Target Program “Sustainable Development of Rural Territories for 2014–2017 and for the period until 2020”.

Incomes in rural residents remain extremely low, and ensuring the economic affordability of food is therefore of particular relevance to Russia. At the present stage,

Table 1: Ratio of disposable resources and expenditures of rural and urban households.

Indicator	Year	2005	2010	2011	2012	2013	2014	2015	2016	2017
	2000									
Ratio of disposable resources in rural and urban households, %	65,38	55,21	62,27	64,22	65,28	60,02	62,34	65,34	63,51	67,30
Ratio of food expenses in rural and urban households, %	59,83	60,83	71,45	73,70	74,10	74,01	75,06	78,07	77,28	76,71
The share of food expenses in consumer spending, %:	48,83	32,03	28,34	28,13	27,02	26,40	27,26	30,66	30,93	30,02
-urban population										
-rural population	52,42	39,49	35,98	36,05	33,51	34,10	34,61	38,19	38,66	36,61

Source: compiled by the author using sources (Bulletin)

Table 2. Dynamics of ratio of the cost of food and cost of the conditional (minimum) set of food.

Indicator	Year	2005	2010	2011	2012	2013	2014	2015	2016	2017
	2000									
The cost of the conditional (minimum) set of food products, thousand rubles	0,85	1,33	2,37	2,64	2,54	2,81	3,11	3,67	3,70	3,85
The ratio of the cost of food and the cost of conditional (minimum) set of food:	0,75	1,18	1,37	1,35	1,50	1,45	1,43	1,37	1,49	1,45
-urban population										
-rural population	0,45	0,72	0,98	1,00	1,11	1,07	1,08	1,07	1,15	1,11

Source: calculated by the author using sources (Bulletin)

this aspect is not sufficiently studied. Theoretical and methodological issues of food security are available in the works of Russian scientists: V.V. Miloserdov, A.I. Altukhov, A.N. Semin and others (Altukhov 2015; Mazloev and Khairullina 2017; Ozsay et al. 2018).

There are separate studies assessing the economic availability of food for the population of the Russian Federation as a whole and the regions for N.I. Shagaida, V.Ya. Uzuna (Eugenio Diaz-Bonilla 2015). In foreign publications, this problem at the level of world food security and food consumption ratios is presented by Amir M. Sharif et al., Donna Mitchell et al., Eduardo Botti Abbade, Eugenio Diaz-Bonilla, Roberto Capone, et al. (Amir 2016;

Capone et al. 2014; Eduardo Botti Abbade. 2017; Eugenio Diaz-Bonilla. 2015; Mitchell et al. 2015; Yarkova and Khairullina 2019).

The importance of economic access to food is also important from the standpoint of food security (Khairullina et al. 2018; Shagayda and Uzun 2017).

MATERIAL AND METHODS

To study the consumption and affordability of food for the rural population, monographic, abstract-logical, and statistical-economic methods were used. The used data were from the Federal State Statistics Service of the Russian Federation

Table 3: Dynamics of consumption of basic foodstuffs by the rural population (kg).

Product	Norm	Year							
		2010	2011	2012	2013	2014	2015	2016	2017
Potatoes	90	76,3	71,8	75,4	72,5	69,9	67,8	70,2	71,3
Vegetable oil and other fats	12	12,1	11,9	11,6	11,6	11,8	12	12,3	12,6
Milk	325	244,6	245,4	248,8	248,5	249	250	260,7	269,2
Meat and meat products	73	71,5	75,4	76,1	77,7	78,6	77,9	81,9	85,6
Vegetables and gourds	140	97,4	97	99,6	97,9	97,8	99,1	104,2	105,4
Fish and fish products	22	21	21,3	21,8	22,4	22,4	21,1	21,6	22,9
Sugar and pastry	24	35,8	35	35,1	34,4	34,6	34	36	36,1
Fruits and berries	100	59,9	59,2	61,8	65,1	64,9	61,3	65,1	67,8
Bread products	96	122	117,5	116,4	113	112,4	111,4	116,9	118,6
Eggs, pieces	260	207,5	208,8	211,5	206,7	209,1	210,1	221,1	234,2

Source: compiled by the author using sources (Bulletin; Miloserdov 2014)

Table 4. Ratio of food consumption in rural and urban households.

Year	Potatoes	Vegetable and other fats oil	Milk	Meat and meat products	Vegetables and gourds	Fish and fish products	Sugar and pastry	Fruits and berries	Bread products	Eggs
2010	1,22	1,11	0,91	0,87	1,01	0,99	1,14	0,81	1,30	0,92
2011	1,19	1,11	0,91	0,91	0,99	1,00	1,14	0,79	1,28	0,95
2012	1,26	1,10	0,91	0,90	1,00	1,00	1,14	0,79	1,27	0,95
2013	1,29	1,13	0,89	0,89	1,02	1,00	1,12	0,81	1,26	0,94
2014	1,28	1,18	0,92	0,91	1,00	1,00	1,15	0,81	1,26	0,96
2015	1,26	1,19	0,92	0,89	0,99	1,00	1,15	0,82	1,25	0,95
2016	1,24	1,17	0,94	0,90	0,99	1,00	1,18	0,86	1,27	0,96
2017	1,27	1,21	1,00	0,95	1,02	1,07	1,19	0,89	1,30	1,01

Source: calculated by the author using sources (Bulletin)

RESULTS

Economic affordability was determined by the existing possibility of buying food, which primarily depends on purchasing power of the population. The summary indicator is the average per capita amount of disposable resources, which includes cash and in-kind income (in monetary value) (Shagayda and Uzun 2015; The order of the healthy diet of the Russian Federation is dated August 19 2016).

In this aspect, the comparative analysis of household disposable resources and the share of food consumption expenditures between the rural and urban population (Table 1) are of particular importance. The ratio of disposable resources in rural and urban households suggests that there has been an increase in rural incomes relative to the urban population in the past five years. However, the existing difference in incomes should still be viewed as a negative factor. The main reason for the existing gap in the disposable resources between rural and urban families is the low income level in the latter case, where wages remain the main component.

The cost of food for rural residents is 23-30% less than that for urban residents. Meanwhile, the share of expenditures on food in the rural population was 37%, which is 7%

more than that in the urban population. It is believed that if the share of food expenditure does not exceed 20%, then food is economically available for the population. This is also evidenced by the world practice of developed countries. If less than one third of the income is spent on food, the level of availability is considered average. More than 30%, but less than 50% is high; and over 50% is critical (Reza Bayrami and Nobakht Dudran 2016; Semin and Karpov 2014).

For Russia, the situation for the rural population with economic access was critical until 2000. From 2005 to the present, the situation has improved, but the problem remains unresolved. An analysis of the ratio of food expenses to the cost of a conditional (minimum) set of food products indicates that a villager spends a minimum of funds (Table 2).

In 2016, as part of the implementation of the Food Security Doctrine, new rational norms of food consumption were established, which were lower than ones were previously adopted. Practically for all types of food, except potatoes, there is a positive trend in the consumption (Table 3). Comparing the actual data with the standards, deviations

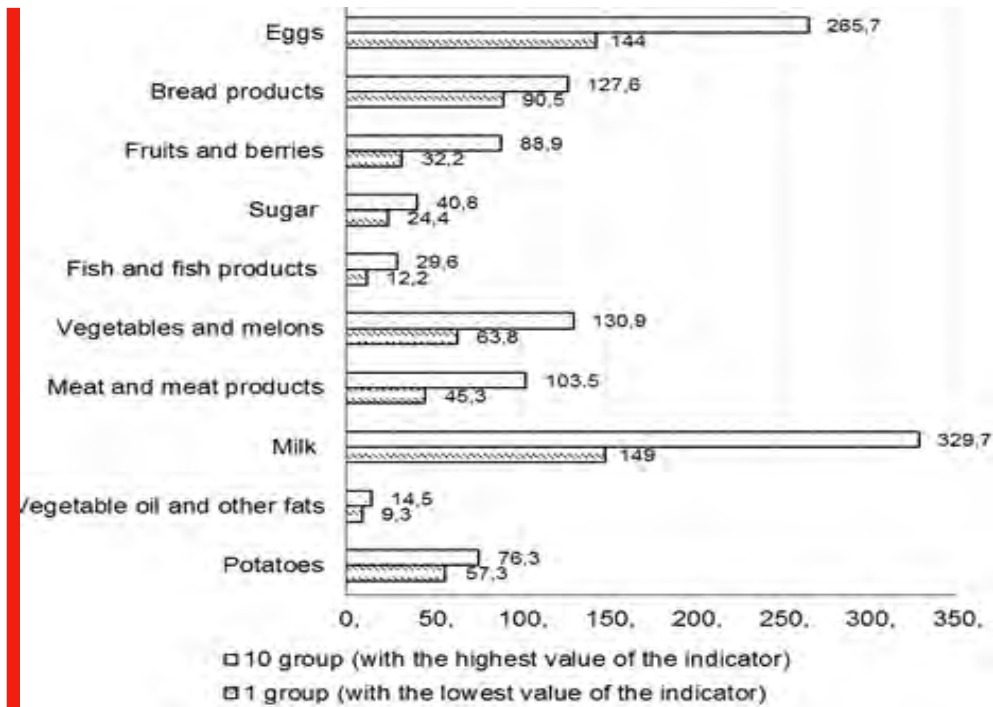


Fig. 1: Consumption of products of 1 and 10 decile groups, kg
 Source: compiled by the author using sources (Bulletin)

were obtained as both positive and negative. For example, the consumption of vegetable oil and other fats, fish and fish products meets accepted standards in the territory of the Russian Federation.

There is a shortage of consumption of potatoes, milk and dairy products, vegetables and melons, fruits, berries and eggs. Excess consumption is observed for meat, meat products (since 2011), sugar and confectionery and bread products. The ratio of food consumption in rural and urban households shows some differentiation (Table 4).

In comparison with urban households, rural households consume less milk and dairy products, meat and meat products, fruits and berries. Despite the marked improvement in the nutritional status of rural residents in Russia, serious problems remain with the economic availability of food for the population due to low real incomes.

Population groups are different in a number of ways, including the nature of food, quality, and others. The income level of the population certainly affects the consumption. Thus, on the basis of the differentiation of rural households in terms of income level, 10 groups are distinguished (decile groups).

The average consumption data presented earlier in Table 3, did not show a serious problem due to the differentiation of incomes in rural residents. The largest gap in food consumption is observed between the first (lowest income) and tenth (highest income) groups.

The first group consumes less potatoes by 25%, vegetable oils and other fats by 36%, milk by 55%, meat and meat products by 56%, vegetables by 51%, fish and fish products by 59%, sugar and confectionery products by 40%, fruits and berries by 63%, bread products by 29%, and eggs by 46%. Thus, the diet of the poorest households in rural areas is critically inappropriate.

Comparing the data from the first decile group of rural households with urban ones, it should be noted that meat and meat products consumption is lower by 20%, milk and dairy products by 15%, fish and fish products by 9%, fruits and berries by 17%, and eggs by 11% (Fig. 1).

At the same time, consumption is higher for potatoes, vegetables, sugar and bread products. Thus, the more expensive protein food is replaced by the consumption of cheaper one- namely carbohydrate. As a result, the average daily caloric intake in rural households was 2757

Kcal, which is 11% more than in urban ones. However, an objective assessment requires additional analysis of indicators by age, gender, intensity of physical activity, etc. Unfortunately, official data on them is freely available.

CONCLUSION

According to the FAO methodology, the concepts of "malnutrition" and "unhealthy diet" are required, implying a shortage of calories in the consumption, and the lack of consumption of important nutritional components, such as proteins, respectively. It is the second component that is of paramount importance for the rural population of Russia.

To ensure rational nutrition of the rural population, an increase in material support and provision of rural households is required. In particular, rural residents are characterized by high income differentiation and widespread poverty, the level of which continues to grow. In the monitoring, it is necessary to introduce indicators characterizing the material situation of rural households. In particular, the rural population shared with cash income below the subsistence minimum, which should not exceed 10% by international estimates.

Taking into account the orientation towards the convergence of the quality of life in rural areas, it is necessary to increase standard values of the indicators predicted for 2030, "ratio of wages in agriculture to the average value for the country's economy" and "ratio of average per capita disposable resources in rural and urban households" to 90% and 100% respectively. Particular attention should be paid to the development of measures in the Strategy for Sustainable Development of Rural Areas in the category of poor rural households that need a targeted food aid system. Until now, such a program of state support has not been developed in Russia. Meanwhile, positive experience has been gained in developed countries with regard to the development of mechanisms for the provision of domestic food aid to certain categories of citizens. The creation of such financing mechanisms at the state budget level would increase the consumption of foods with high amount of animal protein and solve the problem of unbalanced nutrition of the rural population, and, consequently, the food security of the country.

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The Application of Mineral Additives in Different Formulations for Feeding Animals

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ABSTRACT

This paper presents data on the relationship of the mineral composition of soils, plants and living organisms. Mineral supplements in various forms are introduced into the animal diets that are deficient in a number of trace elements, and the physiological parameters of the organism that determine its homeostasis are studied. Analysis of the data shows that an increase in the average daily productivity of cows and milk fat content in the experimental group (by 10.0 and 3.6% compared with the control group) when nano silicon was introduced into the diet resulted in a decrease in the cost of 1 kg of milk by 9%, and increase in the level of profitability by 14.7%, respectively.

KEY WORDS: Mineral Elements, Homeostasis, Nanopowder, Nanosilicon, Blood, Red Blood Cells, Leukocytes, Hemoglobin, Enzymes.

INTRODUCTION

The ecological link of organisms with the geochemical environment occurs through the migration of chemical elements in the biosphere and depends largely on the geochemical environment, climate, physico-chemical composition of soil-forming rocks, which are the storehouse of trace elements, as well as the agrophysical and agrochemical properties of the soil cover. The basis of geochemical ecology is the study of the adaptation of plants and animals to the geochemical environment. This

environment is heterogeneous and is characterized by a significant variety of the chemical composition of soils and soil-forming rocks. Some soils of Russia are poor in some microelements, and some soils are rich in them. Plants growing on these soils reflect their content of chemical elements. In the central and northwestern Non-chernozem zone, the content of all the leading trace elements is below the background (Georgievskii 1979; Reeves 2004).

Soil is the beginning and end of the biotic circulation of macro- and microelements. The biotic circulation of chemical elements begins and ends in the soil. From the point of view of geochemical ecology, soil is a link in the biogeochemical trophic chain, a reservoir of macro- and microelements used by plants and animals. Soil geochemistry is one of the leading factors determining the livelihoods of farm animals, their productivity, reproductive ability and natural resistance. With negative changes in soil biogeochemistry, there is a decrease in productivity, reproductive ability of farm animals, their resistance to macro- and microelementoses.

The chemical composition of parent rocks and soils largely determines the concentration of macro- and microelements in waters. The waters of different water sources used for watering animals differ in the content of copper, fluorine

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and other chemical elements. By the concentration of boron, water differs from each other by 30 times, copper - by 40, strontium - by 100, zinc - by 200, cobalt - by 300 times and more. Some waters contain an insignificant amount of fluorine, while others contain much. With a lack of fluorine in drinking water, animals develop dental caries, while with an excess - fluorosis. In some waters, iodine is absent, which contributes to the disease of animals with an enzootic goiter (Kovalskii 1974).

A practically accessible technique for diagnosing the deficiency of microelements is the use of a map of biogeochemical zones and provinces developed by V.V. Kowalskii. The map shows the main zones of insufficient copper, cobalt, iodine, and excess boron, nickel, molybdenum, fluorine, lead and a number of other elements. These data help prevent micronutrient deficiencies. To do this, all animal farms located in such zones are recommended to introduce the trace elements missing in the feed in prophylactic doses. For the most extensive Central-Non-chernozem zone the following indicative norms of additives are recommended (Georgievskii 1979).

Mineral substances play an important and diverse role in the organism of animals. They affect the energy, nitrogenous, carbohydrate and lipid metabolism; they are structural material in the formation of tissues and organs; part of organic substances; involved in maintaining the

normal colloidal state of protein, osmotic pressure and acid-base balance, in the processes of respiration, blood formation, digestion, absorption, synthesis, decomposition and excretion of metabolic products from the body; have a great influence on the activity of enzymes and hormones, thereby affecting the metabolism, support the protective functions of the body, participating in the processes of neutralization of toxic substances and antibody synthesis; and affect the symbiotic microflora of the gastrointestinal tract (Lapshin 1988; Urazaev 1990).

It is known that the body has a high-degree regulation of homeostasis of minerals. Despite the wide variations in the content of mineral elements in the feed, the mineral status of the organism remains fairly constant. However, these regulatory mechanisms are not infinite. Lack or excess of individual mineral elements, distortion of their optimal ratio in diets lead to disruption of metabolic processes, reduced digestibility, feed efficiency and animal productivity, and even to specific diseases in case of prolonged or acute deficiency or excess. These include: anemia, endemic goiter, hypomicroelementoses, etc (Hambidge 2003; Zakharov 2015 Arsanukaev 2017).

Many researchers use the introduction of mineral substances in the diet of animals in the form of complexes (chelates), which are a complex of microelements (iron, copper, zinc, cobalt, iodine) with an organic ligand — ethylene diamine disuccinic acid (EDDSA) (Alekseeva 2013).

In recent years, studies have been conducted to clarify the role of insufficiently studied mineral substances in a living organism. These include silicon. The emergence of new natural, chemical and microbiological compounds of silicon marked the beginning of their research in medicine and veterinary medicine (Armutcu et al. 2018).

Trace elements such as iron, copper, iodine, cobalt, zinc,

Table 1: Hematological indices of lactating Trakehner mares at the end of the research.

Groups of animals	Red blood cells, 10 ¹² /l	Hemoglobin, g/l
Control	7.07±0.29	128.25±0.51
Experimental	7.56±0.38	150.9±0.56***

Table 2: Indicators of protein metabolism of lactating mares.

Indicators	Beginning		End	
	Control	Experimental	Control	Experimental
Total protein, g/l	68.41±0.99	69.28±1.04	62.46-1.29	69.31±2.01**
Albumin, g/l	32.84±0.61	32.89±0.26	33.63-1.26	33.12±0.99
Globulin, g/l	35.57±0.24	36.39±0.36	28.84-0.34	35.72±0.38
Urea mmol/l	4.89±0.17	4.98±0.22	5.13-0.29	5.89±0.31
Creatinine μmol/l	89.33±1.04	105.09±0.89	80.79-0.87	87.30±0.89**

manganese, molybdenum, selenium, fluorine, play an important role in the vital processes. They are found in all tissues of the body, but in large quantities, in the so-called, depot of trace elements - the liver, spleen, bones, kidneys, skin, pancreas, etc. Biogenic trace elements are part of the enzymes, vitamins, hormones, respiratory pigments, cell structures, cytoplasm, blood, lymph, tissue fluid and are essential components of the intracellular environment (Alekseeva 2013).

An important role in maintaining the hemostasis of the body belongs to the blood and its homeostatic mechanisms.

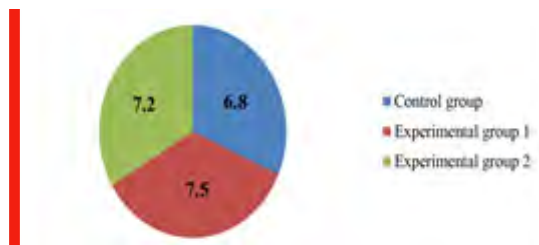


Fig. 1: Red blood cells, 1012 g/l.

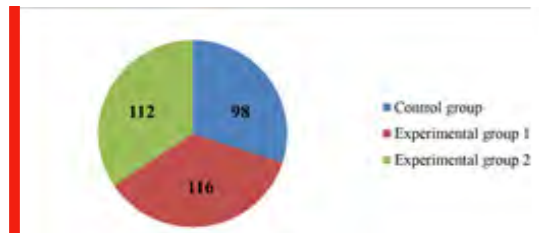


Fig. 2: Hemoglobin, g/l.

Table 3: The content of selenium, copper and zinc in the mane hair of lactating mares at the beginning of research.

Groups of animals	Se, mg/kg	Cu, mg/kg	Zn, mg/kg
Control	0.20±0.01	5.70±0.69	112.56-0.86
Experimental	0.20±0.02	6.20±0.04	117.50-0.64

Table 4: The content of selenium, copper and zinc in the mane hair of lactating mares at the end of research.

Groups of animals	Se, mg/kg	Cu, mg/kg	Zn, mg/kg
Control	0.23±0.02	5.94±0.12	113.27-0.35
Experimental	0.29±0.04	6.96±2.29	123.74-2.62

There is reason to believe that the degree of success of the corrective action of bioelements on a living organism depends on their state when entering the body.

To study the effect of complex compounds of microelements (Hemovit-meian) on the physiological state of Trakehner horses, a scientific experiment was conducted on the basis of the stud farm "Pallada" of Tver region. Hemovit-meian is a complex of microelements (Se, Zn, Cu + organic ligand - methionine succinic acid). The supplement was administered into the diet of lactating mares at the 3rd month of lactation and fed for 60 days in an amount of 30 g per 1 head according to the manufacturer's recommendation mixed with concentrated feed 1 time per day. Then blood was sampled in the animals that received the supplement and the animals of the control group and the complete blood count and biochemistry tests were performed and the content of trace elements was studied in the object of research.

According to the results of the research, we found that the introduction of compounds of microelements affected the metabolic processes in the horses, and, namely, there was a tendency to an increase in the content of red blood cells and hemoglobin in the blood of experimental mares by 6% and 18%, respectively, which indicates intensity of metabolic processes in the body and blood circulation in the mammary glands and the process of lactogenesis during lactation.

Mares treated with the above supplement had a significant increase in the amount of selenium in their hair, which exceeds the control group by 31%, as well as copper and zinc, on average, by 7%. The content of microelements in the hair is an informative value, since the hair stores integral information about the mineral metabolism of the whole organism over the period of its growth.

Thus, we can conclude that the mineral supplement used promotes an increase in the general metabolism in the body of lactating mares, as well as mineral metabolism, and this,

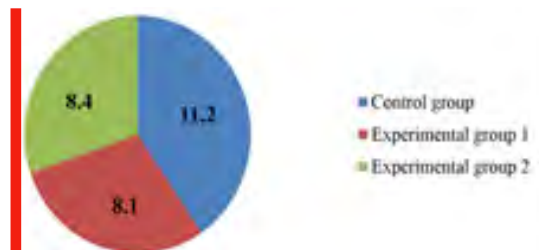


Fig. 3: Leukocytes, 109 g/l.

in turn, has affected the quality of milk and its amount.

Of particular interest are ultrafine metal powders, which act as biological preparations of a new generation. They have exceptional features: in small doses, they activate biochemical and physiological processes in the organism of animals, are environmentally safe, have low toxicity and a prolonged effect, which is economically beneficial in comparison with the use of salts of microelements. UFMPs are particles of metal in reduced form and have an effect on the synthesis, regulation of carbohydrate metabolism and mineral nutrition.

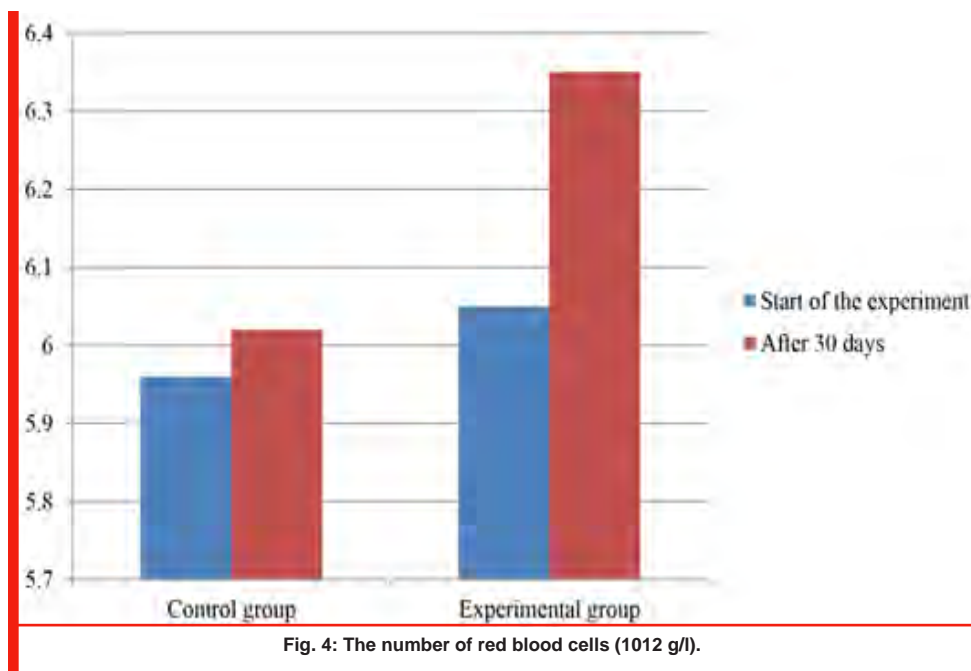
Nanopowders are presented as some version of nanomaterials. Nanomaterials themselves are structured at the level of molecular dimensions, with random or regular structure. When using plasma etching or when processing with particle beams, the surface of a random nanostructure is obtained. The active elements of nanopowders are copper, cobalt, molybdenum, and iron, which are in the ultradisperse state. Such substances have differences from particulates, in their structure, and also take on new chemical and physical properties. There is evidence that ultrafine powders of metals in their pure form do not show biological activity. High adsorption of nanopowder particles is manifested due to their high surface energy (Lukianov 2016; Moradi Merni 2016).

There is a known method of obtaining ultrafine metal powders using low-temperature hydrogen reduction with further ultrasound treatment in water.

Kashin Lug LLC of the Kashinsky district of Tver region conducted an experiment with the introduction of a nanopowder of copper and its salt into the diet of small Hereford bulls. The objective of the research was to determine the effect of these supplements on the growth rate of animals and changes in homeostasis in their body.

The object of research was the small Hereford bulls. Animals were selected at the age of five months, according to the generally accepted methodology of the experiment by the method of analogue pairs. The number of animals in each group was 5 heads (total 3 groups of animals). The age of the animals was 5 months. Animals of the control group were on a diet deficient in many elements, including copper. The diet of bulls of the first experimental group was supplemented with copper nanopowder (at a dose of 0.02 mg per 1 kg of live weight), and the second experimental group was supplemented with copper sulfate (at a dose of 8 mg per 1 kg of dry matter of the diet). Supplements were mixed with the feed mixture (wheat + oat).

For laboratory studies, blood samples were taken from both the experimental and control animals to determine the morphological parameters of blood.



The figures presented reflect the data 60 days after the start of the experiment. In our studies, an increase in the number of red blood cells in the blood of animals of the first experimental group treated with copper nanopowder was found, by 10.3% compared with the control group and in the blood of animals of the second experimental group who received salt of copper sulfate, by 6% compared with the control. These indicators stay within the physiological norm. The amount of hemoglobin in the blood of animals of the first experimental group increased by 18.4% compared with the control group, and by 14.3% in the blood of animals of the second experimental group, which implies an increase in the intensity of hematopoietic processes, as well as an increase in the rate of redox processes in the body of bulls under the action of the above additives. It is known that oxygen combines with copper and forms a fragile compound that has a short bond with hemoglobin. Copper promotes the maturation of erythrocytes in the initial stages, promotes the incorporation of iron into the heme structure, therefore, with its deficiency, the number of erythrocytes decreases, but the concentration of hemoglobin does not change, which is confirmed by the results of our research.

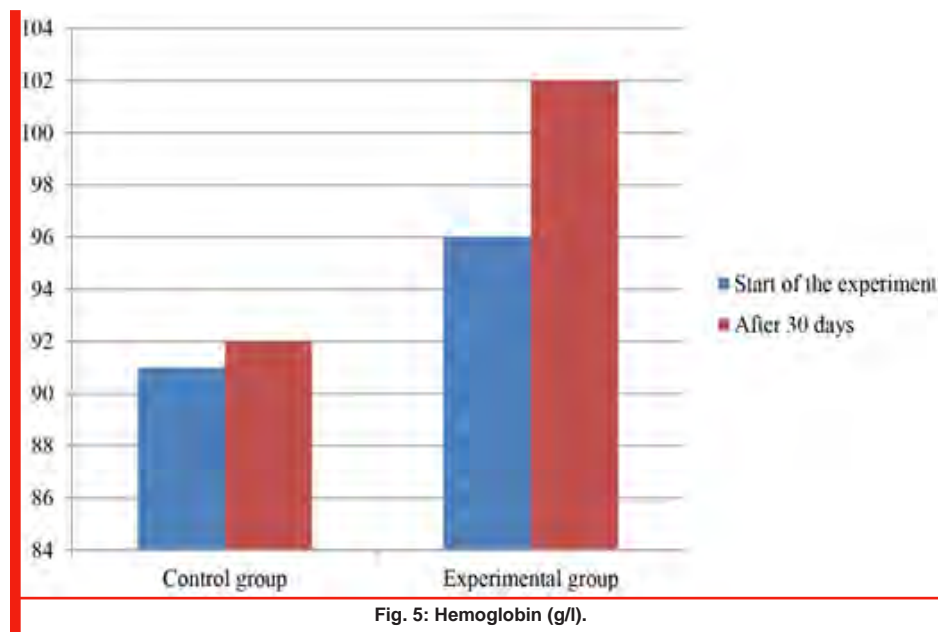
The blood of animals of the first experimental group had a decreased number of leukocytes within the physiological norm by 28% and 25% compared with the control group, which indicates the maintenance of the genetic homeostasis of the organism of animals and, accordingly, the improvement of cellular immunity.

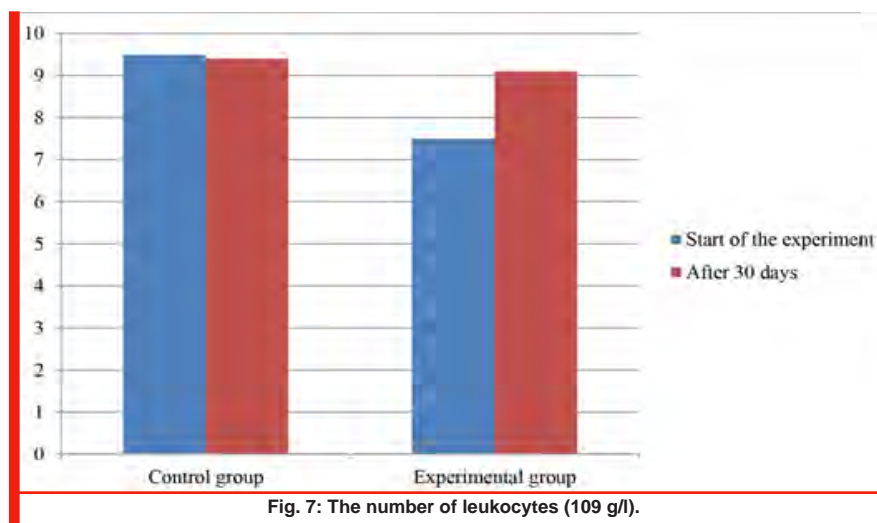
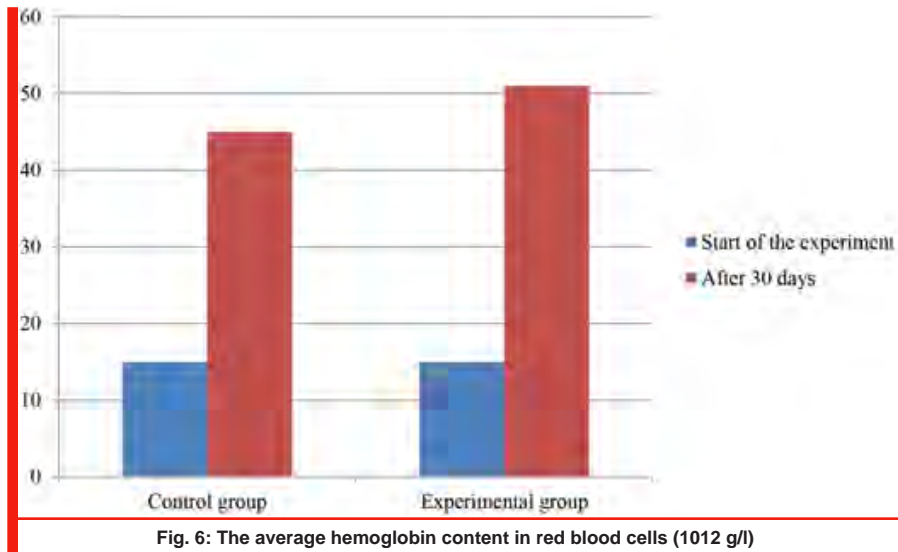
The data obtained prove that the additives used in feeding the bulls do not have a toxic effect. At the very beginning of the experiment, animals were weighed in order to determine the change in their live weight and average daily gains. After 60 days, the average live weight of the bulls of the experimental groups exceeded the live weight of the animals of the control group: the first experimental group exceeded by 5%, and the second - by 3%. The average increase in live weight in animals of the first experimental group was higher than in the control by 53%, in animals of the second experimental group — by 36% (Khodyrev 1988).

The nanosilicon supplement is a mixture of mineral components (copper, zinc, iron) based on silicon containing materials. The product has an expert opinion on the results of laboratory tests and in accordance with the hazard classification according to GOST 12.1.007-76 "Harmful substances", this drug belongs to low-hazard substances (Bedel et al. 2018).

An experiment with nanosilicon supplement in the diet of dairy cows was conducted in Kalininskoe CJSC of Tver region. The objective of our research was to determine the effective and environmentally friendly forms of microsupplements (a new supplement - nanosilicon) introduced into the diet of dairy Holsteinized cows.

The supplement was administered in the amount of 100 mg per 1 head per day, dissolving in water and pouring mixed





feed (as recommended by the manufacturer).

Blood was sampled for the study from the jugular vein of the animals. Then morphological and biochemical parameters were determined, as well as indicators of the enzymatic activity of the blood. The cost-effectiveness of the supplement was determined. According to the results of our experiment, the number of red blood cells 30 days after the start of the experiment in the body of cows from the experimental group increased by 4.95% compared with the beginning of the experiment and by 6% compared with the control group (Figure 4).

The amount of hemoglobin in the blood of cows in the experimental group, who received the nanosilicon

supplement at a dose of 100 mg per head per day, increased after 30 days of the experiment by 5.6%, and in the blood of cows in the control group - by 1.7% (Figure 5).

Thus, the above changes indicate an increase in the hematopoietic functions of the body of experimental animals, i.e. the nanosilicon supplement introduced into the body of lactating cows contributes to an increase in the amount of hemoglobin and red blood cells in the blood of animals, and the result is an increase in metabolic rate and an increase in cow productivity by an average of 30%.

The number of platelets in the blood of cows in the experimental and control groups was normal and amounted

to 279-300 x 10⁹ g/l. Platelet hemostasis is provided by platelets. Their formation occurs continuously in the red bone marrow by ligation from megakaryocytes. Platelet cytoplasm contains a large number of specific organelles, including α -granules, lysosomes and dense granules. Also the blood plates contain the Golgi apparatus, vacuoles, mitochondria and peroxisomes. It can be assumed that the introduction of the nanosilicon supplement into the diet of dairy cows stabilized the number of platelets in the blood of cows, normalized their activity in the thrombovascular mechanisms of homeostasis, i.e. in blood coagulation processes (Bedel et al. 2018).

According to the results of the blood test, the number of leukocytes was normal in animals of all experimental groups (7.54-9.44 · 10⁹ g/l) (Figure 7).

Therefore, the introduction of the nanosilicon supplement, (which consists of the above microelements, activating their functions in the body under the action of silicon) increases the number of blood cells, which in turn increases the intensity of redox processes in the body and maintains its homeostasis. The AST content in the blood of cows of the experimental group, who received the addition of nanocrystals increased after 30 days of the experiment by 1.3%, the ALT content in the blood of the animals of the experimental group increased 12.2%.

ALT (alanine aminotransferase) and AST (aspartate aminotransferase) are special enzyme proteins that are contained within the cells of the body and are involved in the exchange of amino acids. According to the results of our research, the content of these enzymes in the blood of experimental animals was within the normal range and increased slightly during the 30 days of the experiment, which proves the positive effect of the drug on the physiological state of the cows during active lactation processes. Analysis of the data shows that an increase in the average daily productivity of cows and milk fat content in the experimental group (by 10.0 and 3.6% compared with the control group) when nanosilicon was introduced into the diet resulted in a decrease in the cost of 1 kg of milk by 9%, and increase in the level of profitability by 14.7%, respectively. The performed calculations fully confirm the increase in the efficiency of the production of raw milk with the introduction of the nanosilicon supplement into the animal diet, which allowed increasing the productivity of animals and the fat content of milk, and filling the lack of trace elements in the body of dairy cows. Thus, the used microelement supplement (nanosilicon) in the diet of dairy cows adjusts the homeostatic processes in the

body of animals, this affects their productivity and level of profitability.

Tver region belongs to the Non-chernozem zone poor in mineral elements (for example, Cu, I, Co, Cr, etc.). Therefore, diets consisting of plants growing on these soils require adjustment by introducing mineral supplements in various forms. The results of research on this issue are given in the presented paper. Studies have shown a chain of relationships between the mineral composition of the soil → plant → living organism.

Since the lack of mineral elements in the main fodder plants can be filled with the various mineral supplements, this stabilizes the homeostasis of a living organism and leads to high-quality products.

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State Food Security Indicator of Agriculture

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ABSTRACT

Many problems are solved with successful agar management, the degree of various risks is reduced. However, it is necessary not only to take into account the state of agrarian industries in order to enhance food security. It is important to take into account the complex nature of food security development and the processes taking place along with it, which is determined by two main aspects. The first aspect is considered to be the physical accessibility of food to population, which directly depends on the agro-industrial sector state. The second aspect is the socio-economic accessibility of the regional population. This aspect is influenced by a large number of factors, including the population income and expenditure, the culture of nutrition and traditions, the state of economy, the degree of state influence on the state and stability of domestic food market operation.

KEY WORDS: Agriculture, Agro-Industrial Complex, Food, Physical Accessibility, Socio-Economic Accessibility.

INTRODUCTION

In Russian Federation (hereinafter RF), food security as a socio-economic term was cited in the primary basic document of RF Food Security Doctrine (Abakarova 2012). However, along with the generally accepted definition of this concept, a number of Russian and foreign scientists put forward new definitions over time, each of which has the right to exist in a certain period of time. In this case, you should still refer to the official version of the object under study. So, in RF Food Security Doctrine this definition reads as follows:

“This is the state of Russian Federation economy, which ensures food independence, guarantees physical and economic accessibility of food products for the country population that meet the requirements of technical regulations necessary for an active, healthy lifestyle” (Abakarova 2012). Certainly, this definition is very capacious and sufficiently fully reflects the essence and significance of RF food security, and is supported by law in the meantime. It is also important to emphasize that this definition reveals and takes into account the need to implement the course of import substitution and, in fact, provides for the restrictions on food import and export in order to stabilize domestic food markets (Abakarova 2014).

The only unjust thing in the author's opinion is that this definition is not focused on the importance of the agro-industrial complex (hereinafter the AIC) of the country and its regions and agriculture directly, as the basis for the state food security development. It is a well-known fact that AIC is the combination, or more precisely, a systematic interaction between the most important sectors of economy, capable of meeting the primary needs of society, thereby ensuring food security and guaranteeing the nation health. The country agriculture is the closest one in relation with food security and independence. This slogan is ensured by

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the fact that food security cannot be formed by itself and strengthened at the expense of political structure and socio-economic structure only, since this role is entirely played by agriculture, where an intermediate or finished product is produced that is able to ensure food independence and security in the country (Golubev 2012).

It is generally accepted in all countries of the world that the level of agriculture development mirrors the state of food security. This is the main indicative and evaluative criterion. Consequently, food security can be under great threat of security if agricultural regulation is subordinated to chaotic market mechanisms, which, at least, is typical of the Russian market with its established institutional structure.

It is advisable to note that agriculture is the industry dependent on many factors, which is primarily due to natural disasters, the seasonal nature of production, low and long payback of investments in fixed assets, and so on. In this regard, food security is the consequence of the multifunctional nature of agriculture, which requires mandatory ongoing state support and regulation.

There is a practice that many issues related to food security in the world and the need for its government regulation and

support are dealt by the International Food and Agriculture Organization (FAO) of the United Nations. This organization identified the main tasks of food security provision in the countries in order to eliminate hunger, which takes place in a number of countries (Fig. 1).

According to the experience of foreign countries with a developed economy, including agriculture, the country food security is primarily related to the domestic provision of the country population with basic foodstuffs (meat, milk, bread, vegetables, potatoes, eggs, etc.) due to own production account at the level of 80-100%. The calculation of food market ensuring and saturation indicator is carried out in Russia according to the recommended rational norms of basic foodstuff consumption per person during a year. The standards recommended by the United Nations World Health Organization (WHO UN) are used abroad. Since 2010 RF Ministry of Health and Social Development has developed and used the norms somewhat different from those recommended by WHO for such calculations.

Such a settlement and appraisal approach allow us to control and regulate internal production, determine export opportunities and the need to import agricultural raw materials and food. Along with all the above mentioned, one should focus on the importance of state financial support to

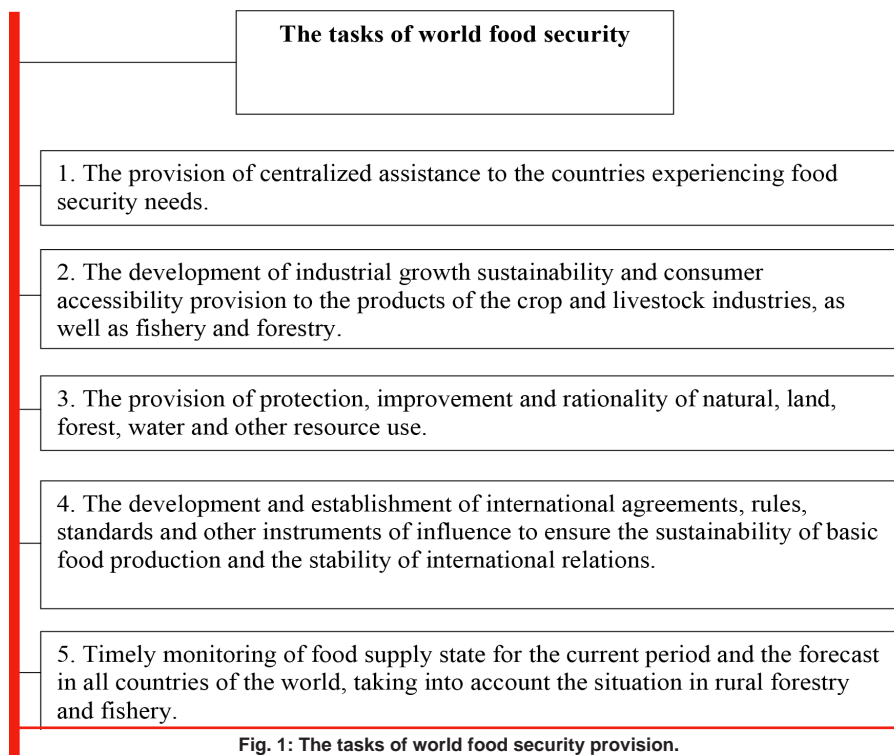


Fig. 1: The tasks of world food security provision.

farmers. In Russia, this important point is weakly regarded by the authorities, which is confirmed by the fact of one of the lowest levels of financial support for agricultural producers in comparison with the developed countries of the world (RF President Decree No. 120).

According to M.L. Vartanova, food security assumes a stable state of economy and the branches of the agro-industrial sector, including agriculture, due to which the domestic needs for food among the population can be fully satisfied, regardless of various kinds of factors, threats and risks influence. In this case, the main role in food security provision belongs to the state (Russia in numbers 2018).

METHODS

In our opinion the problem of food security should be considered in two aspect order, the essence of which is the following one:

The first aspect. The study of physical accessibility for basic types of food among the country population. The methodical aspect consists in physical volume of agricultural raw material and food production determination, as well as in their uninterrupted supply to processing and to a final consumer as a finished food product. It is also advisable to include the logistic movement of food in the state between differentiated by agriculture and processing industry development degree and level within the framework of this aspect.

The second aspect. The study of the socio-economic availability of food within the country and its regions. The

method of this aspect is that the situation of population incomes and expenditures should be monitored regularly and in a timely manner, the information on the expenditures of the population for food is especially important.

Third aspect. The study of import dependence. Here, the technique is formed on the way to the share of imported agricultural raw material and imported food determination. However, such a calculation must be performed along with the assessment of import supply necessity. Virtually no country (no matter how it is developed) can do without imports. This is explained by the elementary principles of market relations and the rules of international trade.

They should also clearly define the number of principles that must be followed within the formation of state policy in the field of food security. First, this is the constant availability of food. The complexity of this principle lies in the fact that food independence is not an artificially created state of the country. It does not have an absolute character and is very dependent on unpredictable climatic factors. Consequently, in order to ensure the availability of food, it is necessary to strive to increase internal production, also paying a close attention to the quality of production, and at the same time build up reserves that can be directed to various needs, including the provision of socially important facilities and segments.

Secondly, it is the stability of food supplies to domestic food markets. Human physiology provides for the regular consumption of food, so the state should attend to regular and stable food supplies to domestic markets through its

Table 1: The share of agricultural product main types in the context of organizational and legal forms of management, 2000 - 2017, %.

Main agricultural products	Agricultural organizations (AO)			Private farms (PF)			Population households (PH)		
	2000	2010	2017	2000	2010	2017	2000	2010	2017
Grain	90,8	77,0	70,1	8,4	21,9	29,1	0,8	1,1	0,8
Sugar beet	94,5	88,7	88,2	4,9	10,9	11,6	0,6	0,4	0,2
Potato	7,5	12,0	19,5	1,3	6,3	11,6	91,2	81,7	68,9
Vegetables	22,9	18,8	25,6	2,4	12,9	19,0	74,7	68,3	55,4
Livestock and poultry (in slaughter weight)	40,2	60,6	77,9	1,8	2,9	3,0	58,0	36,5	19,1
Milk	47,3	45,4	51,9	1,8	4,7	7,9	50,9	49,9	40,2
Eggs	70,8	76,8	80,1	0,4	0,8	1,1	28,8	22,4	18,8

* Compiled by the author according to Rosstat data

own production, as well as through imports. Some foreign experts believe that food security provision is out of the risk zone when domestic food supplies reach the level of 70-80%. Also, according to expert estimates, Russia has the potential to achieve this level of food security.

Thirdly, it is the efficiency of food use. The essence of this principle lies in the system approach to production, transportation, storage and processing.

Fourth, it is the availability of food. The main types of food must be in physical and socio-economic accessibility or in purchasing power for the country population (Russian statistical yearbook 2018).

The compliance with the above mentioned principles should form the basis for a sustainable development of agriculture

and the processing sectors of the country agro-industrial complex.

RESULTS

In 2017, Russian Federation was the first one in the world in the production of sugar beet (51.9 million tons); It took the 3rd place in potato production (21.7 million tons); 4th place in the production of grain and leguminous crops (135.5 million tons); 5th place in meat production (10.3 million tons); 6th place in milk production (30.2 million tons) (Vartanova 2016).

It should be noted that RF agriculture is mainly represented as three main organizational and legal forms, and in particular, agricultural organizations (hereinafter referred to as AO); peasant farms (PF) and population households (PH).

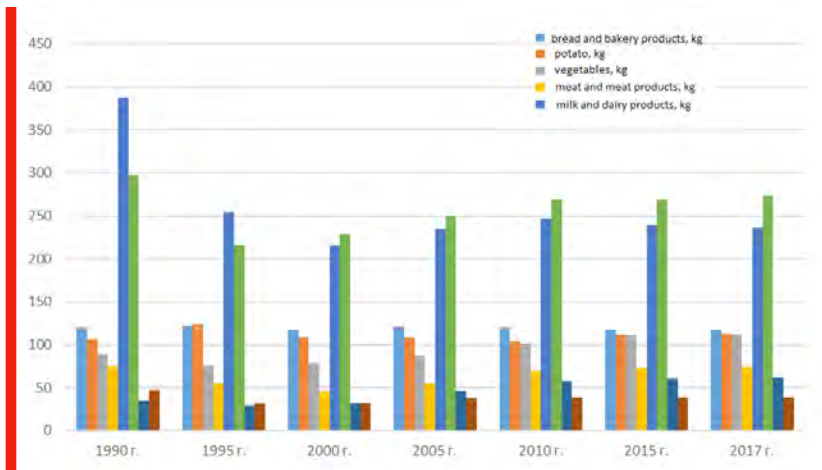


Fig. 2: The level of main types of food consumption by population of Russia during the period 1990 - 2017, kg per capita in a year.

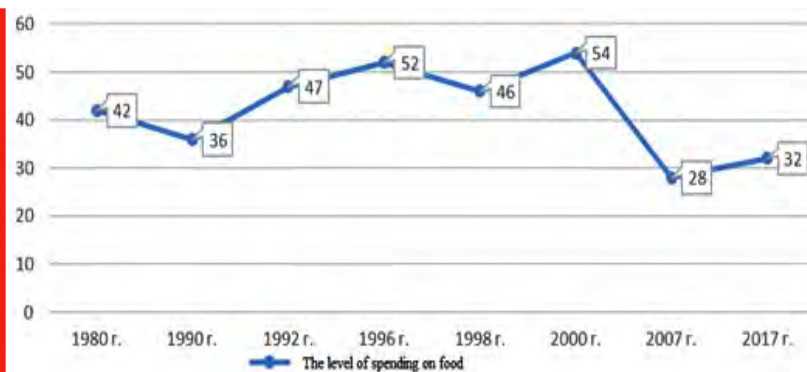


Fig. 3: Socio-economic availability of food in terms of consumer spending on food, %.

Table 2: The assessment of the target achievement within the RF Doctrine of Food Security for the production of main types of agricultural raw materials and food.

Main type of food Target criterion of RF Food Security Doctrine, % (no less than)	Actual value	Target criterion achievement level, %			
		2010	2015	2017	
Grain	95	122	145	146	153
Potato	95	101	105	106	112
Milk and dairy products	90	81	81	82	91
Meat and meat products	85	72	89	91	107
Sugar	80	58	83	92	115
Vegetable oil	80	95	127	138	173

(Fig. 2).

In Russia, the role of each legal form of management changes its importance over time. Thus, for example, in the 90-ies of the 20th century, the role of a small agricultural enterprise lost some of its strength, but in the early 2000-ies it gained popularity again. To the contrary, they tolerated changes in terms of private farm value. Farming enterprises with a cumulative total since the beginning of the transition period to the market acquire their significance, which is not unfounded (Table 1) (Vartanova 2016).

Thus, the characteristic presented in relation to the organizational and legal forms of economic entities in RF agriculture is fully confirmed by the figures reflected in table 1. At the same time, an important point should be emphasized that, in fact, over the course of difficult economic and organizational time for the agriculture of Russia, there has been a certain division of labor, which can be characterized as follows. Thus, the production of grains, oilseeds and sugar beets, as well as poultry and pig farming, was concentrated in agricultural organizations. Farmers are mainly oriented on the production of grain, cattle, sheep and vegetables. A large proportion of potatoes, vegetables, fruits and berries, as well as about half of the total milk yield, is produced on private farms.

Such an agrarian structure of Russia has no analogues in the world, at least among developed countries. The main goal of all economic entities is to meet the food needs of the regional population or in general.

At the beginning of the 21st century, it was possible to observe the increase of food consumption by population

Thus, the data of Figure 1 allows us to correlate the available statistical data on the consumption of main types of foodstuffs with the current consumption standards established in Russian Federation during 2010 in conjunction with RF Doctrine on Food Security. Of course, the required level of consumption has not yet been reached for the current period of time, in particular for such types of food as fruits (the consumption makes 62% from the norm), milk (72.6%) and vegetables (80%). But these figures are not the evidence of food shortages in domestic food markets. This is more indicative of purchase power and food culture level, i.e. of socio-economic accessibility. This is confirmed by the fact that a high-calorie carbohydrate type of nutrition prevails in Russia. So, judging by the diagram data, it can be seen that the population of Russia consumes bread products (121.9% of the required volume), potatoes (125.6%), sugar (162.5%) and vegetable oil (114.2 %) (Voronin 2010; Yarkova 2018; Yarkova and Khairullina 2018; Zyryaeva 2010).

In general, if the country population spends less than one-third of its own income on food, this indicates an average level of food availability; a high level is achieved when food expenditures exceed one third, but no more than 50%; a critical level occurs in the case of 50% of food expenses or more. Let's analyze this situation of the socio-economic availability of food to the population according to the actual statistical data in the context of the last 37 years (Fig. 3).

Analyzing the population expenditures on food, it should be noted that the present is characterized by an average

level of food availability for the population of the country. The peak of critical food availability was from the mid-1990s to 2002. During this period, the expenses often exceeded 50%.

Figures 1 and 2 do not reflect some of the phenomena occurring in the food market of Russia, in particular, we talk about the large influx and the consumption of imported food from 1990 to 2010, which reached 50% for some types of food, which was the catastrophe both for agriculture and for the state of food security in Russian Federation.

In 2010, with the adoption of the Doctrine for Food Security, the state set certain tasks to import substitution and production level increase concerning the main types of agricultural raw materials and food. Along with the Doctrine of RF Food Security, they started to develop actively the programs for agriculture and market for agricultural raw materials and food and implement them at the federal and regional level since 2008. The production results showed that Russian agriculture is still quite viable and can reach the government-defined targets concerning the production level (Table 2).

Thus, it can be stated that the guidelines set by the Doctrine are fulfilled in almost all types of food, with the exception of milk. Experts note that the problem of milk production missing volumes lies in the fact that the material and technical base for the production of feed, in particular concentrated one, is poorly developed in Russia. Practically there are no own domestic technologies for their production. Also, during the transition to market relations, stock breeding lost itself and practically had no state support. In the majority of functioning farms, the dairy herd is represented by the black-and-white breed. The average level of milk production in Russia is based on 5,000-6,000 kg of milk per head, while in a number of developed countries where dairy cattle is developed, the milk yield per head can reach up to 15,000 kg a year.

CONCLUSION

In general, it should be noted that the multidimensional nature of food security development boils down to two main criteria characterizing it: physical and socio-economic accessibility.

In this regard, it should be noted that socio-economic accessibility often does not depend on the state of the economy agrarian sector, if we are not talking about the population living and working in rural areas. The general format of measures contributing to this criterion strengthening should be reduced to population

general well-being increase in terms of life quality level. Consequently, it is advisable to carry out regulatory measures in labor market, where the nature and the complexity of labor must correspond to a personal level of specialization and qualification. Labor should have an appropriate remuneration, but at the same time, wage growth rates should not exceed the growth rates of labor productivity. It is also important to expand the possibilities of population income development, not focusing only on wages and so on.

In terms of physical accessibility, an active state policy aimed at import substitution should be continued. It is necessary to expand the possibilities of international cooperation and, consequently, exercise control over the food export and import. One of the priorities should be the strengthening and the update of the material and technical base of the most important production sites in the agro-industrial complex of the country. The state should also increase the volume of state support to farmers, mastering other areas unrelated to agricultural production according to the rules of WTO, of which Russia is a member.

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Cassava Peel-specimen Lye-digestion Process Optimization

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ABSTRACT

In this study, dimensional changes were measured and applied to compute an index of cassava peel structural collapse (ICPSC) or deformation. 81 specimens (sample segments) of the peel of TME-419 cassava variety (12 months after harvest) were subjected to a factorially-designed-experimental protocol involving strip-immersion in 3 lye-concentrations at 5-temperatures over residence time-intervals between 2 and 60 minutes. Zero-order kinetic parameters (kT, Q10, and Ea) values were generated from the data collected. The results clearly demonstrate a pattern of systematic correlation (within 99 % confidence limit) of ICPSC-values with the sequential progression of the disintegrative breakdown of cassava peel from the inception of immersion in lye to total collapse, resulting in a totally liquified-digest-sludge or pulp, such that peel breakdown was just complete/adequate to ease total peel-removal from the root; peel breakdown was incomplete/inadequate for total peel-removal; and peel breakdown was excessive leading to the proportional loss of root starchy-flesh-tissue when the peel is on the root during actual lye-peeling proper.

KEY WORDS: Cassava Root, Peel-Lignocellulose-Complex, Chemo-Physico-Mechanical (Cpm) Model-System, Index of Cassava Peel Structural Collapse (Icpsc) Or Deformation, Hollow-Roller-Cylindrical-Compression-Press (Hrccp), Lye, Starchy-Flesh-Tissue of Peeled Cassava Root.

INTRODUCTION

Food, Agro-ECONOMIC Importance of The Cassava CROP And Its Processing

Cassava (*Manihot esculanta* Crantz) is a very important root crop of the tropical and sub-tropical ecosystems of the world. It is only second to the cereal crops as a primary source of energy, industrial starch and livestock

feed in countries where it is a food staple (Nweke et al. 2002; FAO 2010, 2012; Onabulu, 2001; and Benesi et al., 2004). Nigeria is the world's largest producer of cassava with an estimated annual output of 26-million tonnes representing 25 % of the global and 60 % of the African crop. As a result of recurrent drought and associated food shortages in Africa, NEPAD (the new partnership for African development), an initiative of the European Union, identified cassava as one of its key mandate crops to reduce over-dependence on cereals and legumes (Fermont, 2009; Hashemi & Faghieh, 2018).

Cassava root is the most perishable of the tropical root-and-tuber crops. It deteriorates within just two or three days after harvest as its useful starchy-flesh-tissue rapidly succumbs to attack by a variety of biological, chemical and biophysical agents of spoilage. Consequently strategic processing of the root immediately after harvest is necessary to transform it into more stable and palatable products that are easier and less-costly to transport and market. Cassava processing embraces a wide range of selective unit operations that include washing, peeling, size-reduction of a variety of types, separation methods

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involving extraction, dewatering, refining; fermentation; heat-treatment involving cooking, toasting, garifrying, drying, etc. depending on the end-product desired.

Over the years, much progress has taken place in the mechanization of these unit operations. However, specific mechanization of cassava root-peeling, which is a preliminary-preparative step of the process and is fundamental for the achievement of any measurable degree of process-efficiency and defining product-quality and safety in every case, remains the greatest single worldwide technological challenge confronting cassava processing (Kolawole et al., 2010; Oluwale and Adio, 2013; Egbeocha et al., 2016).

R And D Challenges And Progress In Mechanized Cassava Peeling

The fundamental reason for the unsatisfactory state of technical-progress in developing effective mechanization systems for cassava root-peeling is the extreme irregularity and non-uniformity of the root shape-and-size, its surface physiographical-contour and differences in peel thickness-and-tackiness. In consequence, despite all the mobilized R-and-D attention directed at mechanized cassava peeling over the last 40-years or so, hand or manual-peeling by rural women and their children estimated at the output rate of 25kg/h. only per capita remains not only the dominant but also arguably the most effective method of cassava-peeling for both domestic and industrial purposes (Odigboh, 1983; Anekwe, 1984; Nweke et al., 2002; Egbeocha et al., 2016).

Much of the significant progress in mechanized cassava peeling has focused on the development of abrasive-type peelers. Without exception, abrasive-type peelers made locally and /or imported from China for small, medium and large-scale peeling of cassava roots in Sub-Saharan Africa and elsewhere, are both inefficient-and-ineffective because, by its very nature, the abrasive peeling mechanism cannot, ipso facto, navigate around the problem of irregularity and non-uniformity of shape, size and physiographical-contour of the root surface (Egbeocha et al., 2016; Ekinci & Özcan, 2018).

At their best, abrasive peeling machines can only achieve 70 % or less of peel-removal efficiency. Therefore, they demand significant hand-trimming of imperfectly peeled surface-fractions of the roots as they are discharged from the machine. In addition to its poor peel-removal efficiency, root irregularity predisposes cassava roots during peeling

to unduly high levels of loss of the starchy-flesh-tissue. The combination of these two negative factors makes abrasive peelers generally inefficient-and-ineffective. These factors are exacerbated when abrasive peeling machines operate at high speeds and high rated-capacities (Odigboh, 1976a; Kolawole and Agbetoye, 2007; Oluwale and Adio, 2013; Azim & Ghodrati Amiri, 2016). One response to these challenges which has received scant research attention by investigators is the lye-peeling of cassava roots.

The Advantages of Mechanized Lye-Peeling of Cassava

Only a handful of disappointingly and largely dismissive studies have been reported in the literature on the lye-peeling of cassava roots (Wurdemann et al., 1976; Igbeka, 1985; Screenparayanan et al., 1995; Deguchi et al., 2006; Bakere et al., 2011) However, a recent exhaustive Master of Engineering (M.Eng.) degree thesis investigation by Tsekwi (2018) at the University of Uyo-Nigeria, has for the very first time ever, sought by experimental-empiricism, to explore and address the fundamental lignocellulosic nature of the peel of the cassava root.

The lacuna created by the continuing absence of adequate insights into the composition and chemistry of the peel of the cassava root as a basic protective structural bio-material of every agricultural crop, has proved to be a serious neglect of past efforts to peel cassava, as indeed, decoat any other seed crop for that matter, by chemical treatment. Such understanding, needless to say, is a necessary pre-requisite for any attempt at the systematic optimization of lye-peeling proper in all relevant food crops. Mechanized lye-peeling of cassava roots has the following advantages over other methods. (i) As a liquid, lye invades the total surface of the cassava root when fully steeped in it uniformly and holistically, irrespective of size, shape, age, variety and whatever other differences or imperfections of root surface physiographical-contour or configuration including bends-and-crevices that may occur on the root. (ii) Three process variables (lye concentration, temperature, and residence-time-interval of immersion) can be readily manipulated using factorial-experimental-design methodology to optimize the lye-treatment process in order to achieve the highest possible process and product efficiencies as well as overall peel-removal effectiveness. (iii) Zero or near-zero loss of cassava root starchy-flesh-tissue can be achieved using previously optimized process parameters, followed by wet mechanical brushing-and-scrubbing.

Objectives of Study In Summary

The objectives of the study reported here are two-fold as serialized in two sequential papers (paper-1 and 2). The present report is focused on using a novel CPM-based kinetic model-system and protocol to monitor the hydrolytic digestion (or conformational-breakdown) process of strips of cassava-peel as distinct-entities (detached or removed from the whole root by careful hand-peeling), to determine optimal lye concentration(s), temperature(s), and residence time-intervals(s) of immersion to achieve measurable and progressive disintegration of the structural-conformation of the cassava peel-lignocellulose-complex, transforming it at collapse (or complete deformation), into a liquified-digest-sludge or pulp conducive to easy removal by scrub-brushing. Paper-2 will apply the findings of paper-1 on the whole cassava root with its peel in-situ, on the root to identify the optimal conditions for successful and total peel-removal, with zero or near-zero loss of root starchy-flesh-tissue and no heat ring.

Theoretical Foundation of Experimentation and Analysis

Anatomy, Structure And Cell-Wall Morphology of the Cassava Root Figure-1 shows the profile of the cassava root (1a) and its transverse cross-section (1b). The root has a central fibrous core, the pith; surrounded by a white or cream starchy-flesh-tissue of parenchymatous cells that constitute the bulk of its main food storage organ, which is adjacent to and surrounded by a cambium layer of meristematic cells surrounding which is the peel of the root (Duckworth, 1966; Phirke, 2007). The peel has two distinct layers: an inner whitish cortex (1.2 to 4.15-mm thick) and an outside periderm composed of thin layers of brownish dead-corky-cells (less than one-tenth the thickness of the cortex) which protectively seals the root surface against water loss and possible invasion of predator biological agents (Dutta, 1981; Adetan et al., 2003; Olomo and Ajibola, 2006).

As the root increases in size and diameter, the outermost portions of the periderm slough-off and are replaced by new cells; while the cortex becomes thicker and more rigid. It achieves this in an array of coaxial layers of cellulose-fibrils embedded in an amorphous matrix of hemicelluloses, lignin and pectic-substances (consisting of sols, gels and gums) mixed together to form a lignocellulose-fiber-complex. The fibres are first generated in the primary (or first) wall (designated P) which is very thin, followed coaxially by a sequence of secondary walls (designated S1, S2 and S3) around the lymphatic channel (lumen) adjacent to the cambium layer (Soper, 1997).

Some Helpful Insights Into The Chemistry Of Cassava Peel-Lignocellulose-Complex

According to Bogstrom (1969), the protective bio-structural tissues of plant food materials are lignocellulosic in nature. Therefore, the protective-covering of the cassava root is fundamentally a peel-lignocellulose-complex.

Figure-2 shows the chemical structures of lignocellulosic moieties which compose the complex, namely: (a) colloidal-emulsions chiefly of the oligosaccharide-moieity consisting of, but not limited to, sols, flocs, gels, gums and pectic-substances; (b) lignins; (c) hemicelluloses; (d) celluloses (Wills, 1989 and Wills et al., 1996).

Sols, flocs, gels, gums and pectic-substances occur as extrudates, mucilages, essential oils and resins, which may exist as complex salts of organic acids transformable by heat and/or chemical treatment into liquid, semi-solid or solid phase with cementing properties of their own as entities and/or in combination with other bonding-substances.

Lignin forms a cementing matrix with sols, flocs, gels, gums, pectic-substances and hemicelluloses to bind cellulose fibrils in the fibre-structure. Lignin is a high alkyl-aromatic amorphous polymer with a high degree of polymerization (DP). It is easy to remove from the macroenvironment of the fibre-matrix of cellulose by aqueous alkali solvents, but not from the micro-environment of the macro-fibrils. When lignin reacts with solvent-chemicals, it produces dark-brownish soluble derivatives.

Hemicelluloses are polysaccharides associated with but fewer complexes than cellulose in the protective structure of plant tissues. As amorphous copolymers of one or more sugars (e.g. xylose, mannose, arabinose or galactose) combined with uronic acids, their average molecular weight and therefore DP is low (about 100-200). They are hydrophobic, swell on water absorption and fairly soluble in aqueous alkaline or acid solvents which readily separate them from cellulose in their cellulose fibre-matrix, producing dark-brown coloured breakdown and/or derivative fragments.

Cellulose is the primary backbone of the protective bio-structure of plant tissues. It is a linear polysaccharide (C₆H₁₀O₅) bio-polymer of glucose units formed by β-1, 4 linkages, quite different from the more easily hydrolysable α-1, 4 linkages of the starch molecule. Cellulose has a high DP (3,000-15,000 and above). It occurs in two forms, an amorphous paracrystalline-region composed of flexible

mass of cellulose-chains which is more susceptible to chemical treatment; and the crystalline-region composed of tightly-packed bundles of cellulose-chains in rigid linear arrangement. Cellulose is insoluble in water and highly resistant to oxidative reduction (oxidation) and dissolution in aqueous alkaline or acid solvents. It exhibits no thermoplasticity or thermosetting properties and does not melt below its degradation temperature (Wang, 2008).

The Chemo-Physico-Mechanical (Cpm-Model) System Approach for Monitoring Cassava Peel Structural Deformation to Collapse As the skin-covering of edible food crops, the peels (of fruits, vegetables, roots and tubers) and the seed-coats (of cereal and legume grains, nuts and oil-seeds) are examples of plant protective bio-structural tissues. As such, they are lignocellulosic in nature (Brogstrom, 1969).

It remains therefore something of a mystery that despite its long history that dates from the 1800s, when lye was first applied to de-coat corn hominy in the form of a solution of leachings from wood ashes, the technology and practice of lye-peeling failed to take cognizance of the basic cellulosic composition of seed coats and peels of edible food crops (Cruess, 1958; Watson and Ramstad, 1987).

For this and other reasons, research in lye-peeling, as its practice, appears to have developed more by the dictates of the specificities of trial-and-error. In the specific case of lye-peeling of cassava roots, much of the scanty research effort reported in the literature have been conducted by food and agricultural engineers dating from 1976 (Wurde mann et al., 1976; Igbeka, 1985; Screenparayanan et al., 1995; Bakare et al., 2011).

At best, the character of these studies have tended to be phenomenological rather than diagnostic and, often times, even dismissive of the practicability of the method until a recent M.Eng. (Master of Engineering degree) study by Tsekwi (2018) at the University of Uyo, Nigeria, which appears to be the first attempt ever to recognize the peel of the cassava root as a peel-lignocellulose-complex; and therefore, the systematic study of the complex must either engage the analytical tools of cellulose chemistry or find ways to navigate around the complex sophistry of modern methods used by polymer chemists via the exploration of methods such as what we now designate as the CPM-model system.

The chemo-physico-mechanical (CPM-model) system derives from empirical observations of the swelling

which occurs when a strip of the peel of cassava root, after physical detachment from the root as an entity, is immersed in aqueous solution of NaOH (lye). The hollow-roller-cylindrical-compression-press [HRCCP-device] (Figure-3) was improvised as a tool that can be applied to systematically track and monitor the deformational effect of swelling, if allowed to progress to the collapse of the lignocellulosic structure of the peel.

Compression of swollen strips of the peel following immersion-and-withdrawal from lye of varying concentrations and temperatures for determinant time-intervals of immersion demonstrated clear reproducible patterns with progressive structural deformation of the peel-lignocellulose-matrix to eventual collapse of its fabric.

Linear dimensional-change measurements recorded from candidate sequences of:

[peel-immersion → peel-withdrawal → compression-to-collapse] were used by adapting the methods of Richard (2002) and Zhang (2012) to define and compute two factors as follows:

(a) Total deformation of cassava peel specimen at collapse (TDPSC), such that:

$$\text{TDPSC} = [t_{\text{swps}} - t_{\text{swpsc}}] \text{ (mm)} \quad (1)$$

(b) Index cassava of peel structural collapse (ICPSC), such that:

$$\text{ICPSC} = [T_{\text{DPSC}}/t_{\text{rcps}}] = [(t_{\text{swps}} - t_{\text{swpsc}})/(t_{\text{rcps}})]$$

(dimensionless)

(2) Where:

t_{swps} = thickness of the swollen peel-specimen after lye-treatment (mm);

t_{swpsc} = thickness of swollen peel-specimen after compression (mm);

t_{rcps} = thickness of raw cassava peel-specimen before lye-treatment (mm).

Plotting ICPSC-values against correspondent time-intervals of lye-treatment at designated concentrations and temperatures resulted in a system of reproducible linear zero-order kinetic plots. From the slope of each plot, the correspondent value of the kinetic rate constant (kT) of hydrolytic digestion was computed.

Values of kT so calculated were applied in accordance with equation-3 to compute correspondent values of the temperature quotient (Q10) of the hydrolytic digestion, such that:

$$Q_{10} = [kT/kT+10] \quad (3)$$

Values of kT and Q_{10} were thereafter applied to compute correspondent values of activation energy (E_a) of the hydrolytic breakdown process in accordance with equation-4 (Rao, 2005; Lee et al., 2008; Tsekwi, 2018), such that:

$$E_a = [\log Q_{10} \times T(T + 10) / 0.522] \quad (4)$$

MATERIAL AND METHODS

Materials used in the study were as follows: fresh raw cassava roots of the TME-419 variety harvested 12-months after planting at the University of Uyo farm, Nigeria. Chemical used was: sodium hydroxide pellets (NaOH), obtained at chemical supply stores in Uyo town. Water was used as tap and distilled water from the Food Engineering Laboratories, University of Uyo.

Laboratory equipment used include standard items and wares such as wooden spatulas, plastic bowls, conical flasks, pipettes and beakers, stop watch, hand fibre-brush, measuring cylinders (plastic), spectrophotometer (UV/Vis DO-83070-73 made in China), thermometers (mercury in glass type), protective hand-gloves (plastic), cooking pots assembled as lye-immersion baths heated on gas, kerosene-stoves or electric heater, Mettler balance (electronic), measuring calipers (electronic), sharp stainless steel cutting knives; and an improvised hollow roller cylindrical compression press (HRCCP) described here-under.

Figure-3 is an improvised hollow roller cylindrical compression press (HRCCP) device developed from mild steel cylinder of mass 10-kg and dimensions [ID=15.3-cm, OD=19.1-cm, length=13.5-cm, and rolling force=7.26-N/cm] improvised as a quantifiable rolling force to be carefully rolled-over detached segments of cassava peel, one at a time, while mounted on a flat hard plastic cutting-board surface of dimensions [length=50-cm, width=30-cm and thickness=0.7-cm].

METHODOLOGY

A factorially designed work-plan was employed to generate 81-samples of lye-treated cassava peel-specimens. To prepare the samples, cassava peel was detached carefully by hand-peeling from thoroughly washed wholesome fresh roots. The peel was cut into uniformly-sized sample-segments using a sharp knife. Each segment (in triplicate-samples) was subjected to lye-treatment by immersion in NaOH-solution embracing a compass of: 3-concentrations

(25, 30 and 35 %), 5-temperatures (32, 50, 103, 105 and 108 OC) and 3 residence time-intervals of immersion ranging between 2 and 60-minutes.

Following withdrawal from lye-treatment, each swollen peel-specimen was compressed to collapse in the HRCCP-device (Figure-3). This was conducted by carefully rolling the steel hollow-cylinder over the full length of the specimen mounted flat on the hard plastic cutting-board. Careful measurement of specimen thickness using electronic calipers was taken on each specimen (in triplicate samples) before immersion in lye, following its withdrawal from lye and after compression in the HRCCP-device. Figure-4 is a simplified flow diagramme of the experimental protocol involved.

From recorded dimensional-change data collected on specimen thickness, two factors, namely: TDPSC and ICPSC were calculated respectively, using equations-1 and 2 (section-2.3). Values of ICPSC were plotted against correspondent residence time-intervals of lye-treatment to obtain kT -values which were thereafter used to compute Q_{10} -values in accordance with equation-3. Values of kT and Q_{10} were used to compute E_a -values in accordance with equation-4.

The model can lend itself readily for problem-solving in food engineering for exploring new opportunities that are opening up in cellulose science, engineering and technology as the potential of cellulose as the largest single renewable and exploitable bio-material of the plant kingdom becomes more apparent.

RESULTS

The Effect Of Lye Wetting And Penetration Into Cassava Root Peel-Specimens

Upon immersion of cassava peel-specimens in lye, the specimens absorbed the lye which simultaneously wetted and penetrated into the samples. One observed outcome of this process was a progressive change in colour of the hitherto colourless lye into an increasingly brownish liquid which became darker-brown with successive samples, their replications and withdrawals and with solution make-up using solid pellets of NaOH.

Swelling of Cassava Peel-Specimens in Lye (NaOH-Water) Aqueous Solvent System

Figures-5, 6 and 7 show characteristic features of the peel-specimens following their withdrawal from lye-treatment at the respective temperatures of 32 and 50OC; and at boiling point temperatures of 103, 105 and 108OC corresponding

to the 3 lye concentrations of 25, 30 and 35% employed in the study.

The Effect of Lye Concentration, Temperature and Residence Time-Interval of Immersion on the Hydrolytic Digestion of Cassava Peel As Manifested in the Index of Cassava Peel Structural Collapse (Icpsc).

Table-2 presents the averaged summary of recorded values of the ICPSC-parameter showing the effect of lye concentration, temperature and residence time-interval of immersion on specimens of the peel of cassava root during lye-treatment of peel samples carefully removed by hand from the root prior to immersion in lye. The degree or extent of the associated hydrolytic digestion by lye is expressed as an index of cassava peel structural collapse (ICPSC).

Definition of Lye-Peeling Efficiency Index (Lpei) and It's Relationship With IcpSC Values

Using hand-peeling as the standard method for cassava root peeling operations, Wurdemann et al. (1976), Adetan et al. (2003), Olukunle (2007) and Bakere et al. (2011) defined a peeling efficiency index for any mechanized peeling method in competition with (or when compared to) hand-peeling on the basis of a universalized dimensionless ratio expressed as follows:

$$\left\{ \frac{\text{Root loss (\% by Hand-peeling)}}{\text{Root loss (\% by Mechanized-peeling Method)}} \right\} \text{ (dimensionless)}$$

Applying this formulation specifically to lye-peeling, led to the following expression:

$$\text{LPEI} = \left[\frac{\text{mphp}}{\text{mrcr}} \right] \left[\frac{\text{mplp}}{\text{mrcr}} \right] = \left[\frac{\text{mphp}}{\text{mplp}} \right] \quad (5).$$

Where:

mphp = mass of peel-loss from hand-peeling [kg]

mrcr = mass of raw cassava root [kg]

mplp = mass of peel-loss from lye-peeling [kg]

LPEI = lye-peeling efficiency index [dimensionless]

By definition therefore, the generic character of the LPEI

factor was a numerical value which straddled the figure 1.0 such that when:

- LPEI= 1.0: lye-peeling was adequate (complete) because its peeling loss (%) was equal to the loss (%) of hand-peeling.
- LPEI< 1.0: lye-peeling was inadequate (incomplete) because its peeling loss (%) was less than the loss (%) of hand-peeling.
- LPEI>1.0: lye-peeling loss was excessive because the peeling loss (%) exceeded that of hand-peeling leading to proportional loss of the starchy-flesh-tissue of root below the peel.

Now recall the definition of ICPSC from equation-2 (section-2.3) which expressed the quantity as:

Thus, ICPSC was a measure of the extent of hydrolytic digestion (or disintegration or degradation) of peel-specimens at collapse during lye-treatment.

As reported earlier, Table-2 recorded values of ICPSC that range from 0.62 to 1.55, which conferred on it, a generic character straddling the figure 1.0 in such a way that when:

- ICPSC = 1.0: deformation at collapse was total (complete) so that lye-peeling loss (%) was equal to hand-peeling loss (%).
- ICPSC < 1.0: (between 0.62 to 1.0) deformation at collapse was incomplete translating to inadequate peel-removal so that lye-peeling loss (%) was less than hand-peeling loss (%).
- ICPSC >1.0: (between 1.55 to 1.0): deformation at collapse is excessive being greater than 1.0 suggesting that lye-peeling loss (%) exceeded hand-peeling loss (%) leading to proportional loss of the starchy-flesh-tissue of root below the peel.

In conclusion, ICPSC and LPEI were generically similar parameters with ICPSC being the precursor of LPEI.

Selection of Optimal Process Variables or Parameters for Lye Digestion of the Peel of Cassava Roots Using IcpSC-Values As The Choice Criterion. As stated earlier, Table-2 provides recorded values of ICPSC in summary relating to all 3 process variable-combinations (81 of them) employed in the experiments.

ICPSC-values were plotted against the corresponding residence time-intervals of immersion used to generate Figures-8, 9 and 10.

Process Options	Process Variables		
	Lye concentration (%)	Temperature (°C)	Residence Time-interval of immersion (Mins.)
1st optimum (a)	30	32	50
2nd optimum (b)	35	50	7.5

Interpolating around ICPSC-values closest to 1.0 (not below it and not excessively greater than it) starting from Table-2 and navigating Figures-8, 9 and 10, furnished the following set of candidate-parameters tabulated in Table-3 as the optimal or near-optimal values for lye-digestion of cassava peel-lignocellulose-complex.

The Kinetics of Cassava Peel Structural Collapse (Cpsc) Table-4 presents the averaged summary of values of the reaction rate constant (kT); values of the temperature quotient (Q10) and values of the activation energy (Ea) recorded from the study.

As stated earlier, kT-values were calculated from the respective slopes of Figures-8, 9 and 10. The values so calculated were applied by interpolation and extrapolation to generate the values in the table. Q10-values were calculated using equation-3 and Ea-values were calculated using equation-4.

DISCUSSION

Effect of Lye Wetting and Penetration Into Cassava Root Specimen

Phenomena of lye wetting, penetration and absorption into the cassava peel specimens with the formation of brown clouration that resulted are in agreement with the findings of Lee et al. (2008) about the colour of alkali soluble and reactive moieties of lignocelluloses which are easily removed from the cellulose-matrix producing dark-brown colouration. The components which bind cellulose fibres in the matrix include colloidal emulsions (sols, flocs, gums, resins, pectic-substances, etc.), lignin and hemicellulose-associated oligosaccharides. According to Wang (2008), the dislodgement and removal of these substances from the environment of the macro-matrix of cellulose fibres allows more direct access of the solvent for attacking the cellulose fibres.

Effect of Swelling of Cassava Peel-Specimens in Lye

Swelling of cassava peel-specimens in lye (NaOH-water) aqueous solvent system from ordinary visual observation of the photographs of the specimens suggested that at the lower temperature range of 32 and 50OC and in-between, the peel-specimens swole, exhibiting a defined spiral shape irrespective of lye-concentration (see Figures-5 and 6). However, the mechanism of heterogeneous swelling of cellulose is complex as it involves so-called ballooning phenomena expatiated extensively by Zhang et al. (2013) for cotton cellulose fibres.

In that case, it is explained that structured shapes of collars, rings or spirals result from differential swelling-induced expansion of cellulose fibres in the secondary and primary walls. In the secondary wall, the microfibrils are aligned in a helical manner with respect to the long-axis of the fibre and swelling of the fibre is greater in the transverse (radial) direction than lengthwise. Therefore, the larger radial expansion of cellulose in the secondary wall causes the primary wall to burst, tearing its membranes. As expanding swollen cellulose pushes its way through the tears in the primary wall, it rolls up at the edges forming collars, rings and spirals. These structural shapes, by their very nature, impede further uniform expansion of the cellulose fibres and therefore generate balloons at selective sites of the cellulose-mass, which possibly exacerbate the shapes. Without the aid of optical microscopy, the ability to gain better direct insights from these observations was restrictive in the context of this study.

Figure-7 showed contrasting photographs at higher temperature lye-treatment of cassava peel-specimens following withdrawal from boiling lye at 25 % concentration (103 OC), 30 % concentration (105 OC) and 35 % concentration (108 OC). Visual inspection of the photographs of these specimens uniformly contrasted significantly from those of the samples treated at lower temperatures as discussed earlier. No spiraling structured shapes (curls, rings or collars) were evident. However, a pattern of heterogeneous bumps (convexic protrusions) characterized the surface of the specimens, suggesting that ballooning occurred at selective sites of the samples. In general, expansion induced by swelling was much larger than observed at the lower temperature range, and obviously occurred more rapidly at boiling temperatures featuring much higher convective heat transfer coefficients induced by mixing turbulent bubbles of the solution.

Given the combined incidence of swelling with ballooning observed in all samples in the study, it made sense to try to explore the possible mechanism by which peel digestion (or disintegrative-degradation) of the cellulose-mass in cassava peel-lignocellulose-complex would have occurred with or without dissolution.

The process was described earlier as characterized by cassava peel structural collapse (CPSC) and calculated as an index of cassava peel structural collapse (ICPSC) associated with the process. Zhang et al. (2013), citing a wide range of foundational support for their findings, suggest five modes by which the hydrolytic breakdown process that can ultimately result in dissolution for wood

and cotton fibres occurs in an alkali solvent system such as lye. The five modes are as shown in Table-1.

The 5-modes reflect the status of solvent quality which decreases from mode-1 to 5. Studies by Zhang et al. (2013) and others cited in their paper, suggest that the digestion mechanism proceeds in such a way that the solvent first wets and penetrates inside the fibres through the primary wall of the cellulose which acts as a semi-permeable membrane. The cellulose-chains of the secondary walls swell and break the primary wall exceeding its elastic limit.

Findings reported by Wang (2008) and Zhang et al. (2013), suggest that (NaOH-water) solvent system is, in relative terms, weak and may not always lend itself to swelling and ballooning leading to outright bursting of wall membranes. It may only swell and balloon the fibres to a certain level of maximum expansion smaller than indicated for mode-2 and stop without bursting and/or dissolving the fibres completely.

By mere visual observation using the naked eyes without the advantage of optical microscopy, only cautious conclusions were possible from the inspection of the photographs of lye-treated cassava peel-specimens. These were to the effect that at the comparatively high lye concentrations and temperatures (relative to the levels reported in the literature) at which the present study was conducted, only mode-3 of the scheme in Table-1 appeared to be relevant or to apply, with the important difference (a caveat), to the effect that the large levels of swelling and ballooning which were observed in all cassava peel-specimens, involved a systematic pattern of disintegration of the macro-structure of the gross-mass of the cellulose (not necessarily the fibres) possibly with minor dissolution resulting in a digest-sludge or pulp which, if it were to occur in the peel of cassava roots while (in-situ) on the roots, would be easy to scrub-off by wet brushing by hand and/or mechanically.

For purposes of effective cassava peel-removal only during lye-peeling, which was the goal of this study, these explanations seemed satisfactory even without significant levels of dissolution or derivatization of the cellulose fibres. One seemingly important implication of this finding could be that the type of cellulose associated with the peel of the cassava variety and age employed in this study had a low degree of polymerization with ($DP < 200$), which had poor crystallinity, was paracrystalline and amorphous in character.

Effect of Lye-Treatment on ICPSC At Varying Concentration, Temperature and Residence Time-Interval of Immersion

Statistical analysis by ANOVA of the effect of lye concentration, temperature and residence time-interval of immersion on the hydrolytic digestion of cassava peel as manifested in the index of cassava peel structural collapse (ICPSC) (see Tsekwi, 2018), showed significant differences ($p < 0.05$) in the residence time-intervals of immersion recorded among the 5 conditions of temperature (32, 50; and the corresponding lye boiling points of 103, 105 and 108OC) investigated when peel-specimens were lye-treated at the 3 designated concentrations of 25, 30 and 35%, respectively. The residence time-intervals of immersion recorded were 20, 40 and 50 minutes at 32OC; 5, 7.5 and 10-minutes at 50OC; and 2, 4 and 6-minutes at corresponding lye boiling points of 103, 105 and 108OC, respectively.

Figures-8, 9 and 10 were plotted on linear graph paper from the recorded values of ICPSC as a function of residence time-interval of immersion at 3 lye concentrations (25, 30 and 35%) and 5 temperatures (32, 50, 103, 105 and 108OC), respectively. In and of themselves, the plots showed a consistent pattern of strong linear correlation between ICPSC-values and the residence time-intervals of deformation to collapse, which the CPM-model system defined as modeling the hydrolytic digestion (or disintegrative-breakdown) process of the peel-cellulose-complex to produce a liquidified digest-pulp or sludge conducive for easy scrubbing using a brush.

The kinetics of cassava peel structural collapse (CPSC) presented in Figures-11, 12 and 13, respectively provided evidence of strong correlation between kT -values, Q_{10} -values and E_a -values and temperature at all lye concentrations (25, 30 and 35%) investigated. Figure-11 showed that within the temperature range investigated, kT -values increased rapidly with decreasing lye-concentration, peaking optimally for each concentration just below 60OC ($< 60OC$) temperature, which instructively is the gelatinization temperature of cassava starch (Ezekiel et al., 2007). This finding could be important for the lye-peeling of cassava roots because it suggested that, as much as possible, temperatures up to and higher than 60OC should be avoided to avert the negative effect of gelatinization of the root starch in the environment of the peel due to excessive heat penetration into the root in the proximity of the cortex.

In choosing from among the optimal parameters recorded in Table-3, this factor among others, must be taken into account; and indeed, it effectively disqualified Option 3(c) which specified a temperature of 103°C well above 60°C (see entry at bottom of Table-3). Figure-12 showed that Q_{10} -values decreased with increasing lye concentration and temperature within the range of process variables investigated. On the contrary, Figure-13 showed that E_a -values increased with increasing concentration and temperature in the range of the variables investigated. These findings suggested that for cassava peel-lignocellulose-complex, hydrolytic digestion reactions with high activation energy are more temperature-sensitive, confirming earlier findings by Wang (2008) for cotton cellulose fibre dissolution in (NaOH + water) at low temperatures.

CONCLUSION AND RECOMMENDATIONS

The following conclusions and recommendations can be drawn from the study.

1. A novel chemo-physico-mechanical (CPM-model) system for quantitatively tracking and monitoring the process of hydrolytic digestion (or disintegration) of cassava peel-lignocellulose-complex into a liquified-digest-sludge (or pulp) was developed, tested and successfully applied to .optimize 3-process variables [lye-concentration (%), temperature (°C) and residence time-interval of immersion (minutes.)] involved in mechanized lye-peeling of cassava roots.

The protocol for achieving this involved the use of an improvised hollow-roller-cylindrical-compression-press (HRCCP-device) to generate and measure dimensional changes in swollen lye-treated cassava peel-specimens which were quantified to give an index of cassava-peel-structural-collapse (ICPSC-value). ICPSC-values when plotted against residence time-intervals of lye-treatment, yielded zero-order kinetic parameter-values (kT , Q_{10} and E_a) that provided a reliable basis of validation for the CPM-model system and its associated protocol as a viable approach for the manner of analysis which the study set out to explore.

2. The following tabulation presents 2-process optimization options (a and b) that resulted from the application of the protocol of the CPM-model system.

Further choice from among these options will be pursued in paper-2 of this series which, will report on their application for peel-removal proper from cassava peel (in-situ) while still on the roots, which constitutes the technique of mechanical lye-

peeling.

3. In practical application, the ICPSC-values were used to signify and define 3-determinant levels of cassava peel hydrolytic digestion (or disintegration) that coincided with differential levels of peel-removal and their consequences as follows:

- (a) ICPSC = 1.0: peel breakdown was complete or adequate leading to total peel-removal from root;
- (b) ICPSC < 1.0: peel breakdown was incomplete/inadequate because peel-removal from root is less than peel loss (%) in hand-peeling proper.
- (c) ICPSC > 1.0: peel breakdown was excessive leading to proportional loss of root starchy-flesh tissue during lye-peeling proper.

4. Because cellulose is the primary product of terrestrial biophotosynthesis, it is the most abundant single renewable bio-polymer of the biosphere with an estimated yield of some 100-billion dry-tonnes per year of which less than 5-percent is currently exploited for fabric-material manufacture, energy, food and other uses. Food engineers, scientists, technologists and agricultural engineers have an important but, unfortunately so far hardly recognized role to play in the new and rapidly expanding frontier of cellulose resource exploitation. The CPM-model system as elucidated and elaborated in the paper, provides an alternative approach that could, down the line, complement the more complex and costly tools of modern polymer science, technology and engineering by which food, agricultural and bio-engineers can meaningfully make inroads into exploratory R-and-D in the study of multiple breakdown products of cellulose hydrolysis and derivatization to harness them for potential application in addressing challenges of the world food, hunger and poverty problem.

5. In particular, well over 100-million tonnes of lignocellulosic skin-covering of edible plant foods designated as peels (within the commodity group of fruits, vegetables, roots and tubers) and seed-coats (within the commodity groups of cereals, legumes, nuts and oil-seeds processing) are routinely wasted by industrial processing practice, which dumps them as discards with serious and compounding environmental consequences. Yet cellulosic biomass in this category can be a mine-field of opportunity for engineers if lye-peeling and lye-decoating can be more widely explored to generate exploitable lye-digested cellulosic by-products.

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The Effectiveness of Concomitant Use of Hmg-Coa Reductase Inhibitors and Endothelial Protectors

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ABSTRACT

Endothelial dysfunction (ED) is a serious complication of systemic inflammation. At the moment, some of the most promising drugs for the prevention of cardiovascular diseases are statins and endothelioprotectors. To study the effectiveness of the concomitant use of statins and endothelioprotectors by applying the endotoxin-induced endothelial injury model. Methods: Cardio- and endothelioprotective effects of HMG-CoA reductase inhibitors (atorvastatin, rosuvastatin, nanosvastatin) in combination darbepoetin were examined by means of the L-NAME- and endotoxin-induced endothelial dysfunction (EIED) model. Rosuvastatin reduces the endothelial dysfunction coefficient from 3.7 ± 0.5 to 1.5 ± 0.2 in the endotoxin-induced endothelial (EIED) dysfunction model; in the L-NAME model of induced ED, atorvastatin reduces coefficient of endothelial dysfunction (CED) from 5.4 ± 0.6 to 1.1 ± 0.1 , whereas the combination of nanoparticulated rosuvostatin + darbepoetin - from 5.4 ± 0.6 to 1.6 ± 0.3 .

KEY WORDS: Hmg-Coa Reductase Inhibitors, Endothelial Dysfunction, Systemic Inflammatory Response Syndrome, Endothelioprotectors

INTRODUCTION

The response of the body to the phlogogenic factor is described by molecular pathophysiology [4]. The active involvement of the endothelium in the formation of these networks has been known for a long time. However, recent studies have found that the endothelium is also one of the most vulnerable links in cases of systemic inflammation. This is proved by the fact that patients who have had sepsis, abdominal disasters and other pathologies associated with

systemic inflammatory response syndrome develop certain further manifestations of endothelial dysfunction (ED) [1, 3, 9, 11]. Based on the current understanding of the molecular mechanisms of systemic inflammation, a promising pharmacological group aimed at restoring the endothelial function in case of a pathology is HMG-CoA reductase inhibitors (statins). Possessing pleiotropic effects, such as anti-inflammatory, antioxidant and anticoagulant, they are able to affect several pathogenetic links in the formation of EIED and prevent complications associated with it [5]. The fact that remedies to make up NO deficiency can improve endothelial function [2, 6, 7, 12] suggests that such drugs as L-arginine can increase the effectiveness of using statins in the pathology in question (Figure 1). In addition, the combination with darbepoetin may happen to be potentially successful, as it was shown that drugs from the erythropoietin group had a maked cardioprotective, anti-ischemic and preconditioning activity [8, 10, 13].

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MATERIAL AND METHODS

Cardio-and endothelioprotective activity of the drugs was studied in two models of endothelial dysfunction: endotoxin-induced (EIDD) and L-NAME-induced. The investigated drugs - atorvastatin 4.3 mg / kg, rosuvastatin

Table 1: Effect of therapy with HMG-CoA reductase inhibitors and their combination with endothelioprotectors on endothelial dysfunction and biochemical markers of inflammation in endotoxin-induced endothelial dysfunction (EIED)

EIED	CED	NOx	eNOS	CRP	IL-6	TNF-α
Intact	1.1 ± 0.1	116.8±10.3	5.4±0.21	0.05±0.01	0.43±0.17	8.42±2.51
EIED	3.7±0.5*	182.3±12.4*	0.04±0.01*	0.38±0.01*	6.87±1.93*	17.83±3.39*
EIED+Statins						
Atorvastatin	2.1±0.3*#	130.0±10.9*#	2.07±0.21*#	0.09±0.01*#	1.27±0.33*#	9.89±1.79*#
Rosuvastatin	1.7±0.5*#	122.1±9.9*#	3.04±0.35*#	0.11±0.01*#	1.17±0.33*#	10.80±1.99*#
Nanorosuvastatin	1.5±0.2*#	132.1±10.3*#	4.01±0.56*#	0.18±0.01*#	1.48±0.24*#	9.56±1.87*#
EIED+L-arginin+Statins						
L-arginin	2.1±0.3*#	132.7±11.3*#	2.14±0.22*#	0.17±0.02*#	2.23±1.67*#	10.23±2.08*#
L-arginin + Atorvastatin	1.5±0.3*#	121.7±9.5*#	4.23±0.69*#	0.07±0.02*#	0.90±0.13*#	9.97±1.36*#
L-arginin + Rosuvastatin	1.7±0.4*#	119.5±9.3*#	4.47±0.72*#	0.06±0.02*#	0.78±0.11*#	10.54±1.72*#
L-arginin + Nanorosuvastatin	1.5±0.2*#	117.8±10.0*#	4.92±0.86*#	0.06±0.02*#	0.63±0.10*#	8.20±2.26*#
EIED+Darbeoetin+Statins						
Darbeoetin	1.9±0.2*#	122.5±10.5*#	4.19±0.72*#	0.17±0.01*#	1.72±0.97*#	8.20±2.26*#
Darbeoetin + Atorvastatin	1.5±0.1*#	120.1±7.6*#	4.59±0.49*#	0.15±0.11*#	3.89±0.17*#	9.89±1.42*#
Darbeoetin+ Rosuvastatin	1.6±0.1*#	119.4±7.7*#	4.67±0.48*#	0.16±0.10*#	4.02±0.21*#	10.40±1.04*#
Darbeoetin + Nanorosuvastatin	1.5±0.1*#	109.5±7.3*#	4.95±0.53*#	0.20±0.11*#	4.09±0.24*#	10.60±1.50*#

CED- endothelial dysfunction coefficient, NOx - final NO metabolites (μmol / L); eNOS expression (%); level of CRP-C-reactive protein (mg / l); IL-6 - interleukin 6 (pg / ml) TNF-α - tumor necrosis factor (pg / ml), * - significant difference from the group of intact animals (p <0.05), # - significant difference from the EIED group (p < 0.05).

Table 2: Effect of HMG-CoA reductase inhibitors and their combination with endothelioprotectors on endothelial dysfunction and NO metabolism in L-NAME-induced endothelial pathology

L-NAME	CED	NOx	eNOS
Intact	1.1 ± 0.1	114.1 ± 10.5	72.9 ± 3.8
L-NAME	5.4 ± 0.6*	61.2 ± 8.5*	21.4 ± 4.7 *
L-NAME + Statins			
Atorvastatin	1.1 ± 0.1	84.3±9.6*#	35.6±4.2*#
Rosuvastatin	2.1 ± 0.1*#	65.7±9.3*#	35.1±4.2*#
Nanorosuvastatin	1.9 ± 0.6*#	63.6±8.7*#	43.6±4.5*#
L-NAME + L-arginin+statins			
L-arginin	1.5±0.3	73.2 ±8.1	42.1 ±3.1
L-arginin + Atorvastatin	1.6±0.3*#	59.3 ±7.1#	58.2 ±6.3#
L-arginin + Rosuvastatin	1.6±0.3*#	59.2 ±7.2#	59.7 ±6.9#
L-arginin + Nanorosuvastatin	1.5±0.3*#	59.3 ±7.3#	59.0 ±6.8#
L-NAME + Darbeoetin+statins			
Darbeoetin	1.8±0.3	90.2 ±5.4	48.4 ±4.2
Darbeoetin + Atorvastatin	1.8±0.4*#	99.0 ±6.3#	58.3 ±4.1#
Darbeoetin+ Rosuvastatin	1.7±0.3*#	97.8 ±5.7#	59.2 ±4.0#
Darbeoetin + Nanorosuvastatin	1.6±0.3*#	98.5 ±5.8#	57.3 ±4.8#

8.5 mg / kg, and nanoparticulated rosuvastatin 11.6 mg / kg were administered intragastrically; L-arginine 200 mg / kg and darbepoetin 500 µg / kg - intraperitoneally once every 7 days. For each of the two models, the following groups of animals were identified (n = 10): 1) intact, 2) control with simulated pathology, 3) atorvastatin, 4) rosuvastatin, 5) nanorosuvastatin, 6) L-arginine, 7) darbepoetin, 8) darbepoetin + atorvastatin, 9) darbepoetin + rosuvastatin, 10) darbepoetin + nanorosuvastatin. For calculations, we used a Microsoft Excel 7.0 program for statistical analysis.

RESULTS

Simulation of EIED leads to the development of endothelial dysfunction with an increase in CED, a decreased myocardial reserve and an increased adrenoreactivity (Table 1), as well as to an increased number of NO metabolites against an increased number of inflammatory markers of C-reactive protein (CRP) and cytokines IL-6 and TNF-α. The use of HMG-CoA reductase inhibitors on the background of EIED leads to the development of a dose-dependent endothelioprotective effect, prevention of increased adrenoreactivity and depletion of the myocardial reserve. The positive dynamics of NO metabolites and eNOS expression was detected (Table 1).

The use of concomitant use of L-arginine with HMG-CoA reductase inhibitors shows a protective effect, the results of which did not differ from those of the intact group. The concomitant use of recombinant darbepoetin with statins showed the additive effect with respect to CED and BP. The values were even slightly higher than with monotherapy with statins, but statistically they were significantly different from those of intact animals (Table 1).

Persistent hypertension was observed in the model of L-NAME-induced endothelial dysfunction, the myocardial reserve was depleted 1.2 times, CED increased to 5.4 + 0.6 units, there was observed an increased number of NO metabolites and decreased eNOS expression. HMG-CoA reductase inhibitors caused a dose-dependent endothelioprotective effect, expressed in preventing an increase of the values of the final NOx metabolites and reduction of the eNOS expression (Table 2). The combination of L-arginine with HMG-CoA reductase inhibitors shows a protective effect, improvement of contractility, hemodynamics and normalization of NO metabolism. An additive effect was shown when combined with darbepoetin, which in the case of a combination of nanoparticulated rosuvastatin + darbepoetin brought the hemodynamic parameters in the EIED group closer to those in intact animals.

CONCLUSION

The study showed that HMG-CoA reductase inhibitors demonstrate their effectiveness in the correction of EIED, both in monotherapy and in combination with endothelioprotectors. At the same time, among the studied statins, the greatest efficacy was shown when using nanoparticulated rosuvastatin at a dose of 11.6 mg. In addition, for all drugs of the group, an additive effect was shown when combined with darbepoetin, which in the case of a combination of nanoparticulated rosuvastatin + darbepoetin brought hemodynamic parameters in the EIED group to those in intact animals.

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Innovated Product from Cassava (*Manihot esculenta*) and Squid (*Loligod uvauceli*) with Different Drying Methods and Packaging Materials

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ABSTRACT

The study was focused on the acceptability of an innovated product from Cassava (*Manihotesculenta*) and Squid (*Loligoduvauceli*) with different drying methods and packaging materials. It employed the different formulations and drying methods, packaging materials as independent variables and acceptability and cost-benefit analysis as the dependent variables. It utilizes mixed methods research design- quantitative data analysis was performed first followed by qualitative data to further reinforce, deepen and clarify quantitative results. This research study is largely descriptive in nature.

KEY WORDS

Cassava (*Manihotesculenta*), Squid (*Loligoduvauceli*), Formulation, Drying Methods, Packaging Materials, Cost-Benefit Analysis.

INTRODUCTION

Cassava kiping is one of Oroquieta's favorite snacks. Other locals call it "Buriki", others call it "Long-play or Plaka". It is typically deep-fried and drizzled with latik, a sweet coconut milk and sugar syrup. Cassava is one of the plentiful root crops in the locality which are usually sold during Sunday markets or "Tabo-an". Cassava is the main ingredient of the crunchy kiping snacks.

In addition, Oroquieta is known for its famous "Lumiyagan" or squid which is a very abundant sea food caught just

around Iligan Bay. During its season, squids are sold at low cost. When people visit the place, they would dare not to miss the "Kilawin and AdobongLumiyagan or Squid".

When it comes to snacks, Filipinos do not mind getting their hands dirty. They just love to munch on salty, spicy, cheesy and sweet snacks (SPOT.ph, 2010). One example is the Cassava Kiping which is usually sold in the market. Being not properly covered and packaged, it is detrimental to health.

The Centers for Disease Control and Prevention (2015) stated that Sanitation and hygiene are critical to health, survival and development. Many countries are challenged in providing adequate sanitation for their entire populations, leaving people at risk for water, sanitation, and hygiene (WASH)-related diseases. Food sanitation is more than just cleanliness. It includes all practices involved in protecting food from risk of contamination, harmful bacteria, poisons and foreign bodies; preventing any bacteria from multiplying to a great extent which would cause various kinds of illnesses to consumers; and destroying any harmful bacteria in the food by thorough cooking, processing and packaging.

Loreto (1996) maintained that the purpose of packaging is to protect and preserve the product throughout the manufacturing, transport, storage and consumption. Good packaging guarantees the health and safety of consumers.

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In this study, the procedure on how to make the innovated product was anchored on the procedure on how to make the “long play” or “buriki” which resulted to kropeck considering the different drying methods and packaging materials. Hence, the inquiry aimed to evaluate the acceptability of the innovated cassava and squid in terms of sensory attributes using the five-point hedonic scale; determine the stability of the innovated cassava and squid in terms of different packaging materials; and prepare cost-benefit analysis for commercialization.

The study aimed to evaluate the acceptability of an innovated product from Cassava (*Manihotesculenta*) and squid (*Loligoduvauceli*) with different drying methods and packaging materials.

Specifically, the study sought to answer the following questions:

1. What is the level of acceptability of the innovated product with different formulations and drying methods in terms of:

- 1.1. Appearance;
- 1.2. Flavor;
- 1.3. Palatability;
- 1.4. Texture; and
- 1.5. Color?

2. Is there a significant difference of acceptability of the product with different formulations and drying methods in terms of:

- 2.1. Appearance;

- 2.2. Flavor;
- 2.3. Palatability;
- 2.4. Texture; and
- 2.5. Color?

3. Which packaging material protect the shelf life of the product in terms of the level of acceptability after seven days, 14 days, 21 days and 30 days as regards:

- 3.1. Crunchiness;
- 3.2. Mouth feel; and
- 3.3. Air retention?

4. What is the result of the cost-benefit analysis on the product with the highest acceptability, correct drying methods and highest acceptability of packaging materials:

- 4.1. Production Cost;
- 4.2. Operations; and
- 4.3. Profitability.

The findings of the study would provide valuable information to the following sectors, to wit:

University/Administration. The results would help in achieving the University’s Vision, that is, to be a nationally-recognized Science and Technology University that focuses not only on Research, Instructions, Production, Extension but Innovation as well.

Producers. They would be aware that this innovated product really contributes to their livelihood. This then will serve as basis for improvement.

Consumers. The results of the study would serve as a guide of the buying public on the quality and safety of the innovated cassava and squid.

Investors. They would be informed of the present analysis. In effect, they would gain an idea of what to invest or engage for future benefits.

Future Researchers. The findings of this study would encourage the future researchers to improve and intensify the investigation by probably including other variables which are not included in this study.

MATERIAL AND METHODS

The study used experimental method design – a systematic and scientific approach to research in which the researcher manipulates one or more variables and controls and measures any change in other variables (Oskar, 2008). It utilized quantitative procedure as commonly used in descriptive research studies in terms of acceptability and stability. Creswell (2003) maintained that descriptive research is an approach in which the inquirer often makes knowledge claims based primarily on constructivist’s perspectives. These are constructed with intent of participatory perspectives in quantitative data analysis. This study then considered qualitative data analysis particularly cost and benefit analysis in terms of production costs,

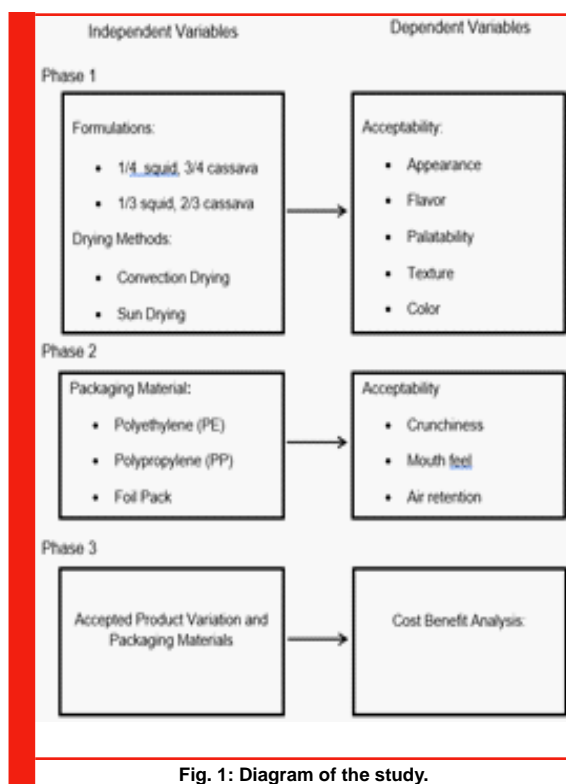


Fig. 1: Diagram of the study.

operations and profitability to further reinforce, deepen and clarify qualitative results.



Fig. 2

The study was conducted at University of Science and Technology of Southern Philippines – Oroquieta Campus, Mobod, Oroquieta City, Misamis Occidental. USTP envision a nationally-recognized Science and Technology University providing the vital link between education and the economy. Its mission is to bring the world of work (industry) into the actual higher education and training of students; offer entrepreneurs the opportunity to maximize their business potentials through a gamut of services and product conceptualization to commercialization; and contribute significantly to the national development goals of food security and energy sufficiency through technology solutions (Al-Nimer et al, 2018; Kilitci et al, 2018; Nourizadeh et al, 2015).

The study used simple random sampling with strategic approach. The respondents of the study were students, faculty, personnel, staff and outsiders. One hundred of them were invited to determine the level of acceptability while five from the field of food processing at University of Science and Technology of Southern Philippines – Oroquieta Campus, Mobod, Oroquieta City, Misamis Occidental were selected to determine stability.

The study utilized a researcher-made product evaluation instrument which was used in determining food acceptability specifically in terms of its appearance, flavor, palatability, texture and color. Another researcher-made instrument was utilized upon gathering description on product variation in terms of percentage, methods and packaging materials.

Below is a categorization of variables and scoring guidelines:

Response	Range	Implication
Like very much	4.60 - 5.00	Very good
Like a little	3.70 - 4.59	Good
Not sure	2.80 - 3.69	Average
Dislike a little	1.90 - 1.89	Poor
Dislike very much	1.00 - 1.89	Very poor

Final Product



The research data were gathered accordingly. A letter was sent to the Campus Director of USTP-Oroquieta Campus, Mobod, Oroquieta City, asking permission to conduct the study. As soon as the consent was sought, the survey questionnaires were prepared and validated. Then, cooking was performed. (see recipe below). The researcher explained the purpose of the study and distributed the questionnaires and products personally.

The data were then tabulated and analyzed according to the design employed when the survey questionnaires were accomplished. The researcher then tabulated and analyzed the data according to the design employed.

**Sampling Procedure
Process Flow**

The food ingredients for the formulation 1/3 squid and 2/3 cassava include 300 g squid (ground), 700 g cassava (ground); 50 g white onions (ground); 50 g garlic (ground); 5 g seasonings; 5 g iodized salt, and 2 liters oil for frying.

The food ingredients for the formulation 1/4 squid and 3/4 cassava include 250 g squid (ground), 750 g cassava (ground); 50 g white onions (ground); 50 g garlic (ground); 5 g seasonings; 5 g iodized salt, and 2 liters oil for frying.

The tools and utensils consist of mixing bowl, knife, chopping board, weighing scale, utility tray, deep fryer, strainer, food tong, cassava grater, spoon, fork, and steamer. Whereas the equipment includes gas range, cassava grater, home-made sun drier,

Mise en place

The pre-preparation are as follows: 1) prepare the banana leaves and cut into circular shape at approximately 6 inches in diameter. Set aside; 2) Wash, peel and sanitize cassava and squid. And mince finely white onions and garlic. 3) Prepare salt for seasoning to taste.

Mixing

4) In a mixing bowl, mix thoroughly in a separate mixing bowl the two formulations of cassava, squid, spices then grind using meat grinder. Add seasoning and iodized salt to taste. 5) Use a spoon to transfer an ample amount of

cassava mixture to the banana leaves and flatten thinly over the entire leaf leaving an inch away from the edge. Be sure to put an indicator to the two formulations.

Steaming

6) Boil water on large a steamer. When water reaches the boiling point, steam one by one the molded cassava squid mixture. See to it that each has been steamed thoroughly for about 10 to 15 minutes. 7) Using a food

tong, take out one by one the cassava squid mixture on the steamer. Place separately on a large tray. See to it that maximum boiling temperature is maintained throughout the process.

Drying

8) For sun drying, dry the cassava squid kropeck under the heat of the sun with approximately 34 degrees Celsius for about 3 days and for convection drying, pre-heat the oven for about 15 minutes, then set the temperature to 120 degrees Fahrenheit for about 1 hour.

Cutting

9) When both of the formulation is dried, clean the kropeck by taking out the banana leaves and cut into kropeck to a 3 cm by 4 cm size in a rectangular shape.

Frying

10) Deep fry the kropeck until light brown in color. 11) Drain and cool

Packaging

11) Pack the product using the polyethylene, polypropylene and foil pack.

Labeling

In labeling the products, indicate the day manufactured and date of expiration.Store.

Sensory Evaluation

The sensory evaluation of the innovated product from cassava and squid was conducted at University of Science and Technology of Southern Philippines – Mobod, Oroquieta City. The researcher prepared the food samples of four formulations; 1/3 squid and 2/3 cassava convection

Table 1: Distribution of statistics frequency, percentage distribution, mean and standard deviation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) 1/3 squid and 2/3 Cassava using convection drying.

Response	Range	f	%
Like very much	4.60 - 5.00	41	41.00%
Like a little	3.70 - 4.59	49	49.00%
Not sure	2.80 - 3.69	9	9.00%
Dislike a little	1.90 - 2.79	0	0.00%
Dislike very much	1.00 - 1.89	1	1.00%

Mean 4.31 Standard Deviation 0.54

	LM	LL	NS	DL	DM	mean	St. Dev
Appearance	42	47	6	4	1	4.25	0.82
Flavor	45	43	10	2	0	4.31	0.73
Palatability	48	43	5	2	2	4.33	0.83
Texture	39	48	9	2	2	4.20	0.84
Color	58	33	5	4	0	4.45	0.77

Note.LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

Table 2: Distribution of statistics frequency, percentage distribution, mean and standard deviation of CASSAVA (Manihotesculenta and SQUID (Loligoduvauceli) 1/3 squid and 2/3 cassava using sun drying.

Response	Range	F	%
Like very much	4.60 - 5.00	48	48.00%
Like a little	3.70 - 4.59	44	44.00%
Not sure	2.80 - 3.69	6	6.00%
Dislike a little	1.90 - 2.79	2	2.00%
Dislike very much	1.00 - 1.89	0	0.00%

Mean 4.41 Standard Deviation 0.55

	LM	LL	NS	DL	DM	Mean	St. Dev
Appearance	53	39	6	2	0	4.43	0.70
Flavor	46	35	10	8	1	4.17	0.97
Palatability	48	43	7	2	0	4.37	0.71
Texture	52	43	4	1	0	4.46	0.63
Color	67	31	1	0	1	4.63	0.61

Note.LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

Table 3: Distribution of statistics frequency, percentage distribution, mean and standard deviation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) ¼ squid, ¾ cassava using convection drying.

Response	Range	F	%				
Like very much	4.60 - 5.00	48	48.00%				
Like a little	3.70 - 4.59	42	42.00%				
Not sure	2.80 - 3.69	9	9.00%				
Dislike a little	1.90 - 2.79	1	1.00%				
Dislike very much	1.00 - 1.89	0	0.00%				
Mean 4.39 Standard Deviation 0.59							
	LM	LL	NS	DL	DM	Mean	St. Dev
Appearance	54	38	4	3	1	4.41	0.79
Flavor	47	37	10	6	0	4.25	0.87
Palatability	46	40	11	3	0	4.29	0.78
Texture	47	46	4	3	0	4.37	0.71
Color	71	24	4	0	1	4.64	0.66

Note.LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and St. Dev standard deviation.

Table 4L Distribution of statistics frequency, percentage distribution, mean and standard deviation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) 1/4 squid, 3/4 cassava using sun drying.

Response	Range	f	%				
Like very much	4.60 - 5.00	53	53.00%				
Like a little	3.70 - 4.59	37	37.00%				
Not sure	2.80 - 3.69	9	9.00%				
Dislike a little	1.90 - 2.79	0	0.00%				
Dislike very much	1.00 - 1.89	1	1.00%				
Mean 4.44 Standard Deviation 0.60							
	LM	LL	NS	DL	DM	Mean	St. Dev
Appearance	59	36	2	2	1	4.50	0.73
Flavor	48	39	8	3	2	4.28	0.89
Palatability	46	43	7	2	2	4.29	0.84
Texture	58	35	3	3	1	4.46	0.78
Color	73	24	2	1	0	4.69	0.56

Note.LM like very much, LL like a little, NS not sure, DL dislike a little, DM disliked very much and St. Dev standard deviation.

dried, 1/3 squid and 2/3 cassava sun dried, ¼ squid and ¾ cassava convection dried, and ¼ squid and ¾ cassava convection dried. The researcher asked each respondent to taste each sample and in turn the respondent checked the box, from 1 dislike very much, 2 dislike a little, 3 not sure, 4 like a little and 5 like very much. The tasting of the samples was done by 10 persons per batch of 10, and the researcher then analyzed and tabulated the result according to the design employed.

Acceptability Test for Different Packaging Materials

Acceptability test for different packaging materials was determined using the structured questionnaire. The researcher together with the five experts checked the innovated product with different packaging materials through the four samples provided; polyethylene, polypropylene and foil pack. Upon opening of the product every after seven days, 14 days, 21 days and 30 days, the five experts checked the sensory evaluation using the structured questionnaire through crunchiness, mouth feel and air retention. Based on the result of the findings, the highest packaging was polypropylene.

Table 5: Distribution of statistics (Analysis of Variance) on level of acceptability in terms of appearance when grouped according to different methods and formulation.

category	Groups				P-value	F-value
	1/3 squid & 2/3 cassava	1/3 squid & 2/3 cassava	¼ squid & ¾ cassava	¼ squid & ¾ cassava		
	convection dried	Sundried	convection dried	sundried		
	n=100 mean	n=100 mean	n=100 mean	n=100 mean		
Appearance	4.25	4.43	4.41	4.50	0.1261	1.917NS
Flavor	4.31	4.17	4.25	4.28	0.6978	0.477NS
Palatability	4.33	4.37	4.29	4.29	0.8729	0.233NS
Texture	4.20	4.46	4.37	4.46	0.0442	2.7116*
Color	4.45	4.63	4.64	4.69	0.0545	2.560+
Over-all						
Acceptability	4.30	4.41	4.39	4.44	0.3748	1.039NS

Note. + almost significant, * significant

Table 6. Distribution of statistics (frequency, percentage, mean and standard deviation) of CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after seven days using Polyethylene.

Response	Range	f	%
Like very much	4.60 - 5.00	5	100
Like a little	3.70 - 4.59	0	0.00
Not sure	2.80 - 3.69	0	0.00
Dislike a little	1.90 - 2.79	0	0.00
Dislike very much	1.00 - 1.89	0	0.00
Mean 5.00 Standard Deviation 0.00			
	LM	LL	NS DL DM mean St. Dev
Crunchiness	5	0	0 0 0 5 0.00
Mouth feel	5	0	0 0 0 5 0.00
Air retention	5	0	0 0 0 5 0.00

Not elm like very much, LL like a little, NS not sure, DL dislike a little DM disliked very much and standard deviation.

The experts evaluated the product based on the questionnaire given through the following:

- crunchiness – the cracking sound as an evident that the chips can be chewed without difficulty;
- mouth feel – has deliciously consuming until the last bite and has enough crunchiness, taste and texture; and
- air retention – by pressing the packaging of the product to feel the presence of the air.

Statistical Tool

The study utilized descriptive statistics, mean, standard deviation, frequency, percentage and percentage distribution on level of acceptability and stability. It utilized inferential statistics, test of difference, Analysis of Variance (ANOVA) to compare the product evaluation when grouped according to product variation in terms of drying methods and formulation.

RESULTS AND DISCUSSION

Problem 1. What is the level of acceptability of the innovated product in different formulations and drying methods in terms of:

- Appearance;
- Flavor;
- Palatability;
- Texture; and
- Color?

The data showed that majority (90%) of the respondents evaluated CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) 1/3 squid and 2/3 Cassava using convection drying from "like a little" to "like very much" wherein 49% of them "like a little". The over-all rating is at "like a little" (mean=4.31). The standard deviation of 0.54 indicates that the respondents evaluation of CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) 1/3 squid and 2/3 cassava using convection drying is similar or close to each other. The highest mean for each

Table 7: Distribution of statistics Frequency, percentage distribution, mean and standard deviation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after seven days using Polypropylene.

Response	Range	f	%				
Like very much	4.60 – 5.00	5	100.00%				
Like a little	3.70 – 4.59	0	0.00%				
Not sure	2.80 – 3.69	0	0.00%				
Dislike a little	1.90 – 2.79	0	0.00%				
Dislike very much	1.00 – 1.89	0	0.00%				
Mean 5.00 Standard Deviation 0.00							
	LM	LL	NS	DL	DM	mean	St. Dev
Crunchiness	5	0	0	0	0	5	0.00
Mouth feel	5	0	0	0	0	5	0.00
Air retention	5	0	0	0	0	5	0.00

Note LM like very much, LL like a little, NS not sure, DL dislike a little DM dislike very much and standard deviation.

Table 8: Distribution of statistics Frequency, percentage distribution, mean and standard deviation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after seven days using foil pack.

Response	Range	f	%				
Like very much	4.60 - 5.00	5	100.00				
Like a little	3.70 - 4.59	0	0.00				
Not sure	2.80 - 3.69	0	0.00				
Dislike a little	1.90 - 2.79	0	0.00				
Dislike very much	1.00 - 1.89	0	0.00				
Mean 5.00 Standard Deviation 0.00							
	LM	LL	NS	DL	DM	mean	St. Dev
Crunchiness	5	0	0	0	0	5	0.00
Mouth feel	5	0	0	0	0	5	0.00
Air retention	5	0	0	0	0	5	0.00

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

indicator for CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) 1/3 squid and 2/3 Cassava using convection drying is at Palatability. However, the standard deviation indicates that the respondents' evaluation response varies a lot from each other.

The data revealed that majority ninety-two percent (92%) of the respondent evaluated CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) 1/3 squid and 2/3 Cassava using sun drying is from like a little to like very much, greater percentage of that at forty-eight percent (48%) is from like very much. The over-all rating is at "like a little" (mean=4.41). The standard deviation of 0.55 indicates that the respondents evaluation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) 1/3 squid and 2/3 Cassava using sun drying is "similar"

or "close to each other". The highest mean for each indicator for CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) 1/3 squid and 2/3 Cassava using sun drying is "at color". The standard deviation shows that the respondents' evaluation indicates that their response is categorically classified as "similar to each other".

The data displayed that majority (90%) of the respondent evaluated CASSAVA (Manihotesculenta) AND SQUID (Loligoduvauceli) ¼ squid, ¾ cassava using convection drying from "like a little" to "like very much", wherein greater percentage (48%) of the number evaluated the product as "like very much". The over-all rating is at "like a little" (mean=4.39). The standard deviation of 0.59 indicates that the respondents evaluation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) ¼

Table 9: Distribution of statistics (frequency, percentage, mean and standard deviation) of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after 14 days using Polyethylene.

Response	Range	f	%				
Like very much	4.60 - 5.00	2	40.00				
Like a little	3.70 - 4.59	3	60.00				
Not sure	2.80 - 3.69	0	0.00				
Dislike a little	1.90 - 2.79	0	0.00				
Dislike very much	1.00 - 1.89	0	0.00				
Mean 4.40		Standard Deviation 0.55					
	LM	LL	NS	DL	DM	mean	St. Dev
Crunchiness	2	3	0	0	0	4.40	0.55
Mouth feel	2	3	0	0	0	4.40	0.55
Air retention	2	3	0	0	0	4.40	0.55

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

Table 10: Distribution of statistics (frequency, percentage, mean and standard deviation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after 14 days using Polypropylene.

Response	Range	f	%				
Like very much	4.60 - 5.00	4	80.00				
Like a little	3.70 - 4.59	1	20.00				
Not sure	2.80 - 3.69	0	0.00				
Dislike a little	1.90 - 2.79	0	0.00				
Dislike very much	1.00 - 1.89	0	0.00				
Mean 4.80		Standard Deviation 0.45					
	LM	LL	NS	DL	DM	mean	St. Dev
Crunchiness	4	1	0	0	0	4.80	0.45
Mouth feel	4	1	0	0	0	4.80	0.45
Air retention	4	1	0	0	0	4.80	0.45

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

squid, ¼ cassava using convection drying is similar or close to each other. The highest mean for each indicator for CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) ¼ squid, ¾ Cassava using convection drying is at color. The standard deviation indicates that the respondents' evaluation indicates that their response is categorically classified as "similar to each other".

The table showed that majority (53%) of the respondents evaluated CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) 1/3 squid, 2/3 cassava using convection drying as "like very much". The over-all rating is "like a little" (mean=4.44). The standard deviation of 0.60 indicates that the respondents evaluation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) 1/3 squid, 2/3 cassava using sun drying is similar or close to each other. The highest mean for each indicator for CASSAVA

(Manihotesculenta) and SQUID (Loligoduvauceli) 1/3 squid, 2/3 cassava using sun drying is at "color". The standard deviation indicates that the respondents' evaluation indicates that their response is categorically classified as "similar to each other".

Problem 2. Is there a significant difference in the acceptability with different formulations and drying methods in terms of:

- 2.1. Appearance;
- 2.2. Flavor;
- 2.3. Palatability;
- 2.4. Texture; and
- 2.5. Color?

The table displayed the distribution of statistics (Analysis of Variance) of level of acceptability in terms of

Table 11: Distribution of statistics (frequency, percentage, mean and standard deviation of CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 14 days using foil pack.

Response	Range	f	%				
Like very much	4.60 - 5.00	3	60.00				
Like a little	3.70 - 4.59	2	40.00				
Not sure	2.80 - 3.69	0	0.00				
Dislike a little	1.90 - 2.79	0	0.00				
Dislike very much	1.00 - 1.89	0	0.00				
Mean 4.60		Standard Deviation 0.55					
	LM	LL	NS	DL	DM	mean	St. Dev
Crunchiness	3	2	0	0	0	4.60	0.55
Mouth feel	3	2	0	0	0	4.60	0.55
Air retention	3	2	0	0	0	4.60	0.55

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

Table 12: Distribution of statistics (frequency, percentage, mean and standard deviation) of CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 21 days using Polyethylene.

Response	Range	f	%				
Like very much	4.60 - 5.00	1	20.00				
Like a little	3.70 - 4.59	3	60.00				
Not sure	2.80 - 3.69	1	20.00				
Dislike a little	1.90 - 2.79	0	0.00				
Dislike very much	1.00 - 1.89	0	0.00				
Mean 4.01		Standard Deviation 0.37					
	LM	LL	NS	DL	DM	mean	St. Dev
Crunchiness	1	4	0	0	0	4.20	0.45
Mouth feel	1	4	0	0	0	4.20	0.45
Air retention	0	4	1	0	0	3.80	0.45

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

appearance, flavor, palatability, texture and color of the innovated product when grouped according to formulation and drying methods. There were four groups being compared: 1/3 squid and 2/3 cassava convection dried; 1/3 squid and 2/3 cassava sun dried; ¼ squid and ¾ cassava convection dried; and ¼ squid and ¾ cassava sun dried.

The null hypothesis is accepted in appearance, flavor, and palatability and over all acceptability. This means that there is no significant difference in the level of acceptability in terms of appearance, flavor, and palatability of the innovated product when grouped according to formulation and drying methods.

The null hypothesis is rejected in texture and color. This means that there is a significant difference in the level of acceptability in terms of texture of the innovated product when grouped according to formulation and drying

methods. Also, the data shows that there is almost a significant difference in the level of acceptability in terms of color of the innovated product when grouped according to formulation and drying methods.

Problem 3. Which packaging material protect shelf life in terms of level of acceptability after seven days, 14 days, 21 days and 30 days, in terms of:

- 3.1. Crunchiness?
- 3.2. Mouth feel?
- 3.3. Air retention?

The study made four variety of the packaging materials. Packaging One, polyethylene, Packaging Two is polypropylene and Packaging Three foil pack.

The table above displayed that majority (100%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID

Table 13: Distribution of statistics (frequency, percentage, mean and standard deviation) of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after 21 days using Polypropylene.

Response	Range	f	%
Like very much	4.60 - 5.00	3	60.00%
Like a little	3.70 - 4.59	2	40.00%
Not sure	2.80 - 3.69	0	0.00%
Dislike a little	1.90 - 2.79	0	0.00%
Dislike very much	1.00 - 1.89	0	0.00%
Mean 4.50 Standard Deviation 0.38			
	LM	LL	NS DL DM mean St. Dev
Crunchiness	4	1	0 0 0 4.80 0.45
Mouth feel	1	4	0 0 0 4.20 0.45
Air retention	3	2	0 0 0 4.60 0.55

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

Table 14: Distribution of statistics Frequency, percentage distribution, mean and standard deviation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after 21 days using foil pack.

Response	Range	f	%
Like very much	4.60 - 5.00	1	20.00%
Like a little	3.70 - 4.59	4	80.00%
Not sure	2.80 - 3.69	0	0.00%
Dislike a little	1.90 - 2.79	0	0.00%
Dislike very much	1.00 - 1.89	0	0.00%
Mean 4.13 Standard Deviation 0.30			
	LM	LL	NS DL DM mean St. Dev
Crunchiness	1	4	0 0 0 4.20 0.45
Mouth feel	1	4	0 0 0 4.20 0.45
Air retention	0	5	0 0 0 4.00 0.00

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

Table 15: Distribution of statistics frequency, percentage distribution, mean and standard deviation of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after 30 days using Polyethylene.

Response	Range	f	%
Like very much	4.60 - 5.00	0	0.00%
Like a little	3.70 - 4.59	3	60.00%
Not sure	2.80 - 3.69	2	40.00%
Dislike a little	1.90 - 2.79	0	0.00%
Dislike very much	1.00 - 1.89	0	0.00%
Mean 3.80 Standard Deviation 0.30			
	LM	LL	NS DL DM mean St. Dev
Crunchiness	0	5	0 0 0 4.00 0.00
Mouth feel	0	4	1 0 0 3.80 0.45
Air retention	0	3	2 0 0 3.60 0.54

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation

Table 16: Distribution of statistics (frequency, percentage, mean and standard deviation) of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after 30 days using Polypropylene.

Response	Range	f	%					
Like very much	4.60 - 5.00	5	100.00%					
Like a little	3.70 - 4.59	0	0.00%					
Not sure	2.80 - 3.69	0	0.00%					
Dislike a little	1.90 - 2.79	0	0.00%					
Dislike very much	1.00 - 1.89	0	0.00%					
		Mean 4.46	Standard Deviation 0.00					
	LM	LL	NS	DL	DM	mean	St. Dev	
Crunchiness	5	0	0	0	0	5.00	0.00	
Mouth feel	0	5	0	0	0	4.00	0.00	
Air retention	5	0	0	0	0	5.00	0.00	

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

Table 17: Distribution of statistics (frequency, percentage, mean and standard deviation) of CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after 30 days using foil pack.

Response	Range	f	%					
Like very much	4.60 - 5.00	0	0.00%					
Like a little	3.70 - 4.59	4	80.00%					
Not sure	2.80 - 3.69	1	20.00%					
Dislike a little	1.90 - 2.79	0	0.00%					
Dislike very much	1.00 - 1.89	0	0.00%					
		Mean 3.87	Standard Deviation 0.30					
	LM	LL	NS	DL	DM	mean	St. Dev	
Crunchiness	0	5	0	0	0	4.00	0.00	
Mouth feel	0	4	1	0	0	3.80	0.45	
Air retention	0	4	1	0	0	3.80	0.45	

Note LM like very much, LL like a little, NS not sure, DL dislike a little, DM dislike very much and standard deviation.

Table 18: Distribution of statistics (ANOVA Analysis of Variance) Evaluation by 5 Food experts of the different packaging materials of the product in terms of acceptability after seven days.

Category	Groups			P-value	F-value
	Polyethylene	Polypropylene	Foil-pack		
Crunchiness	(Mean=5)	(Mean=5)	(Mean=5)	Undefined	65535NS
Mouth feel	(Mean=5)	(Mean=5)	(Mean=5)	Undefined	65535NS
Air retention	(Mean=5)	(Mean=5)	(Mean=5)	Undefined	65535NS
Over-all	(Mean=5)	(Mean=5)	(Mean=5)	Undefined	65535NS

Note. NS not significant, * Significant. ** Highly significant

Table 19: Distribution of statistics (ANOVA Analysis of Variance) Evaluation by 5 Food experts of the different packaging materials of the product in terms of acceptability after 14 days.

Category	Groups			P-value	F-value
	Polyethylene	Polypropylene	Foil-pack		
Crunchiness	Mean=4.4	4.8	4.6	0.4932	0.75NS
Mouth feel	Mean=4.4	4.8	4.6	0.4932	0.75NS
Air retention	Mean=4.4	4.8	4.6	0.4932	0.75NS
Over-all	Mean=4.4	4.8	4.6	0.4932	0.75NS

Note. NS not significant, * Significant. ** Highly significant

Table 20: Distribution of statistics (ANOVA Analysis of Variance) Evaluation by 5 Food experts of the different packaging materials of the product in terms of acceptability after 21 days.

Category	Groups			P-value	F-value
	Polyethylene	Polypropylene	Foil-pack		
Crunchiness	4.2	4.8	4.2	0.0877	3.00NS
Mouth feel	4.2	4.2	4.2	1.0000	0.00NS
Air retention	3.8	4.6	4.0	0.0236	5.20*
Over-all	4.07	4.53	4.13	0.1148	2.60NS

Note. NS not significant, * Significant. ** Highly significant.

Table 21: Distribution of statistics (ANOVA Analysis of Variance) Evaluation by 5 Food experts of the different packaging materials of the product in terms of acceptability after 30 days.

Category	Groups			P-value	F-value
	Polyethylene	Polypropylene	Foil-pack		
Crunchiness	4	5	4	Undefined	65535
Mouth feel	3.8	4	3.8	0.6186	0.500
Air retention	3.6	5	3.8	0.0003	17.2**
Overall	3.8	4.67	3.87	0.0001	19.62**

Note. NS not significant, * Significant. ** Highly significant

Table 22: Cost of Goods

Item	Specification	Unit Used	Unit Cost	Total Cost
Cassava	Yellow; fresh	25 grams	P 15.00	P 0.375
Squid	Red skin; fresh	6.25 grams	P 120.00	P 3.00
White onions	Fresh	0.75 grams	P 120.00	P 3.00
Garlic	Fresh	0.5 grams	P 120.00	P 3.00
Seasonings	All Spice	0.125 grams	P 5.00	P 0.025
Salt	Rock salt	0.125 grams	P 7.00	P 0.175
Cooking oil	Vegetable	50 liters	P 91.35.00	P 2.28
Total				P 11.855

Table 23: Supplies and Materials (@ 600 packs per month).

List of Item	Total cost
Food Tissue	P 15.00
Banana Leaves	P 10.00
Hand Gloves	P 30.00
Total	P 55.00

Table 24. Operating Expenses.

List of Items	Cost
Gasul	P 840.00
Light and Water	P 1, 000.00
Labor of P 150.00 per day	P 3, 600.00
Transportation	P 500.00
Total	P 5, 940.00

Table 25: Tools and Equipment.

Item	Specification	Quantity	Measure	Unit Cost	Total Cost
Mixing bowl	Stainless	3	Pc	P 120.00	P 360.00
Spoon	Stainless	1	Pc	P 5.00	P 5.00
Fork	Stainless	1	Pc	P 5.00	P 5.00
Steamer	Stainless	1	Set	P 650.00	P 300.00
Cassava					
Grater	Stainless	1	Pc	P 250.00	P 250.00
Gas Range	1 burner	1	Set	P 400.00	P 400.00
Weighing scale	Digital	1	Set	P 450.00	P 450.00
Food tong	Stainless	2	Pcs	P 75.00	P 150.00
Strainer	Screen	1	Pc	P 200.00	P 200.00
Home- made sun dryer	Screen	1	Pc	P 250.00	P 250.00
Tray	Stainless	3	Pcs	P 100.00	P 300.00
Knife	Stainless	1	Pc	P 150.00	P 150.00
Chopping board	Hard wood	1	Pc	P 50.00	P 50.00
Deep Fryer	Stainless	1	Pcs	P 338.00	P 338.00
Sealer	Metal	1	Pc	P 500.00	P 500.00
Total					P 3, 708.00

Table 26: Packaging (@ 600 packs per month).

List of Item	Quantity
Measures	Unit Cost
Total cost	
Polypropylene	600
Pcs	P 0.75
450.00	
Total	P 45 0.00

Table 27: Projected Sales.

Months	Unit Sales	Unit Price	Total Sales
Month 1	600	P 22.00	P 13, 200
Month 2	600	P 22.00	P 13, 200
Month 3	600	P 22.00	P 13, 200
Month 4	700	P 22.00	P 15, 400
Month 5	700	P 22.00	P 15, 400
Month 6	700	P 22.00	P 15, 400
Month 7	800	P 22.00	P 17, 600
Month 8	800	P 22.00	P 17, 600
Month 9	800	P 22.00	P 17, 600
Month 10	900	P 22.00	P 19, 800
Month 11	900	P 22.00	P 19, 800
Month 12	900	P 22.00	P 19, 800
Total			P 198.00

Table 28: Projected Production.

Months	Number of Production	Months	Number of Production
Month 1	600	Month 7	800
Month 2	600	Month 8	800
Month 3	600	Month 9	800
Month 4	700	Month 10	900
Month 5	700	Month 11	900
Month 6	700	Month 12	900

(Loligoduvauceli) after seven days using Polyethylene as “like very much”. The overall rating is also “like very much” (mean=5.00). The standard deviation of 0.00 indicates that the experts rated the CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after seven days using Polyethylene as similar or very close to each other.


The data illustrated that majority (100%) of the experts rated the CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after seven days using Polypropylene as “like very much”. The overall rating is also “like very much” (mean=5.00). The standard deviation of 0.00 indicates that the experts rated the CASSAVA (Manihotesculenta)

and SQUID (Loligoduvauceli) after seven days using Polypropylene as “similar” or “very close to each other”.

Impact Plastics (n.d.) cited reasons why polypropylene is the best packaging materials for foods because of the following: low density, light weight, low price, versatile temperature range, sustainable, has high heat resistance, durable and recyclable

(Loligoduvauceli) after seven days using foil pack as “like very much”. The overall rating is also “like very much” (mean=5.00).The standard deviation of 0.00 indicates that the experts rated the CASSAVA (Manihotesculenta) and SQUID (Loligoduvauceli) after seven days using foil pack as similar or very close to each other.

This further supports to the claim of Marsh et al. (2007)

PROJECTED COST PROFILE ANALYSIS 

COMPANY NAME	Smart Food Process	DATE CONDUCTED	15 Jan 20											
PROPOSED PRODUCT	Cassava Starch Chips 100g	COMPLETED BY	CP Naelga											
		YEAR	2020											
COST PROFILE														
COST CATEGORY	Pre-Operating	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	TOTAL
Location	300.00													300.00
Cost of Goods Sold (COGS)		7,750.00	7,750.00	7,750.00	8,750.00	8,750.00	8,750.00	9,450.00	9,450.00	9,450.00	10,850.00	10,850.00	10,850.00	108,500.00
Operating Expense		7,940.00	4,240.00	4,240.00	8,340.00	8,340.00	8,340.00	9,740.00	9,740.00	9,740.00	11,240.00	11,240.00	11,240.00	108,540.00
Depreciation Expense		25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	300.00
Salaries		450.00	450.00	450.00	525.00	525.00	525.00	600.00	600.00	600.00	675.00	675.00	675.00	6,750.00
Utilities & Supplies	7,750.00													7,750.00
TOTAL COSTS	4,520.00	13,950.00	13,950.00	13,950.00	15,240.00	15,240.00	15,240.00	16,825.00	16,825.00	16,825.00	18,810.00	18,810.00	18,810.00	197,495.00
CUMULATIVE COSTS	4,520.00	18,900.00	31,850.00	45,790.00	60,413.00	75,653.00	90,893.00	107,318.00	124,143.00	141,968.00	160,278.00	178,588.00	197,493.00	

that aluminum is commonly used to make cans, foil, and laminated paper or plastic packaging, aluminum is a lightweight, silvery white metal derived from bauxite ore, where it exists in combination with oxygen as alumina. Magnesium and manganese are often added to aluminum to improve its strength properties (Page and others 2003). Unlike many metals, aluminum is highly resistant to most forms of corrosion; its natural coating of aluminum oxide provides a highly effective barrier to the effects of air, temperature, moisture, and chemical attack.

The table above showed that majority (60%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 14 days using Polyethylene as "like a little". The overall rating is also "like a little" (mean=4.40). The standard deviation of 0.55 indicates that the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 14 days using Polyethylene as "similar" or "close to each other".

The data above exemplified that majority (80%) of the experts rated the CASSAVA (*Manihotesculenta*) AND SQUID (*Loligoduvauceli*) after 14 days using Polypropylene as "like very much". The overall rating is also "like very much" (mean=4.80). The standard deviation of 0.45 indicates that the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 14 days using Polypropylene as "similar" or "close to each other".

The table explained further that in terms of polypropylene as packaging material, most of the expert evaluated polypropylene as like very much. This strongly supports that polypropylene is a good packaging material.

The data shows that majority (60%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 14 days using foil pack as "like very much". The overall rating is also "like very much" (mean=4.60). The standard deviation of 0.55 indicates that the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 14 days using foil pack as "similar" or "close to each other".

The data showed that majority (60%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 21 days using Polyethylene as "like a little". The overall rating is also "like a little" (mean=4.01). The Standard deviation of 0.37 indicates that the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 21 days using Polyethylene as "similar" or "close to each other". This explained that out

of five experts only three rated "polyethylene packaging" as good for packaging after 21 days.

The data shows that majority (60%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 21 days using Polypropylene as "like very much". The overall rating is also "like very much" (mean=4.53). The highest mean for each indicator is in "crunchiness". The standard deviation of 0.38 indicates that the experts rated the acceptability CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 21 days using Polypropylene as "similar" or "close to each other".

The data showed that majority (80%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 21 days using foil pack as "like a little". The overall rating is also "like a little" (mean=4.13). The standard deviation of 0.30 indicates that the experts rated the acceptability of CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 21 days using foil pack as "similar" or "close to each other".

The data shows that majority (60%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 30 days using Polyethylene as "like a little". The overall rating is also "like a little" (mean=3.80). The standard deviation of 0.30 indicates that the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 30 days using Polyethylene as "similar" or "close to each other".

The data revealed that majority (100%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 30 days using Polypropylene as "like very much". The overall rating is also "like very much" (mean=4.46). The standard deviation of 0.00 indicates that the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 30 days using Polypropylene as "similar" or "very close to each other".

The data revealed that majority (80%) of the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 30 days using foil pack as like a little. The overall rating is also "like a little" (mean=3.87). The highest mean for each indicator is for "crunchiness". The standard deviation of 0.30 indicates that the experts rated the CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*) after 30 days using foil pack as "similar" or "close to each other".

The table presented the distribution of statistics (ANOVA Analysis of variance) evaluation by five Food experts in terms of crunchiness, mouth feel and air retention when grouped according to different packaging materials after 7 days. There were three groups being compared: Polyethylene, Polypropylene and Foil-pack.

The null hypothesis is accepted. The result indicates that there is no significant difference in the Evaluation by five Food experts in terms of crunchiness, mouth feel and air retention ($F=65535NS$).

The table displayed the distribution of statistics (ANNOVA Analysis of variance) Evaluation by 5 Food experts in terms of crunchiness, mouth feel and air retention when grouped according to different packaging after 14 days. There were three groups being compared: Polyethylene, Polypropylene and Foil-pack.

The null hypothesis is accepted. The result indicates that there is no significant difference in the Evaluation by five Food experts in terms of crunchiness, mouth feel and air retention ($F=0.75NS$) in crunchiness, mouth feel, air retention and overall.

The table shows the distribution of statistics (ANOVA Analysis of variance) Evaluation by five Food experts in terms of crunchiness, mouth feel and air retention when grouped according to different packaging after 21 days. There were three groups being compared: Polyethylene, Polypropylene and Foil-pack.

The null hypothesis is accepted. The result indicates that there is no significant difference in the Evaluation by five Food experts in terms of crunchiness, mouth feel and air retention ($F=0.75NS$) in crunchiness, mouth feel, air retention and over-all rating.

However, the null hypothesis is rejected. The result shows that there is a significant difference in the Evaluation by five Food experts in terms of air retention ($F=5.20^*$) when grouped according to different packaging after 21. The highest mean is Polypropylene.

The table exemplified the distribution of statistics (Analysis of variance) Evaluation by five Food experts in terms of crunchiness, mouth feel and air retention when grouped according to different packaging after 30 days. There were three groups being compared: Polyethylene, Polypropylene and Foil-pack.

The null hypothesis is accepted. The result indicates that there is no significant difference in the Evaluation by five Food experts in terms of crunchiness, mouth feel ($F=65535NS$), ($F=0.500$).

However, the null hypothesis is rejected. The result showed that there is a highly significant difference in the Evaluation by five Food experts in terms of air retention ($F=17.20^{**}$) and overall ($F=19.62$) when grouped according to different packaging after 30 days. The highest mean is Polypropylene.

Problem 4: What is the result of the cost benefit analysis on the product with the highest acceptability, correct drying methods and highest acceptability of packaging in terms of:

- 4.1. Production Cost;
- 4.2. Operations; and
- 4.3. Profitability?

CONCLUSION & RECOMMENDATIONS

The study was very informative as it distinguishes the level of acceptability of the innovated product – CASSAVA (*Manihotesculenta*) and SQUID (*Loligoduvauceli*), in terms of formulation and drying method. The study further clarifies the formulation, drying methods and packaging materials that a consumer would prefer. Thus it is found out in the findings that the product can be profitable.

Considering the findings, the following recommendations are presented.

1. The University should not only focus on Instruction, Research, and Extension in achieving its vision to be a nationally-recognized Science and Technology University but also in Innovation.
2. Producers should be aware that this innovated product really contributes to their livelihood. In fact, it will serve as basis for improvement.
3. Consumers should serve as a model of the buying public in promoting quality and safety of the innovated products (cassava and squid).
4. Investors should be informed of the results of the analysis, so they may consider the innovation a potential investment in the future.
5. For future researchers, vacuum packaging is strongly recommended to further test its air compression, crunchiness and moisture of the innovated product.

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Ecological Mapping of the Territory on the Basis of Integrated Monitoring

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ABSTRACT

Process and pollution level by radionuclides of lands adjacent to the territory of Semipalatinsk Nuclear Test Site (SNTS) are considered in the article. Data of space monitoring of the territory and experience use of integrated technology was analyzed. This technology is the result of the integration of the geographic information system (GIS) and space monitoring. Complex monitoring results (geodetic and radio ecological) in SNTS territory aimed at creation of common information space and prevention of the secondary emission of radioactive substances are given. Primary analysis of geodetic monitoring results using «Balapan» «Telkem» where surface subsidence measured up 5-6 mm were analyzed. Based on complex monitoring dynamic maps of the temperature and ecological characteristics of the test site territory were obtained. Attained results are used for additional assessment of pollution consequences of SNTS and recommendation development on the use of lands in the context of radiation safety.

KEY WORDS: Underground nuclear explosion, geographic information systems, space monitoring, geodetic monitoring, radio ecological monitoring, analysis of the results, temperature anomaly, deformation of daylight surface, radioactive contamination maps.

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INTRODUCTION

At the present stage of the development of society, the geo-ecological problems in terms of urgency of their solution are on par with social and economic problems; therefore their study cannot be carried out without a holistic study of the whole complex of socio-ecological-economic factors that form the living environment of human society in a certain territory (Grummo, Zelenkovich, Zhilinskiy, Iluchik & Voznyachuk, 2012). At the same time, a clearly defined spatial aspect of geo-ecological problems determines the crucial role of cartographic materials, especially complex geo-ecological maps, which are research tools that allow all the main characteristics available to evaluate the geo-ecological state of the territory.

Geo-ecological mapping will allow not only to conduct a regular survey of the territory based on the analysis of the obtained data, but also to identify changes in the state of geo-ecological systems in a timely manner, to simulate their condition and justify measures to restore disturbed areas, as well as to correct the decisions taken on the special engineering protection of production facilities and the environment in areas of possible critical situations (Nikiforova, 2010). At the same time, the lack of a general concept of cartographic support for the development of territories and methodological developments in cartography for territorial entities, in particular for developing countries, makes solving the problem of cartographic support as one of the most important tasks (Selestin, 2010).

The deterioration of the environment state and ensuring environmental safety require the creation of a visual image of a new environmental reality. This task is most consistent with the cartographic form, which adequately reflects the ecological situation. Environmental maps have a special role in the implementation of environmental control, monitoring, environmental protection measures, and economic management (Leshanin & Brehova, 2016).

The cartographic mapping of the anthropogenic human influence on the environment is a difficult task for many reasons:

- versatility and high dynamic changes;
- insufficient knowledge of the response of the natural environment, both to individual types of impact, and to their combinations;
- weak elaboration of classifications and systematics of anthropogenically and technologically changed environments;
- frequent absence of obvious signs and limits of manifestation of certain environmental change.

The complexity of integrated environmental mapping is due all, a multiplicity of characteristics that need to be considered. In this regard, integrated environmental mapping is not comparable with any particular thematic area (geological, soil, socio-economic and other mapping), but with thematic mapping as a whole (Hohlava, Osadchaya & Ovcharuk, 2013).

The complexity of environmental mapping involves the simultaneous display:

- geographical environment (landscapes) in which the interaction takes place and development of ecological relations between natural and socio-

economic systems;

- anthropogenic and technogenic impacts and environmental response on them;
- assessments of the effects of exposure (i.e. the ecological status of the natural environment).

In this case, the object of mapping can be both current and retrospective or predicted state of the environment.

Practically, the task of integrated environmental mapping is solved by creating a set of interrelated maps of environmental content or by drawing up individual integrated maps, the content of which includes all of the listed elements (albeit in minimal amounts). When compiling a set, the predominant part of the maps describes the state of the individual components of the environment (Makarov, Novakovskiy & Chumachenko, 2002).

Mapping is almost always based on the results of comprehensive studies (often carried out specifically) and allows a deep and comprehensive characterization of the ecological situation in the territory. At the same time, conclusions from a comprehensive description, including comparative assessments and usually causing the greatest public and practical interest, should be presented on a separate synthesis map. Therefore, the features of integrated environmental mapping are most fully revealed in the creation of integrated environmental maps (Leshanin & Brehova, 2016).

There are 7 positions that should be taken into account when designing and reflected in the mapping of environmental topics:

- natural resource potential of the mapped territory, types and the intensity of its modern use;
- the overall level of the ecological status of natural complexes and the associated morbidity of the population;
- placement on the territory of objects of economic and other activities that affect the natural environment;
- assessment of damage to the natural environment and the health of the population caused by various types of economic activity;
- factors limiting the further development of specific types of economic activities determined by existing standards on indicators of the quality of the natural environment and public health;

- environmental and economic priorities that determine further socio-economic development of the region;
 - a system of recommendations aimed at stabilizing and improving the environmental situation in the locations of objects of economic and other activities.
- Currently, there are 3 types of integrated environmental maps:
- inventory;
 - inventory assessment;
 - comprehensive assessment.

Elements of the natural environment are shown on the inventory maps (natural areas, landscape areas, landscapes) and the nature of their use (agriculture and forestry, etc.), as well as sources and (not always) the amount of anthropogenic impact on them - human settlements, transport communications, industrial and agricultural enterprises (Lopandya & Nemtinov, 2007; Lurye, 2008).

The main meaning of maps of this type in showing the subjects of evaluation, elements objects, which are sources of environmental hazards and environmental violations. The map shows the location of hazardous objects and other objects that are of interest from the point of view of the formation of environmental situations. The availability of such information will allow assessing the overall situation, to present the possible development of events. Maps of this type do not yet give an opportunity to assess the situation (Telegina & Yannikov, 2013).

On integrated assessment maps, the main element of the content is the assessment of the environmental situation, which characterizes the state of both individual components and the natural environment as a whole. The ecological situation is understood as a combination of various, including positive and negative, from the point of view of living and state of human health, conditions and factors that create a certain ecological situation in the territory, varying degrees of well-being or distress (Hohlova, Osadchaya & Ovcharuk, 2013; Veselova & Shmarova, 2010).

Based on the foregoing, at the moment there are four directions integrated environmental mapping:

The first direction is the creation of maps showing the division of territory into landscapes, an assessment of the degree of auspiciousness of living conditions of the population and disturbed landscapes. The main object of study is the natural territorial complex (NTC), the rank and size of which is determined by the scale of the study. Separately on the map mark the centers and centers of environmental pollution, the volume and nature of harmful emissions. Such a direction of ecological mapping can be called landscape-ecological.

The second direction of integrated environmental mapping has received the name of the administrative and environmental. The object of environmental assessment in this case is administrative territorial units or their

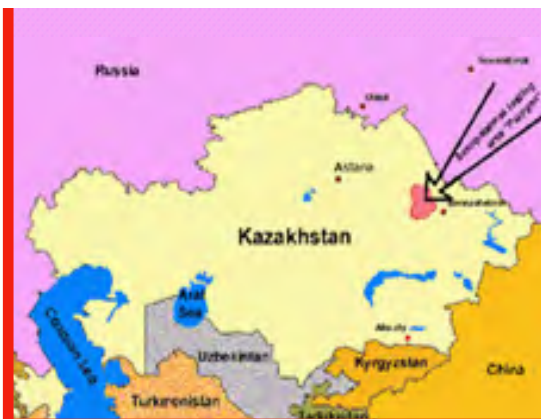


Fig. 1: SNTS location

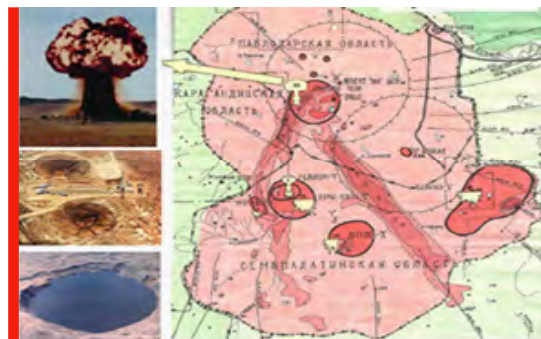


Fig. 2: Map and consequences of test sites.

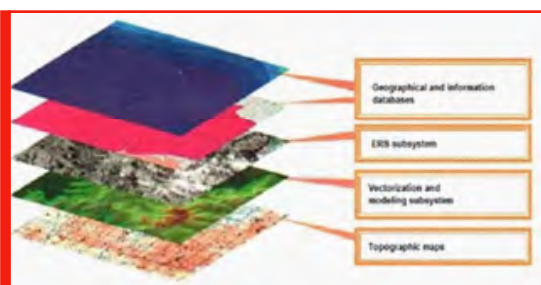


Fig. 3: Geographic information system of SNTS

combination. Administrative environmental mapping is widely used in assessing the spatial differences in the environmental situation at the federal and regional levels. The advantage of this approach is the reliance on sufficiently extensive environmental information and statistical data. Disadvantages are revealed by a simple comparison of the sizes of territorial operational units

(mapping objects) of the same rank (Baimbetov, 1999).

For the third direction of ecological mapping, almost complete refusal to draw up integrated maps and display the most complete information about the territory (natural landscape differentiation, anthropogenic load, negative changes in habitat, etc.) on one final map. With such

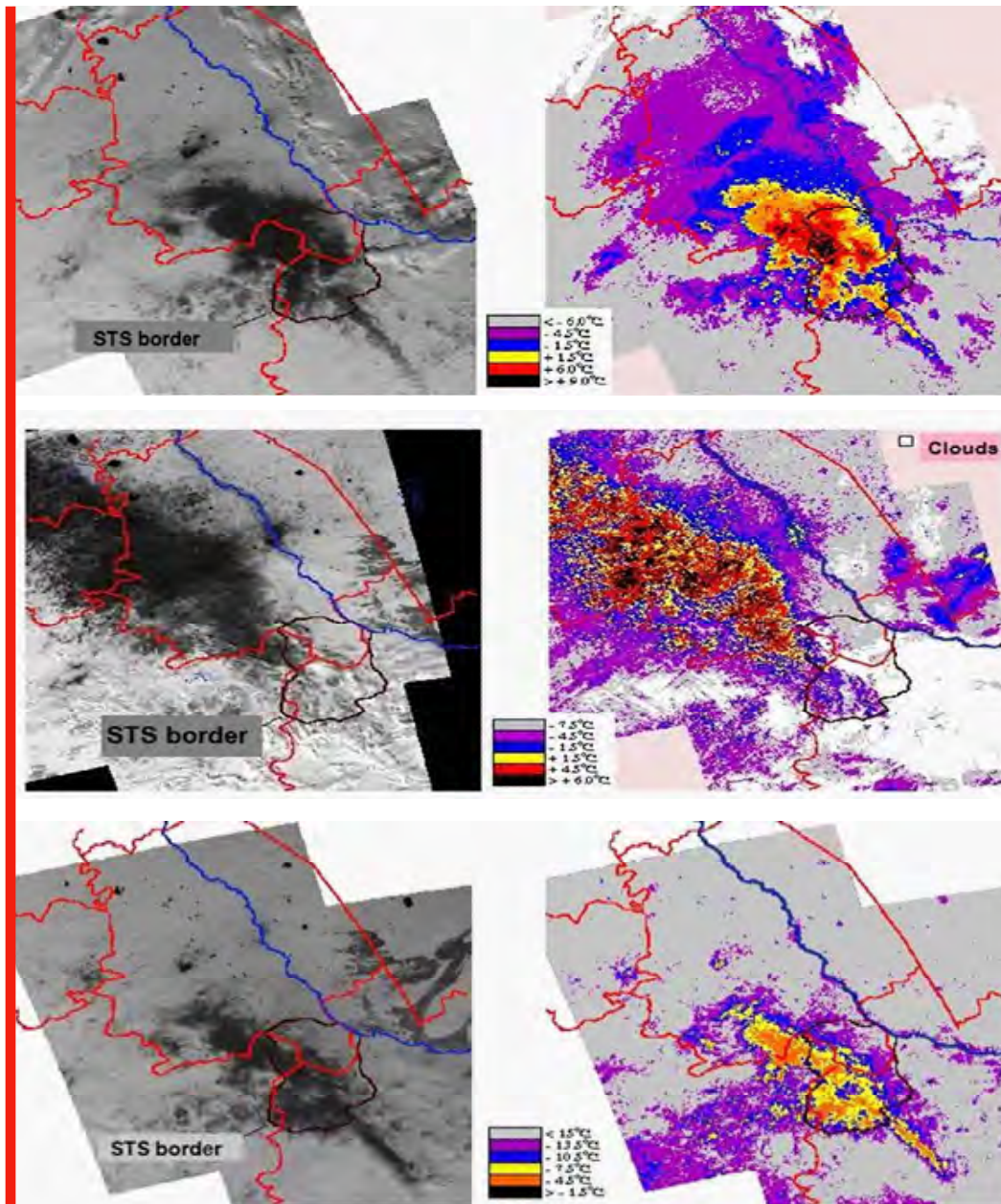


Fig. 4: State of the snow cover and infrared (IR) range temperature field of SNTS area according to the data of the US satellite NOAA in different years: a) 17.02.1997; b) 12.03.1999; c) 03.07.2000

approach, it is not necessary to talk about the main object of mapping, since the objects of topographic base, natural landscape areas, and areas of pollution of the territory are simultaneously displayed on one map. This direction can be called information and environmental mapping.

Fourth, problem-ecological direction is associated with the development of maps environmental situations created since the late 80s of XX century for the territories of the former USSR, Russia and its individual regions, CIS countries and the world.

The basis of these maps is the division of the territory into natural and natural anthropogenic habitats (geo-systems), which are assessed according to the nature and extent of changes in the ecologically significant natural properties of landscapes that are important to humans and their economic activities.

The specific content of the ecological map is the display of areas environmental situations of varying degrees of severity with a set of environmental problems of different significance or a single problem. When economic impact on nature occurs, as a rule, a number of negative environmental changes in the components of nature (pollution, degradation, violation, etc.), which interact with each other, form an ecological situation.

Thus, the mapping of environmental situations provides for a number of strictly sequential actions and the creation of a multi-layered system of maps, providing a focused characterization of the state of nature, population and economy (Sturman, 2000; Aleksandr Minkov, 2012).

Ecological systems of Kazakhstan are characterized by low resistance to human intervention. About 75% of its territory (territory of the Aral sea and SNTS , the coast of the Caspian Sea, desert and semi desert pastures of Central and Southern Kazakhstan, etc.) are subject to an

increased risk of environmental disruption. SNTS was one of the main test sites used for nuclear weapons tests for 40 years (Fig.1) (Proceedings from International Scientific Conference: Semipalatinsk nuclear test site. Radiation heritage, and development prospects. 2012; Sultangazin, 2002).

By the decree of the President of the Republic of Kazakhstan N.A. Nazrbayev test site was closed on August 29, 1991 leaving the contaminated zones on the testing territory and in nearby regions. This circumstance caused intensive researches of the nature and pollution level of test site territory with aim of determination of the consequences of nuclear explosions and monitoring of radiation-hazardous objects.

For the timely indication of further changes, assessment of the tempos and areas' degradation of the natural environment, prevention of negative processes and situation control, operational control of the state of these regions is necessary.

In view of large area of Kazakhstan, hardness of many areas and limited funding in modern conditions such control can be effectively organized only based on multi-method research (satellite monitoring and ground investigations).

The government, as a body of general competence, develops the state environmental policy, establishing its main directions, state environmental programs aimed at ensuring environmental protection and environmental management. In the event of a negative environmental situation on the territory of Kazakhstan, the Government declares this region a zone of emergency environmental situation, and after eliminating the consequences, decides on the removal of this status.

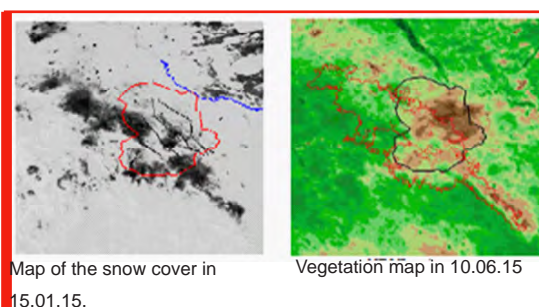


Fig. 5: Vegetation condition in SNTS area.

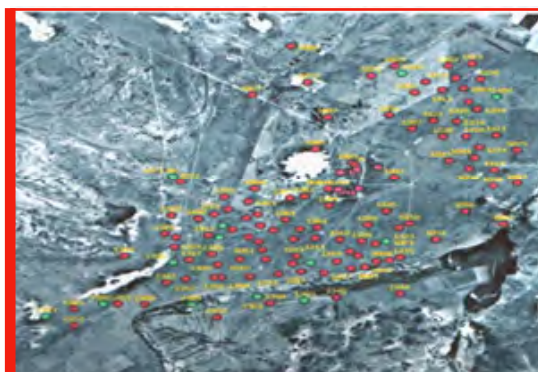


Fig. 6: Scheme of closed tunnel on the test site

The state takes certain steps in the field of environmental protection. To this end, it has given local representative and executive bodies sufficiently broad powers. They in the respective territories approve and implement environmental programs, manage natural resources, prohibit or allow the construction of enterprises and facilities, and so on. And this is fully justified, since it is the local authorities that know the entire ecological situation and have detailed information. The local authorities in various ways and methods help public associations, whose role in the field of environmental protection is invaluable. Public associations, in turn, control the activities of state bodies, if necessary; apply to judicial bodies, whose activities represent a promising area of control activities in the field of environmental protection.

However, to date there have been no significant changes in the direction of improving the environmental situation. Therefore, in modern conditions, there is a growing need for a new legal mechanism that should ensure environmental safety, protect the rights and legitimate interests of citizens from industrial pollution, accidents or disasters.

Ecological zoning is one of the modern and effective legal measures to ensure environmental management and protection of the environment. It is not carried out by the Government, or local authorities, or public associations, although the latter are not prohibited from participating and helping in the process of environmental zoning.

Ecological zoning of the territory of the country is necessary for the practical activities of government bodies in solving environmental problems. The criteria for assessing the environmental situation lose their meaning if they are used in relation to the undifferentiated space of the country (Kuderin, 2014).

The process of environmental zoning in the Republic of Kazakhstan is a function of special state bodies in the field of environmental protection, which is one of the constituent parts of the general system of state policy in the field of state security and national priorities in ecology.

It is necessary to set before the state the task of conducting ecological zoning and improvement of legislation in this area. To solve it you need:

- definition of the concept of "ecological district" and "ecological zoning";
- determining the role and effectiveness of environmental zoning in the implementation of environmental policy and ensuring the

environmental safety of Kazakhstan;

- scientific support, which is one of the important elements of increasing the efficiency of the state for the sustainable environmental development of the country;
- creating an effective regulatory framework. The results of scientific research could be used in the development of new and with the addition of existing laws and regulations;
- definition of legal principles, their relationship with other environmental principles;
- identification of the most effective legal methods, methods and means of regulating environmental zoning;
- creation of an appropriate system of government bodies;
- analyze international treaties and conventions on environmental zoning;
- financial support for the formation of environmental areas.

Summarizing the above, we can say that at the present time there is a need to carry out environmental zoning of Kazakhstan. But this task was not assigned to local authorities and public associations. At the same time, the practice of recent years has shown the inexpediency and ineffectiveness of the implementation of certain functions by local state administration, which requires revising and reassigning some of them to the central level of state administration (Agleshev, 2004).

MATERIAL AND METHODS

SNTS is located at the intersection of three regions of Kazakhstan: Pavlodar, Karaganda and East Kazakhstan and covers 18 thousand square kilometers. During the operation of the SNTS (1949-1989), 456 nuclear tests were conducted on its territory, including 86 - air test sites, 340 - underground and 30 - contact tests. Here, the first in the USSR nuclear (1949) and the world's first hydrogen (1953) bombs were tested.

As the result of the nuclear explosion in 1965, more than 10 million tons of ground was thrown to a kilometer height and funnel with a diameter of 430 meters and depth of 100 meters was formed, this funnel called «Atomic lake». As the result of the tests, radioactive decay residues – radionuclides covered SNTS territory (Fig.2) (Bekbassarov & Nurpeisova, 2017).

A lot of scientific researchers had been devoted to the research of the territory of the former SNTS. However,

these researches were not put on common information basis, which would allow moving from scientific researches to solving practical problems.

In this case, creation of GIS is the most effective way, which allows to not only preserve the available data and provide easy access to it, but also to carry out simulation, the results of which can be combined with geographical and space images of the region under study. All the components of GIS and SNTS presented in Fig. 3 are interrelated (Nurpeisova & Kirgizbaeva, 2011).

The main tool that combines subsystems into integrated GIS is the ArcInfo package. It is one of the most powerful tools for creating geographic information systems.

Cartographic data «poured» into the subsystem of remote sensing, i.e. participate in the process of georeferencing space images. In turn, space images are source of information for geographic information database. Geographical data and remote sensing data are inputs to the subsystem «Modeling».

During the space images processing, number of interesting results including the detection of temperature anomalies in SNTS area were obtained, which had large resonance both inside the country and abroad.

Methods for reconstructing the surface temperature from Earth remote sensing (ERS) data are based on the separation of the part corresponding to the radiation surface (taking into account the absorption and radiation of the atmosphere) (Sultagazin & Zakarin, 2000; McClain, Pichel & Walton, 1985; Sultagazin, Zakarin, Spivak, Arkhipkin, Muratova & Terekhov, 1998). After this, surface temperature using the known dependence (model) on the brightness of radiation is determined.

These modules were approved fully for homogeneous

surfaces, in particular surfaces of the sea and oceans, for which there are reliable methods of temperature recovery.

Task of the temperature recovery of the land surface is more complex, as additional difficulties are emerged associated with surface relief. This complicates the use of simple models to determine the relationship between brightness and physical temperature. It is possible to recovery temperature of the earth's surface truly only for homogeneous areas: steppe, desert, snow cover, etc. Territory of Kazakhstan is satisfied this condition. Such cases, temperature recovery algorithms usually are used developed for the temperature recovery of surface of seas. In this field, algorithm developed by McClain (McClain, Pichel & Walton, 1985) was found an extensive application according to which the temperature of the underlying surface of the land is determined by the formula:

$$T = -283.934 + 4.081 * T4 - 3.046 * T5. (1)$$

To process the obtained temperature fields in the GIS environment, they must be resulted in the cartographic form and combined with topographic base of the studied territory. The corresponding technology was tested in dynamics mapping of the temperature characteristics of the underlying surface in SNTS area.

From 1998 to 2008 SNTS territory was studied by various earth satellites rockets (ERS), but in those years ERS were not available. At present, during the processing of space images, including the detection of temperature anomalies in SNTS area, number of interesting results had been obtained. Snowless areas during winter period (Fig. 4) and areas without vegetation in the summer were identified.

According to IR range data several focuses on the constructed thermal field are allocated, where temperature

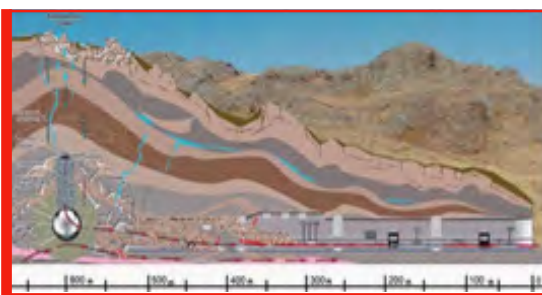


Fig. 7: Location of the nuclear object in the test site

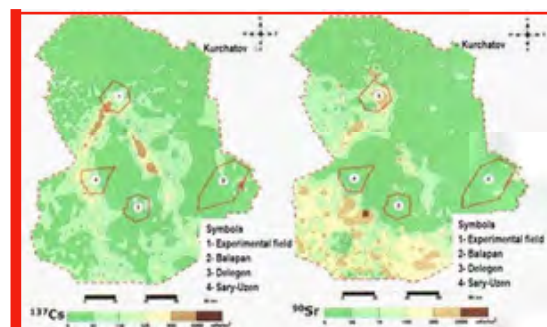


Fig. 8: Site pollution map

more than 10 °C exceeded the general background of the surrounding snow cover (Fig. 4, a). In the middle of March 1999, a snowless spot was appeared and it covered a vast territory of the test site (Fig. 4, b). On the temperature maps within the spot, the areas of high temperature (to 8-9 °C) are clearly distinguished (Nurpeisova, 2012a). The mapping results of the temperature fields from data surveys of 2000 year confirmed the presence of temperature anomalies in this region (Fig. 4, c).

It is also necessary to note the similarity of the configuration of the snowless zones in winter with the areas without vegetation in summer (Fig. 5).

The analysis of remote sensing data indicates the presence of a stable connection in the location of snowless areas and summer drought focuses in SNTS area, they are confined to test sites. The foregoing facts could have been caused by an accidental combination of weather conditions or local terrain features (relief, hydrothermal regime, etc.) that contribute to the denudation of the snow cover and, as a result, more intensive heating of bare areas of the earth by the sun's rays.

On the other hand, temperature increase could be consequence of the activation of tectonic processes caused by numerous nuclear explosions. The fact is that several deep faults pass through the territory of the test site. It is well known that, as the result of underground explosions cardinal changes are occurred in the state of geological environment and hydro geological conditions (Nurpeisova, 2012a).

Although the explosive hills are closed, the natural environment of SNTS territory is covered by waste of radioactive decay - radionuclides. The energy of underground explosions in the form of seismic vibrations is caused destruction in the thickness of the enclosing rocks. The radius of the impact zone can reach several

kilometers. The force of seismic action in underground nuclear explosions depends on the power of the charge and geological conditions (tectonic faults, fracture of rocks, etc.) of the test site.

The Nevada polygon is dominated by porous tuffs that can significantly absorb the seismic energy of blast waves. At the same distance from the explosion of the same power at the Nevada test site, the intensity of Despite more than 20 years have passed since the last tests in SNTS were carried out, the region is still an ecologically dangerous zone. Fig. 6 shows the plan of closed wells only at «Balapan» test site.

seismic vibrations is 3-4 times lower than in Semipalatinsk.

The sites of the Semipalatinsk test site are robust rocks of granite origin. Granites have low absorption properties of elastic seismic vibrations. Therefore, underground explosions are accompanied by significant tremors (Nurpeisova, 2013b).

Totally 343 underground explosions were conducted, each of them lead to earth movement. Rock destructions during nuclear underground explosions as formation of new open fissures and ancient tectonic structure are taken place, which caused depression of earth surface.

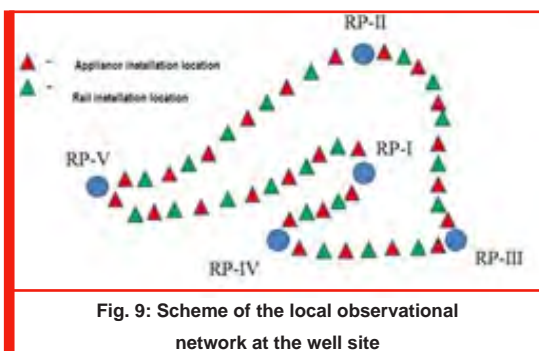
Fig.7 shows structure section of one of the fields of the underground tunnel, where the nuclear object is located in the last box.

Researches of hydro - geologists have shown that nuclear tests have a destructive effect on groundwater. In fissure waters content of uranium, strontium, and cesium is ten times higher than the maximum permissible concentration.

At present, the coal deposit Karazhyra is being developed, salt is extracted from Zhaksytuz lake, geological survey is carrying out, cattle is pastured, hay is prepared on the territory of the test site.

Such activities, firstly, contributes to the transfer of radioactive contamination inside the test site and beyond it; secondly, it is connected with the additional risk of workers, for the population of the region as a whole and for consumers of products.

Exploitation of the mineral deposit, carried out without notice the radioactive situation, hydro geological maps of radioactive contamination can lead to loss of the deposit



- for hundreds and even thousands of years, the territory, soils and minerals themselves may be contaminated.

Therefore, it is vitally important to conduct comprehensive researches in SNTS territory. The object of the research is the natural environment: soil and vegetation cover, water and air mediums, fauna. Radio-ecological monitoring is also integrated within GIS; where it is possible to integrate terrestrial geodetic methods with space ones. It increases the reliability and accuracy of measurements and monitoring. GIS-based space monitoring is the most comprehensive monitoring, since it performs all monitoring functions: observation, analysis, forecasting and control.

RESULTS AND DISCUSSION

The results of radio ecological researches conducted in SNTS territory from 2011 to 2017 have revealed areas of significant radioactive contamination with nuclear materials (Fig. 8). Main part of the radionuclides formed during the explosions fell directly the test sites («Experimental field», «Balapan», «Degelen», « Sary-Ozen»). Underground nuclear explosions (UNE) in the Balapan area were conducted in 105 « combat » wells. At many sites, underground nuclear tests led to deformation of the day surface in epicentral zones. It proves that afterward previously conducted underground nuclear explosions, over focus cavities different geodynamic processes are occurred after several decades.

To identify technogenic objects on the territory of «Balapan» space images were studied, which allowed identifying a number of objects, including large epicenters. Then field visits were conducted to inventory technogenic objects and assess the degree of technogenic disruption of the natural landscape.

Since 2005 on the territory of the test sites of «Balapan» and « Sary-Uzen», complex monitoring of the so-called «combat» wells had begun. As a result, the nature of the change in the daytime surface uplift and subsidence

was established, which may indicate various processes that occur over focal cavities of UNE. This can lead to dangerous phenomena both in and out of objects, and at a distance from them.

Seven wells at «Balapan» site (wells № 1414, 1207, 1066, 1203, 1226, 1235 and Glubokaya) and two wells at the Sary-Uzen site (№ 101 and №104) were selected to control these phenomena, changes in the daylight surface were revealed on these wells by results of geodetic monitoring (Ustavich & Yakovenko, 2013).

To determine the location of points in the geographical coordinate system global positioning device Garmin Rino 520 was used, which allows determining the position of points with an accuracy of ± 5 m. A survey network was preliminarily calculated. The coordinates of the survey network points were recorded in the GPS receiver and were determined on-site in the navigation mode (GPS receiver Garmin rino 520. Manual).

Observation of daylight surface changes was conducted by II class geometric leveling instrument. For this purpose, the project of the observational network was developed (Fig. 3). This scheme was used for all sites.

Geodetic monitoring on the site is carried out by II class leveling instrument on the local observational network, which consists of 5 ground-level benchmarks. The total length course of II class leveling is 695 m., maximum distance between the rapiers did not exceed 242 m., minimum distance was 61 m.

On the leveling line, wooden markers were mounted for installing leveling instrument over them (painted green) and installing racks (painted in red). In Fig. 9 shows the scheme of the local observational network at well site № 104.

Leveling instrument distance to rods was measured by digital leveling and did not exceed 30 m, the inequality of

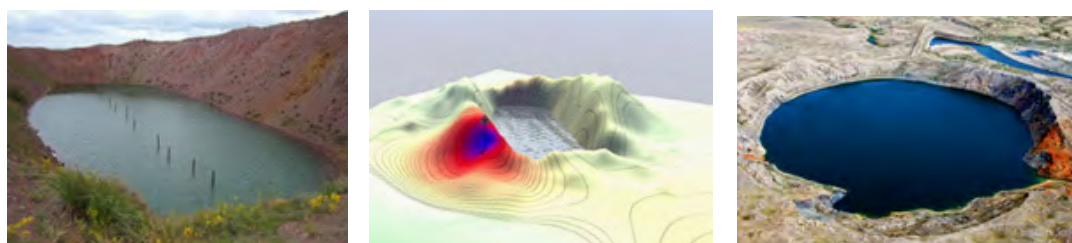
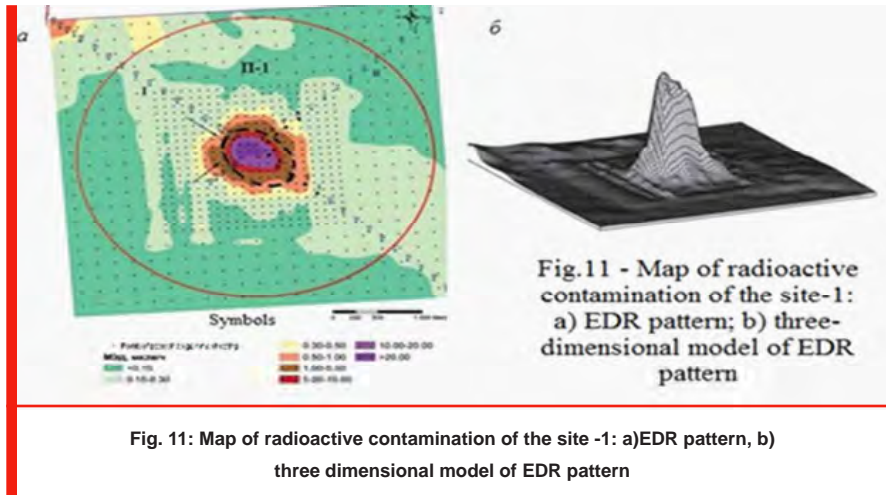


Fig. 10. a): Telkem-2 and b) its three-dimensional model with a radioactive contamination site; c) Atomic Lake.



distances from leveling instrument to rods at the station did not exceed 1 m, and accumulation of inequalities in the section did not exceed 2 m. The height of the sighting beam did not exceed 0.5 m.

During II class leveling the digital leveling instrument SOKKIA SDL 30 (Japan) was used, leveling process was carried out using bar-code rods with RAB code. Leveling process was carried out in closed loop in the forward and backward directions along the stakes. Measurements were carried out in the spring and autumn periods of the year, according to the requirements (Nurpeisova, Umirbekova & Bekbassarov, 2018c).

According to the data from 2011 to 2016 we can say about the preserved trend of positive change in the altitude position on the monument I, during this period, upwell occurred to +21.9 mm., rest of the benchmarks showed minimal changes in the altitude position: at the benchmark II +2.2 mm., benchmark III +0.6 mm., benchmark IV - 0.0 mm.

Comparing the data of 2016 and 2011, we can speak of daylight surface swelling the in SNTS epicenter, at the benchmark I (bottom of the funnel) its value was +23.9 mm., at the benchmark II - slight sagging of -3.2 mm, at the benchmark III altitude did not change , and at the benchmark IV minimum change in altitude position - 0.8 mm.

Thus, we can speak about heterogeneity and inconstancy of dynamical changes in altitude position of observable monument, which may be caused by insufficient data. It is necessary to continue observations on the local monitoring

network to obtain more data and to establish the causes of the ongoing processes (Yakovenko & Ustavich, 2015).

Two underground nuclear tests were conducted in the south- eastern part of the Semipalatinsk test site with subsoil release: single explosion «Telkem-1» (21.10.1968) and group (of three linearly disposed charges) – «Telkem-2» (12.11.1968). The funnel formed by the group explosion filled with water (Fig. 10, a and b). Atomic lake was formed as a result of an excavation thermonuclear explosion with a capacity of 140 kilotons. After the explosion, a funnel with a diameter of 400 m. and depth of more than 100 m appeared. Radiation contamination of the earth around this lake amounted to about 3-4 km. There is the nuclear SNTS legacy.

During performing ground-based field observations it is necessary to take into account the radioactive contamination at the site, which arose due to UNE. To do this, performers must have access to geodetic work in the zone of increased radiation pollution in accordance with the requirements of regulatory documents, and also the methodology for performing measurements should ensure minimum time for staying of performers in a radiation-contaminated site.

To determine the radiation situation and to inventor radiation-hazardous objects at the technical site -1, gamma survey was performed using Radiagem 2000 dosimeter radiometer (Operating Instructions for the Radiagem 2000 Radiometer.)

Based on the survey results, map of EDR pattern was constructed at this technical site -1 Balapan (Fig. 11, a).

The funnel of radiation-hazardous object (RHO) of site-1 has small dimensions, no visible ridges of funnel (pile), there is an outlet to the groundwater surface in the center of the funnel.

Contamination area with EDR level is 0.24 mcSv/h more, where the population staying must

be limited. For more visual representation of EDR pattern a three-dimensional map-scheme of pattern of pollution is constructed on the site (Fig. 11, b).

As result of the analysis of conducted studies materials, information on the current state of ecosystem components of «Balapan» site was received. It is established that radioactive contamination with technogenic radionuclides of soil and bottom sediments of the territory is confined to funnels of the «Atomic lake» and «Telkem». The total area of pollution is limited to 10-12 km from funnel crest.

It is determined that the main pollutant of water resources is technogenic radionuclide ^3H , maximum value of which in 2015 was recorded in the flood period at distance of 5 km from «Atomic Lake» amounted to 200 000 Bq/kg. It is necessary to continue monitoring observations; it will allow obtaining more complete picture of the seasonal variations of tritium distribution.

Tritium presence was found in all samples of plants selected on the banks of «Shagan» river and around the funnel of «Atomic Lake». Values of radiation parameters outside the funnel of «Atomic Lake» are within background values for this area. There is no doubt that the earth interior contains large number of radioactive products, including long-lived ones which were tested in galleries and wells. Such places, which are not subject to development, have to be guarded for a long time, excluding people's access there.

Based on the available data on the radiation situation in the area, the plan of stepped inspection of SNTS until 2021 was developed by the government with aim to solve cardinally the problems of the former SNTS to the 30th anniversary of the Independence of the Republic of Kazakhstan (Resolution of the Republic of Kazakhstan on the integrated solution of the problems of the Semipalatinsk zone of ecological disaster to 2020 in accordance with the developed plan for the stepped inspection of SNTS until 2021. (2017,September29).

CONCLUSION

Based on the above facts, it can be confidently asserted

that the SNTS area is located in the zone of stable climatic anomaly characterized by an earlier snow cover, increased surface temperature in the winter-spring period and reduced volume of green biomass in the summer. These facts provide sufficient grounds for the conclusion that nuclear explosions are involved in the temperature anomalies in area and emergence of drought focus in this region.

To solve problems aimed at preventing the secondary distribution of radioactive substances, the most acceptable approach is carrying out the complex monitoring (space, geodetic and radio-ecological) of SNTS territory. Main task of integrated monitoring - creation of common information space that can be formed on the basis of modern geoinformation technologies.

Application of geographic information systems for the analysis of radio-ecological processes in radioactively contaminated areas at nuclear testing sites will effectively process large amounts of information needed to solve problems associated with the rehabilitation of contaminated areas.

Obtained results allow justifying the recommendations on improving the operation of local networks and creation on their basis of a regional network at whole SNTS. This will allow us to further study the geodynamic processes and build maps of the temporal movements of the earth's crust for the entire SNTS territory. Additional work is required to assess the consequences of radionuclide contamination of SNTS with further development of recommendations on the use of lands in terms of radiation safety

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Development of Geodetic Methods of Monitoring of Open-Pit Sides Stability

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ABSTRACT

The article describes the results of the long-term researches by scientists of Kazakh National Research Technical University (KazNRTU) for the development of methods of mechanical processes studies. The article shows that the problem of geomechanical processes management can be solved on the basis of the described procedure of the rock mass condition geomonitoring which provide integrated analysis of all natural and technological factors, as well as the use of the control means developed by the authors of this article. Characteristic features of the ore deposits used in the process of development of the geo-mechanical techniques have been analyzed. The necessity of use of the satellite geodetic methods, electronic total stations and laser scanning for open-pit monitoring is determined and proved. For the installation of the high precision electronic and laser devices during geomonitoring the authors have developed the permanent ground benchmark, which allows providing the fast and accurate alignment and eliminating the use of tripods. Since the ultimate goal for all geomechanical studies is to ensure industrial safety, composition for hardening fractured rocks has been developed to prevent deformations..

KEY WORDS: Ore deposits, rock fracturing, deformations, monitoring, observation station, geomechanical monitoring, innovative methods, benchmarks, geodetic instruments, electronic total station, laser level, laser scanner, processing of results, mass state assessment.

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INTRODUCTION

The Republic of Kazakhstan, occupying a prominent position in the world mineral resources balance, has a high potential for further development and increase of influence on the world mineral market. Currently, the development of most of the fields is carried out in an open way. The scope of modern mining requires in-depth study and continuous monitoring of geomechanical processes taking place in the subsoil, based on monitoring of the state of open-pit slopes, which provides a systematic approach to solving all components of the problems, integrated accounting and analysis of all natural and technological factors (S. Ozhigin et al., 2014). In a broad sense, monitoring is an observation of environment that represented as a dynamic, i.e. constantly changing system, aiming at its control, study,

prediction and protection (Great Encyclopedic Dictionary, 2002).

Currently, Kazakhstan is intensively developing mineral deposits by open method. The main ones are: copper ore – 12 (Zhezkazgan, Itauyz, Kounrad, Nikolaev, Aktogay, Bozshakol, Akbastaus, Kosmurun, Nurkazgan, Sayak, Chatyrkul, Koktaszhal), polymetallic – 6 (Karagaily, Koktenkol, Akzhal, etc.), gold – 7 (Vasilkov, Abyz, Varvarin, Kamarov, Pustynnoe, Zagadka and Bakarchik), iron ore – 7 (Sarbay, Sokolovsky, Kachar, Kurzhunkul, Lomonosov, Kentobinskoe and Karazhal), coal – 10 or more (Ekibastuz, Maikuben, Turgay, Tengiz-Corzhanakulskoe, Shubarkol, Zhalyn, Karazhirinskoe, Borly, Kushoky, Karaganda, etc.), manganese – 5 (Ushkatyn – III, Tur, Bogach, Vostochny Kamys and Zapadny Kamys, Zhomart, etc.), bauxite (Turgay, etc.), nonmetallic (Topar and Katpar - limestone, Alekseevskoe – dolomite), and others. Kazakhstan is intensively conducting open-pit mining in more than 50 medium and large fields. A deposit or its part that is mined by one open-pit is called an open-pit field. It is part of the land allotment of the open-pit mine, within which there are also overburden rocks, removed from the open-pit mine, mine site and other mining facilities. The stepped side surface, formed by a slope and bench areas, limiting the mined-out space called the pit sides (Nizametdimov, 2015).

Around the world, mining is carried out mainly by the open method, which accounts for 75% of the mineral products extracted from the subsurface, and this level will be maintained in the future. At the same time, in the trend of its development, an increase in the depth, size and productive capacity of open-pits can be traced. Under these conditions the task of ensuring the stability of open-pit sides becomes particularly relevant. In this regard, it is necessary to conduct geomechanical monitoring and improve its geodetic observation methods to ensure the long-term stability of open-pit sides. One of such fields in Kazakhstan is Akzhal field of 'Nova Zinc' LLP, which is the largest enterprise in the Karaganda region. The management of 'Nova Zinc' LLP pays special attention to industrial safety of the development of mineral resources. One of the real examples is the geomechanical studies conducted by the KazNRTU named after K. I. Satpayev, within which the study of the strength properties of rock mass and geodetic observations were conducted.

Akzhal deposit is located in Shetsky district of Karaganda region. The nearest mining center is Balkhash, located 130 km to the South-East. Currently, the reserves production is

conducted by the 'Central' open-pit mine, which maximum depth reaches 240-245m. The deposit reaches 5.5 km, orebodies in the central part of the deposit had access to the daylight area, the occurrence of orebodies to a depth of 600 m, the width of the ore zone to 350 m, the dip in the central part is steep, in the eastern section is low (up to 20-30°); the vein rocks accompanying the intrusions are widely developed on the area of the Akzhal ore field. Rock unit corresponds to the dikes of the second phase and presented by diorite, diabase, quartz diorite porphyry, granosyenite-porphyrines.

The area of Akzhal ore field is characterized by comparative poverty of surface and underground waters and belongs to the zone of insufficient moisture. Hydrogeological conditions of the region are determined by a specific combination of climatic, physical, geographical and geological factors typical for the Central part of Kazakhstan. Groundwater is contained in rocks of most stratigraphic units, however, they are diverse by the mode of occurrence, chemical composition, mineralization and transmissibility.

Kazakhstan can be described as the mineral resource power, the economy of which depends on the development of the commodity sector. In this regard, it should be noted that Kazakhstan has recently adopted a number of legislative acts in support of the intensification of the extraction and processing of natural resources. These might include:

Law of the Republic of Kazakhstan dated June 24, 2010 'On Subsoil and Subsoil Use', aimed at protecting the interests of the Republic of Kazakhstan, as well as rational and integrated use of subsoil.

Law of the Republic of Kazakhstan dated January 8, 2003 'On investments', aimed at stimulating investments and guaranteeing protection of investors' rights in the implementation of investments in Kazakhstan;

State program on forced industrial and innovative development of the Republic of Kazakhstan for 2010-2014, approved by the decree of the President of the Republic of Kazakhstan dated March 19, 2010, aimed at ensuring diversification and increasing the competitiveness of the country's economy. (Nizametdimov, 2015).

Intensive development of mineral deposits in the way of open-pit mining in general and the formation and operation of open-pit mines in particular cause the manifestation of a

wide range of geodynamic processes on the Earth's surface and near it. They are the result of various mechanisms, explosions and other technological processes through which mining is carried out. The building of open-pit mine related ground and underground structures, their heating and ventilation along with pumping groundwater also lead to rocks thawing, degradation of permafrost, the occurrence of taliks and thermokarst.

All of the above makes it necessary to constantly monitor the open-pits, especially their sides and dumps in order to timely identify and prevent unpleasant and even dangerous changes in their morphodynamic state (Stupin

& Antipina, 2012). The scope of the modern mining requires a comprehensive study and a constant monitoring of the geomechanical processes occurring in adjacent rock mass, caused by the disturbance of crustal equilibrium, in order to prevent uncontrolled catastrophic situation in mining sites, such as severe landslides and collapsing (Ozhigina, 2016).

In the 1960s and 1970s considerable research was carried out into the stability of rock slopes in open-pit mines. It was also during this period that early development of numerical analysis methods took place, but there was relatively little application of them to the evaluation of

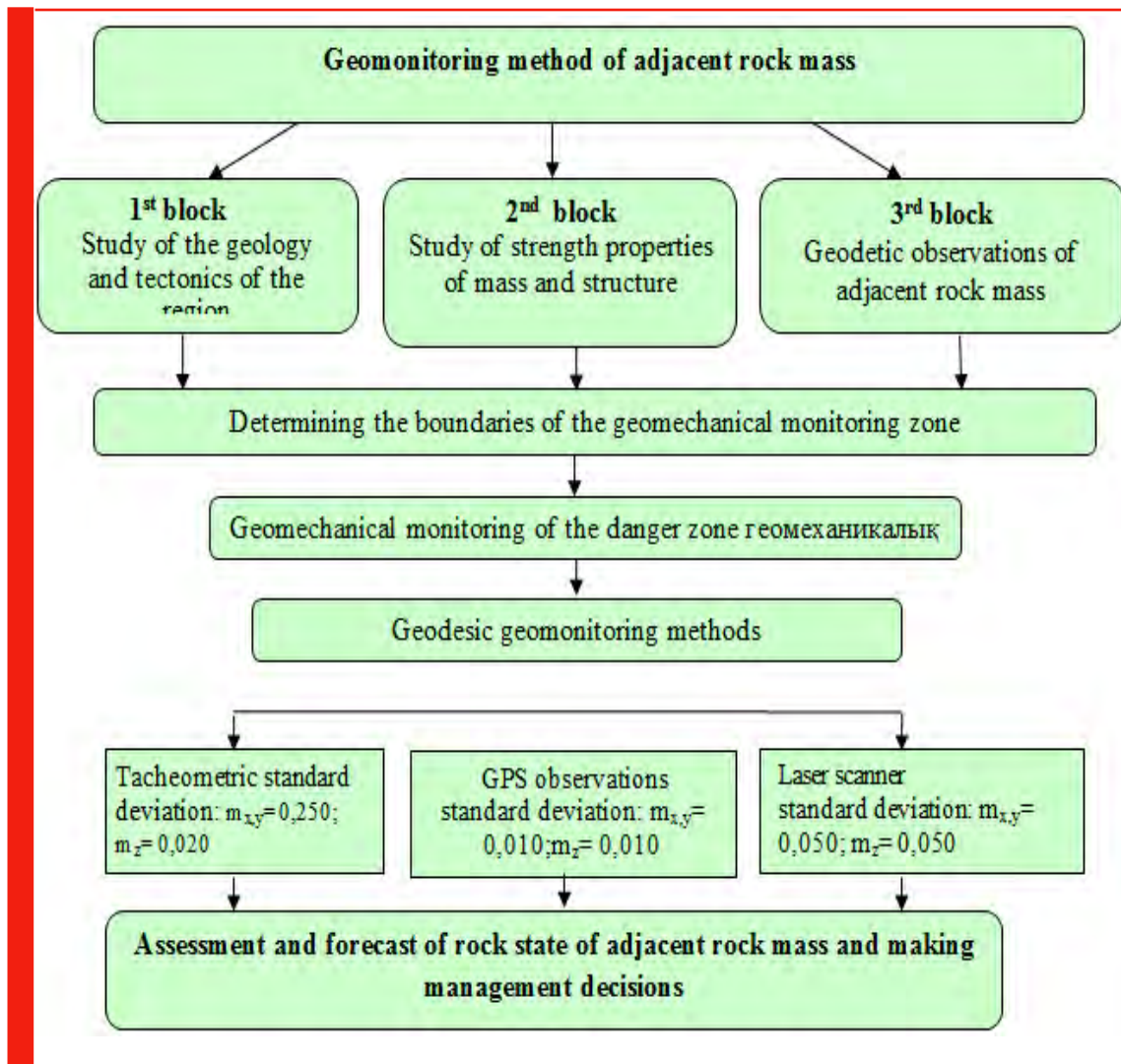


Fig. 1: Scheme of complex geomonitoring methodology

slope stability. Most of the works carried out concentrated on the use of limit equilibrium techniques, and the work of Hoek and Bray (1981) summarizes the state of the art at that time. As indicated by Stacey (1996), there has been surprisingly little development in the technology of stability evaluation of open-pit mine slopes in the 30 years since this period, and limit equilibrium techniques are still most commonly used (Stacey et al., 2003). However, for the last years the subject of open-pit mining safety gained much more attention (Nurpeisova, Kyrgyzbaeva, & Aitkazanova, 2016; Nurpeisova, Bek, & Kyrgyzbaeva, 2016; Nurpeisova, 2016).

A necessary condition for the safe and environmentally balanced development of open-pit mining is to improve the system of monitoring and observation of deformations of the pit sides, slopes and dumps with the use of modern

methods of surveying and high-precision deformation measurements (Trubetskoy & Rylskaya, 2015). Intuitively one would expect that mining activities have an influence on levels of fracturing within a slope – the deeper a slope is, the more stressed and therefore the more it fractures (Lynch & Malovichko, 2006). As noted L. Qiao and Y. Li (2004), as the mining method is turning from open-pit mining to sag by mining, the vertical height of open-pit mine slope continues to increase, the slope deformation and failure mode has close relationship with regional geological structure characteristics and the rock mass structure feature, the stability is influenced largely by rock mass, joints and fissures, and blasting vibration. Particularly, open-pit mine's productive blasting vibration and rainfall has an important effect on the mine slope stability. Productive blasting vibration has an indirect dangerous damage on the high and steep slope. It is mainly caused

Table 1: Physico-mechanical properties of rocks in the sample

Sampling depth,m	Name of the rock	Uniaxial compression strength σ_c , MPa	Uniaxial compression tensile σ_t , MPa	Specific weight , 10^3 kg/m ³	Cohesion in block c, MPa	Angle of friction in degrees	Hardness of rock, H
Data KazNTU for 2002-2008							
50,1-51,8	Cement rock	110	13,0	2,66	25	32	8,0
52,6-53,0	Cement rock	112	13,6	2,66	27	31	8,1
83,5-84,0	Cement rock	125	14,0	2,67	28	32	8,3
112,0-113,0	Cement rock	126	14,3	2,68	32	31	8,6
152,6-153,0	Cement rock	139	14,5	2,71	34	31	9,2
170,0-170,8	Cement rock	140	14,8	2,72	34	29	9,5
218,1-218,6	Cement rock	140	14,8	2,73	35	31	9,6
53,1-54,0	Green stone	137	16,0	2,62	36	31	7,6
53,6-54,0	Green stone	138	16,0	2,62	36	30	7,6
115,0-115,6	Green stone	160	16,8	2,65	42	30	8,2
155,0-156,0	Green stone	170	16,0	2,67	46	30	8,8
200,0-201,5	Green stone	171	16,2	2,69	48	30	9,0
Data of 'Geoservice' LLP for 2010							
248		100,5	12,3	2,7	22,5	34	8,0
258		89,6	6,7	2,7	23,0	34	8,0
Data of KazNRTU for 2018							
260	Cement rock	170,1	16,5	2,71	37	28	8,2
265	Cement rock	173,1	17,2	2,72	49	30	8,8
545	Cement rock	170,0	16,0	2,73	45	30	9,0
545	Cement rock	172,0	16,9	2,71	48	35	8,2
505	Cement rock	170,0	16,2	2,72	48	30	8,8
505	Cement rock	170,0	16,8	2,73	50	38	9,5

by blasting seismic wave after the blasting, especially for the joint fissures development. The high and steep rock slope containing a fault or fracture zone is more likely as this (Li et al., 2006).

The stability of the open-pit sides is characterized by the stability factor, the value of which shows the relative excess of the strength of the rock mass compared to the shear stresses. At the open-pit design stage, in order to determine and justify the parameters of its sides and benches, the calculation of the stability factor is performed taking into account the geological and hydrogeological conditions of the adjacent rock mass. The choice of optimal parameters of the sides and local benches of open-pit mines affects the safety of mining operations and the economic efficiency of the enterprise (Kharisov, 2018).

Requirements for long-term stability of the pit sides rise with increasing depth of mining. Deformation of the pit side

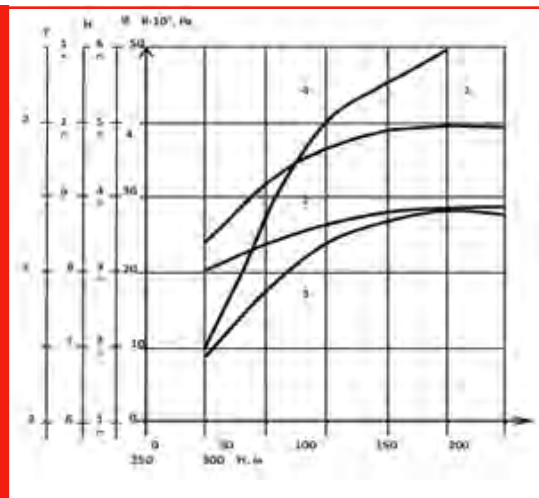
slopes can lead to the destruction of engineering structures and pose a danger to the life of working personnel. Therefore, to ensure the safe mining operations in deep open-pit mines, a forecast is required, the implementation of which is determined mainly by the establishment of the causes, conditions, time and place of deformation (Umarov, 2013).

The understanding of rock slope instabilities is becoming increasingly important as a consequence of population growth and increased land use and transportation demands in mountainous regions. In order to optimize early warning systems, knowledge about the specific geological conditions of each landslide site is necessary (Willenberg et al., 2002).

An adequate geomechanical model of the complicated-structure side mass developed on the basis of geomechanical monitoring is to include: geological and geomechanical assessment of the deposit; substantiation of the design strength properties of the mass; methodology of computing accounting for the slope geometry, the mass structural features, the open-pit slope forming duration and service life of its separate sections (S. Ozhigin, S. Ozhigina & D. Ozhigin, 2018).

Instrumental surveying and geodetic control of the stability of open-pit slopes is performed by creating a network of observation stations in the form of profile lines of benchmarks laid on the marginal line, on the bench berms or on the dumps perpendicularly to the upper open-pit edge on the most unfavorable areas of stability, and the production of high-precision instrumental observations on them (Ozhigina, 2015).

Modern observation methods for the geomechanical state of the open-pit mine sides are very diverse. In recent years, the methods of remote sensing of the Earth using satellite radar interferometry have been relevant. Currently, the most promising are the methods using modern electronic



1- cohesion - c; 2- Angle of friction - φ ; 3- hardness - H; 4- average specific weight - g.
Fig. 2: Dependence of strength properties of massive cement rocks with the depth of their occurrence at Akzhal mine

Table 2: Equations of relations of rock properties with the depth of their occurrence

Investigated value	Function equation	Reliable value	Limits of action
Cohesion by crack c, Pa*105	$c = 14,5 + 0,2h - 0,0004h^2$ (1)	0,88	300<h<50
Angle of friction φ , degrees	$\varphi = 25,5 + 0,1h - 0,0002h^2$ (2)	0,90	250<h<50
Hardness of rock H	$H = 6,15 + 0,018h - 0,00003h^2$ (3)	0,89	300<h<50
Specific weight g, ton/m3	$g = 2,36 + 0,0038h - 0,000008h^2$ (4)	0,88	250<h<50

equipment, based on the determination of the deviation of the coordinates of the working benchmarks of observation stations from their initial position (Mozer, 2013). Among the equipment used more often to monitor the safety situation on the open-pit mines are: laser scanning, electric total stations and GPS technologies. Modern electric total stations can simultaneously measure horizontal and vertical angles, distances and elevation differences. The principle of operation of the total station is based on the reflection of a straight laser beam from the reflecting target and measuring the distance to it. Generally, the reflector is a special prism fixed on the surface of the object. The measurement of two angles (vertical and horizontal) makes it possible to calculate the three-dimensional spatial coordinates of the reflection point. The emergence of non-reflective total stations that are able to work without special reflectors,

revolutionized geodesy. Now it is possible to carry out measurements without a reflector, but simply pointing the device at the desired point. The beam can be reflected from any flat surface (Azarov, 2011). The laser scanning technology operating principle is to determine the spatial coordinates of the points of the object surface. This is done by measuring the distance to all points to be determined using a laser reflectorless distance meter. The device that implements the above measurement technology is called a laser scanner. The result of the scanner is a set of points with calculated three-dimensional coordinates. Such sets of points are called point clouds or scans. Normally, the number of points in a single cloud can range from several hundred thousand to several million ('Surface laser scanning', n.d.). Namely, M. Nurpeisova et al. (2017) in the geodetic monitoring of the facilities located in the industrial

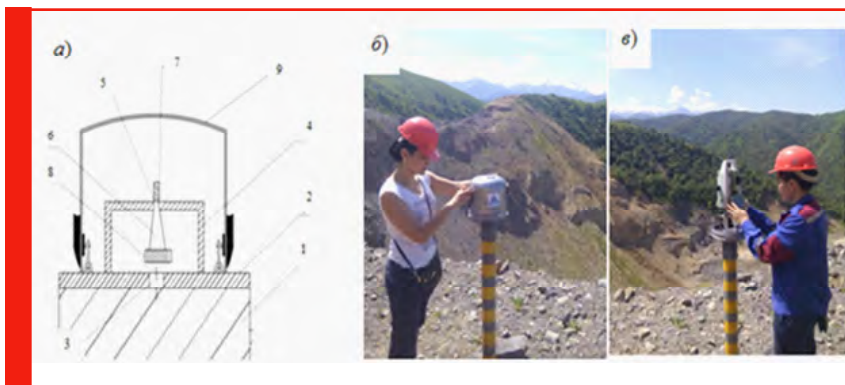


Fig. 3: Permanent ground benchmark a- construction section: 1- concrete footing; 2- metal plate 3- center; 4- steel set; 5- frame hole; 6- attachment screw- 7; 8- butt; 9- receiver b- removing of receiver; c- device installation and monitoring.

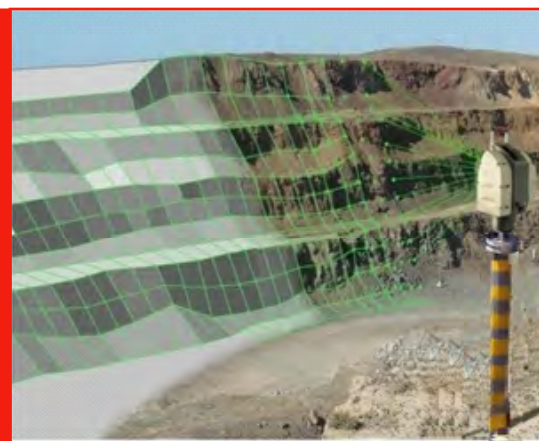


Fig. 4: Shooting adjacent rock mass of Akzhal by Leica HDS4400 laser scanner installed at fixed point

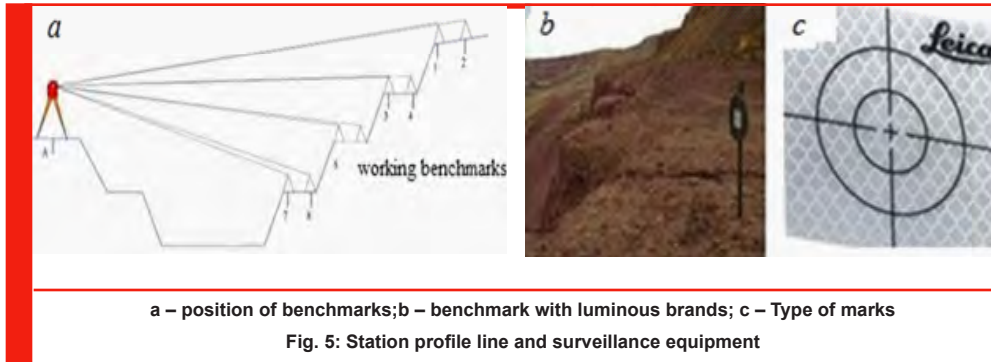
area of the Maykain mine in Kazakhstan have used such surveying instruments, as satellite technologies, electronic total stations and laser levels.

Along with the increase in the depth of open mining increases the service length of the adjacent rock mass. Existing open mining are characterized by the open-pit mines with a long service of 50-60 years or more, such as copper ore: Kounrad, Nikolaev, as well as iron ore: Sokolovsky and Sarbay. The average design lifetime of open-pit mines ranges from 20 to 30 years. At the same time, with the increase in the depth of mining, as a rule, there is a deterioration in the geological conditions of the deposits. The current stage of open-pit mining and coal mines is characterized by modernization and acquisition of new technical means of mining, the use of new technological solutions, which leads to the intensification

of mining. Under these conditions the special role is given to a reliable control, support and instrument control of a condition of the adjacent rock mass on the open-pit mining (Nizametdimov, 2015).

Technical level of traditional geodetic observations during geomechanical monitoring does not always meet

the requirements of mining enterprises, since working with them requires many working hours and there is no possibility to obtain promptly the necessary information about the deformation state of the rock mass. Therefore, the use of modern geodetic instruments (electronic total stations, GPS technologies and laser scanners) for geomonitoring and improving of methods of working with

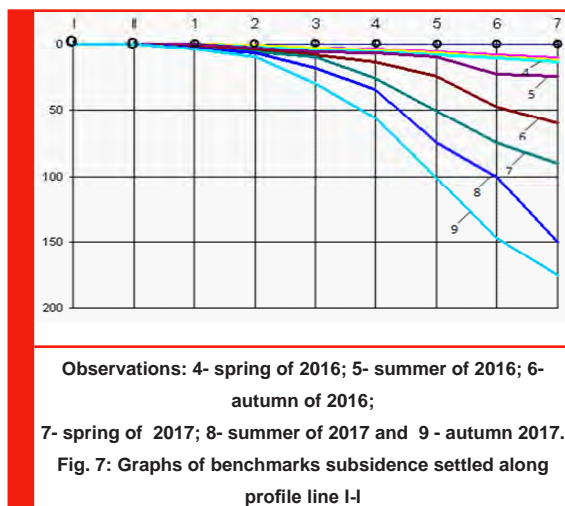


them, we consider that it is closely related to the increase in the level of innovative areas (Nurpeisova, & Kyrgyzbaeva, 2014).

This confirms the importance of methodology improvement for conducting geomechanical monitoring using modern geodetic instruments as the basis for solving scientific and technical issues.

MATERIAL AND METHODS

The analysis of state of methodology for conducting geodetic observations on the territory of mined deposits is particularly related to the lack of effective methods for determining deformation scale, which necessitates improvement of methodology of rock deformation geodetic observations using modern instruments. Geodetic observations provide opportunity to identify the massif deformation, which is essential for geomechanical situation assessment in mining area. But they do not provide complete picture of the deformation processes in time. This can be done only with using integrated methodology of geomonitoring of adjacent rock mass (Fig. 1).



According to 2nd and 3rd blocks of the recommended methodology (Fig. 1), engineering-geological and mining-technical conditions of development are studied in detail, as well as geomechanical state of adjacent rock mass, structural and tectonic features, and physicommechanical properties of the rocks of Akzhal deposit are studied.

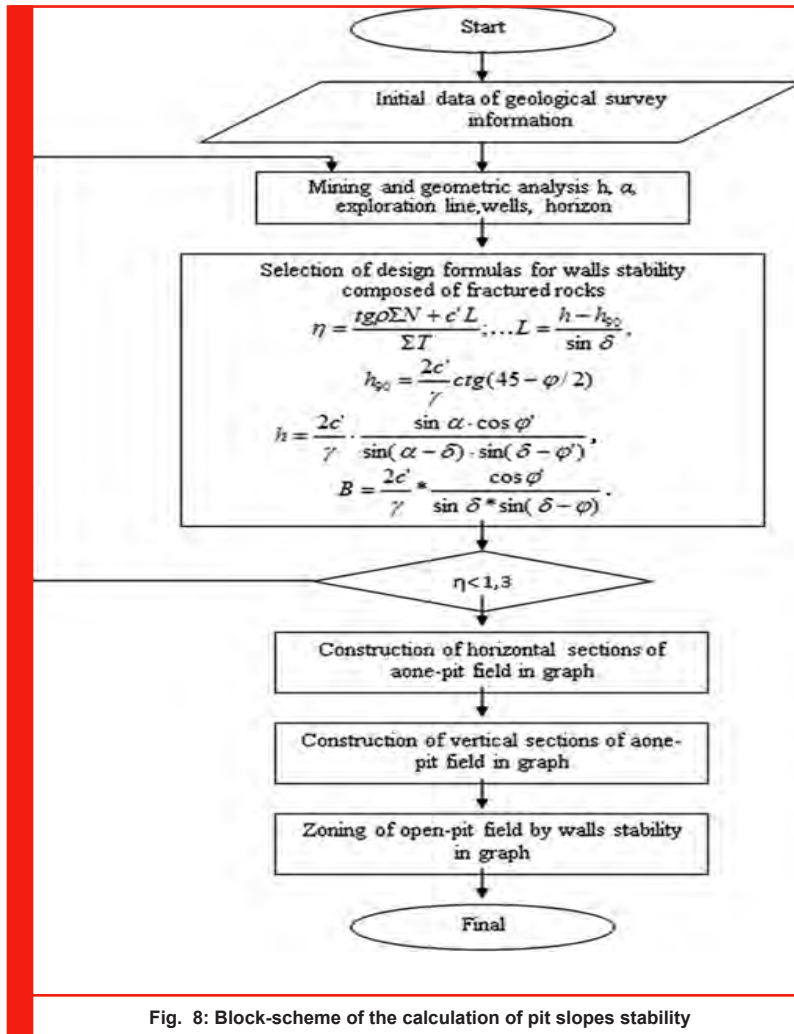
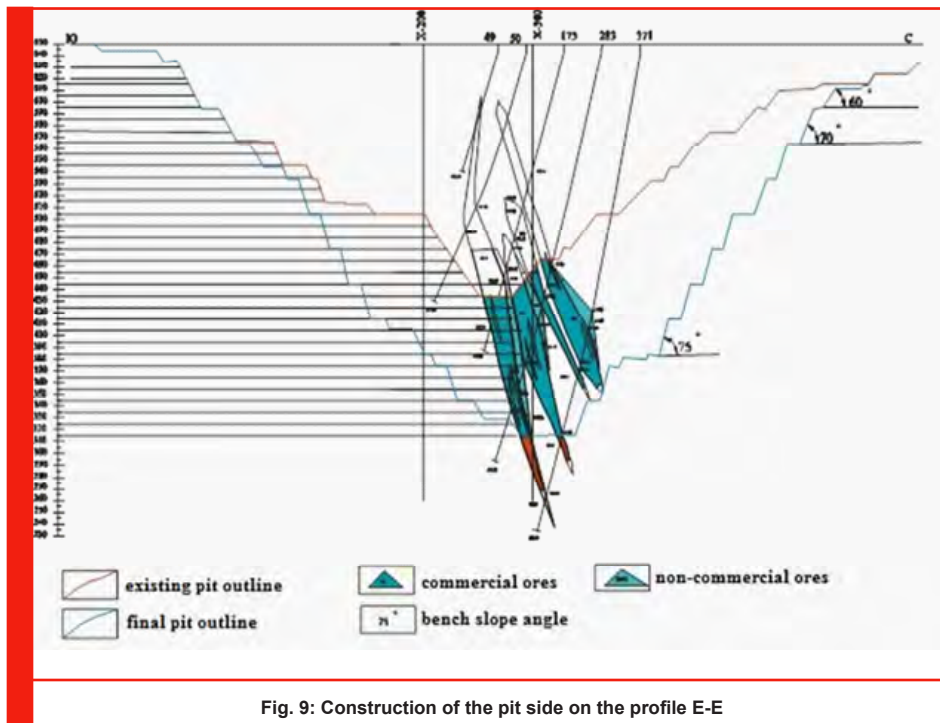


Table 3. Assessment of open-pit sides stability of Akzhal

Sections	Design characteristics of rocks					Crack angle α , degree	Crack angle δ , degree	h_s , m	Stability index
	In mass γ , ton/m ³	c_m , ton/m ²	φ_m , degree	By crack c_t , ton/m ²	φ_t , degree				
South B-IX	2,68	55,8	22,5	18,6	20,0	65	75	60	1,3567
South B -VI	2,70	62,0	22,5	19,0	20,0	70	5	90	1,2890
North M- 22	2,70	62,0	22,5	19,0	20,0	70	75	190	1,2100
South B -IX	2,68	55,8	22,5	18,6	20,0	60	75	30	2,7450
North I- I	2,68	55,8	22,5	18,6	20,0	65	75	60	1,2560
South B -IV	2,70	62,0	22,5	18,6	20,0	70	75	90	1,6030
South B -IX	2,68	55,8	22,5	18,6	20,0	75	75	190	1,2240
North M- 22	2,68	55,8	22,5	18,6	20,0	75	75	190	1,2240



In connection with increasing of pit depth, physico-mechanical properties of rocks were determined at deep levels in order to compare the data of previous studies with their actual values. Significant discrepancy with the data on the upper horizons due to the influence of weathering, watering and technogenic impact on the rock mass was evaluated.

Based on the analysis and synthesis of data performed earlier of engineering-geological surveys and testing of rock strength in laboratory and in-situ conditions, number of scientific institutes were completed and indicators of rock strength properties were supplemented.

According to results of the survey, large number of deformations of various types and intensities were revealed: landslides, cracks, collapse. It has been established that the main causes of disturbances of benches stability are relatively low bearing capacity of waterlogged rocks and overestimated parameters of the working benches (Nurpeisova, Kyrgyzbaeva, & Bek, 2017).

RESULTS AND DISCUSSION

Main strength properties of rocky and semi-rocky mass, which are crucial for solving the problems of the stability of mine workings are specific weight g , rock compressive strength sc and tensile strength st , rock cohesion c and

angle of internal friction φ . These properties are different in the piece (sample) and in mass for the same type of rocks. For example, rocks cohesion obtained by laboratory tests in a sample may be ten times more than for the same rock in mass. As stated by United States Department of Agriculture Natural Resources Conservation Service (2012), the properties of a rock mass are significantly different from the properties of samples of the same rock mass. The strength and mechanical behavior of the rock mass are commonly dominated more by the nature of its mass properties than by its material properties. A rock mass comprised of even the strongest intact rock material is greatly weakened by the occurrence of closely spaced discontinuities. Material properties, however, tend to control the strength of the rock mass if discontinuities are widely spaced or if the intact rock material is inherently weak or altered. Discontinuities within a rock mass, therefore, reduce its strength and stability and reduce the energy required to excavate or erode it. The term 'discontinuity' applies to any distinct break or interruption in the integrity of a rock mass. Discontinuities are classified as either stratigraphic or structural, according to their mode of formation.

Determining the uniaxial compression strength of rocks is made in accordance with international standards. Researches of the All-Russia Research Institute of Mining Geomechanics have established that the angle of internal

friction in the mass (φ_m) over the surfaces of weakening can be taken to be equal to the angle of internal friction (φ_s) obtained for rock sample by laboratory tests. Cohesion of the rock mass significantly differs from the cohesion of the piece of rock in the way of reduction and can be obtained by field tests, measurements of the collapse that occurred using the structural weakening coefficient (Fisenko, 1965).

Table 1 shows physico-mechanical properties of rocks of Akzhal deposit according to the results of laboratory tests.

According to G. L. Fisenko, angles of internal friction of rocks in the sample and in the mass are the same, i.e. $\varphi \approx \varphi'$, therefore it is recommended to use only our tests to determine the amount of cohesion c' , and angle of internal friction φ' to be found as a result of laboratory studies of rock samples taken from the field sites.

Analysis of the study of the actual stability of the slopes, identified main types of deformations of adjacent rock mass and causes of these deformations, as well as the results of the structural features and the physico-mechanical properties of the rocks allowed us to obtain graphical and analytical dependencies between the parameters of the slopes and the properties of the rocks (Fig. 2 and Table 2).

Variation curves of the properties of rocks were carried out according to average indicators over the depth of 50 m. Assessment and reliability of determining dependencies were made using the formulas of mathematical statistics.

Deviation of the calculated curves from the empirical curves ranges from 5-8%, and most of them coincide with each other. Analysis of the data also shows that the strength properties of rocks with depth of their occurrence change noticeably (Nurpeisova, Adilbaev, & Zhusipov, 2017).

Observations of absolute deformations of pit slopes on researchable object were carried out on the profile lines of the observation station with instruments of new generation. Repeated geodetic measurements were carried out with electronic total stations from Leika TS110 and TS1206 in combination with reflectors and 3D scanners installed on permanent ground benchmark.

Long-term instrumental observations have shown the laboriousness of field work, especially the transferring a

set of instruments (the device itself, tripod, slats, etc.) from one point to another. In this regard, for the installation of instruments and efficiency of measurement operations, firstly, we have developed permanent benchmark that is installed at the reference point when conducting geomechanical monitoring (Fig. 3). The device is the geodesic center for installing new instruments. Purpose of this invention is to improve the accuracy of centering, measurement efficiency in the absence of tripods in points of standing and observation. New device allows for quick and accurate centering and eliminating the use of tripods (Nurpeisova, Kyrgyzbaeva, & Donenbaeva, 2018; Nurpeisova, Bek, & Kyrgyzbaeva, 2016).

In this case, there is a unique opportunity to obtain information on the position of adjacent rock mass without direct contact of the contractor.

Methods of measuring fracturing of rocks are mainly reduced to direct measurements in outcrops, on slopes in quarries, along with hole walls and mine workings, and observations from cores of geological wells. In open-pit mining, rock fracturing was studied by means of using rock compass, i.e. the angles of incidence of cracks and azimuths of their strike were measured by mountain compass.

3D scanners usage in surveying and geodesic practice allows us to study in sufficient detail occurrence of cracks and faults (Fig. 4). The accuracy of obtaining shooting parameters is determined by the distance between device and object to be photographed.

During the processing of results of laser scanning, software package 'Maptek I-Site Studio' was used, where the values of the occurrence of fracture elements were calculated: strike azimuth, incidence angles and sizes of rock blocks (Nurpeisova, Kyrgyzbayeva, & Kopzhasaruly, 2016)

Using the results of shooting with laser scanner to obtain elements of the occurrence of cracks and sizes of structural blocks is possible when the device is located up to 800 meters from the adjacent rock mass. In this case, there is a unique opportunity to obtain information on the position of the adjacent rock mass without direct contact of the contractor.

Benchmarks on the benches were set higher and on the front side of the benchmark were glued luminous marks of the Leica Geosystems company (Fig. 5).

Observations of absolute deformations of rock mass were carried out on the profile lines of the observation station with instruments of new generation. Repeated geodetic measurements were carried out with electronic total stations installed on permanent basis, as well as with laser devices in inaccessible areas. For the first time, we observed observational marks at Akzhal mine, which ensured an increase in the accuracy and productivity of field surveying (Fig.6).

For 2016-2017, 6 series of geodetic observations were carried out on profile lines. According to the results of observations for each profile line, statements of vertical and horizontal displacement of benchmarks as well as displacement graphs were compiled (Fig.7).

For stability assessment of slope composed of fractured rocks, method of automated assessment of their condition has been developed. There are many design schemes that take into account the surface of weakening in massif. Theoretically, the most reasonable are design schemes recommended by R. P. Okatov and F. K. Nizametdinov for fractured rocks, in which the parameters of stable slopes are determined taking into account surface of weakness in relation to the strength properties of rock mass (Nizametdinov, 2014) (Fig.8).

This complex of calculations is carried out on computer for each block of pit section being modeled, summary tables of database are formed (Table 3) and zoning of pit slopes is made by the sustainability factor.

Analysis of data in Table 3 shows that along the southern side of the open-pit side in sections of profile lines with slope angles of longitudinal steeply falling cracks 75-780, stability of the slopes at their incidence angles of 65-700 is ensured.

On the northern side of the section of the profile line I-I, as well as on the southern side (profiles M 22), slopes will be in a temporarily stable state ($\eta_3 = 1.21-1.22$), and over time the bench may be subject to local collapse. The results of the study allowed to clarify the parameters of the stable sides and benches in the limit position and to adopt new version of the contour of Akzhal open-pit mine (Figure 9).

Since the ultimate goal for all geomechanical studies is to ensure industrial safety, there has been developed solution for hardening cracked rock mass to prevent further deformation of open-pit sides. Solution contains cement, filler and water. The filler used wastages of processing plants of mining complex.

At the same time, new composition was investigated and obtained to strengthen the reinforcement of the support points of the observation station in wells allowing to dispose of the mining waste and increase the strength and frost resistance of the material obtained.

CONCLUSION

Based on the analysis of domestic and foreign scientific and technical literature, experience in the study of geomechanical processes and deformation of engineering structures and observation means of deformations, comprehensive methodology for geomonitoring using modern high-precision geodetic measurements was recommended.

According to the 1st and 2nd blocks of recommended methodology, geology and tectonics of deposit area have been studied, studies of strength properties and structural features of rocks mass have been carried out. Methods of mathematical statistics and correlation analysis made it possible to summarize the data of physical and mechanical properties of rocks of Akzhal deposit.

Unified mathematical system was developed, generalizing graph-analytical dependencies between properties of rocks and depth of their occurrence in the subsurface were obtained. Possibility of predicting stress-strain state of rock mass at the studied fields was proved, i.e. it will be possible to determine: strength limit - σ_c ; cohesion - c ; specific weight- γ and hardness of the rocks H on M. M. Protodyakonov scale.

Existing methods for conducting geodetic measurements using GPS observations, electronic total station and laser scanner have been improved, namely:

- . use of deformation (luminous) marks;
- . positioning of permanent ground benchmarks;
- . during studying the fracturing of rocks in mass, using laser scanner instead of using mountain compass.

Obtained results were used in assessment of the stability of adjacent rock mass and ensuring industrial safety of subsoil development.

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Integrated Monitoring of the Earth Surface Dynamics of the Caspian Zone

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ABSTRACT

Abstract. The article includes the results of long-term researches of geodynamic processes during development of hydrocarbon deposits in the western region of Kazakhstan. Results of integrated monitoring of the deformation of the Earth's surface and coastal lines of the Caspian Sea are presented through the example of areas of intensive and large-scale exploration of the subsoil. Integrated research method was used to perform the works including: analysis and synthesis of domestic and foreign experience in geodynamic researches; conducting repeated geodetic observations of the deformations of the undermined areas using modern instruments; comparative analysis of radar interferometry and ground-based observations; analyze of influence of deposits development intensity on the displacement of the earth's surface and on changing the coastlines of the Caspian Sea. Also, conclusions on the nature of geodynamic processes in the territory under consideration are presented too.

KEY WORDS: Hydrocarbon Deposits, Earth Surface, Subsidence, Coastal Lines, Geodynamic Polygon, Geodetic Monitoring, Satellite Monitoring, Radar Interferometry.

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INTRODUCTION

The Caspian Sea is developing many oil and gas fields. The proven oil resources in the Caspian Sea amount to about 10 billion tons, the total oil and gas condensate resources are estimated at 18-20 billion tons. Oil production in the Caspian Sea began in 1820, when the first oil well was drilled on the Absheron shelf near Baku. In the second half of the XIX century, oil production began in industrial volumes on the Absheron Peninsula, and then in other territories. In 1949, for the first time, oil from the bottom of the Caspian Sea began to be extracted on the Oil Rocks. So, on August 24 of this year, a team of Mikhail Kaverochkina started drilling a well, which gave long-awaited oil on November 7 of the same year (Roshydromet). In addition to oil and gas, salt,

limestone, stone, sand and clay are also being mined on the coast of the Caspian Sea and the Caspian shelf (Caspian Sea: Hydrology and Hydrochemistry, 1986; Hodorevskaya, Sudakov & Romanov, 2007).

The environmental problems of the Caspian Sea are associated with water pollution from the extraction and transportation of oil on the continental shelf, the flow of pollutants from the Volga and other rivers flowing into the Caspian Sea, the activity of coastal cities, and the flooding of individual objects due to rising levels of the Caspian Sea. Predatory prey of sturgeon and their caviar, rampant poaching leads to a decrease in the number of sturgeon and forced restrictions on their production and export (Caspian Sea. Ichthyofauna and commercial resources, 1989).

The Caspian Sea, as is known, is divided by the Mangyshlak and Absheron rifts into three parts: the Northern, Middle and Southern Caspian. The Volga flows into the North Caspian, compensating 63% of the water evaporating from the sea, and 100% of the biogenic salts buried in the bottom sediments and taken along with the fish (Zhilkin, Zaitsev,

Kurapov, Monakhov, & Aldabaev, 2013; Ivanov, 2000).

In the process of developing offshore oil and gas fields in the Northern Caspian, it is necessary to know the features and patterns of the spatial distribution of marine biota in the area affected by possible oil and gas production, especially oil spills, in order to reduce or prevent a negative impact on biota and on the quality of sea water (Ostrovskaya, Kolmykov, Kholina, Pronina & Voinova, 2016a).

The water area of the Caspian Sea is subject of significant anthropogenic impact. The main sources of hydrocarbons here are traditionally coastal and offshore oil and gas facilities, shipping and river runoff (mainly runoff of the Volga River, which brings about 80% of the total river water to the sea). Oil production in the Russian sector of subsoil use (RSSU) of the Caspian Sea was launched in 2010 and by April 2015 reached a total of 4 million tons. In the Kazakh sector, by 2020, oil production is planned to increase from the current 80 to 120 million tons per year. This increase in production is expected to be achieved through the development of three recently explored deposits: Tengiz, Korolevskoe and Kashagan.

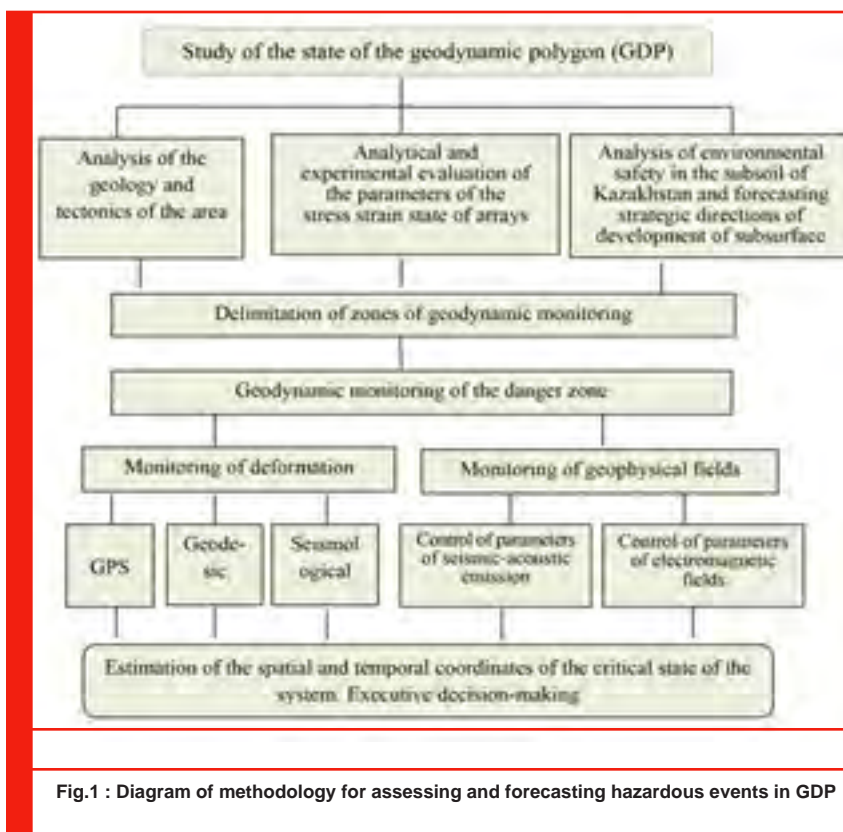


Fig.1 : Diagram of methodology for assessing and forecasting hazardous events in GDP

Tanker and other transportations also significantly increase the risks of oil pollution in the northern part of the sea, on the shores of which there are several rather large ports. For example, the turnover of the largest Kazakhstani port of Aktau on the east coast reached 12.81 million tons in 2010, and 12.1 million tons in 2011 (Ostrovskaya, Kolmykov, Kholina, Pronina & Voinova, 2016a).

Cargo turnover of Russian ports amounted to 9.4 million tons in 2011, and half of them accounted for oil and oil products. Taking into account existing plans to increase oil production, even if their implementation will be postponed for the time of the current crisis, in the future we should expect an increase in the risks of oil pollution of the marine environment in the area. Another important, but still undervalued source of hydrocarbons in the northwestern part of the Caspian Sea is atmospheric deposition. At least, polluted air is the main supplier of many pyrogenic polyaromatic hydrocarbons into the marine environment (Nizetto, Lohmann, Gioia, Jahnke, Temme, Dachs, Herckes, Di Guardo & Jones, 2008; Nemirovskaya, 2004e).

In addition to anthropogenic sources of hydrocarbons (HC), their natural sources exist in the northwestern part of the Caspian Sea. The Caspian Sea is a highly productive body of water from a biological point of view (Glumov, Malovitskiy, Novikov & Senin, 2004). The living organisms inhabiting it produce various hydrocarbons, including those similar to petroleum. Along with the gas and oil seeps existing in the water area (Bezrodnykh, Deliya, Lavrushin, Yunin, Poshibaev & Pokrovskii, 2013), these biogenic hydrocarbons form the so-called natural background in the

marine environment (Nemirovskaya, 2013a; Kvenvolden & Cooper, 2003).

Despite the recognition of the threat of oil pollution to the ecology of the Caspian Sea, the number of comprehensive studies in this area is small. In 2000-2001 In the framework of the Caspian Ecological Program (CEP), studies of the accumulation of hydrocarbons in the bottom sediments of the coastal zone of the sea were carried out, published in the work "Aliphatic and aromatic hydrocarbons in coastal Caspian Sea sediments" by Tolosa, I., de Mora, S., Sheikholeslami, M. R., Villeneuve, J. P., Bartocci, J. and Cattini, C. (2004). Later, in 2004-2013 The Russian Academy of Sciences conducted research in the delta of Volga and in the deep water area of the Middle and Southern Caspian. This data is observed in several works by Nemirovskaya I.A. and Brekhovskikh V.F. "Hydrocarbons in bottom sediments of the marginal filter of the Volga River" (2006b); Nemirovskaya I.A. and Brekhovskikh V.F. "Origin of hydrocarbons in the particulate matter and bottom sediments of the northern shelf of the Caspian Sea." (2008c); Nemirovskaya I.A., Kozina N.V. and Lisitzin A. P. "Origin of hydrocarbons in the contemporary sediments of the Caspian Sea." (2014d). However, the northern part of the sea, and especially its western coast, was practically not affected.

Subsoil of the Caspian zone of the Republic of Kazakhstan is rich in hydrocarbon deposits. Large-scale development of oil and gas resources leads to intensive movements of the earth's surface, both within local areas and in individual structural elements, resulting in curvature of bore wells, rupture of oil and gas and water pipelines, disruption of railways and highways, underground utilities and engineering structures, which in turn leads to significant economic damage. All this is a direct consequence of changes in the geodynamic regime of the geological environment under the influence of large-scale development of the subsoil, which is convincingly confirmed by the results of experimental studies of the movement of the earth's surface using geodynamic polygon (GDP) of the Caspian zone as an example (Sidorov, 2004a; Sidorov, 2000b).

In accordance with the Regulation on the State Monitoring of the Subsoil of the Republic of Kazakhstan, the function of the geodetic service is to monitor the subsoil, including the displacement of rocks and the earth's surface, geomechanical and geodynamic processes in subsoil use,

Table 1: Total hydrocarbons concentrations in sediments of the Caspian Sea.

Area	Survey year	Concentration (µg/g dry weight)
Northern Caspian, Russia	1998-2003	<0,5-56,1
Northern Caspian, Russia	2012-2014	1,0-114
Northern Caspian, Russia	2000	<0,5-30
Northern Caspian, Kazakhstan	2001	<0,5-30
Southern Caspian, Azerbaijan	2000	30-1820
Southern Caspian, Iran	2001	30-600

Source: Based on research data presented by Tolosa I., de Mora S., Sheikholeslami M. R., Ostrovskaya E.V., Monakhov S.K. and others.

as well as objects of the earth's surface and the natural environment.

Figure 1 shows the structure of the methodology of studying and predicting hazardous states in geodynamic polygon (GDP) taking into account the whole complex of types of geophysical and geodetic measurements and their joint processing.

According to the analysis of the geology and tectonics of the area, numerical modelling and experimental evaluation of stress state in the massif are allocated «high power zones», which determine the geodynamic monitoring zone boundary. Then monitoring of the danger zone is organized which includes primarily control of the deformation and geophysical field parameters.

Accurate information on deformations of the earth's surface can be obtained by direct instrumental measurements at the sites of the site. During studying of modern movements of the earth's surface, their vertical component is obtained from the results of repeated high-precision levelling.

MATERIAL AND METHODS

Hydrocarbons in bottom sediments Northwest Caspian Sea. In 2012-2014 HC content in bottom sediments also differed by high spatial heterogeneity, ranging from 1 to 114 µg/g (Table 1) with the largest values in the coastal zone of Dagestan and in the areas of shipping routes.

As shown by the data given in "Pollution of the bottom sediments of the Northern Caspian."(Ostrovskaya, Monakhov, Kashin, Nepomenko, Popova & Tatarnikov, (2013b), HC concentrations in the bottom sediments of the Northern Caspian in the period 1998–2003 varied from traces to 56.1 µg/g, which is significantly lower than

we received in 2012-2014. Table 2 shows for comparison the data obtained by the CEP expedition in 2000-2001 (Tolosa, de Mora, Sheikholeslami, VilleneuveBartocci & Cattini, 2004).

The values of HC concentrations observed in 2012-2014 are still significantly lower than those found in the sediments of Azerbaijan (30-1820 µg/g) and Iranian (30-600 µg/g) coastal waters. Volkmann and colleagues (1992) suggested that hydrocarbon concentrations in precipitation in excess of 500 µg/g be considered an indicator of significant oil pollution, and concentrations of about 10 µg/g and below - an indicator no pollution. It should be noted here that in 2012-2014 HC concentrations in precipitation did not exceed 10 µg/g in 40.4% of samples.

Thus, the concentrations of hydrocarbons in the bottom sediments of the northwestern part of the Caspian Sea were higher than those observed earlier, thus showing a tendency to increase the risks of hydrocarbon pollution in this area of the sea in recent years. However, these values are still at the level of unpolluted or low-contaminated areas (Ostrovskaya, Kolmykov, Kholina, Pronina & Voinova, 2016a).

Held in 2012-2014 In the framework of the "Roshydromet" program for transboundary monitoring of the Caspian Sea, research has allowed assessing the current level of pollution of the marine environment of RSSU with hydrocarbons. The concentrations of these substances in the water and bottom sediments of the studied water area turned out to be higher than those observed in this area a decade earlier, but they are still characteristic of unpolluted

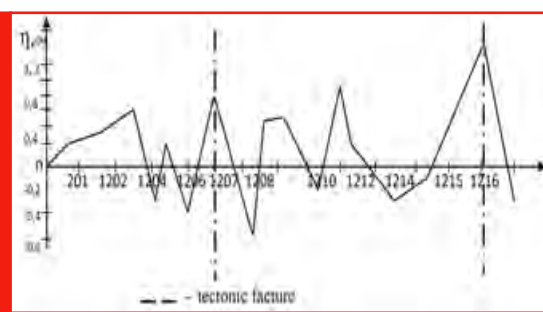


Fig. 2: Graphs of the benchmark displacement of «Tengiz» GDP.

Table 2: Comparative analysis of satellite and linear measurements.

From the point (network scheme)	To the point	S GPS	NS 1201	dS	Relative error
1	2	2359,266	2359,265	0,001	1/1947000
2	4	2606,720	2606,714	0,006	1/429000
2	3	1220,430	1220,428	0,002	1/663000
1	4	2276,461	2276,465	-0,004	1/625000
1	3	2840,789	2840,796	-0,007	1/386000
4	3	1962,898	1962,896	0,002	1/1002000
Standard error				0,005	

and slightly polluted water bodies (Ostrovskaya, Kolmykov, Kholina, Pronina & Voinova, 2016a).

The coastal zone of Dagestan, where the port and oil handling infrastructure, as well as oil refineries are located, was distinguished by a higher HC content. Relatively high concentrations of hydrocarbons were found in the open sea in areas of busy shipping routes (Ostrovskaya, Kolmykov, Kholina, Pronina & Voinova, 2016a).

Identification of HC sources in the area confirmed the findings of previous studies on their mixed origin. Part of the HC is undoubtedly of petrogenic origin. Molecular markers indicate the presence in this area of sources of fresh oil pollution, which can be oil spills and seepage from sedimentary strata. Satellite monitoring data show that the main source of oil spills at the present time is ship discharges of petroleum products into the marine environment. In addition to oil, hydrocarbons of pyrogenic and diagenetic origin are present in the marine environment.

Hydrocarbons and persistent organic pollutants (POPs) have a great influence on the quality of the marine environment of the Caspian Sea. In this regard, the determination of HC and POP content in bottom sediments was included in the "Program for monitoring transboundary water bodies of the Caspian Sea for 2012-2014" of "Roshydromet" (Ostrovskaya, Asaeva, Korshenko, Samsonov, Kolesnikova, Kochetkov & Pantyukhina, 2014c).

Bottom sediments in the northwestern part of the Caspian Sea are generally poorly polluted with HC and POPs, although local zones of increased pollution are noted, especially characteristic of the Middle Caspian. Polyaromatic hydrocarbons in sediments have mixed genesis, however, most of them, in all likelihood, are of petroleum origin. Not weathered hydrocarbons are present in the bottom sediments, which indicate the presence of local sources of fresh oil pollution in the studied area. It can be either oil spills or oil outflow from the sea bottom. In the coastal zone of the Middle Caspian, active diagenetic processes in the sediments are noted, contributing to the transformation of hydrocarbons of petroleum and terrigenous (natural) origin entering its water area.

POP content in the sediments remains at about the same level as during the international expedition of the Caspian Ecological Program in 2002, which confirms their high environmental sustainability and the presence

of local sources of pollution. The exceptions are isomers of chlordane, aldrin and dieldrin, whose concentrations in 2012–2013 did not exceed the analytical zero.

The concentration of polyaromatic hydrocarbons, organochlorine pesticides and congener chlorinated biphenyls generally occur in the finest (pelitic) fractions of bottom sediments, which on average make up about 40% of the total mass of precipitation in the northwestern part of the sea. The distribution of hydrocarbons in fractions over the foreseeable period was more even, significant correlations were not found with any of them (Ostrovskaya, Asaeva, Korshenko, Samsonov, Kolesnikova, Kochetkov & Pantyukhina, 2014c).

Integrated geodynamic monitoring was performed at the Tengiz deposit located in Atyrau region of Republic of

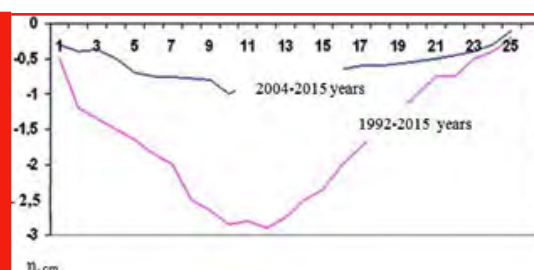


Fig. 3: Graph of benchmark displacements on profile 1-3

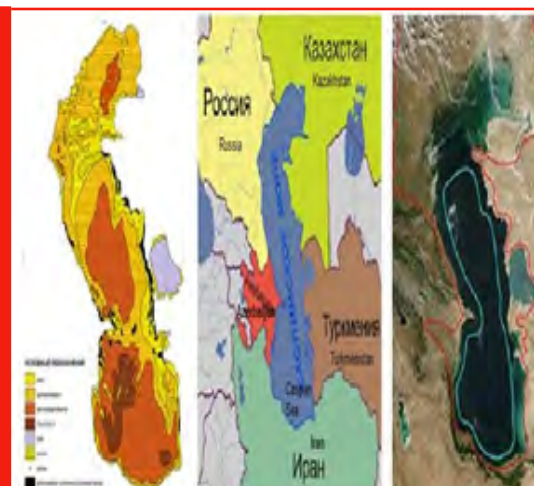


Fig. 4: a- map of the Caspian Sea bottom sediments, b- location of five states developing oil and in- changing coastlines due to man-made processes c- change in coastlines due to technogenic processes.



Fig. 5: Interannual variability of the Caspian Sea level

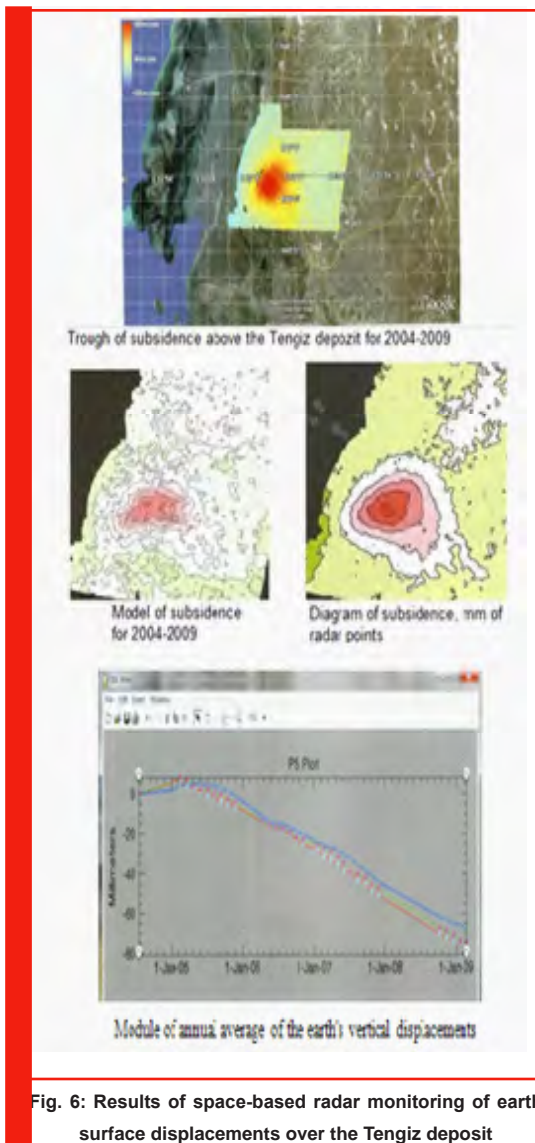


Fig. 6: Results of space-based radar monitoring of earth surface displacements over the Tengiz deposit

Kazakhstan. Tengiz oil and gas deposit was discovered in 1979, and the first oil refining and production complex was opened in 1991, which marked the beginning of the commercial production of hydrocarbons in Tengiz. Massive deposits of this field are located at a depth of 3.8 to 5.4 km. The forecasted reserves of the field amount to 3 billion 133 million tons of oil and 1.8 trillion, m³ of gas.

The analysis of the conducted researches on the Tengiz field shows the dependence between the parameters of the deformation process and the dynamic phenomena in GDP is observed. It was concluded that the probability of the power of dynamic events increases with increase of daily deformation speed (Kozyrev & Panin, 2001).

These problems and difficulties are eliminated using geodynamic monitoring, the main purpose of which is to obtain operational information on the geomechanical processes occurring in the strata of the rocks and the earth's surface and the consequences they cause for timely taking preventive measures.

At « Tengiz » GDP, the leveling of the II class was carried out with a digital laser gradiometer of LEIKA WILD NA 3003 with invar bars using the double leveling method in the direct and reverse directions. Accuracy tolerance of 0.4 mm. was established for the gradiometer, which corresponds to the I-class leveling tolerances.

The principle of leveling is based on the processing of the encoded signal (received from the rack via the lens). Microprocessor calculates the rake data and the corresponding horizontal distance between the rack and the level. Advantages of such a system are the simplicity of measurement, the absence of read and write errors, the automatic calculation of heights during measurement

and data recording (Nurpeisova, Rysbekov & Kirgizbaeva, 2015a).

High-precision levelling was carried out in two cycles, sometimes according to the forecast of seismologists additional measurements were made, the results of which are shown in Figure 2.

The figure shows the results of the levelling definitions for 2015, which indicate:

1) continuity of the processes of deformation of the earth's surface, and along with this the deformation is unevenly in time and;

2) maximum rates of deformation observed in 2008-2016 and confined to fault zones.

Repeated geodetic measurements were also carried out by electronic total stations of Leika TS110, TS120 and the results of determining the subsidence of the frames were compared with the results of levelling. 8 cycles of GPS

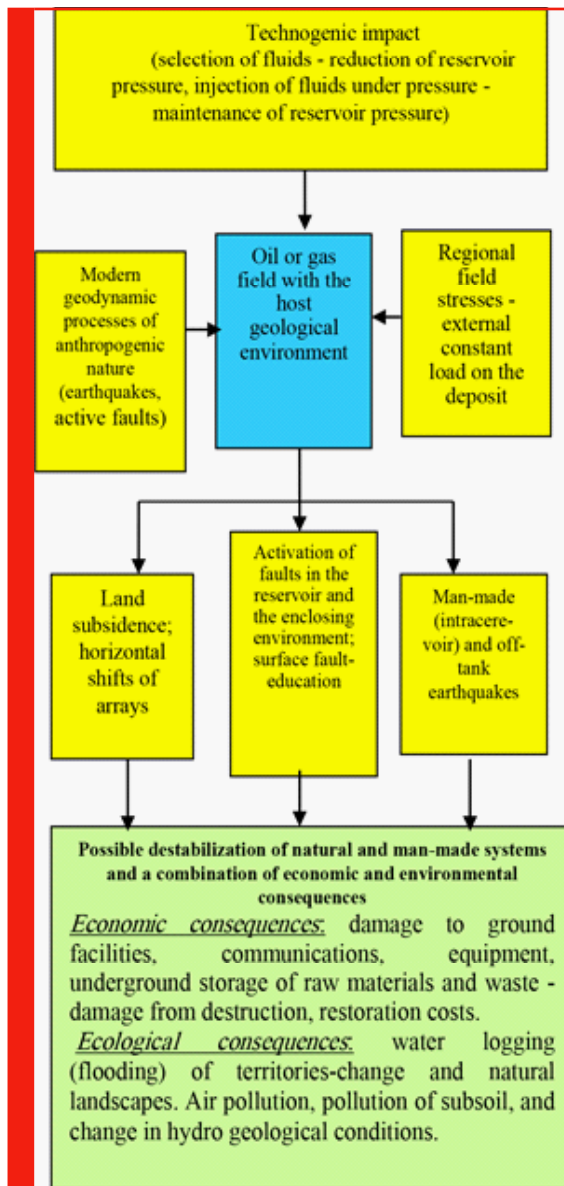


Fig. 7: Diagram of formation of extreme geodynamic phenomena and their industrial and environmental consequences.

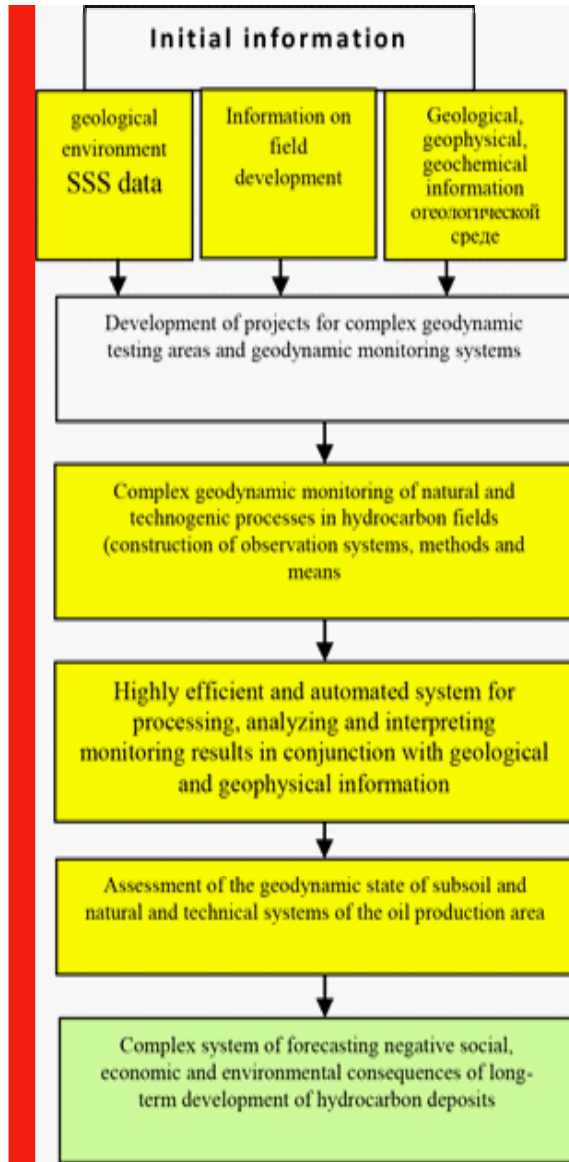


Fig. 8: Structure of integrated assessment system of geodynamic risk and Industrial and environmental impacts forecasting.

measurements were conducted at the «Tengiz» GDP for the period 2008 to 2016:

- transfer of coordinates from the point of ITRF to control point;
- determination of the coordinates of all three GPS reference points;
- determination of shifts of working points on the pipeline;
- measurement time for one work point was on average up to six hours, depending on the length of the line and the conditions of the receiving radio signals at the point.

The processing of satellite observations was carried out according to the standard program SKI («Leica» Switzerland), included in the set of GPS-receivers, as a result of which the planned coordinates of all points of the network in the given local coordinate system and elevations of reference marks were obtained.

To evaluate GDP deformations of the earth's surface that arise and develop on the earth's surface, horizontal and vertical displacements of 9 work stations on the pipeline profile line are analyzed. The coordinates of the working points are determined from satellite measurements. Based on the results of previous studies, this approach makes it possible to increase the accuracy of the coordinate definitions of working points about 3 times.

Analyzing the measurements of the locations displacement of the working points, we can say that according to the results of the satellite coordinate definitions from November, 2008 to June, 2016 there were no planned displacements of the points. As for the high-altitude changes of these points, only those points on which changes are registered more than 4 mm deserve particular attention.

To analyze the accuracy of measurements made by GPS receivers, the main satellite network was measured by an electronic total station TS 1201 (Leica). The control network diagram represents a quadrilateral with measurements of all angles and distances. The scheme includes the support points of the GPS-network 1, 2, 3 and the working point of the GPS-network -4. The maximum distance in the triangle is 2.9 km between points 1 and 3. The minimum distance is 1.2 km between points 2 and 3. A comparative analysis of the measurements performed (Table 2) shows that the accuracy of GPS measurements practically coincides with the accuracy of measurements by an electronic total station (Nurpeisova, 2013b).

Figure 3 shows the graph of the benchmark movements of «Tengiz» GDP levelling net for the period 2008-2016 and 1992-2016 on the profile 1-3, consisting of 25 benchmark.

Profile 1-3 runs across the polygon from north to south, crossing the central part of the polygon. In the period 2008-2015 benchmark displacements were from 2 mm to 8 mm. and for the period 1992-2016. $h_{\text{max}} = 2.9$ cm.

At the same time, ground-based geodetic observations of changes in the coastlines of the Caspian Sea were carried out and their satellite images were analyzed (Fig. 4). The Caspian Sea washes the shores of five coastal states: Russia, Kazakhstan, Turkmenistan, Iran and Azerbaijan.

In the northern part of the coastline is cut by water channels and islands of the Volga and the Urals delta, the coast is low and swampy, and the water surface in many places is covered with thickets. On the east coast, limestone shores dominate adjacent to semi-deserts and deserts. The most winding shores are on the west coast in the area of the Absheron peninsula and on the east coast in the area of the Kazakh Bay and Kara-Bogaz-Gol.

Company «Tengizchevroil» deals with the problem of the Caspian region. Our studies were conducted in the framework of the project of the Republic of Kazakhstan «Oil Pollution of the Caspian Sea based on Space Radar Data» conducted jointly with the international public organization on the problems of Caspian region ISAR (Kosarev, 1990).

The annual variability of the Caspian Sea level over the period 1837–2015, obtained by geodetic observations is shown in Fig.5.

Currently, sea level rises to 12.5 cm per year. If this rate continues, in 25-30 years the sea level will reach the levels of 1929, which will result in a catastrophe and many billions in losses for the inhabited coastal territory. Nature itself restores the imbalance. However, this should not be allowed, since the man lived in most of the coast, and the rise in sea level brings a new catastrophe. Considering all the above, we can see that the Caspian Sea is a common object of the Caspian region and this crisis will affect the personal plans of each state and its development prospects (Study of the dynamics of the Caspian coastline according to distance Earth sounding, 2017).

RESULTS AND DISCUSSION

As a result of the study, it was found that the length of coastlines for the period from 2009 to 2015 gradually increased. Major increase in area of coastal area accounted for the period from 2010 to 2012. Area of the sea during this period decreased by 99429 300 m².

At present, according to the «Caspian» program space interferometric monitoring of vertical displacements of the earth's surface is being carried out over the developed oil and gas field of Tengiz, the results of which are shown in Figure 6.

depth interval 3.8-5.4 km from the earth's surface. High reservoir pressure, complex geological structure, as well as a significant exploitation period of the deposit with constantly increasing volumes of recovered oil, give grounds to expect possible drawdowns of man-made origin, which served as the basis for carrying out this space monitoring (Zhantaev, Fremid, Kaldybaev & Kantemirov, 2012).

Subsidence trough over the Tengiz field (a space image) is shown in Fig. 7, a, where the subsidence trough is located within the coordinates 53° 18' - 53° 30' (longitude) and 46° 10' (northern width). The resulting model of displacements in colour coding and graphs of subsidence in millimetres for several typical points-the constant signal spreading of the radar are shown in Fig. 6, b.

A model of the average annual rate of displacement of the earth's surface above the Tengiz field from 2004-2012 is shown in Fig.6, b.

Analysis of the results of ground-based monitoring of earth surface displacements that occurred over the Tengiz field and recorded during the interferometric processing of the ENVISAT radar data showed the presence of accelerated subsidence of the earth's surface over the area of active hydrocarbon production from this field. And also the results of interferometric monitoring fully confirm the data obtained by geodetic observations in the period 2008-2016.

Analyzing research results which are stated in monograph (Nurpeisova, 2016c), the whole procedure for the activities of the enterprises of the oil-extracting complex of the Republic of Kazakhstan can be presented in the form of a scheme of extreme geodynamic consequences formation (Figure 7).

Proposed structure of the system for the integrated assessment of geodynamic risk and forecasting of

industrial and environmental consequences will make it possible to conduct studies of the background of natural tectonic and seismic processes on the territory of the Republic of Kazakhstan deposits, which will make it possible to understand the conditions for the preparation and occurrence of extreme geodynamic events leading to serious adverse consequences (Nurpeisova, Bekbassarov & Kyrgyzbaeva, 2017d).

The structure of timely prevention of environmental consequences resulting from the development of hydrocarbon fields can be represented in the form of a number of measures that need to be carried out at the geodynamic test site (Fig. 8).

Currently, instrumental geodynamic researches conducted in a number of regions have proved that in many cases localized seismic manifestations and accidents are directly or indirectly associated with abnormal changes in the current stress-strain state of the earth's surface. Technogenic geodynamic phenomena are confined to the areas of impact of man-made loads created in mining areas.

CONCLUSION

As a result of the study, the following conclusions can be drawn:

1. Comprehensive analysis of the domestic and foreign experience in geodynamic studies on instrumental observations of deformations areas was carried out, which allowed developing methodology for integrated assessment and prediction of hazardous phenomena in GDP. The ultimate goal of these decisions is to provide them with the adaptive functioning of NTS or the withdrawal of its critical state.
2. Improved methods for conducting repeated observations of GDP points which include complex geodetic observations: high-precision digital leveling, use of electronic tachometers and GPS-technologies, which will improve the accuracy and efficiency of determining subsidence of the earth's surface, as well as the effectiveness of monitoring through computerization of field and office geodetic works.
3. By studying the dynamics of the coastline using satellite sounding, it is possible to get very useful information that can be combined with data obtained during field observations, as well as be used as an alternative to outdated information about the dynamics of the coastline.
- 4) In accordance with the results of interferometric processing of the results of space radar monitoring, the

earth surface displacement maps were obtained at the Tengiz GDP, the data of which fully confirm the results obtained by geodetic observations.

5) In the future, all information about regularities of geodynamic processes of the system and the parameters of its critical state come into the expert system, where, based on the integration of databases and knowledge, assessment of the state of GDP is made and appropriate decisions are justified. The ultimate goal of these decisions is to provide them with the adaptation functioning of GDP or the withdrawal of its critical state.

Thus, it can be said that this area requires further research and development, since at this moment the problems of the Caspian Sea have been little studied.

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Carp Fish of the Caspian Sea of Individuals of Different Sex and their Variability of Morphological Characteristics

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ABSTRACT

Representatives of the family of carp fish: bream, roach, carp, Kutum, ASP, fish, Shem-are of great commercial importance, still insufficiently studied in ecological and systematic terms, despite the numerous works relating to the systematics and morphology of individual species. The influence on the average value of the coefficient of variation on the set of morphological characteristics of other variables of sample characteristics was studied on the carp fish of the Caspian sea basin in order to assess the possibility of using this indicator for quantitative comparison of the relative morphological variability of different species and to clarify the nature of restrictions in cases of application.

KEY WORDS: Morphology, Variability, Coefficient of Variation, Coefficient, Population, Sampling, Plastic Features, Meristic Features, Heterogeneity, Caspian Sea.

INTRODUCTION

To date, we have considerable material on the traditional external morphological characteristics of the main species of carp fish in the Caspian Sea basin, obtained on a number of samples by one operator. This allowed us to put the main task of this work analysis of the influence on the average value of the coefficient of variation of morphological characteristics of other variables of sample characteristics (size of the sample, the average size of the studied individuals, sample size, etc.).

The aim of this analysis was to determine the appropriateness of using the mean coefficient of variation to quantify the morphological variability of different species and the nature of the limitations in cases of applicability of this indicator. Taking into account the obtained results, a comparative analysis of the General morphological variability in a number of species of carp fish in the Caspian Sea basin was carried out for the first time (Al Tariq, 2018; Al Jamal & Al Yousef, 2018; Gupta & Kumar, 2018; Mirzaei, 2017).

In the work of V.V. Cherepanov (1986) the average values of CV in males and females in different samples of several species of salmon-like, carp and perch-like fish are given. Unfortunately, the necessary data on the compared samples are not available in the work, and it is not possible to estimate the significance of differences in the magnitude of morphological variability between individuals of different sexes. In fact, the author himself refrains from any definite conclusions, stating that "in some species...there is a tendency to higher variability of phenotypes of females, in others, on the contrary, males are more variable...but in the vast majority of cases the differences...between males and females are insignificant." This allows him "to draw a General conclusion about the indep (Putra & Riahi, 2018; Waheed & Kafeei, 2018; Makvandi et al, 2018).

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Table 1: Floor View Cvplast Cvmer Cvbsch CBTL TL

Floor	View	CV _{пласт}	CV _{мер}	CV _{общ}	CBT _L	TL
Males	Bream	6.27+0.352	6.00+0.237	6.20+0.279	10.80+1.860	334.8+16.09
females	Bream	7.21+0.775	5.70+0.377	6.84+0.552	11.31+1.896	363.6+21.92
Males	vobla,	8.14+0.429	6.54+0.400	7.74+0.367	10.93+2.015	191.8+10.58
females	vobla,	6.77+0.317	6.15+0.125	6.62+0.223	9.25+1.644	215.5+16.65

Note: N is the number of samples that the rest of the notation.

Table 2: Indicators of variability of morphological features in the samples of different species of carp fish of the Caspian basin

2 Area	3 Floor	4 TL	5 CBTL	6 CV _{пласт}	7 CV _{мер}	8 CV _{общ}	9		
Vobla	Kyzylagachsky gulf Kizlyar Bay	Both gender	123.1	8.15	8.47	6.63	8.01	14	
		Both gender	245.6	9.14	9.95	5.66	8.88	41	
	Atreck	Both gender	220.4	12.40	6.67	6.72	6.69	53	
		Females	245.6	4.02	5.82	6.43	5.97	25	
		Males	197.8	7.67	6.58	5.87	6.40	28	
	Kanal Kizlyar-Kaspiy	Both gender	267.2	6.79	5.92	8.50	6.57	25	
		K-8 Channel	Both gender	258.4	6.24	6.27	5.30	6.03	25
	Kura	Both gender	233.0	9.03	9.27	5.86	8.42	15	
		Island of Chechnya	Both gender	284.2	5.72	6.06	3.61	5.45	25
	Carp	Terek	Males	453.7	32.47	8.13	5.39	7.66	50
			Females	527.7	18.87	7.99	5.75	7.60	50
			Both gender	490.3	26.59	8.16	5.87	7.83	100
			Both gender	440.5	46.99	10.27	12.97	10.88	60
		Sulak	Males	485.4	21.82	8.76	6.59	8.22	50
Females			564.7	29.86	8.96	6.24	8.28	50	
Kura		Males	500.6	10.15	5.78	7.15	6.09	50	
		Terek							
Zherekh		Terek							
Sulak		Both gender		511.6	11.48	5.81	6.57	5.98	100
			Both gender	448.0	20.24	7.64	7.68	7.65	100
Bream Skye Bay	Kizlyar-	Both gender	353.4	15.72	6.41	6.34	6.39	30	
		Females	460.9	15.13	5.53	6.50	5.77	11	
	Terek	Males	367.1	16.17	6.85	5.91	6.62	19	
		Whitebait	91.1	15.79	9.56	6.64	8.83	15	
	Sulak	Both gender	386.9	10.74	7.81	5.44	7.22	109	
		Females	397.9	11.25	8.96	5.32	8.05	53	
		Males	376.4	9.45	6.42	5.52	6.20	56	
		Whitebait	149.2	17.26	7.67	5.45	7.12	15	
		Both gender	334.9	19.77	7.22	6.15	6.95	62	
		Females	336.8	19.84	6.48	6.67	6.53	36	
	Island of Chechnya	Both gender	347.7	8.58	5.69	7.16	6.02	26	
		Females	212.3	11.22	6.94	6.19	6.75	50	
		Males	190.7	17.64	8.74	5.46	7.92	50	
	Vobla	Island of Chechnya	Both gender	267.5	11.42	6.73	6.51	6.68	30
Sulak	Both gender		163.0	24.17	6.90	6.70	6.85	25	
		Whitebait	112.5	16.31	10.10	8.00	9.58	20	
		Females	152.7	6.78	6.48	5.85	6.32	19	

Note: CV_{нн} – the average coefficient of variation for 24 plastic signs; CV_м is the same for 8 meristics signs, CV_{общ} is the same for all 32 morphometric characteristics, CBTL - coefficient of variation in total body length, TL – total body length, n is the number of individuals.

MATERIAL AND METHODS

The paper used data on a total of 100 samples of 5 species of carp fish in the Caspian sea basin, including from 10 to 165 copies. (table.) caught in the period from 2015 to 2018,. In each sample, all individuals were subjected to standard morphometric analysis (Pravdin,1966), including 24 plastic and 8 meristic traits (only in the samples of bream from the Agrakhan Bay, a smaller number of meristic traits were studied, see below). For each sample (except for the bream of the Agrakhan Bay) the average coefficient of variation CV ($CV=100s/M$) was calculated separately for all plastic features, all meristic and all features (32) together. The relationship between the mean CV and other sample characteristics was estimated on the basis of the calculated correlation coefficients (r). The significance of interspecific differences in variability (as well as differences between sample groups) was assessed on the basis of standard univariant analysis (tst) methods (Kilitci et al, 2018; KUMBHAR et al, 2019).

RESULTS AND DISCUSSION

Among the studied carp fish adequate for comparison of CV morphological features were samples of males and females of 5 species. In bream, on average, no significant differences between males and females in the mean CV were found for any group of morphometric characteristics, whereas in roach males on average significantly differed from females in greater variability in plastic characteristics and all morphometric characteristics (table. 1). It should be emphasized that in some populations of these species may not be observed compliance with the above trends, which, incidentally, corresponds to most of the data provided by the Cherepanov for individual populations of these species. In single populations of carp and ASP with samples of males and females similar in average size of individuals and their size differences in terms of variability of morphological characteristics between fish of different sexes were not revealed. At the same time, the females of Kutum from the Kirov Bay differed from the adequate sample of males by greater variability of plastic characteristics and all morphometric characteristics and less – meristic characteristics (table. 1). Based on these data, it seems more appropriate to conclude that the species specificity of more or less morphological variability of males compared with females in fish. This conclusion is in accordance with the real situation of specificity of genetic sex determination in this group of animals, characterized by the absence of differentiated sex chromosomes (and, consequently, pronounced heterozygosity of one sex compared to the other) in the vast majority of species (Vasiliev, 1985). endence of the shaping of the individual Table 1. Indicators

of variability of morphological features in males and females of bream and roach of the Agrakhan Bay.

It seems that the species specificity of more or less morphological variability of representatives of the same sex is associated with the absence in our case of a reliable correlation of mean CV morphometric characteristics with the size of different quality samples in males of the studied carp fish in the presence of such a correlation in females and, conversely, the lack of reliable correlations in females indicators of morphological variability with the average size of individuals in the samples and with the number of samples in the presence of these correlations in males . The obtained results impose another restriction on the applicability of the average coefficient of variation of morphological features for comparative analysis of phenotypic variability: the compared taxa or populations should be represented either by samples of the same sex (and then more correctly state the results for a particular sex), or, what is much preferable from the point of view of the characteristics of the species as a whole, by samples mixed on the floor in a ratio close to 1:1.

Thus, as shown by our analysis, the average CV on morphometric characteristics is influenced by other sample characteristics: the degree of dimensional heterogeneity of individuals, the average size of individuals, as well as, to a lesser extent, and the sample size. It should be noted that here we do not touch upon the fact that the value of the average CV on morphological features, of course, depends on the features themselves.

It is well known that the greater the value of a trait, the (on average) smaller the value of its variability - CV (Yablokov,1966 b; Efimov, Galaktionov, Galaktionov, 1977; Vasilyeva,1977; Cherepanov, 1986). Therefore, it is clear that, for example, (in the case of fish) if we use the scheme of morphometric features expressed as a percentage of head length, the average CV for these features in the sample will be less than the average CV in the same sample and with the same features, but expressed as a percentage of body length. In the case of using different systems of features, the result (even under other equal conditions) will naturally not be predictable.

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Exposure to Shadow Phenomena in the Agroindustrial Complex of the Region

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ABSTRACT

The low efficiency of the agro-industrial sector is a destabilizing factor contributing to the emergence of economic crimes, shadow processes, and phenomena, generating corruption in the management structures of economic entities and governmental bodies. The state should implement a whole system of measures to combat these phenomena in the agro-industrial complex. Among such measures, a significant place should be occupied by the ones to assess the state of economic security, determine the economic efficiency of public investments in the agro-industrial complex, and control their development with the help of experts in relevant branches of agriculture and in the whole agro-industrial complex. This approach will strengthen the state of economic security and improve the economic efficiency of agrarian economic entities.

KEY WORDS: Economic Security; Agro-Industrial Complex; Shadow Processes; Economic Crimes; Government Measures.

INTRODUCTION

At first glance, the shadow economy is a completely legal term and is poorly studied in the economy. However, it gained particular popularity in Russia during the transition period.

A number of scientists believed that the shadow economy is represented by certain processes and phenomena that

violate various ethical norms and rules, in particular, if they are dictated by law (Ageev 2016; Akoz et al. 2018).

These illegal phenomena in the agro-industrial sector, country's agriculture and its subjects are of the greatest interests in this study. However, the shadow economy is present in many sectors of the economy. Nowadays, the agro-industrial complex is characterized by its connection to the state system, and has been quite deformed since the planned economy has been implemented (Bisultanov 2009).

In order to present the main features of agriculture, causing various kinds of illegal actions, the following cases can be mentioned:

- Low orientation of industries to final consumer demand;
- Deforming the price structure of the products in the agrarian complex in comparison with other sectors, e.g., industry;
- Weak technical and technological development;
- High dependence on public investment;
- Low quality and weak competitiveness in manufactured agricultural products;

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- Lack of control over the effectiveness of budget appropriations;
- The unsatisfactory system of internal management;
- Almost complete lack of investment attractiveness in agriculture.

Meanwhile, there are reserves for agricultural production in the country, but only units of economic entities can effectively use them. Unfortunately, it is believed that the current system of agri-food policy itself does not allow to achieve high results of efficiency and competitiveness, which depend on the rationalization of the use of natural resources, the development of science and technology, expanding the boundaries of production, the supply of agricultural raw materials and food inside and outside the country, etc. (Khodashenas 2015).

The agri-food policy of the state is directed not only to the development of agro-industrial production, but also to the socio-economic development in the country (Bisultanov 2009).

It is known that agriculture is not very attractive for investors and, on the whole, is considered as a low-income sector of the economy. Few people would like to invest in this sector with a long payback period, and in some cases without payback. However, at the same time, agriculture serves as a basis in shaping the food security of the state.

As a result of the efficiency of the functioning and development of agriculture affects, food security not only supports the national security of the state, but also has the global importance. Thus, this connection between the interests of the state and society as a whole contributes to the development of the shadow economy at the source. The principles of economics dictate the following: the expansion of the scale of one economic process contributes to the oppression of the development of another. This principle rightly reflects the phenomena of the shadow economy in agriculture, which inhibit its further development and effectively use of state financial resources.

According to A. Tufetulova and Sabirovoy AI, the shadow economy has wide distribution in agriculture, and contributes to the formation of completely free parallels throughout the country's agro-industrial complex (Kuznetsova 2017).

Such relations "in the shadow" entail changes in the market structure, which is caused by the deformation in

the mechanism of market relations and the presence of unfair competitiveness (Latov 2001).

According to the data of the Main Directorate of Legal Statistics and Information Technologies of the General Prosecutor's Office of the Russian Federation, over 105 thousand cases of economic crimes were detected in the country in 2017, 8654 crimes of which are taxable and almost 30,000 crimes are in all sectors of the economy. If you rely on the data of the crime structure happening at the same period, it should be noted that 10.8% is fraud, 38.3% is theft, 0.8% is misappropriation or embezzlement (Luciani 1988).

According to Rosstat, over the past five years, about 20% of the country's total GDP are as result of the shadow economy, and the level of shadow phenomena in the agro-industrial complex reaches 70% of the total value of all productions (Novenkova 2017).

In agriculture, the shadow economic phenomena are often represented by the corruption component, the embezzlement of public funds and other fraudulent activities. As a rule, such crimes are committed by a group of individuals, but the identification of such crimes is rather difficult, and often impossible.

In general, the development of economic crime, in particular, the shadow processes and phenomena, is also influenced by some organizational and economic directions for improving the function of agriculture. For example, N. Ageeva suggests that the government's policy of import substitution can lead to completely unexpected and negative shadowing processes in the agro-industrial complex and in most parts of agriculture (Orinich 2001).

This viewpoint needs support, since the *tenizatsiya* in the agro-industrial complex, as we have already noted, is formed earlier on the basis of government injections to support the agricultural sector.

The main task of the Criminal Law in accordance with Article 2 of the Criminal Code of the Russian Federation is to protect the rights and freedoms of a person and citizen, property, public order and public safety, the environment, the constitutional system of the Russian Federation from criminal encroachment, assurance of peace and human security, and prevention of crime. The process of importing substitution implies an increase in quantitative and qualitative indicators of domestic producers. Therefore, it can be concluded that with an increase in the number of AIC subjects, the number of subjects of crimes in the economic

sphere will also directly increase. Over the past five years, only in the agriculture sector, the units of economic security and anti-corruption of the Ministry of Internal Affairs of Russia revealed over 40 thousand crimes, and the amount of damage was about 27 billion rubles (Thazeplov 2008; The state of crime in Russia in January-December 2017; Tufetulov and Sabirov 2016).

The shadow economy in agriculture is due to several reasons:

- Firstly, the lack of proper control by state bodies for the expenditure of budget allocations, on which all economic relations of the industry are dependent;
- Secondly, the illegal relations of civil servants (representatives of agricultural departments and the sectorial ministry in the region) with agricultural entities that provoke corruption ties.

It is almost impossible to quantify the shadow economic phenomena in agriculture. In this case, the only tool that will allow to identify the facts of economic offenses are budget funds aimed at subsidizing agricultural production. This is the implementation of proper control over their provision, monitoring of agricultural holdings that need state support, and their resource capabilities to be effective, as well as the results of their effective use. All of these are the basis for preventing a number of shadow processes in the economy of agriculture.

The main goal of the state to combat shadow processes in the agro-industrial complex of the region and at all levels in Russia is to develop an effective system that will provide wide participation opportunities for all stakeholders including all levels of government, law enforcement, public and political organizations.

Government influence on shadow processes and phenomena occurring in the agro-industrial complex and, in particular, in agriculture should be an integral part of long-term state policy. At the same time, government measures to combat *tenizatsiya* in the agro-industrial complex should be aimed at the entire structure of the economy, as they are directly related to the processes of production, distribution, redistribution and consumption. All these processes form the gross regional, and then the gross domestic product of the country, on which the level of support for agricultural production depends. Consequently, the first thing to do is to carry out a well-coordinated systemic work with regard to monitoring the development and efficiency of public investments in agriculture, the agrarian and industrial

complex as a whole. According to the author, the system of state measures should be built in several stages (Fig. 1).

In the framework of the first stage, attention should be paid to the following tasks:

- Firstly, it is the establishment of threshold values for the main indicators characterizing the economic security of the regional agro-industrial complex;
- Secondly, these are measures to identify negative deviations of the indicators of economic security in the agro-industrial complex in the region from the threshold values established earlier, as well as to identify the causes of their occurrence;
- Thirdly, timely monitoring of economic security in the agricultural sector;
- Fourth, determining the degree of development and the level of efficiency of public investment in the field of agriculture.

With regard to the above mentioned tasks at the first stage of state measures to combat shadow processes and phenomena, it should be noted that one of the key tools for identifying destabilizing economic security factors in the regional agro-industrial complex and the development of shadow processes and phenomena is the timely assessment of the effectiveness of public funds invested in the agro-industrial complex. It is recommended to use well-known assessment methods. First and foremost, econometric and expert methods will contribute to effective monitoring of public investment.

Also, it is recommended to use the following key indicators that are private, and characterize the economic security of business entities including the profitability ratio of the main activity, current liquidity ratio, equity ratio, and the level of labor productivity.

The research carried out by K. Bisultanov provides an opportunity to determine the integral indicator for assessing the level of economic security for enterprises and the region as a whole. At the same time, to determine further tactical and strategic measures, it is recommended to use the rating scale characterizing the state of economic security in the agro-industrial complex:

- Perspective level - more than 0.9 units;
- High level - 0.76 - 0.9 units;
- The normal level is 0.63 - 0.75 units;
- Satisfactory level - 0.5 - 0, 62 units;
- Critical level - less than 0.5 units. (Sharifi et al.

2018)

Within the framework of the second stage, two main directions should be implemented:

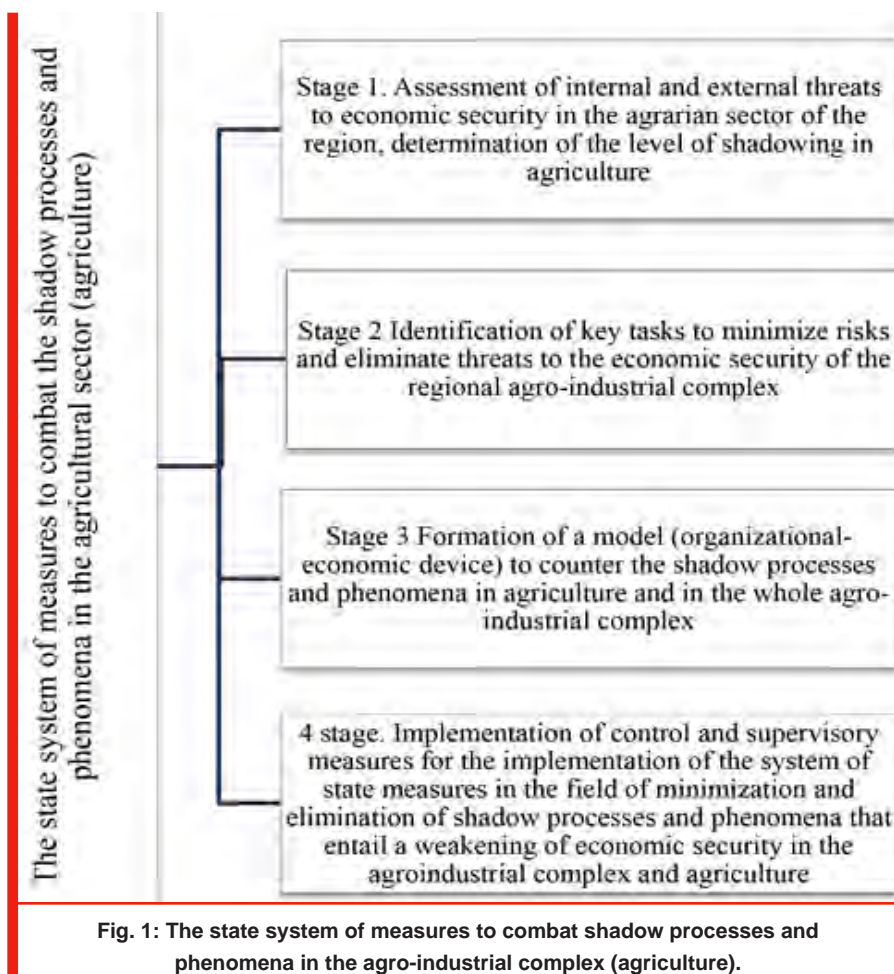
- The development of a regulatory framework for ensuring economic security in the agricultural sector of the economy;
- The development and implementation of targeted measures to counter the development of shadow processes and phenomena, and in general economic crimes in the regional agro-industrial complex.

The third stage should be implemented from the standpoint of improving the organizational, economic and managerial structure in all areas of the agro-industrial complex of the region.

The final stage of the recommended system of state measures to combat shadowing has focused on the activities of the control and supervisory authorities, forming

a coherent systemic work. The performers of these events are meant:

1. Registration authorities;
2. Sectorial ministries and departments;
3. Local governments
4. Judicial authorities;
5. Supervisory authorities;
6. Licensing authorities
7. Law enforcement bodies (services of the Ministry of Internal Affairs);
8. Fiscal bodies: management by definition of insolvency of economic entities, currency and export control authorities, the antimonopoly service, the tax inspectorate, etc.
9. Other bodies (extra-budgetary funds, customs authorities, employment services, control and accounting chamber, etc.).



All four stages in the presented system of measures should act consistently, systematically and in constant interaction of all the performers.

At each stage of the implementation of the proposed measures, it should be borne in mind that shadow economic activities that are present in the interests of entrepreneurs are the source of corruption in government structures, and the result of its progressive state is social and economic tensions, leading to the lack of trust and tension.

The modern agro-industrial complex is currently experiencing massive difficulties, among of which are problems with resources, including personnel and material, as well as financial difficulties that accompany virtually all industrial and economic activities, especially when it comes to agricultural production. These problems underlie the development of the shadow economy, which further destabilizes the security of this economic complex.

In order to realize the intended goals for counteracting economic crime and shadow processes and phenomena in the sphere of the agro-industrial complex, it is recommended to implement the proposed system of government measures to improve the organizational and managerial structure in this sector of the economy and increase the economic efficiency of business entities. It is also possible to assume that the results of such work will contribute to the solution of many socio-economic problems of rural areas.

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The efficiency of Sprayed Water and Steam Applied Against Forest Fire

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ABSTRACT

The paper considers the possibility of extinguishing forest fires and creating barrier strips with sprayed water and steam and presents technical means to reduce water consumption. Theoretical and experimental studies are presented confirming the effectiveness of water vapor and sprayed water both as independent fire extinguishing agents and means for creating support strips. As the research results show, water vapor can be used not only as an independent means of extinguishing, but also as a means of greatly increasing the efficiency of moistening with sprayed water. To determine the most effective use of water vapor as a fire extinction agent, studies have been carried out to extinguish the wooden bars and dry grass and branches.

KEY WORDS: Forest Fires, Water, Steam, Temperature, Pressure, Cooling, Burning, Speed.

INTRODUCTION

Annually, forest fires cover significant wooded areas causing economic and environmental damage.

Global wide developments have been carried out to increase the effectiveness of monitoring systems, accurate forecasting technologies and technical means which allow timely to detect and handle incipient fires (Fernandez et al. 1997; Gundar et al. 2012; Hoseinzadeh, 2016; Jain et

al. 1996; Tak and Ehi 2018; Zaitsev and Gubskii 2016; Zhuravleva and Kovalev 2014).

Only in Russia from 10 to 35 thousand fires are registered in forests covering up to 2.5 million hectares (Johnson, 1980). The main reason of fire breaking-out is associated with the economic activities of people. About 85-90% of forest fires occur in areas of intensive forest management.

source in the close proximity and the difficulty of vehicle movement in the forest. The success of fighting forest fires largely depends on their timely detection and the rapid taking action of their limitation and elimination.

The most widely used methods are liquid extinguishing agents, in particular water and its solutions in particular. Forest fires extinction with water is far from the most effective way because of the high intensity of the water supply and the required flow rate. However this method remains the most common. To increase the efficiency additives which increase the wetting ability and reduce consumption are added into the water.

The fire extinction efficiency of water and water solutions can also be increased by spraying it onto the fire. This

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reduces the delivery distance but increases the irrigation area and the intensity of vapor formation. As a result, the temperature in the combustion zone decreases and the concentration of combustible components of the gas mixture decreases.

Water and its solutions are also used to create barrier strips. The recommended width of the strip should be one meter, while for the cluttered areas and at a wind speed of more than 3 m/min - two meters (Köseoğlu et al. 2018). The effectiveness of the barrier strips depends not only on their width, but also on the uniformity and degree of impregnation of forest fuel materials. The studies on the use of sprayed water, water vapor, and combinations of steam and water to extinguish natural fires extinction have been conducted at the department of "Technosphere Safety and Transport and Technological Machines" N.I. Vavilov Saratov State Agrarian University (Kovalev and Zhuravleva 2012; Molokova 2004).

The Proposed Designs of Manual Fire Extinguishers

The following technical means have been developed to carry out research on the effectiveness of forest ground fires extinctions by spraying water, steam, and two-phase media.

1. A number of spray nozzles with different spray angle, flow rate and multi-jet nozzles have been developed for the RLO-M and Ermak forest knapsack tank.
2. An autonomous steam mini-generator consisting of a heating device and a heat exchanger (Fig. 1). A blowtorch burner fixed in a casing is used as a heating device. The supply tank is equipped with a built-in pump for supplying fuel under pressure to the burner.
The heat exchanger consisted of a metal casing, a piping system and an 8 l supply tank. The internal diameter of the output nozzle is re-adjustable (from 2 to 5 mm). The developed pressure is 0.2 MPa.
3. To improve the efficiency an electric steam generator unit (Fig. 2) was developed including a supply tank and an electric heating element. The spray device is installed at the end of the rod. The unit is supplied from the generator installed on small vehicles. Water volume - 4 liters. Generated pressure - from 0.2 MPa.

The limiting factor in setting up the volume of the water tank in both cases was the weight of the unit.

Theoretical Research

Sprayed Water

For forest fuel materials wetting under a barrier strip creation or fire edge extinction, the operator's speed movement with a forest fire extinguisher knapsack is defined as (Roy 2003):

$$h_{CP} = \int q(L) dt = \int q(L) \frac{dL}{V_p}, \quad (1)$$

where h_{CP} is the thickness of the liquid film.

q is the performance of forest fire extinguisher knapsack, l/min;

V_p is the operator's speed movement with a fire extinguisher, m/min;

L is the fire edge length, m

Let s consider the effectiveness of direct extinction with sprayed fluid.

Tables 1 and 2 show the average data on the rate of the ground forest fires edge extinction with the RLO-M forest fire extinguisher depending on the intensity of the fire and water consumption (Shcherbakov 2005).

Extinction time τ can be found from the formula, min:

$$\tau = \frac{LI}{qk}, \quad (2)$$

where

I - linear intensity, l/m;

k is the efficiency factor ($k = 0.85$).

The RLO-M forest fire extinguishing knapsack efficiency is 2.25 l/min. The results of the time extinction calculations are summarized in Table 3.

Water Steam

During vapor generation, the specific volume of water increases significantly. For water at 0.1 MPa the specific volume of boiling water is $V = 0.001043$ m³/kg. The specific volume of dry saturated steam is 1.696 m³/kg. One liter of water forms a water mist with a volume of up to 1.5 m³.

The ratio between the internal diameter of the steam generator rod pipeline D , m, the steam flow rate w_2 and the flow rate G_C is:

$$D = 2 \sqrt{\frac{G_c}{\pi w_2 \rho_2}}, \quad (3)$$

where

G_c – steam mass flow rate, kg/s;

w_2 – nozzle velocity, m/s;

ρ_2 – fluid density, kg/m³.

Internal diameter of the output nozzle on the rods of steam mini-generators was chosen the re-adjustable one from 2 to 5 mm.

Experimental Procedure

The purpose of the research is to evaluate the effectiveness of ground forest fires extinction by sprayed water and steam. To substantiate the effectiveness of indirect fire extinction technique and the creation of barrier strips the contact wetting angles of the duration of water and steam treatment using a RLO-M forest fire extinguisher with a wetting agent (20% calcium chloride solution with the

addition of 0.5% OP-7 wetting agent) and steam generators were investigated. The geometric characteristics of the steam jet, the temperature, the steam content in the jet, and the mass of the condensate were determined. The multiplicity of tests ranged from 3 to 5.

Field tests were conducted in the fire danger period. The height of the grass is up to 30 cm, the wind speed is not more than 1.5 m/s. The fire front was formed artificially. The maximum height of the flame is 40 cm. The front width reached 0.3-0.5 m. The obtained experimental data were processed according to the method (Steyaert et al. 1997).

The Results of Experimental Studies With Sprayed Water



Fig. 1: Autonomous steam generator.



Fig. 2: Electric steam generator.

Table 1: Ground forest fire extinguishing rate, m/h.

Type of ground fire	Fire intensity		
	high	moderate	low
stable	20-40	40-80	80-150
running	30-50	50-100	100-200

Table 2: Water consumption in extinguishing the 1 m long edge of the ground forest fire using RLO-M.

Type of ground fire	Fire intensity		
	high	moderate	low
l, l/m			
stable	2.8-5.7	1.4-2.8	0.7-1.4
running	2.3-3.8	1.1-2.3	0.5-1.1

Table 3: Time of extinguishing of the 1 m long edge of the ground forest fire with the RLO-M knapsack.

Type of ground fire	Fire intensity		
	high	moderate	low
Water feed time, s			
stable	90-180	45-90	24-45
running	72-120	36-72	18-36

The results of the studies of wetting angles based on the duration of treatment τ using the RLO-M knapsack are presented in Figure 3.

- 1 – Distance from the nozzle 1m, wetting agent;
- 2 – Distance from the nozzle 2m ($\theta = -\tau + 43$; $R_2 = 0.99$, wetting agent);
- 3 – Distance from the nozzle 3 m ($\theta = -6.25\tau + 89.5$; $R_2 = 0.98$, wetting agent);
- 4 – Water without wetting agent.

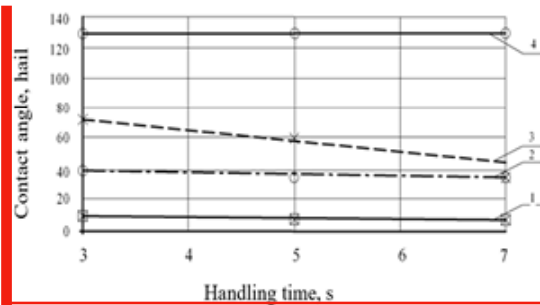


Fig. 3: Dependence of the wetting angle on the time of treatment with sprayed water:

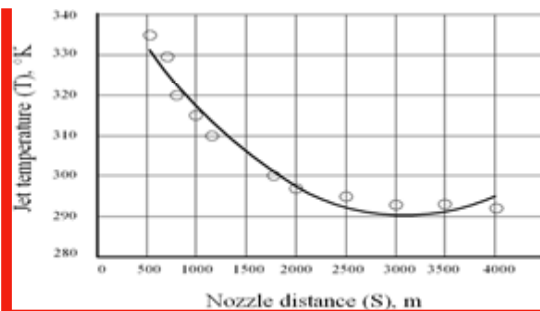


Fig. 4: Dependence of the jet temperature on the distance from the steam generator nozzle:
 $T = 332.1222 - 0.0321S + 6.1453e$; $R = 0.996$.

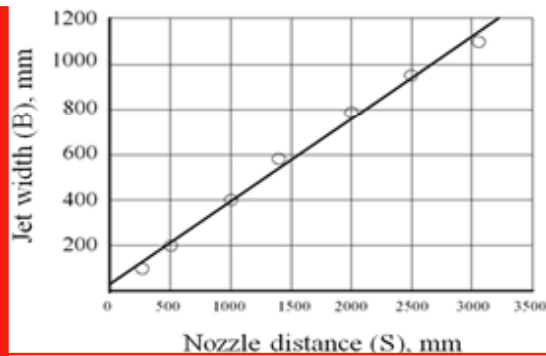


Fig. 5: Dependence of the jet width on the distance from the steam generator nozzle;
 $B = 32.9167 + 0.3635S$; $R = 0.996$.

The obtained data indicate that the surface of forest fuel materials is practically not wettable and treatment with water without a wetting agent is inefficient and requires greater intensity. Treating the surface with aqueous solutions with a wetting agent provides smaller wetting angle than when treated with water, which decreases with the increasing treatment time.

The surface wetting intensity is non0-uniform. Its central part, about 40%, is irrigated with an intensity from 0.043 to 0.077 l/m²s, which amounts to 0.02 l of water (55%). The developed multi-jet nozzles allow to increase the uniformity of spraying. About 35% of the total area is irrigated with an intensity from 0.068 to 0.058 l/m²s, and about 30% is irrigated with an intensity of 0.026-0.058 l/m².

The Results of the Studies of Fire Characteristics of Water Vapor

The results of the measurements showed that the temperature at the steam generator nozzle output is about 75°C (Fig. 4).

The width of the steam jet, depending on the distance from the nozzle reaches 1.2 m, Fig. 5.

The study of condensate share in the steam jet shows its presence in the range of 3-9%. With increasing distance from the nozzle it slightly increases (Fig. 6).

The thickness of the condensate film depends on the operators speed movement with the steam generator (Fig. 7). The effective operators speed is about 30 m/min.

The results of the study of the dependence of the wetting angles on the duration of treatment and the distance from the steam generator nozzle are presented in Fig. 8.

As the research results show, water vapor can be used not only as an independent means of extinguishing, but also as a means of greatly increasing the efficiency of moistening with sprayed water.

To determine the most effective use of water vapor as a fire extinction agent, studies have been carried out to extinguish the wooden bars and dry grass and branches.

Short-term treatment of the burning center of wood bars with steam stopped burning. But in some cases reignition occurred.

Treatment of the burning source of dry grass and branches with a steam jet led to burning decrease. The complete

blowout of fire was in the zone of direct impact of the jet, that is, at a distance of up to 2.5 meters.

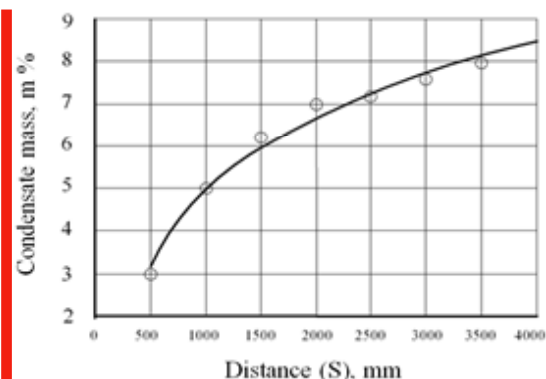


Fig. 6: The condensate share in the steam jet: $m\% = 5.8648 \log S - 12.6454$; $R=0.996$; $R^2=0.993$

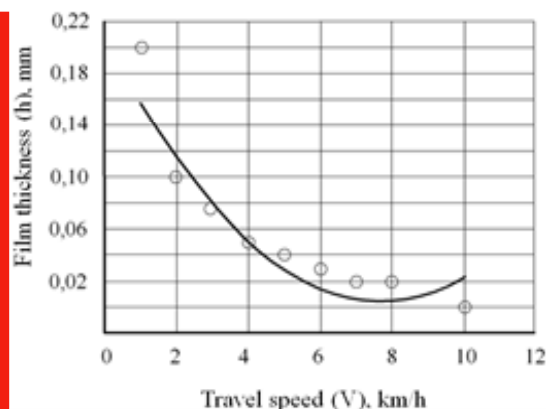


Fig. 7: Dependence of the condensate film thickness on the operators speed with the steam generator: $h=0.2067-0.0527V+0.0034V^2$; $R^2=0.93$

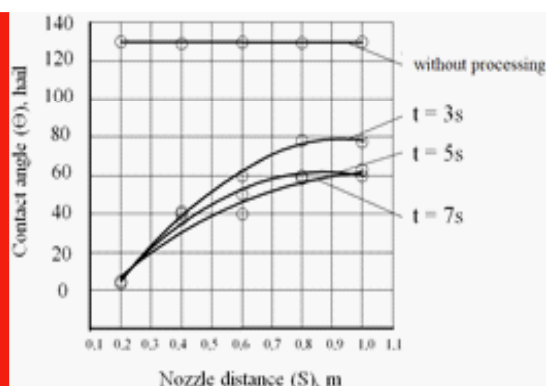


Fig. 8: Dependence of the wetting angle on the distance from the nozzle:

**1 – $\theta t=3 = - 40.8+251.5714S - 132.1429S^2$; $R^2=0.95$;
 2 – $\theta t=5 = - 32.8+218.6429S - 126.7857 S^2$; $R^2=0.95$;
 3 – $\theta t=7 = - 20.6+155.3571S - 73.2143 S^2$; $R^2=0.95$.**

The effective speed of the operator with the steam generator along the fire edge is 20 m/min.

Summary

The use of manual fire extinguishing knapsacks for low and moderate ground forest fires extinction and creating support and barrier strips is very promising. The main methods that increase extinction efficiency are the use of solutions of chemical substances that increase the wettability of the surface, the optimization of the ratio of the operators speed movement with the intensity of the fluid supply and the use of sprayers that increase the uniformity of the fluid supply.

Water steam can also be used not only as an independent fire extinction agent but also as a means that significantly increases the efficiency of moistening with sprayed water, for example, to create support strips.

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The Influence of the Depth of the Rocks on the Ameliorative State of the Soil and the Growth and Development of Woody Plants in the Arid Conditions of Mangistau

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ABSTRACT

The influence of the depth of the rocks on the main agrochemical characteristics of the brown zonal soils of the Mangystau desert zone, as well as the decorative qualities and biometric growth indicators of Robinia pseudoacacia L. (white acacia) and Elaeagnus oxycarpa Schlecht (oleaster). It has been established that under conditions of regular irrigation with an increase in the capacity of loose soils from 40-60 to 160-240 cm, a noticeable decrease in the content of toxic salts in the upper soil layers is observed due to their washing out into the lower horizons; an increase in the degree of humus content of the soil; content of available forms of nitrogen, phosphorus and potassium. However, as a result of the change in the sulfate and chloride-sulfate chemistry of salinization to sulfate-chloride and sulfate-soda, a slight increase in the alkalinity index was observed in excess of the critical level (10%). A significant correlation was found between the depth of lime-stone and the main soil-reclamation factors, which made it possible to derive between them the regression equations of a reverse-linear, exponential, normal-logarithmic and multiplicative form. It is shown that proximity to the surface of bedrock leads to a significant decrease in the growing energy and ornamental value of woody plants. Derived based on the correlation and regression analysis of the formula of multiple linear dependence of decorative points of woody plants on the depth of Sarmatian limestones and the "total effect" of toxic soil ions are recommended for use to develop effective agro-meliorative measures and predict the success of creating garden and park stands taking into account the provincial characteristics of the soil cover Mangistau.

KEY WORDS: Influence, Depth of Occurrence, Sarmatian Limestone, Ameliorative Condition, Woody Plants, Decorative Effect, Growth of Shoots

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INTRODUCTION

The nature of Mangyshlak is extremely unfavorable for the introduction of plants, green building, and phy-tomelioration. The peninsula is located on the eastern coast of the Caspian Sea, at the interface of the subzones of the northern and southern deserts within 42-46 degrees' north latitude and 50-54 degrees' eastern longitude and is administratively a part of Mangystau region. The climate of the peninsula is extra-arid. The average annual air temperature is 9.6-11.5°C, the absolute minimum is -34°C, and the maximum is +47°C. Precipitations reach only 107-181 mm. The sum of positive temperatures above 10 degrees reaches 3800-4100 degrees. Frequent strong winds lead to the spread of dry winds, dust storms, and withdrawal of salts from the Caspian waters.

Until the 60s of the last century, no detailed studies of the Mangystau

soil cover were conducted. Only in the early 70s, following the results of the stationary expedition of the Institute of Soil Science of the Academy of Sciences of the Kazakh SSR, a series of articles and the book "Soils of the Mangyshlak Peninsula" (Abdulhameed et al. 2018; Arinushkina 1970; Bazilevich and Pankova 1968; Borovskii 1983) were published, which contained detailed soil-cartographic materials and recommendations for the development of oasis farming in the region. According to these sources, 57.0% of the territory of the Mangyshlak and Buzachi peninsulas and the western chinks of the Ustyurt Plateau is occupied by zonal soils (34.9% of which are gray-brown and 22.1% are brown); 37.2% - by intrazonal and soil-geological formations; 5.2% - by exposed bedrock, and 0.6% - by intrazonal meadow and meadow-brown soils.

All zonal soils have pronounced signs of desert soil formation such as light color, presence of porous crust and compacted clayed horizon, low profile development, low content of colloidal silt and, as a result, low absorption capacity. Even the upper soil layers are extremely poor in nitrogen, phosphorus, and, on average, potassium.

One of the provincial specific properties of soils in the region of research is their close bedding with dense Sarmatian limestones impenetrable to water and root systems of plants. For example, out of 200 hectares of land surveyed in detail within the city and Aktau suburb, only 25 hectares (13%) contain areas with limestone deeper than 1.5 - 2 m; 54 ha (27%) - the area with the shell at a depth of 1 - 1.5 m; 70 hectares (34%) contain limestones at a depth of 0.5 - 1 m; and the remaining area of 53 hectares (26%) includes dense rocks at a depth of 0.5 m. In other settlements (the city of Zhanaozen, the villages of Zhetybai, Yeralievo, Tenge, etc.), the Sarmatian limestone strata are even closer to the surface; mostly above 0.5 - 1 m (Abdulhameed et al. 2018). On the territory of the botanical garden in the 10th microdistrict of Aktau, according to the data of engineering and geological surveys, almost half of the soil mass (49.6%) of bedrock is located closer than 1 m (27.1% - 0-0.5 m and 22.5% - 0.5 - 1 m) (Borovskii 1983).

As the observations of the green areas planted in the region of research have shown, the close occurrence of rocky soil leads to an early onset of the main development phases of woody plants, a decrease in the growth of shoots and a reduction in the vegetation period. In addition, ethylation, necrosis, and a decrease in water content of the leaves are observed. When the thickness of loose sediments is less than 0.5 m, it is recommended to plant trees and bushes in specially cut caverns or trenches with their subsequent filling with imported non-saline soil with high nutrient content, or to build flowerbeds 40-70 cm above the soil surface (Abdulhameed et al. 2018; Arinushkina 1970; Bazilevich and Pankova 1968).

Artificially fitted caverns and trenches do not ensure ideal

growing conditions too. After 2-4 years of irrigation, as a result of temporary watering in summer, they develop anaerobic conditions that favor active reduction (recovery) of sulfate into sulfides with the help microorganisms followed by the release of free sulfide, which negatively affects the plants. According to the Institute of Microbiology and Virology of the Academy of Sciences of the Kazakh SSR, there is 10 to 70 mg of hydrogen sulfide per 1 kg of soil under the tree plantations of the city of Aktau (Borovskii et al. 1974). An effective measure to combat these phenomena is considered to be a drainage system in the form of narrow trenches filled with rubble and imported soil (Dorofeeva et al. 2018). Due to the high labor intensity, this method has not yet gained the proper widespread in the practice of green building and phytomelioration in the Mangistau region. Moreover, previously no special laboratory field experiments have been conducted to study the relationship of the agrochemical characteristics of the soil and the morphological isomers of woody plants with the depth of the bedrock. Therefore, in 2018, the Mangyshlak experimental botanical garden within the framework of research on a special grant project "Study of the features of the adaptive response of plants to environmental limit factors in the arid conditions of the Mangystau desert as a scientific and theoretical basis for their conservation and rational use ex-situ" set a challenge to identify patterns of influence of the capacity of loose soil layers on soil amelioration indicators and growth of introduced species with the purpose of developing differentiated methods of the approach to the reclamation of green areas (Pankova et al. 2016; Recommendations on soil amelioration 1976; Vorobieva 1998).

MATERIAL AND METHODS

To study the influence of rock on the agrochemical parameters of the soil, the growth and development of woody plants under the protective perimeter strip of the botanical garden, 9 dynamic sites were laid out with a depth of 40-50, 60, 70, 100, 120, 140, 160, and 240 cm. Objects of research were white acacia (*Robinia pseudoacacia* L.) and oleaster (*Elaeagnus oxycarpa* Schlecht.) planted in a perimeter green strip in 1978.

White acacia (*Robinia pseudoacacia* L.) refers by its growth form to large-to-giant deciduous foliage trees of the family Fabaceae Lindl (Legumes). Originally from North America. It is characterized by an exuberant and openwork crown. Heliofit, mesotroph, xerophyte, salt-tolerant plant. It is widely used in landscape gardening as part of biogroups, single trees, and alley plantings.

Oleaster (*Elaeagnus oxycarpa* Schlecht.) is a 3-7-m-high low-stem tree or a large shrub of the family Elaeagnaceae Juss. (Loho-rye). One of the few representatives of the local dendroflora with a very high tolerance to the extra arid habitat. It is often used for the phytomelioration of sands and eroded lands.

The depth of Sarmatian limestone was determined using a manual soil drill with simultaneous sampling of soil every 10 cm to a depth of 1 m, and every 20 cm in deeper layers. Chemical analysis was carried out at the Laboratory of the Mangyshlak experimental botanical garden. The composition of the soil water extract was investigated by the method developed by E.N. Ari-Nushkina (Egorov et al. 1977) and L.A. Vorobiova (Fai-zullina 1976). The assessment of the chemical proper-ties and the degree of salinity, the classification of the soil by the depth of the salt horizon was carried out following the guidelines by N.I. Bazilevich and E.I. Pankova (Faizullina 1976; Lakin 1990; Mendeshev 1974). The degree of alkalinity was diagnosed using a scale in the reference book "Classification and diagnosis of saline soils" (Nourizadeh and Mastani 2015). Mathematical processing of research materials was performed by the method by G.F. Lakin (Pankova et al. 2017) using the Statgraphics Centurion XVI.I statistical software package as well.

RESULTS AND DISCUSSIONS

The depth of Sarmatian limestone affects the plants both directly, by limiting the development of root sys-tems, and indirectly, by modifying salt, solonetzic, nu-trient and water-physical soil regimes.

Materials of land reclamation studies (Fig. 1, Table 1) indicate that with increasing depth of limestone under regular irrigation with fresh water against the background of horizontal drainage built in the botanical garden, salts are withdrawn to the lower horizons. The prism-like type of salt location along with the profile changes to pyramidal. If at a depth of 40 and 50 cm the upper layers of 0-30 and 0-50 cm are moderately and strongly saline (total salt content is 0.542-0.999%), then in other areas (60–240 cm) they

have low and average salinity (0.112-0.404%). The sulfate and chloride-sulfate chemistry of their salt content is transformed into sulfate-chloride, chloride-soda, and sulfate-soda. This is the reason for the equalization of the magnitude of the "total effect" of toxic ions in mg-Eq. Cl-. Virtually all sites with limestone depth from 70 to 240 cm in the upper layers of the soil of 0-30 and 0-50 cm are moderately saline by this indicator. In general, in the upper one meter, salinity in terms of total salt content is low, with a depth of bedrock of 140 cm (0.261%), moderate - 40, 60, 70, 100, 120, and 240 cm (0.327-0.523%) and high - 50 cm (0.988%).

On the site with a loose soil depth of 160 cm, the top meter layer is classified as "non-saline" (0.21%). The ratio of the amounts of toxic salts between the sites is similar to the total salt content. However, the degree of salinization, in this case, is about one order of magnitude lower, which is due to the significant content of less plant-toxic sulfate- and calcium-ions in the soil solution (Fig. 1, Table 1).

In addition to salinity, an essential role in the formation of favorable edaphic growth conditions belongs to the state of the alkaline regime. The alkalinity is a property of the soil cover, which is formed when the soil-absorbing complex (organic, mineral, and organic-mineral colloids) is saturated with exchangeable sodium ions. When this happens, alkalization of the medium occurs due to the appearance of soda in the soil solution. Colloidal systems acquire the properties of sols and, therefore, during irrigation, they become fluid, structure-less and finely dispersed, which further leads to compac-tion and coalescence of the soil, and the reduced degree of aeration. The living environment of living organisms (including beneficial microflora) sharply deteriorate, up to the emergence of an

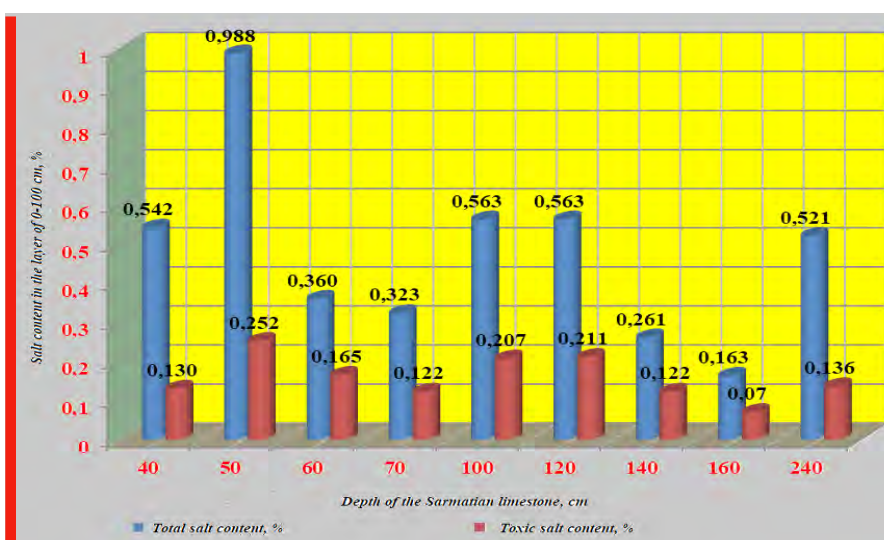


Fig. 1: Histogram of changes in salt content in the soil, depending on the depth of the Sarmatian limestone.

Table 1: Effect of the depth of the Sarmatian limestone on the soil salt regime.

Depth of the Sarmatian limestone, cm	Soil thickness, cm	Total salt content, %	Toxic salt content, %	The total effect of toxic ions, mg-Eq. Cl-	Degree of salinity
40	0-30	0.623	0.149	2.07	high
	30-40	0.299	0.072	0.99	low
50	0-40	0.542	0.130	1.80	medium
	0-30	0.999	0.255	3.73	high
	30-50	0.972	0.248	3.63	high
60	0-50	0.988	0.252	3.69	high
	0-30	0.243	0.111	0.99	medium
	30-50	0.623	0.286	2.54	high
	0-50	0.395	0.181	1.61	medium
70	50-60	0.185	0.085	0.76	low
	0-60	0.360	0.165	1.47	medium
	0-30	0.115	0.043	0.60	low
	30-50	0.453	0.168	2.38	high
	0-50	0.250	0.093	1.31	medium
100	50-70	0.521	0.194	2.73	high
	0-70	0.327	0.122	1.72	medium
	0-30	0.342	0.126	1.73	low
	30-50	0.497	0.183	2.51	medium
	0-50	0.404	0.149	2.04	medium
120	50-100	0.722	0.265	3.64	high
	0-100	0.563	0.207	2.84	medium
	0-30	0.298	0.112	1.54	low
	30-50	0.523	0.216	2.65	medium
	0-50	0.388	0.146	2.00	low
	50-100	0.738	0.305	3.74	high
140	0-100	0.563	0.211	2.90	medium
	100-120	0.701	0.289	3.55	high
	0-120	0.586	0.242	2.97	medium
	0-30	0.218	0.101	1.16	low
	30-50	0.278	0.129	1.48	low
	0-50	0.242	0.113	1.29	low
160	50-100	0.280	0.130	1.49	low
	0-100	0.261	0.122	1.39	low
	100-140	1.430	0.666	7.59	very high
	0-140	0.595	0.277	3.16	medium
	0-30	0.116	0.050	0.59	non-saline
	30-50	0.106	0.045	0.54	non-saline
240	0-50	0.112	0.048	0.57	non-saline
	50-100	0.214	0.092	1.09	low
	0-100	0.163	0.070	0.83	non-saline
	100-160	0.667	0.286	3.41	medium
	0-160	0.352	0.151	1.80	low
	0-30	0.214	0.056	0.78	low
240	30-50	0.217	0.056	0.79	low
	0-50	0.215	0.056	0.78	low
	50-100	0.827	0.215	3.01	high
	0-100	0.521	0.136	1.90	medium
	100-160	1.255	0.326	4.57	very high
	0-160	0.884	0.230	3.22	medium
	160-200	1.257	0.327	4.58	high
	100-200	1.255	0.326	4.57	very high
	0-200	0.888	0.231	3.23	high
	200-240	0.739	0.192	2.69	medium
0-240	0.863	0.224	3.14	high	

Table 2: Effect of the depth of the Sarmatian limestone on the soil alkaline regime.

Depth of the Sarmatian limestone, cm	Soil thickness, cm	Sorption capacity	Sodium absorbed mg-eq./100 g of soil	Alkalinity %	degree
40	0-30	8.59	0.51	5.9	low
	30-40	7.59	0.36	4.8	non-alkaline
50	0-40	8.34	0.47	5.6	low
	0-30	9.04	0.40	4.4	non-alkaline
	30-50	7.25	0.34	4.7	non-alkaline
60	0-50	8.59	0.38	4.5	non-alkaline
	0-30	10.18	0.90	8.8	low
	30-50	7.83	0.49	6.3	low
70	0-50	9.59	0.80	7.8	low
	0-30	11.94	1.09	9.1	low
	30-50	8.42	0.72	8.5	low
100	0-50	11.06	0.99	8.9	low
	0-30	14.29	1.21	8.5	low
	30-50	6.66	0.37	5.5	low
120	0-50	12.38	1.00	7.3	low
	0-30	12.34	0.84	6.8	low
	30-50	8.50	0.47	5.5	low
140	0-50	11.38	0.75	6.3	low
	0-30	11.55	0.87	7.5	low
	30-50	10.38	0.57	5.5	low
160	0-50	11.26	0.79	6.7	low
	0-30	13.34	1.13	8.5	low
	30-50	13.71	1.32	9.6	low
240	0-50	13.43	1.18	8.9	low
	0-30	13.45	1.37	10.2	medium
	30-50	12.14	0.78	6.4	low
	0-50	13.12	1.22	8.7	low



Fig. 2: Histogram of changes in the soil alkalinity, depending on the depth of the Sarmatian limestone

abiotic environment in the case of the formation of alkalinity when humus and illuvial horizons of exchangeable sodium are present in excess of 15% of the absorption capacity. In addition to adverse soil characteristics caused by the phenomenon of alkalization, exchangeable sodium has a physiologically negative effect on the plant organism. There is a distortion of the ratio of calcium and sodium cations, which slows down the delivery of calcium into the plant, and it can even be released from the roots into the soil.

In our experiments, the absorption capacity of soil layers on all dynamic sites is very low (6.66-13.71 mg-eq/100g of soil) due to their fine texture and low humus content, which is a characteristic feature of Mangistau zonal brown soils (Abdulhameed et al. 2018; Arinushkina 1970; Bazilevich and Pankova 1968; Bo-rovskii 1983).

Table 3: Effect of the depth of the Sarmatian limestone on the soil nutrient regime.

depth of the Sarmatian limestone, cm	Gross humus Soil thickness, cm	Easily hydrolyzable nitrogen (N ₂ O) %	Digestible phosphorus (P ₂ O ₅) degree of humus content	Available potassium (K ₂ O)	
				mg per 100 g of soil	content
40	0-30	0.38	low humus content	9.1	low
	30-40	0.29	very		
	7.2	low	1.8	very	
	16.4	medium			
50	0-40	0.36	low humus content	8.6	low
	0-30	0.40	low humus content	10.6	low
	30-50	0.23	very		
	9.7	low	2.3	low	19.5 medium
60	0-50	0.33	low humus content	10.2	low
	0-30	0.52	low humus content	9.1	low
	30-50	0.40	low humus content	9.4	low
	0-50	0.47	low humus content	9.2	low
70	18.9	medium			
	0-30	0.61	medium humus content	14.4	medium
	30-50	0.43	low humus content	11.5	low
	0-50	0.54	low humus content	13.2	medium
100	0-30	0.73	medium humus content	10.1	low
	30-50	0.34	low humus content	9.2	low
	0-50	0.57	low humus content	9.7	low
	0-30	0.63	medium humus content	12.7	medium
120	30-50	0.37	low humus content	10.6	low
	0-50	0.53	low humus content	11.9	low
	0-30	0.59	low humus content	13.4	low
	30-50	0.53	low humus content	12.4	low
140	0-50	0.57	low humus content	13.0	low
	0-30	0.75	medium humus content	15.4	low
	30-50	0.70	medium humus content	14.7	low
	0-50	0.73	medium humus content	15.1	low
160	0-30	0.75	medium humus content	15.5	low
	30-50	0.62	medium humus content	13.6	low
	0-50	0.70	medium humus content	14.7	low
	0-50	0.70	medium humus content	14.7	low
240	0-50	0.70	medium humus content	14.7	low
	0-50	0.70	medium humus content	14.7	low
	0-50	0.70	medium humus content	14.7	low
	0-50	0.70	medium humus content	14.7	low

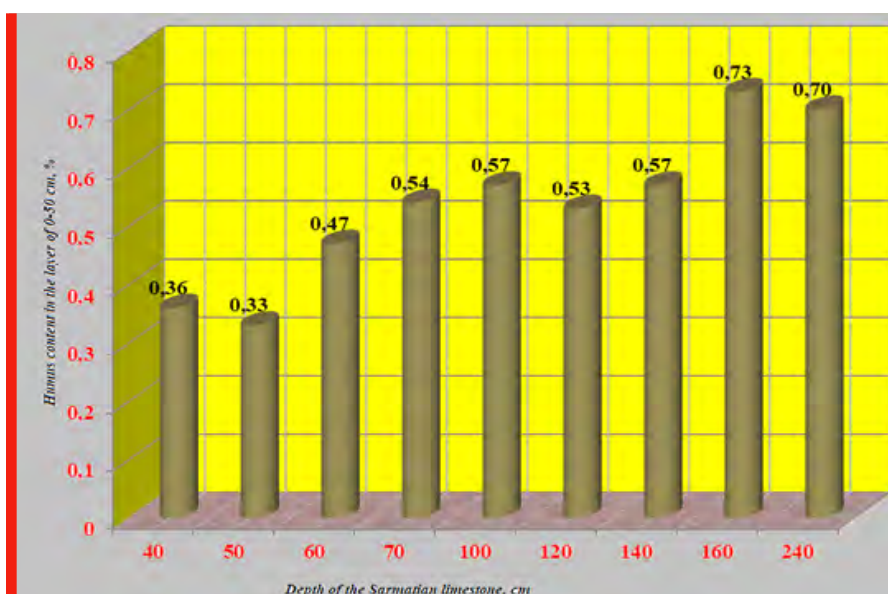


Fig. 3: Histogram of changes in humus content in the soil, depending on the depth of the Sarmatian limestone.

The degree of alkalinity of the soil varies inversely with most characteristics of the salt regime (Table 2, Figure 2). Flushing the upper soil horizons from salts provides for their more intensive saturation with readily soluble sodium ions. The type of salt content is transformed from magnesium-calcium to calcium-sodium, and therefore its introduction into the colloid system occurs more actively, which increases the per-centage of alkalinity.

The maximum amount of sodium in the soil-absorbing complex was observed at limestone depths of 70 (8.9%), 160 (8.9%), and

240 cm (8.7%), the minimum was observed at 40 (5.6%) and 50 cm (4.5%). Down the profile, there is a decrease in the degree of alkalinity. Taking the upper half-meter layer as an estimate, the soil on the site with bedrock depth of 50 cm can be referred to non-alkaline (4.5%), depth of 40, 60, 70, 120, 140, 160, and 240 cm - slightly alkalized (5.6-8.9%). All sites with different depths of rock currently require no chemical soil amelioration by adding gypsum, phosphogypsum, or other ameliorants, since the value of alkalinity does not exceed the critical level (10%).

Table 4: Key statistics of soil-ameliorative factors.

Soil-ameliorative factors	Soil thickness, cm	X	S	Cv, %	Sx	p, %	Xmin	Xmax	Rv
Depth of the Sarmatian limestone, cm	40-240	108.9	64.3	59.1	21.4	19.7	40	240	200
	0-30	0.352	0.286	81.3	0.095	27.1	0.115	0.999	0.884
Total salt content, %	0-50	0.393	0.257	65.5	0.086	21.8	0.112	0.988	0.876
	0-100	0.476	0.241	50.6	0.080	16.9	0.163	0.988	0.825
	0-160	0.577	0.231	39.9	0.077	13.3	0.327	0.988	0.661
	0-240	0.575	0.227	39.5	0.076	13.2	0.327	0.988	0.661
	0-30	0.111	0.065	58.4	0.022	19.5	0.043	0.255	0.212
Toxic salt content, %	0-50	0.130	0.063	48.7	0.021	16.2	0.048	0.252	0.204
	0-100	0.157	0.057	36.0	0.019	12.0	0.070	0.252	0.182
	0-160	0.197	0.057	28.8	0.019	9.6	0.122	0.277	0.155
	0-240	0.197	0.056	28.7	0.019	9.6	0.122	0.277	0.155
	0-30	1.47	0.99	67.7	0.33	22.6	0.59	3.73	3.14
Total effect of toxic ions, mg-eq. Cl-	0-50	1.68	0.91	54.3	0.30	18.1	0.57	3.69	3.12
	0-100	2.06	0.90	43.7	0.30	14.6	0.83	3.69	2.86
	0-160	2.52	0.82	32.5	0.27	10.7	1.47	3.69	2.22
	0-240	2.51	0.81	32.3	0.27	10.8	1.47	3.69	2.22
	0-30	7.74	1.79	23.1	0.60	7.7	4.4	10.2	5.8
Alkalinity, %	0-50	7.18	1.57	21.8	0.52	7.3	4.5	8.9	4.4
	0-30	0.60	0.14	23.6	0.05	7.9	0.38	0.75	0.37
Humus content, %	0-50	0.53	0.13	25.2	0.04	8.4	0.33	0.73	0.4
	0-30	12.3	2.6	21.2	0.9	7.1	9.1	15.5	6.4
Easy hydrolysable nitrogen (N ₂ O), mg/100 g of soil	0-50	11.7	2.4	20.6	0.8	6.9	8.6	15.1	6.5
	0-30	3.1	0.7	22.3	0.2	7.4	2.2	3.9	1.7
Digestible phosphorus (P ₂ O ₅), mg/100 g of soil	0-50	2.8	0.7	23.5	0.2	7.8	2.1	3.8	1.7
	0-30	25.5	4.8	18.9	1.6	6.3	18.1	32.2	14.1
Available potassium (K ₂ O), mg/100 g of soil	0-50	24.2	4.2	17.4	1.4	5.8	18.9	30.3	11.4

Note: X is the average of the variable; S - standard (average quadratic) deviation; Cv - coefficient of variation, %; Sx is the average error; p is the accuracy of the sample average, %; Xmin is the minimum value of the variable; Xmax is the maximum value of the variable; Rv is the range of variation of the variable.

A change in the state of the nutrient regime of the soil is nothing but a quantitative expression of the ratio of the inflow and outflow parts of the balance of nutrients. Under irrigation, an insignificant share in the supply of nutrients falls on organic compounds and colloids contained in irrigated fresh water. Due to the sorption properties, they linger in the soil and then undergo humification and mineralization. The main part of the replenishment is due to the introduction of organic and mineral fertilizers during planting of woody plants and subsequent agrotechnical care, as well as strengthening of the soil nitrification capacity, speeding up of the humification process of the biomass of litter and the involvement in the circulation of elements of an additional number of elements that before irrigation were firmly bound in primary and secondary minerals. The expenditure part of the balance is the loss of nutrients due to wash-out into lower horizons and the consumption of plants for their growth and development.

As the depth of bedrock increases due to desalination of the upper soil layers and, as a result, the activation of microbiological processes, a noticeable increase in soil saturation with gross humus, easily hydrolyzed by nitrogen absorbed by phosphorus and available potassium is observed (Table 3, Figure 3). When the thickness of loose rocks is 40-50 cm, the humus content in the layer is 0-50 cm - 0.33-0.36%; nitrogen - 8.6-10.2; phosphorus - 2.1-2.4, and potassium 19.6-19.9 mg/100 g of soil, and at 160-240 cm, it increases, respectively, to 0.70%; 14.7-15.1; 3.7-3.8, and 29.4-30.3 mg/100 g of soil. At the same time, according to the degree of humus content, the soil transfers from the "low-humus" class to

the "medium-humus" class. The soil content of easily hydrolyzable nitrogen is classified in all experimental sites as "low", although the upward trend in its content with the depth of bedrock is clearly visible (Table 3). Sites bedded with the Sarmatian limestone at a depth of 40-60 cm have assimilable phosphorus estimated as "low", at 70-240 cm - "medium". According to the content of available potassium up to the depth of limestone of 100 cm inclusive, the soil layers are classified as "medium-content", from a depth of 120 to 240 cm - as "high-content". Thus, an increase in the degree of development of the soil profile contributes to the improvement of its nutritional regime.

Statistical processing of research materials indicates a significant fluctuation of the agrochemical characteristics of the soil throughout the territory of the botanical garden and, therefore, the need for a differentiated approach to the implementation of agrotechnical and reclamation measures at each collection site. In addition to the depth of limestone (coefficient of variation - 64.3%), indicators of the state of the salt regime of the soil - 28.7-81.3%, to a somewhat lesser extent - alkaline - 21.8-23.1% and nutrient - were subjected to particularly strong variability. 17.5-25.2% (Table 4).

According to the correlation analysis, the relationship between the bedrock depth and salinity indices (Table 5), significant at the 5% significance level (Table 5), is observed only at 0-30 (r = -0.517-0.571) and 0-50 cm (r = -0.622-0.697). In deeper horizons (100-240 cm), the correlation becomes statistically unreliable and even becomes positive (r = 0.217-0.367) due to the cumulation

Table 5: Correlation coefficients (r) of the main soil-ameliorative factors with the depth of the Sarmatian limestone.

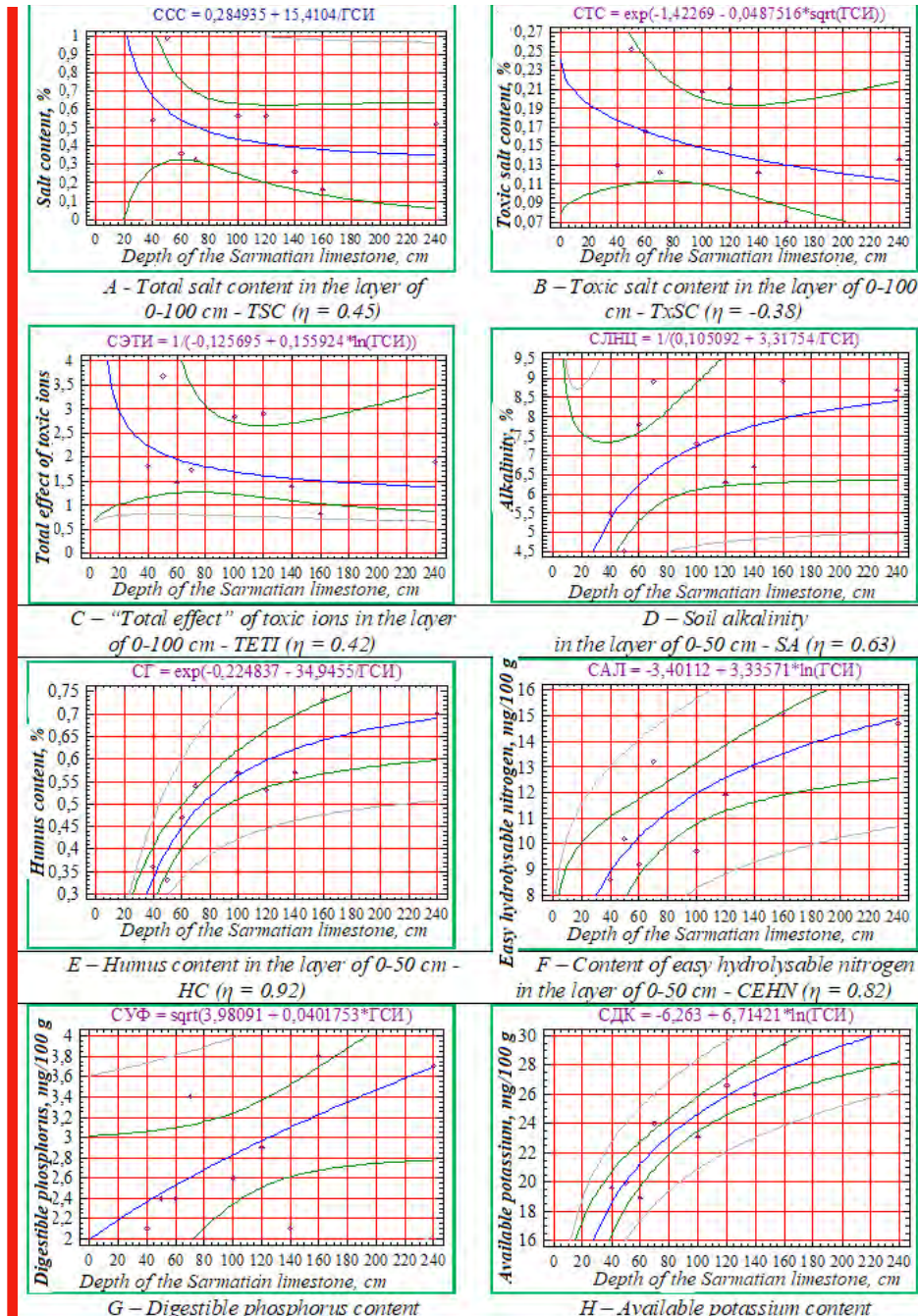
Soil-ameliorative factors	Soil thickness, cm				
	0-30	0-50	0-100	0-160	0-240
Total salt content, %	-0.523	-0.622	-0.320	0.237	0.217
Toxic salt content, %	-0.574	-0.697	-0.374	0.367	0.342
Total effect of toxic ions, mg-eq. Cl-	-0.517	-0.631	-0.299	0.331	0.311
Alkalinity, %	0.603	0.543			
Humus content, %	0.785	0.859			
Easy hydrolysable nitrogen (N ₂ O), mg/100 g of soil	0.773	0.800			
Digestible phosphorus (P ₂ O ₅), mg/100 g of soil	0.770	0.640			
Available potassium (K ₂ O), mg/100 g of soil	0.866				
	0.916				

Note: The critical value of the correlation coefficient at the 5% level of significance is 0.381.

of salts in the lower layers of the soil profile. Depth of limestone closely correlates with the indicator of alkalinity ($r = 0.543-0.6003$). The highest correlation ratio is observed between the thickness of the loose soil layer and the content of humus ($r = -0.622-0.697$), as well as available forms of nitrogen ($r = 0.785-0.859$), phosphorus ($r = 0.773-0.800$), and potassium ($r = 0.866-0.916$).

the depth of the Sarmatian limestone and the main agrochemical factors, having a complex back-linear, power, exponential, normal logarithmic, and multiplicative form with a correlation ratio from -0.38 to 0.94 , which can be used in green construction when forecasting changes in the indicators of ameliorative soil condition under regular irrigation (Fig. 4A-4Z). All indicators for assessing salinity, especially the "total effect" of toxic ions, drastically reduce their values on average over a layer of 0-100 cm to a depth of

The research results derive the regression equations between



bedrock of 70-120 cm, then the curves appear to be on a “plateau” and their values insignificantly decrease up to loose soil thickness of 240 cm (Fig. 4A-4B). Alkalinity in the upper soil horizons of 0-50 cm, otherwise, significantly increases in the limestone depth from 40 to 140 cm, then its increase stabilizes (Fig. 4A-4B). A similar trend is observed for the soil content of humus (Fig. 4D), available forms of nitrogen (Fig. 4E) and potassium (Fig. 4Z), where the relations are described by exponential and normal logarithmic types with a very high level of correlation of 0.82-0.94. The regression equation between digestible phosphorus and the depth of the rocky soil has a power-like appearance (Fig. 4G), similar in appearance to a linear function, according to which the increase in a given plant nutrient occurs evenly but insignificantly in quantitative terms.

Based on the materials of research, as the thickness of loose rocks increases from 40–60 to 140–160 cm, there is a steady tendency to increase in both decorative effect (from 2-3 to 4-5 points) and shoot growth: from 7–8 to 10 cm in white acacia, and from 18-22 to 50-54 cm in oleaster (Table 6). If in the range of 0-240 cm, the correlation coefficient between the depth of rock and the growth

rate of acacia is 0.150-0.347, and of oleaster is 0.331-0.556, then in the range of 0-140-160 cm it rises up to 0.641-0.969 and 0.588-0.780, respectively (Table 7). Moreover, as the thickness of loose rocks increases, the correlation ratio of the decorative effect and the growth of acacia increases with the salinity and humus content of the soil, while the same parameters in oleaster, on the contrary, decrease. The growth rates of both species poorly correlate with low alkalinity (5-10%).

Based on the regression analysis, formulas No. 1-4 were derived depending on the growth rates of introduced species on the main edaphic factors - the depth of limestone and the “total effect” of toxic ions they most closely correlate with. In addition, the “cumulative effect” is quite convenient for assessing salinity, since it is an integral parameter of the toxicity of all anions, expressed in milligrams - equivalents of chlorine.

$$ADE = 1.98 + 0.0138 \times SLD - 0.0057 \times TETI \quad (1);$$

$$ASG = 9.76 + 0.0064 \times SLD - 0.8026 \times TETI \quad (2);$$

$$ODE = 3.58 + 0.00861 \times SLD - 0.3212 \times TETI \quad (3);$$

Table 6: Effect of the depth of the Sarmatian limestone on the decorative effect and growth of woody plant shoots.

Depth of the Sarmatian limestone, cm	White acacia decorative effect	Oleaster shoot growth	Student t-test, t_{ϕ}	decorative effect	shoot growth	Student t-test, t_{ϕ}
50 (1)	2-3	7.6±0.34	1-2 = 2.80			1-2 = 3.72
			1-3 = 0.80	2-3	22.6±1.03	1-3 = 5.51
			1-5 = 4.80			1-4 = 12.08
			1-6 = 1.80	4	29.0±1.43	1-5 = 10.54
70 (2)	3	9.0±0.41	2-3 = 3.18			1-6 = 7.40
			2-5 = 1.77			2-3 = 1.88
100 (3)	3-4	7.2±0.44	2-6 = 4.20	3-4	33.0±1.59	2-4 = 9.00
			3-5 = 4.95			2-5 = 7.55
140 (4)	-	-	3-6 = 0.60	4-5	54.0±2.38	2-6 = 3.72
160 (5)	4	10.0±0.42	5-6 = 6.20	3	50.0±2.42	3-4 = 7.28
240 (6)	3-4	6.9±0.33		3	37.2±1.71	3-5 = 5.89
						3-6 = 1.80
						4-5 = 1.18
						4-6 = 5.71
						5-6 = 4.35

Note: The critical (tabular) value of student's t-test (t_{05}) is 1.98-2.00.

Table 7: Correlation coefficients of decorative effect, growth of shoots of woody plants, and soil-ameliorative factors.

Soil-ameliorative factors	Soil thickness, cm	White acacia	Oleaster		
		decorative effect	shoot growth	decorative effect	shoot growth
Depth of the Sarmatian limestone, cm	0-100	0.993	0.568	0.563	0.970
	0-160	0.969	0.641	0.588	0.780
	0-240	0.347	0.150	0.331	0.556
Total salt content, %	0-30	-0.759	-0.417	-0.518	-0.619
	0-50	-0.482	-0.560	-0.814	-0.623
	0-100	-0.621	-0.756	-0.905	-0.714
	0-160	-0.553	-0.831	-0.787	-0.406
	0-240	-0.540	-0.858	-0.721	-0.384
Toxic salt content, %	0-30	-0.711	-0.415	-0.376	-0.519
	0-50	-0.584	-0.720	-0.641	-0.381
	0-100	-0.380	-0.811	-0.524	-0.283
	0-160	-0.218	-0.732	-0.453	-0.093
	0-240	-0.242	-0.796	-0.465	-0.095
Total effect of toxic ions, mg-eq. Cl-	0-30	-0.736	-0.736	-0.440	-0.590
	0-50	-0.678	-0.729	-0.735	-0.464
	0-100	-0.564	-0.751	-0.676	-0.407
	0-160	-0.483	-0.802	-0.533	-0.140
	0-240	-0.482	-0.808	-0.053	-0.132
Alkalinity, %	0-30	0.285	0.054	0.231	0.325
	0-50	-0.224	0.101	0.046	-0.096
Humus content, %	0-30	0.627	0.511	0.366	0.474
	0-50	0.590	0.610	0.602	0.554
Easy hydrolysable nitrogen (N ₂ O), mg/100 g of soil	0-30	0.514	0.474	0.118	0.503
	0-50	0.582	0.499	0.099	0.590
Digestible phosphorus (P ₂ O ₅), mg/100 g of soil	0-30	0.636	0.465	0.094	0.452
	0-50	0.670	0.493	-0.202	0.152
Available potassium (K ₂ O), mg/100 g of soil	0-30	0.872	-0.801	0.083	0.538
	0-50	0.705	0.781	0.290	0.564

Note – The critical value of the correlation coefficient at the 5% level of significance is 0.304-0.349.

$$OSG = 9.06 + 0.2877 \times SLD - 0.5219 \times TETI \text{ (4);}$$

where ADE and ODE are decorative effects of acacia and oleaster on a five-point scale (1 point - very low, 2 - low, 3 - medium, 4 - high, and 5 - very high);

ASG and OSG is the average growth of shoots, cm;

SLD is the depth of the Sarmatian limestone, cm;

TETI – «total effect of toxic ions in the layer of 0-100 cm, mg-eq. Cl-.

Using the correlations, formula No. 5 was also de-rived to predict the decorative effect of woody plants for gardening.

$$DE = 41.82 + 0.2764 \times SLD - 3.5576 \times TETI \text{ (5),}$$

where DE is a decorative effect measured for better comparison in the range of 0 to 100 points.

The decorative effect is classified as very low with a score of 0–20, low - 21-40, average 41–60, high 61–80, and very high - 81–100. It should be noted that formula 5 is used to predict not intraspecific comparative but intraspecific decorative effect, which is caused by eco-topic variability. It can be used only for biologically resistant woody plants, most common in landscaping in Mangistau: *Ulmus pumila* L., *Gleditsia triacanthos* L., *Populus diversifolia* Schrenk., *Ailanthus altissima* (Mill.) Swingle, *Fraxinus lanceolata* Borkh.,

Elaeagnus oxycarpa Schlecht., *Tamarix ramosissima* Ledeb., *T. hohenackeri* Bunge, *T. meyeri* Boiss., *T. laxa* Willd. and *T. elongata* Ledeb., *Robinia pseudoacacia* L., *Sophora japonica* L., *Haloxylon aphyllum* (Minkw.) Iljin, *Populus bolleana* Lauche., *Morus nigra* L., *Rosa beggerana* Schrenk., *Amorpha fruticosa* L. and *Ligustrum vulgare* L. In addition, the formula is applicable for the bedrock depth from 30 to 250 cm and in case of optimal moisture content in soil under greening plantings (60–100% of full field moisture capacity).

According to our scheme, before planting each particular object, it is necessary to determine the depth of the Sarmatian limestone and soil salinity according to the "total effect" of toxic ions, predict the expected decorative effect of tree-shrub species and then take one of the following solutions based on the points obtained: 1) create green spaces without additional reclamation activities; 2) landscape the area with the mandatory construction of drainage; add additional layers of soil or completely replace saline soil with imported vegetation of good ameliorative quality; wash the soil from salt, etc., or 3) reject the site (or use it for another purpose).

CONCLUSION

The depth of the bedrock, as a provincial property of Mangistau zonal brown soils, has a significant effect on the salt, alkaline and nutrient regimes of the soil cover, especially under long-term irrigation, causing ultimately from 32.3 to 94.1% of changes in the intensity of growth and general ornamentation of woody plants and creating the prerequisites for the need for a differentiated approach to the implementation of costly ameliorative activities in green areas.

As the thickness of loose soils increases, both the total salt content and their composition and distribution pattern in the soil profile change. The prism-like type of salt location along the profile changes to pyramidal; sulfate and chloride-sulfate chemistry turns into sulfate-chloride, chloride-soda, and sulfate-soda. As a result of perennial irrigation, the salinity of the upper meter stratum becomes low, with a bedrock depth of 140 cm, medium - 40, 60, 70, 100, 120, and 240 cm, and high - 50 cm. With a loose soil thickness of 160 cm, the top meter layer is classified as "non-saline".

Unlike the characteristics of salinity, the maximum amount of sodium in the soil-absorbing complex was observed at a limestone depth of 70, 160, and 240 cm, the minimum - 40 and 50 cm.

By reducing the salinity of the upper soil horizons and activating the beneficial microflora with increasing depth of the rocky soil, a significant increase in the content of humus substances in the soil and the available forms of nitrogen, phosphorus and potassium are noted. At the same time, the availability of digestible phosphorus

shifts from "low" to "medium", and available potassium - from "medium" to "high".

All soil-amelioration factors are distinguished by very strong variability over the territory of the botanical garden, especially the depth of the rocky soil itself (coefficient of variation - 64.3%) and estimated salinity (28.7-81.3%).

A statistically significant correlation ratio at the level of 5% is established between the depth of bedrock and the parameters of the salt regime only in the upper layers of the soil - 0-30 ($r = -0.517-0.571$) and 0-50 cm ($r = -0.622-0.697$). At a depth of 100–240 cm, it becomes much lower and even statistically unreliable, in some cases positive ($r = 0.217-0.367$), as a result of the accumulation of salts in the lower soil horizons. Comparatively high correlation indices of limestone depth were noted for alkalinity ($r = 0.543-0.603$) and soil saturation with humus ($r = -0.622-0.697$). The maximum correlation ratio is observed in the experiments between the thickness of the loose soil layer and the content of easily hydrolyzed nitrogen ($r = 0.785-0.859$), digestible phosphorus ($r = 0.773-0.800$), and available potassium ($r = 0.866-0.916$).

Formula relationship between the bedrock depth and the main agrochemical indicators have a complex back linear, power, exponential, normal logarithmic, and multiplicative form with significant correlation relations ($\eta = -0.380-0.940$). All parameters for assessing the state of the salt regime significantly reduce their values on average over a layer of 0-100 cm to a rock depth of 70-120 cm, then their values decrease to a loose layer thickness of 240 cm almost linearly and to an insignificant extent. The degree of alkalinity in the upper layer of 0-50 cm, on the contrary, is significant in the range of the Sarmatian limestone from 40 to 140 cm and remains almost the same to a depth of 240 cm. A similar pattern is observed for the content of humus, available forms of nitrogen and potassium with increased correlation ratio ($\eta = 0.82-0.94$). The relationship between soil saturation with digestible phosphorus and the depth of bedrock is similar in appearance to a direct linear function with a correlation ratio of 0.660.

As the thickness of loose rocks increases from 40–60 to 140–160 cm, there is a steady tendency to increase in both decorative effect (from 2-3 to 4-5 points) and shoot growth: from 7-8 to 10 cm in white acacia, and from 18-22 to 50-54 cm in oleaster (Table 6). The correlation coefficient between the depth of rock and the growth rate of acacia is 0.150-0.347, and of oleaster is 0.331-0.556. Then in the range of 0-140-160 cm, it rises up to 0.641-0.969 for white acacia and to 0.588-0.780 for oleaster.

Preliminary diagnostics of the decorative factor of woody plants according to the derived regression equations between the

decorative effect of woody plants and the depth of limestone will avoid mistakes when choosing areas for gardening, timely choose the most important ameliorative measures and thereby improve the state and increase the durability of the collection and landscaping plantings created.

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State Support of Investment Attractiveness of Agricultural Sector

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ABSTRACT

In this paper, the role and importance of investments for the development of agriculture are considered. Moreover, the investment attractiveness factors are determined. Besides, an analysis of the dynamics of investment in agriculture in Russia is presented; the tendency of their reduction in fixed assets is established, as well. It was noted that the state support of agricultural sector is an important component of investment attractiveness. Budget funds are focused on subsidizing loan rates. The rating estimation of investment attractiveness of regions is also presented. Discrepancy in the allocation of state support funds is revealed. In the current situation, it is recommended to consider the implementation of domestic food assistance programs.

KEY WORDS: Agriculture, Investments, Fixed Capital, Regions, Budgetary Funds.

INTRODUCTION

Investment in fixed assets is a factor in the economic development of agriculture. Investment is needed for several reasons including:

- 1) Updating the existing material and technical base and the introducing new production technologies;
- 2) Increasing the volume of proceeds from the sale of agricultural products; and
- 3) Development of new types of products.

Initially, in addressing this issue, scientists limited themselves to studying the role of labor and physical capital in economic growth. However, the inability to adequately explain growth has led to the development of a theory of endogenous growth. Meanwhile, there is still unambiguous understanding of the causal relationship between investment, development and growth. For instance, investment in infrastructure was identified as an important source of growth for the agricultural sector. The dependence of investments on the political halt in the country is also taken into account, since the macroeconomic situation is an important indicator for private business (Auraujo et al. 1997; Khairullina and Yarkova 2019; Lachaal 1994; Sandu et al. 2005; Ushachev 2010).

For example, public investment in forms of human capital, education and research can increase productivity.

Investment impulses generated by the state create the conditions and prerequisites for private investment (Committee on a Framework for Assessing Health, Environmental, and Social Effects of the Food System).

In itself, the buildup of exclusively physical capital is not capable of ensuring the production growth. Therefore,

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intellectual capital in the form of intangible assets is of particular value. This directly affects the acquisition and the use of information and technology. In addition, the ability to adapt technology to a specific situation or changing needs depends on it (Agricultural Productivity for Sustainable Food Security in Asia and the Pacific; The National Report). The presence of effective demand can also increase investment.

To this end, it is recommended to increase the domestic purchasing power by expanding exports and import substitution, as well as to redistribute assets. The state should take consider not only the existing conditions for the economy development in the country, but also the trends of the international economy, in order to eventually stimulate the flow of private investment (Gataulina and Borodin 2017; Sandu et al. 2007).

Thus, the state economic strategy and policy is essential for forming the investment structure. Local advantages, economic growth, industrial structures and the reform process are the main economic factors influencing investment decisions (Gulzar and Rafiq).

Elements of the system of financing investment activities in agriculture can be:

- Financial resources of agricultural companies;
- Funds from specially organized extra-budgetary funds and financial institutions;
- Funds of state, regional and local budgets;
- Commercial and state loans;
- Funds of the population; and
- Foreign investment (Khairullina 2018).

In this regard, the mechanisms for attracting investment in agriculture are of particular importance, where the regulatory conditions of business created by the state also are of paramount importance.

Investment attractiveness is characterized by a complex of factors affecting the flow of funds into the agricultural sector of the economy.

The investment attractiveness of agricultural companies is related to internal and external factors encouraging potential investors to invest in refusing alternative investments in a certain period.

External factors are associated with regional investment attractiveness, generally depending on macroeconomic

conditions.

Internal factors are tied to the formed organizational and management system of an agricultural company, determining the effectiveness of activities at micro level (Fig. 1).

MATERIAL AND METHODS

Monographic, abstract-logical and statistical-economic methods were used to study the factors of investment attractiveness and state support for agriculture. The data of the Federal State Statistics Service of the Russian Federation, OECD and FAO are also used.

This research is focused on agricultural companies at the micro level and the regions of the Volga Federal District of the Russian Federation (hereinafter the Volga Federal District) - to assess the regional investment attractiveness. Located in the center of the European part of the Russian Federation, the territory of the Volga Federal District is 7.27% of the territory of Russia, including 14 regions with 6 republics (Bashkortostan, Mariy-El, Mordovia, Tatarstan, Udmurtia, Chuvashia) and 8 regions (Kirov, Nizhny Novgorod, Orenburg, Penza, Samara, Saratov, Ulyanovsk) and Perm Krai.

In 2017, the share of the Volga Federal District in the total agricultural output of all agricultural producers in Russia is 23.3% or 1,192 billion rubles (Li and Clarke-Hill 2004).

To assess the regional investment attractiveness of the industry, the following rating indicators were selected:

- Gross agricultural production per capita (X1);
- Investments per capita (X2);
- Subsidies received from the federal budget (X3);
- The amount of taxes paid (X4);
- The region's average self-sufficiency in food products (potatoes, milk, dairy products, meat and meat products, vegetables, fruits and berries, eggs and egg products) (X5);
- Share of industry in gross regional product (X6);
- The profitability of crop production (X7); and
- Profitability of livestock (X8).

The values of the indicators in a standardized form were translated using a ten-point assessment by the following equation (1):

$$KN_i^j = \frac{x_i^j}{\max(x^j)} * 10 \quad (1)$$

Where KN_i^j represents the standardized value i of the j region index;

X_i^j is the value of the indicator j for the region i ;

X^j shows the maximum value of the indicator j for the Volga Federal District.

The rating of the Volga Federal District regions was built by calculating the integral assessment using the following equation (2):

$$IR = \sum_{i=1}^{n=8} KN_i^j \quad (2)$$

Where IR is the integral rating score.

The study period for the rating is 2015 to 2017

RESULTS

In recent years, in Russia unprofitable agriculture, the industry has been gradually turning into a growing sector of the economy. Despite the prevailing perception of increased investment risks that inhibition of capital inflows,

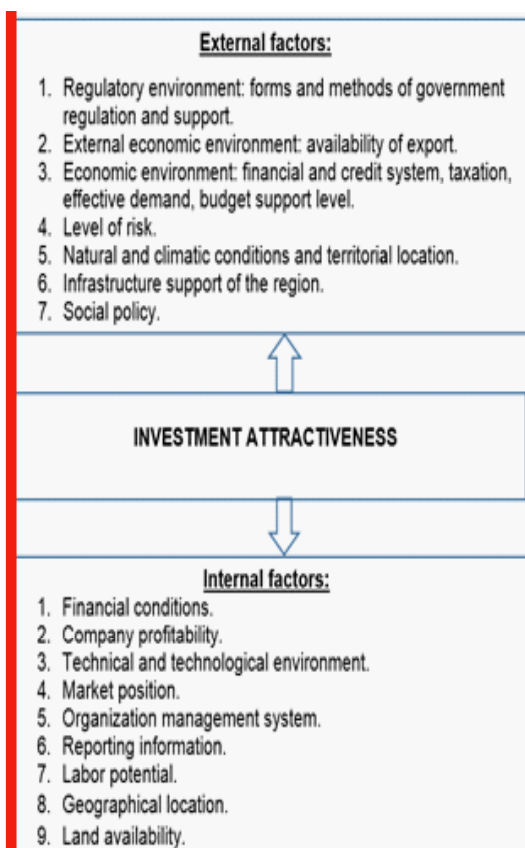


Fig. 1: Factors of investment attractiveness of agricultural companies

Source: compiled by the author

the return on investment in agriculture exceeds the average for the economy (Evenson and McKinsey 1991). There is an increase in the value of fixed assets while the degree of their wealth remains extremely high - 40% (Fig. 2).

In 2017, more than 70% of investments in fixed assets were directed to the development of the economic activities including mining (25.1%), transportation and storage (18.1%), manufacturing (16.0%), provision of electrical energy, gas and steam, air conditioning (6.8%), and real estate operations (6.7%). The share of agriculture in the total investment in the economy is still not significant - 3.1%.

The observed increase in acreage and an increase in the livestock and poultry population are accompanied by the decreased level of energy use. There is an extensive increase in the volume of agricultural production.

As negative trends, it is also worth referring to the increased number of unprofitable agricultural organizations to 4.3 thousand units, a decrease in the profitability of assets to 5.4%, activity (including subsidies) to 14%.

The reduction in public investment is of particular concern. An assessment of the situation in the agrarian sector shows that without effective government incentives and the phased restoration of agricultural production an increase in investment attractiveness will be impossible.

Limited private investment in Russia is also associated with the low profitability of agricultural organizations, which is due to the technical and technological lag of the industry (Mazloev and Khairullina 2017; Mazloev and Khairullina 2018; Sandu 2005).

The share of investments aimed at reconstruction and modernization in the total volume of investments in fixed assets has dramatically decreased in recent years (Fig. 3).

The main source of financing investments in fixed assets is the organizations' own funds -52.1%, and the share of attracted funds is 47.9% of investments.

Public investment in various forms of support amounted to 3.9%, seeming to be insufficient.

activity of the agrarian sector is carried out through using the tools of the State Program, within which grants from

the federal budget are provided to the constituent entities of the Russian Federation.

The implementation of measures to support investment activity was carried out under the sub-program "Stimulation of investment activity in the agro-industrial complex" and "Development of financial-credit system of the agro-industrial complex" in the following directions:

- "Support for investment lending in the agro-industrial complex";
- "Compensation of direct costs incurred for the construction and modernization of the facilities of the agro-industrial complex";
- "Supporting preferential loans to organizations of the agro-industrial complex"; and
- "Additional capitalization of the state bank JSC "Agricultural Bank"" (Regional Statistics).

Budget support is aimed at compensating part of the interest rate on investment and short-term loans to refund

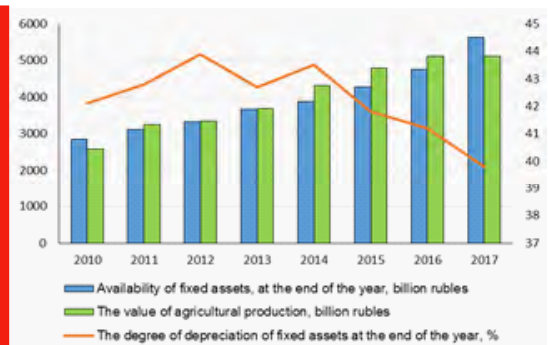


Fig. 2: Indicators characterizing the conditions for the formation of investment activities. Source: compiled by the author using (Li and Clarke-Hill, 2004)

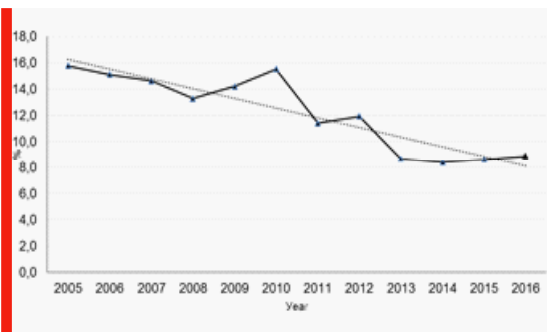


Fig. 3: The share of investments aimed at reconstruction and modernization in agriculture. Source: compiled by the author using (Li and Clarke-Hill 2004)

the costs of agricultural producers associated with the construction, modernization and (or) reconstruction of production facilities, the acquisition of machinery and equipment. The mechanism of concessional lending provides for compensation for lost revenue of banks in the amount of 100% of the key rate of the Central Bank of the Russian Federation. This is while, the interest rate for the agricultural producer initially does not exceed 5% per annum.

It should be noted that in Russia, obtaining loans for farmers has its own difficulties. In particular, the creditworthiness of many of them does not meet the requirements of the bank, there are problems with the assessment and availability of collateral.

Credit resources are actively used, first by single large agro-industrial formations, with which it is difficult for small and medium businesses to compete in the struggle to attract budgetary funds. Budget support is distributed very unevenly and often performance indicators are not fully considered. The priority remains for the quantitative indicators: livestock number, acreage, as well as the volume of agricultural production.

At the macro level, there are also contradictions in the distribution of budget support funds and the output of production.

According to the previously presented method, a rating system of investment attractiveness of the regions from the perspective of the agricultural economy was compiled and analyzed (Table 1).

The rating of the regions of the Volga Federal District shows that there are annual changes in the positions of the subjects.

However, the undisputed leader remains the Republic of Tatarstan (Table 2). More than a half of the regions have a positive trend in increasing investment attractiveness.

At the same time, receiving state support funds has several other trends. In general, it should be noted the low level of budget financing of agricultural companies. In addition, there is a reduction in funding in almost all regions in the range of 0.01 ruble to 0.07 ruble per unit of agricultural output produced (Table 3).

The current mechanism of distribution of state support funds is not focused on the investment attractiveness of the

regions; except for The Republic of Tatarstan, where such a source of funding is attracted quite actively (Table 4).

The criteria used for state support for obtaining subsidies

change annually and do not allow private businesses to focus on this type of funds for long run. The application nature of the procedure does not guarantee agricultural companies.

Region	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	Total score
Republic of Bashkortostan	5,22	3,92	4,78	6,30	7,47	4,96	0,27	1,72	34,63
Mari El Republic	7,69	2,14	1,57	5,21	8,45	10,00	-19,34	6,03	21,75
The Republic of Mordovia	10,00	4,53	1,74	6,34	7,24	9,43	5,08	6,75	51,11
Republic of Tatarstan	8,14	10,00	10,00	10,00	10,00	5,04	3,26	2,82	59,26
Udmurtia	5,81	3,22	1,55	7,46	8,68	5,04	5,51	5,26	42,53
Chuvash Republic	4,24	2,57	1,35	2,29	7,66	6,38	6,68	10,00	41,17
Kirov region	4,13	2,70	1,71	7,19	7,66	5,53	3,99	9,76	42,66
Nizhny Novgorod Region	2,87	4,59	2,65	5,40	6,81	2,13	2,03	4,07	30,54
Orenburg region	7,70	5,59	1,51	5,66	7,93	6,60	-0,10	3,06	37,94
Penza region	7,48	3,31	2,06	1,95	7,49	9,22	5,61	8,09	45,21
Perm region	2,13	5,89	2,43	9,52	6,70	1,63	-3,16	2,92	28,06
Samara Region	3,69	4,80	1,94	5,53	8,15	3,12	10,00	-0,57	36,66
Saratov region	7,39	3,59	1,56	7,90	7,22	8,72	9,57	3,49	49,44
Ulyanovsk region	4,16	4,48	0,53	3,09	7,21	5,25	1,89	3,88	30,48

Source: compiled by the author using (Li and Clarke-Hill 2004)

Region	Year			Changes in investment attractiveness rating
	2015	2016	2017	
Republic of Tatarstan	1	1	1	without changes
Mari El Republic	2	8	14	decline
Saratov region	3	2	3	decline
The Republic of Mordovia	4	3	2	boost
Penza region	5	4	4	boost
Orenburg region	6	9	8	boost
Samara Region	7	7	9	decline
Republic of Bashkortostan	8	5	10	decline
Udmurtia	9	6	6	boost
Chuvash Republic	10	11	7	boost
Kirov region	11	10	5	boost
Perm region	12	13	13	decline
Nizhny Novgorod Region	13	12	11	boost
Ulyanovsk region	14	14	12	boost

Source: compiled by the author

Currently, the share of organizations receiving funds from the federal and regional budgets is 68.8%, 75.5% of which includes large companies (Agriculture Organizations Get Subsidies).

Thus, the priority of financing large industrial agrarian formations continues to be strengthened.

A detailed analysis of the distribution of state support funds by recipients for the whole of the Russian Federation

Table 3: State support for the agricultural output in ruble.

Region	2015	2016	2017	Absolute change 2017 to 2015
Volga Federal District	0,08	0,07	0,06	-0,02
Republic of Bashkortostan	0,08	0,08	0,07	-0,01
Mari El Republic	0,08	0,06	0,05	-0,03
The Republic of Mordovia	0,05	0,04	0,04	-0,01
Republic of Tatarstan	0,14	0,11	0,10	-0,04
Udmurtia	0,05	0,06	0,04	-0,01
Chuvash Republic	0,08	0,06	0,07	0,00
Perm region	0,08	0,09	0,10	0,01
Kirov region	0,09	0,07	0,06	-0,03
Nizhny Novgorod Region	0,08	0,07	0,07	-0,01
Orenburg region	0,11	0,07	0,04	-0,07
Penza region	0,05	0,05	0,04	-0,01
Samara Region	0,08	0,05	0,05	-0,03
Saratov region	0,05	0,03	0,04	-0,02
Ulyanovsk region	0,05	0,04	0,03	-0,02

Source: compiled by the author using (Li and Clarke-Hill 2004)

Table 4: Rating of regions by the level of state support.

Region	2015	2016	2017
Republic of Tatarstan *	1	1	2
Orenburg region	2	6	9
Kirov region	3	4	6
Mari El Republic	4	9	7
Perm region	5	2	1
Samara Region	7	10	8
Republic of Bashkortostan	8	3	4
Chuvash Republic	9	7	3
Nizhny Novgorod Region	10	5	5
Udmurtia	11	8	10
Saratov region*	12	14	13
The Republic of Mordovia*	13	12	12
Penza region	14	11	11
Ulyanovsk region	15	13	14

* leader of investment attractiveness rating
Source: compiled by the author

reveals that the maximum share of revenue subsidies is accounted for unprofitable agricultural companies (Table 5).

Furthermore, a group of subjects with profitability up to 20% received 45.6% of budget support funds.

Thus, the role of the state can be viewed more as a compensating, rather than a stimulating increase in the investment attractiveness of the industry.

The race to increase production by any means also leaves the product quality indicators second.

Of course, such a volume of funds, as a matter of fact, concentrated on a point in certain hands of private business, does not allow solving the problems of the agrarian sector as a whole. More capacious investment injections and effective regulatory mechanisms by the state are required. In addition, part of the financial burden falls on consumers buying domestically produced food products at prices higher than on their world counterparts. Starting

Table 5: Grouping of agricultural companies in terms of profitability.

Profitability level (including subsidies),%	Number of organizations, units	Share in total, %	Revenue, million rubles	State support, million rubles	The share of subsidies in revenue, rubles
Unprofitable	2308	13	294225	19746	0,07
from 0% to 20%	9343	51	1355551	59089	0,04
20% -40%	3787	21	621856	32807	0,05
From 40% and more	2990	16	316655	18038	0,06
Total	18428	100	2588323	129680	0,05

Source: compiled by the author using (Regional Statistics)

in 2015, the imposed food embargo has created favorable market conditions for Russian companies, raising the prices of whose products to 40% (Jalili et al. 2015). In recent years, a protectionism policy is most preferred by many countries. However, the fall in demand and real incomes of the Russian population, as a response, also does not allow producers increasing their incomes to a sufficient level. Moreover, in such as situation there are also social problems need to be addressed.

For example, in 2017 the population with incomes below the subsistence minimum has sharply increased and amounted to 19.3 million people. Therefore, the investment attractiveness of the agrarian sector of Russia at this stage should be increased indirectly through the implementation of programs of domestic food aid to the population.

The effectiveness of measures has been proven by the experience of other countries. For example, in the US, \$ 1 billion in retail spending on food for recipients generates \$ 87 million in agricultural production (Çanakçı et al. 2018).

The basis for the development of specific programs in the Russian Federation in conditions of limited budgetary funds is considering individual regions and products (for instance, meat and its products) that especially need such support (Khairullina 2019; Kuzmin and Chepik 2014). A typology of subjects of the Russian Federation should also be used, which is an effective mechanism for improving the analysis of public policy and identifying market or government incentives underlying management decisions.

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Optical Radiation and Growth of Farm Animals

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ABSTRACT

The article describes the design of a prototype model of an irradiating device proposed for radiation of animals. The results of measurements of the lighting characteristics of a prototype model of an irradiating device are presented. Industrial tests of the prototype were carried out at the enterprise "KPIA-GRO" for two months on a bird and two months on cloven-hoofed animals with the mode of lighting day - night. The installation worked 14 hours a day with working LED bars and 15 minutes a day with a UV lamp. Figures 8 - 9 clearly show how the prototype model illuminates and irradiates animals in the enterprise.

KEY WORDS: Radiation, Ultra-Violet Radiation, A Prototype Model, Lighting Characteristics, Leds, Luminescence Lamp

INTRODUCTION

On the basis of previous researches, which showed that for radiation and illumination of birds, it is favorable to use radiation sources in the green region of the spectrum in combination with long-wave ultraviolet radiation; a less expensive and compact version of the irradiation unit was designed (Akar et al. 2018; Almasi 2016; Kovalenko 2016; Kovalenko 2017; Kovalenko 2018; Mardanian et al. 2018; Ovchukova 2006; Pilshchikova 2012; Pilshchikova, 2014)

OBJECTIVE AND METHODS

Green light LED strip was chosen as a source of visible radiation, and a compact UV luminescence lamp with a spectrum of UVA, on the basis of which a prototype model of the irradiating device was designed (Figure 1) was selected as a source of ultra-violet radiation.

Measurements of the characteristics of the prototype model were carried out on a goniophotometer GO2000A in the Center for collective usage "Lighting Metrology" of Institute of Electronics and Lighting of Ogarev Mordovia State University in accordance with GOST R 8.749-2011. Goniophotometer GO-2000A can measure the luminous

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Fig. 1: Prototype model of the irradiating device complete with the powered UV lamp and LED strip.

intensity distribution, effective angle of illumination, total luminous flux, luminaire efficiency, illumination diagrams, isocandela - diagrams, voltage, current, power, frequency and other values.

The photometric installation of this type includes the following components: precise goniometer GO-2000A; CT400 goniophotometer precision controller; ID-1000 precision photometric head; YF1750 photometric head holder; precision laser leveling device; GO-SOFT software for GO-2000A; standard light source; WY3010 digital DC power supply (DC); PF2010A high precision digital power meter (0.05% accuracy); DPS1060PWMAC power supply; YF1000 panels; adapters for lamps, lanterns, spotlights. The main parameters of the photometer:

- Temperature control: $\pm 0.05 \text{ }^\circ\text{C}$ (constant temperature point: $t = 35 \text{ }^\circ\text{C} \pm 1 \text{ }^\circ\text{C}$);
- Measurement range of illumination: 0.0001lx - 200 klx;
- Photometry measurement accuracy: standard class (calibration by standard source of luminous intensity).

A schematic representation of the principle of operation and the appearance of the installation is presented in Figures 2 and 3.

The results of measurements of the light distribution of the radiation power measured by the goniometer GO-2000A are presented in Figure 4.

The spectral characteristics of the prototype model were measured using a spectroradiometer Specbos 1211. The Specbos 1211 is a compact, highly sensitive spectroradiometer of general purpose that measures a wide range of wavelengths from near ultraviolet to infrared radiation. The results of measurements of spectral characteristics are presented in Figures 5 - 7.

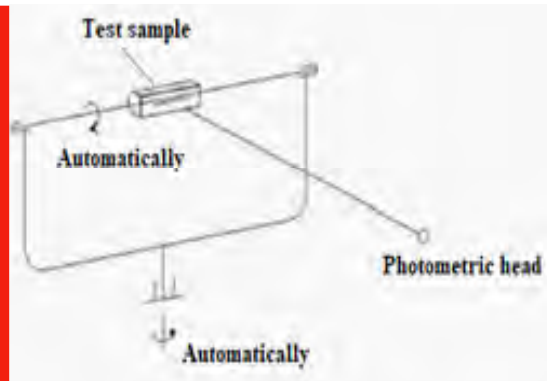


Fig. 2: Schematic representation of the principle of operation of photometric installation



Fig. 3: Appearance of the installation GO-2000A

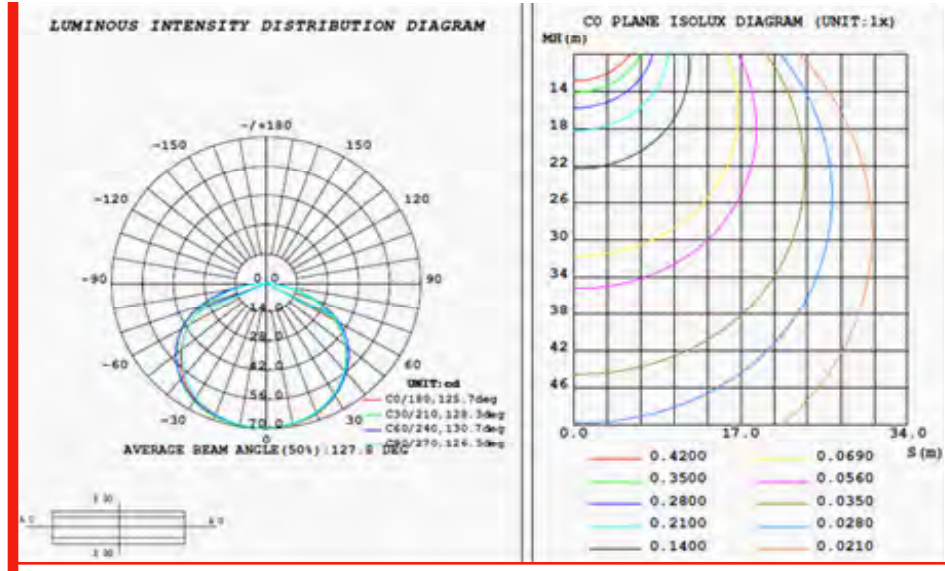


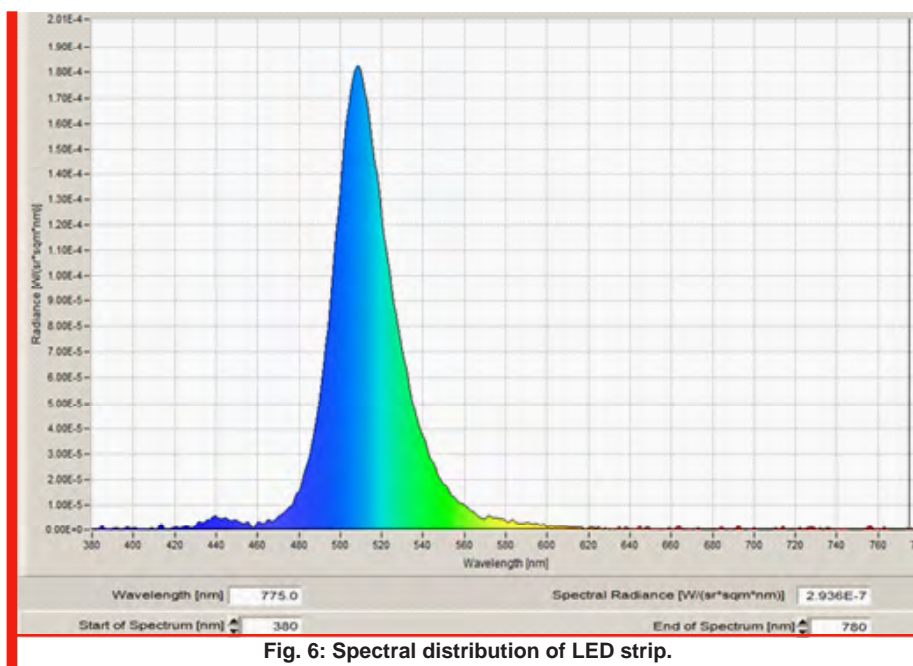
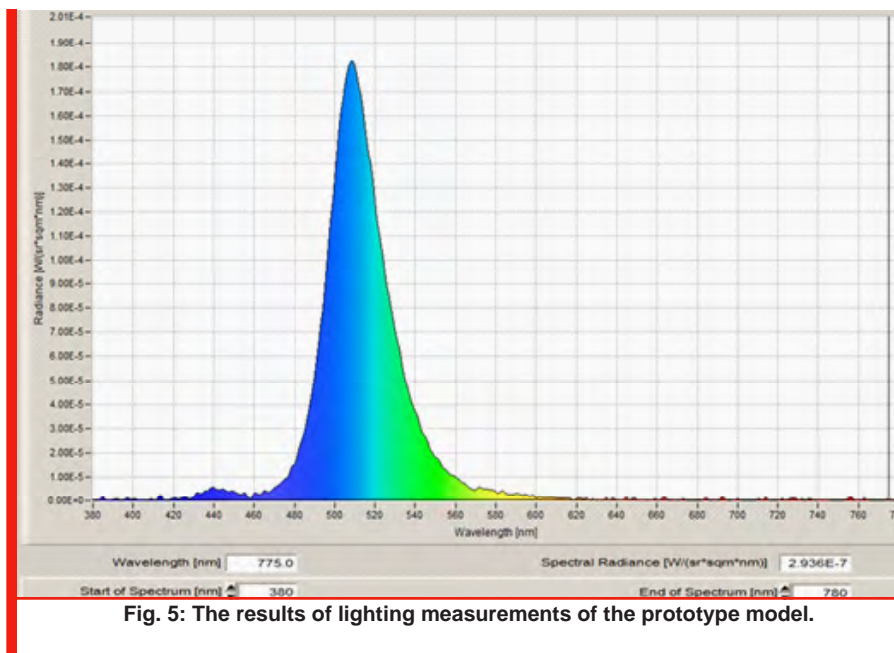
Fig. 4: The results of lighting measurements of the prototype model.

RESEARCH RESULTS

Industrial tests of the prototype were carried out at the enterprise “KPIA-GRO” for two months on a bird and two months on cloven-hoofed animals with the mode of lighting day - night. The installation worked 14 hours a day with working LED bars and 15 minutes a day with a UV lamp. Figures 8 - 9 clearly show how the prototype model illuminates and irradiates animals in the enterprise.

FINDINGS

Industrial studies of the influence of the spectral composition of the radiation sources included in the prototype model did not reveal any negative effects on animals. The results of both studies showed that there were no significant differences in weight in both groups, the average weight of the birds was 1.65 kg, and the lambs — 64 kg.



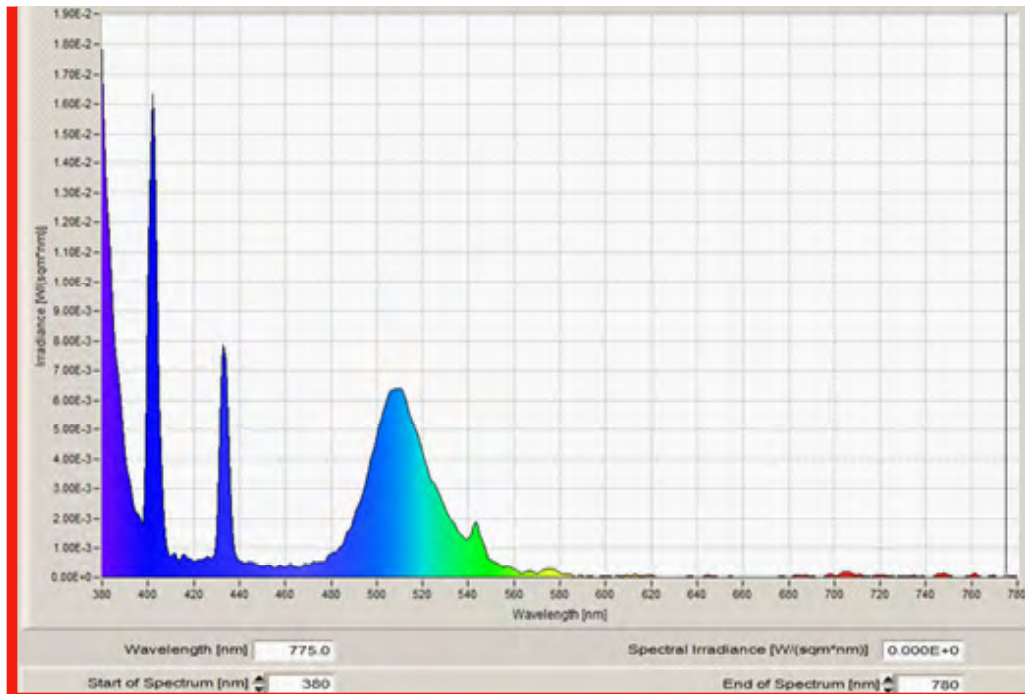


Fig. 7: Spectral distribution of the LED strip when the lamp is on.

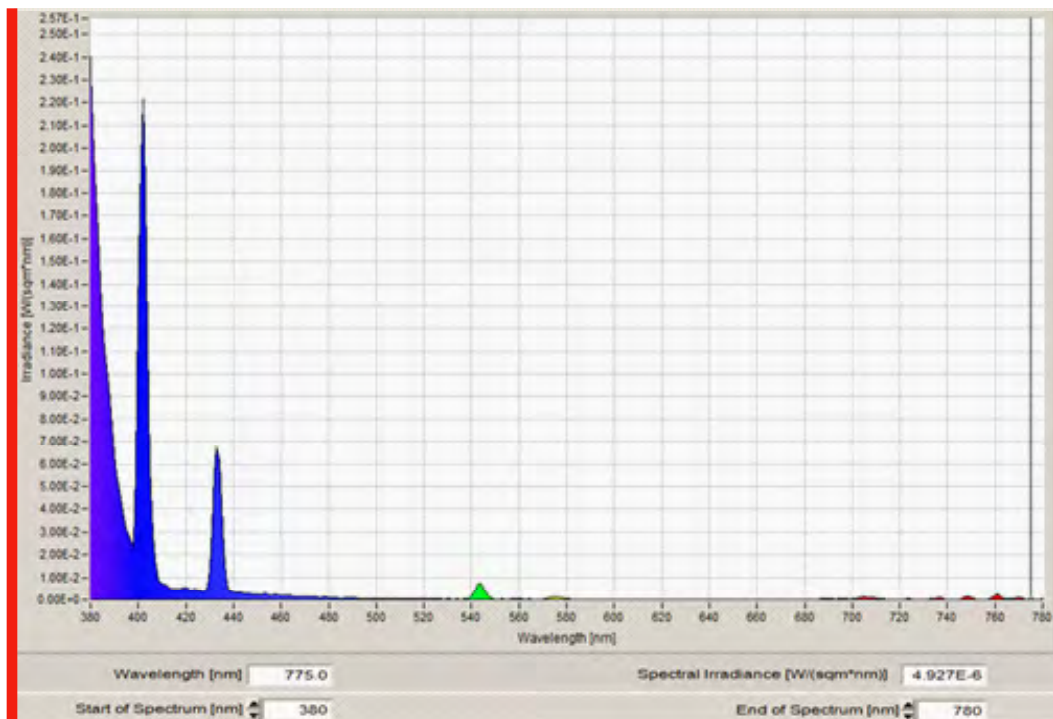


Fig. 8: Spectral distribution of the UV lamp.



Fig. 9: Schematic representation of the principle of operation of photometric installation



Fig. 10: Schematic representation of the principle of operation of photometric installation

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PAM Aqueous Solution Flow and Enhance Oil Recovery

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ABSTRACT

This work studied the effect of polymer on the water flow behavior towards extracting the remaining oil from the reservoir by polymer flooding method experimentally and numerically. The results showed that the viscosity of aqueous solutions decreases with the shear rate, temperature, and salt concentrations increasing, while increases with the polymer concentration increasing. Non-Newtonian flow and shear-thinning effect associated with the polymer solutions behavior. PH value increases and surface tension increase with the polymer concentration increases. Oil recovery reaches 95% at 2500 ppm of PAM/brine water solution during core tests. High stability and less viscous finger effect produced in touching region between polymer solution and crude oil, at this ratio clearly appear as a qualitative contour in numerical simulation.

KEY WORDS: Polymer Flooding, Non- Newtonian Flow, Viscosity, Surface Tension, Crude Oil, Core Flooding Test And Numerical Simulation.

INTRODUCTION

Crude oil is a complex hydrocarbon component (hydrogen and carbon), salinity or acid was classified according to the level of sulfur that found on it, extracted and pull out crude oil from reservoir was differ for north and south Iraq, later known by high salinity water with crude oil was extracted from well (Abubakar et al. 2014). Oil represent backbone of modern life that used in industry, energy etc. However, found problems associated to the amount of oil was remain in reservoir after primary and secondary

stages. Three stages were applied to extract crude oil from reservoir (Afsharpoor et al. 2012). Primary recover~ 15% from Original Oil In Place (OOIP) by pressure was able to pull out reservoir (Akpınar and Yangın 2018). Secondary stage recover ~ 30% from OOIP by injected external fluids like gas or water to increase pressure within reservoir. Due to macroscopic and microscopic factors lead to still ~ 55% from OOIP in pores of rocks (Akter and Deb 2017). Chemicals, thermal or gas were injected to obtained further amount from oil after water flooding (Al-Ameri et al. 2009). On the other hand In water flooding was need to high amount of water, high different viscosities between water and oil lead to viscous finger was obtained and not has ability to transform wettability from oil-wet to water-wet then lead to unsweep efficiency and lowering oil recovery (Bandyopadhyay et al. 2014; Zheng et al. 2017). Chemicals such as surfactant, alkaline and polymer successful methods for tertiary or enhance oil recovery (EOR) (Bear 2013). Polymer flooding was able to enhance Macroscopic and Microscopic sweep efficiency. Oil in macroscopic porous media was effected by viscosity of aqueous solution. Increase viscosity lead to decrease mobility ratio of injected fluid by increase concentration dissolved within solution and less formation viscous fingerings and/or channels (Buchgraber et al. 2009). Moreover, polymer solution was reduced relative permeability of oil (Kro) less

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than water relative permeability (K_{rw}) (Das et al. 2014). Elasticity of non-Newtonian fluid that related to viscoelastic phenomena was controlled on microscopic porous media of oil. Therefore, oil remain in closed end was removed (de Castro et al. 2016; Farouq-Ali and Stahl 1970; Wei et al. 2014), oil film on rocks was striped it (Ghahremani et al. 2018; Huifen et al. 2004; Jiang et al. 2008; Kulawardana et al. 2012), prevent oil droplet from broken in oil zone (Lenormand et al. 1988) and shear thickening phenomena for injected fluid (Li et al. 2018). Wettability was important petro physical properties that accelerate oil recovery from porous media after water flooding (Liu et al. 2017). In petroleum engineering preferred water-wet system in which oil was flowed in free shape and not connected on rock surface (Maia et al. 2009). Oil-wet system in shape of continuous film of oil was connected on rock surface (Mishra et al. 2014). The rheological properties of an injected fluid have an important effect on oil-displacing efficiency in the chemical flooding process (Mishra et al. 2014). Enhanced rheological behaviors by add polymer which play advantage role in producing less viscous finger in the EOR process (Muggeridge et al. 2014). Therefore, it

is necessary to investigate the rheological properties of the samples before experimental flooding is measuring.

Modelling of non-Newtonian fluid flow in porous media have more complicated because these related to the ability of one phase to remove another. Furtherer more, size, distribution of pores, porosity and permeability. Computational Fluid Dynamic (CFD) were used by (Orhan 2018), studied compared between Newtonian and viscoelastic fluid by design geometry represent stable oil droplet in pore throats, observed pull out trapped oil by viscoelastic fluid in reason of high normal stress; Debora number and imposed force on oil droplet to release it. Finite element method (FEM) based on Galerkin approximation were used by (Patel et al. 2017; Xia et al. 2008), made simulation for laminar multiphase water and oil, designed geometry from circular tube with radius 0.05 m and 8m length in Computational Fluid Dynamic (CFD), the result obtained, velocity profile; volume fraction; shear rate; pressure distribution and interfacial thicknesses at different time were showed by COMSOL multiphasic software. Computational Fluid Dynamic (CFD) were used by

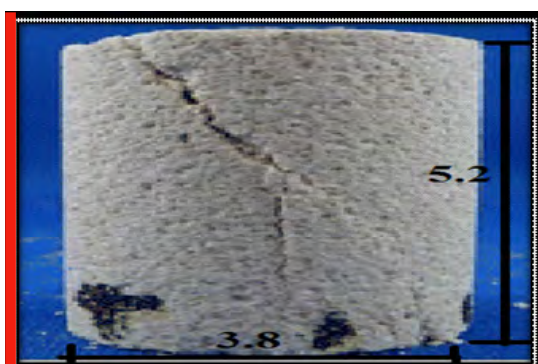
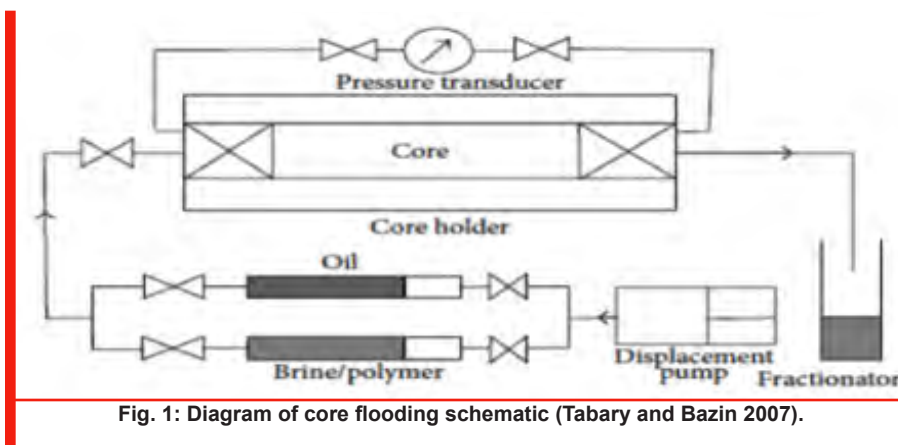


Fig. 2: Sandstone core with (5.2) cm length and (3.8) cm diameter.

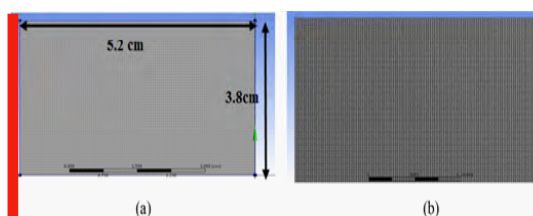


Fig. 3a(a): Geometry of model and (b) Meshing of model.

(Sedaghat et al. 2013), made simulation of displacement process for multiphase water-oil flow in downward inclined pipe, volume of fluid (VOF) model and refine mesh was used, result obtained, increase inlet water velocity led to

high displacement efficiency and instability of interface was caused by increase pipe inclination angle. Simulation of non-Newtonian pseudo plastic fluid by vertical helical coils geometry were designed by (Seright et al. 2018), used Computational Fluid Dynamic (CFD) in Fluent 6.3, these study based on static pressure at hexahedral and tetrahedral grid; total pressure and velocity magnitude at different angle, they obtained that details inside flow phenomena of the coil. Mathematical model used to simulation polymer flow in porous media by depend on viscosity of polymer were showed by (Shoghi and Norouzi 2015), observed that concentration, molecular weight, alkaline, PH and salinity effect on viscosity of hydrolysis polyacrylamide (HPAM) (Singh et al. 2016). used analytical solution, showed stability in contact region between injected fluid and oil depend on viscosity of solutions which effect on mobility ratio and viscous finger.

In this present work, polyacrylamide (PAM) at different concentrations was mixed with tap and brine water. Rheological, physical and petro physical properties were measured. Experimental flooding was performed to check oil recovery. Computational Fluid Dynamics (CFD) by FLUENT16.1 was used to investigate volume fraction of oil-brine water and oil-polymer aqueous solutions .Two- phase flow through core consider as porous media was used in core flooding test. Volume of Fluid (VOF) approach which including effect of surface tension and viscosity was apply to produce viscous finger difference between brine water and polymer aqueous solution.

Experimental Part

MATERIAL AND METHODS

Polyacrylamide (PAM) with molecular weight ≤ 3000000 (g/mol), density (1.182) g/mol and glass transition temperature (159) C° provided from (china). Tap water, brine water and

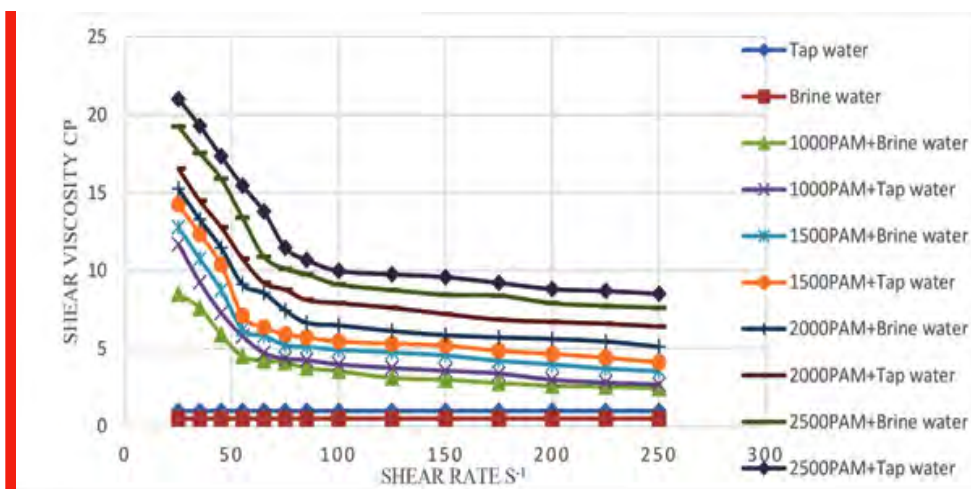


Fig. 4: Shear viscosity versus shear rate for different PAM aqueous solutions.

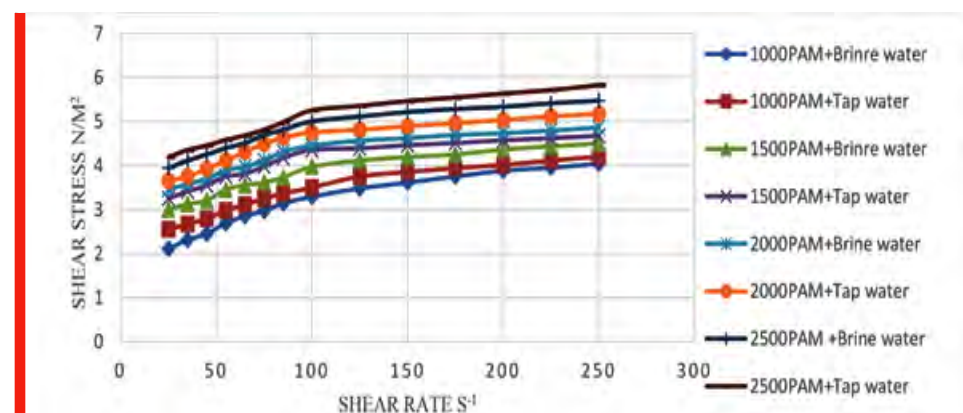


Fig. 5: Shear stress against shear rate of different PAM aqueous solutions.

crude oil with viscosity (3.115) Cp and density (0.9993) g/cm³ at 25C° were used. Rock (core) in type of sandstone provide from Nasiriya reservoir cut from depth of (2010.07) m .

Viscosity test due to different shear rate (25-250) S-1, temperature (25-55) C°, brine and polymer concentration. In addition, flow curve at shear rate range (25-250) s-1 was obtained.

Polymer Aqueous Solution

Brine water was prepared by mixing 20% of Nacl with tap water using magnetic stirrer for 10min. Mixing each (1000, 1500, 2000 and 2500) ppm of PAM with (50) ml tap water and brine water separately. Magnetic stirrer also, used for 30min at 25C° to dissolve PAM added. The tests done after one day.

Physical Properties Measurement

Density

Density test was performed using GP-120 S based on ASTM D-792 from China. The test made with different solutions.

PH

PH was perform using WTW, type Inolab 720. Technical Specification: 4X Alkaline AA, 1,5V. PH range: 2.000 to 19.99. Temperature: -5 to 105 C°. Housing (D) x (H) x (W): 23x8x21, 5cm.

Rheological Properties Measurement

Brookfield cone - plate viscometer with spindle: 41Z was used to measure rheological properties at different concentrations of polyacrylamide with tap and brine water.

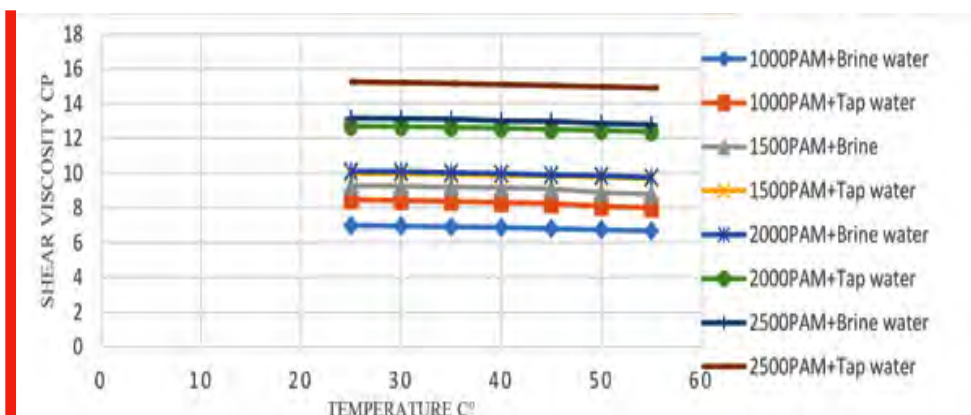


Fig. 6: Shear viscosity against temperature of different PAM aqueous solutions at 25 s⁻¹ shear rate.

Table 1: Density, PH, Surface tension for polymer aqueous solutions.

Aqueous solution (ppm)	Density (g/cm ³)	PH	Surface tension (mN/m)	Interfacial tension (mN/m)	Power law (n) index	Consistency K (pa .s ²)
oil	0.9993	10	35	-	-	-
Tap water	1.05	7	72	38	-	-
Brine water	0.65	9	20	15	-	-
1000PAM+ tap water	0.98	8	25.8	9.2	0.3283	0.08544
1500 PAM+ tap water	0.9838	8	26.6	8.4	0.2731	0.1308
2000 PAM+ tap water	0.9952	8	27.3	7.7	0.2358	0.23003
2500 PAM+ tap water	0.9979	8	28.5	6.5	0.1434	0.4783
1000PAM+ brine water	0.9791	9	25.1	9.9	0.4657	0.03837
1500 PAM + brine water	0.9799	9	25.5	9.5	0.3593	0.08093
2000 PAM+ brine water	0.9951	9	26.8	8.2	0.2630	0.1746
2500 PAM+ brine water	0.9968	9	27.7	7.3	0.1841	0.3521

Surface tension

Surface tension was performed using JZYW-200B Automatic Interface Tensiometer provided through BEING UNITED TEST CO., LTD China. Check surface tension of polymer aqueous solutions in tap and brine water at 25°C are made in contact with air.

Petro Physical Properties

These tests available in Basra Oil Company / Research and Quality department-Nahran Omar.

Porosity

ULTRA PORE 300 makes this test. TEMCO DIV. OF CORE LAB. TULSA, Oklahoma. www.temco.com.

Permeability

The permeability of all solutions and air made using Ultra Perm 550.

Core Flooding Test**Preparation Core**

Core was cleaned by Soxhlet extraction utilizing toluene and methanol, placed the core in a drying oven for 12 hours to dried it at 100 °C, saturated dried core by brine water, weight after and before saturated, put inside accumulative filled by brine water and weighted again. In this stage can determine pore volume (PV), porosity and permeability for air and liquid. Table 2, show that.

Conditioning Stage For Core

Put core sample inside core holder, same reservoir pressure applied on it, displacement brine water by experimental oil. The purpose from this method to make core with reservoir conditions and calculate irreducible water saturation (S_{wi}) and initial oil saturation (S_{oi}).

Experimental Flooding

In this work experimental flooding was held on two steps to make compare between brine water without and with (2500) ppm PAM. Firstly, by brine water and secondly, by brine water and when reach to break through point (water cut) inject (2500) ppm brine polymer aqueous solution. Figure 1 shows the core flooding schematic.

Flooding carried out by remove oil from core at flow rate (6) cm³/min derived from average of all south oil reservoir. Magnitude of pressure (1600) Psi related to permeability of core. Flooding continue and calculate time to reach break through point, which represent first drop of water with oil. Displacement continue until water read with total volume

equal 99.9%, and then calculate oil recovery. Table (3), show that.

Cfd Analysis By Fluent16.1**Modeling**

Figure 2 (a), shows the sandstone core used in this study. Geometry consist of 2-D, same dimension of core that used in experimental flooding. Oil is found in core by filled it firstly. Introduced brine water or polymer aqueous solutions from inlet zone.

Applying mesh to divided the model into number of elements and nodes basic on finite volume method. Mesh is complete by depend on face sizing, body sizing, edge sizing, face meshing and refine. Figure 3(b), show the mesh of 2-D model consist of elements (8800) and nodes (8991).

Main Assumptions**A-Steady, laminar flow.**

B- Viscosity dependent on shear rate for polymer aqueous solutions but brine water viscosity independent on shear rate.

C- Power law model.**Governing Equations**

The governing continuity and momentum equations can be write as,

Continuity equation:

$$\nabla u = 0$$

Where, u is the non-Newtonian PAM solution velocity.

Momentum equation:

$$\rho \frac{\partial u}{\partial x} + \rho u \cdot \nabla u = \mu \nabla^2 u - \nabla P$$

For steady non-Newtonian, PAM solution flow, momentum equation is write as,

$$u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = \left(\frac{1}{\rho}\right) \frac{\partial \tau_{xy}}{\partial y}$$

Where, u and v are the x and y velocity components respectively, τ_{xy} is the shear stress and ρ is the density of non-Newtonian PAM solution with shear thinning.

Power law model

$$\mu = k\dot{\gamma}^{(n-1)}$$

Where μ is the viscosity, k is consistency index, γ is the shear rate and n is the power law index.

Boundary conditions

A-Volume Of Fluid (VOF) model is selected with number of phases=2. Then select Implicit of VOF.

B- Viscosity, density, surface tension, n and k taken from experimental data that showed in table1.

C- Operating pressure is set as (101325) and gravity is consider in Y-direction as (-9.81) m/s²

D- Select(6) cm³/min flow rate in inlet zone for brine water and polymer aqueous solutions.

E- Wall be stationary and No-slip.

F- Select pressure as outlet.

G-Number of iteration is 50.

Experimental Results

Viscosity Curve

Figure 4, shows viscosity curve behavior of (1000, 1500, 2000 and 2500) ppm at 25C°. Tap and brine water behave as Newtonian flow without mixing with PAM polymer. Which independent of shear rate. While the non-Newtonian

Sample	Pore Volume (%)	Porosity (\emptyset)	Permeability K (mD)		
			Ka	Kl	Ko
Core	14.76	26.4	50	26.92	7.45

Sample	Injection solution with Brine Water	Oil Recovery from (OOIP) %	Additional recovery (OOIP) %	Saturation (%)		
				Swi	Soi	Sor
Core	Brine water (2500) ppm PAM	60.82at99.98% water cut	-	18.7	81.3	39.18
		95at99.8% water cut	34.18			5

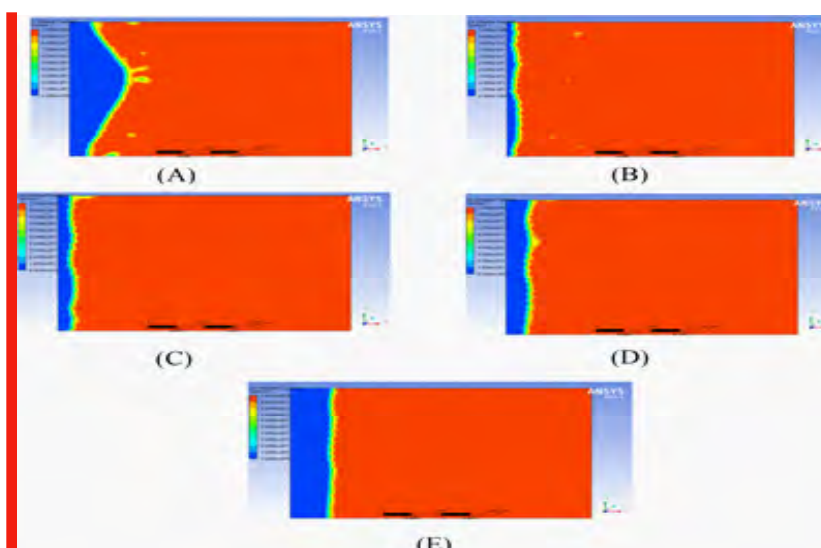


Fig. 7: visualization of volume fraction contour for brine water without and with PAM concentrations increases with crude oil, A)brine water, B)1000PAM, C)1500PAM, D)2000 and E)2500 PAM.

behavior and shear thinning effects increase with the PAM concentrations increasing. The shear viscosity indicates rapid decreasing up to 100 S⁻¹ shear rate then the behavior gradually decreasing and attempt to be stable. Shear viscosity increases with PAM concentration increasing. Moreover, the brine solutions indicate lower viscosity for all concentrations. Gel like formation increase with PAM concentration increasing which decreases mobility ratio. While the viscous finger reduces by increasing the viscosity of PAM aqueous solution. These results compatible with the boundary conditions of reservoir.

Flow curve

Figure5, show demonstrates the shear stress increments with shear rate expanding for all PAM aqueous solutions. PAM with brine water indicate lower shear stress than that with tap water. Shear stress attempt to be nonlinear with PAM concentrations increasing because non-Newtonian behavior. (2500) ppm PAM aqueous solutions which is more suitable to use in polymer flooding.

Effect of Temperature

Figure6, Indicates approximately constant behavior with temperature increasing for all aqueous solutions. Lower viscosity for PAM with brine as compared in tap water. The different values between brine and tap aqueous solutions reductions with PAM concentration decreasing.

Density

Density of polymer aqueous solution increase with (1000, 1500, 2000 and 2500) ppm PAM increasing respectively as show in table 1. High density referred by increase interlink ages between chains. On the other hand dissolved these concentrations by brine water led to lower density compared with the tap water.

PH

Dissolved (1000, 1500, 2000 and 2500) ppm PAM respectively in water increase PH value from neutral to basic with same magnitude for all concentrations. On the other hand, when dissolved these concentrations by brine maintained on constant PH values with same concentrations as show in table1. The PAM/ brine aqueous solutions indicate higher PH values than that with tap water.

Surface Tension

The surface tension increases with the PAM concentration increasing for all solution. While the surface tension of PAM with tap indicate, higher value compared with brine water as show in table 1. The maximum surface tension values

obtained for tap and brine aqueous solutions with 2500 ppm tables1 show that.

The power law index n decreases and viscosity consequences K increase with the PAM concentrations increasing for tap and brine solutions. Calculated values for n and K comparable with the non-Newtonian flow behavior and shear thinning effect of PAM aqueous solution. The lower n value the higher shear thinning effect which representing by 2500 ppm PAM aqueous solutions. The n and K values are very important data for Ansys program to simulate the flow in porous media in core test.

Core Flooding Test

Viscosity increased was applied to EOR by polymer flooding and compared by water flooding. Oil release from sandstone core sample in core flooding by injected brine water and 2500 ppm PAM aqueous solution separately were application. The result of that show in table 3. Injected brine water was accelerate time for reach to break through point and increase water cut magnitudes. Increase brine water injected lead to obtain 99.98% water cut magnitude. Slowly time with decrease water cut values to 99.8% by injected 2500 ppm polymer aqueous solution after break through point. This result agreement with (Tie et al. 2018), show increase injected solution viscosity was lead to decrease water cut amounts, time and increase oil recovery. The oil recovery amounts about (60.82 and 95) % by brine water and 2500 ppm PAM aqueous solution respectively. Furthermore, additional oil recovery reach about 34.18 % by later solution. This result like (VAHIDI and MOHI ALDIN QHOMSHEIE 2015), which used (2000 and 2500) ppm partial hydrolysis polyacrylamide give (19.21 and 21) % additional oil recovery respectively. Through these results conclusion ability of polymer aqueous solution to enhanced macro and micro sweep efficiency. This result similar to (Wang et al. 2000), show rheological effects joined with microscopic phenomena that the non-Newtonian solution release oil from both pore throats and pore bodies, macroscopic shared by high oil recovery 56% and development break through time. Also, macroscopic pictures indicated that the pulling and stripping techniques.

Qualitative Numerical Result

Volume Fraction Contour

Simulation oil release from porous media was depend on viscosity of injected fluid. This agreement with (Wang et al. 2011). Viscosity of aqueous solution was depended to make simulation for core sample as porous media. Oil is 3.115 cp more viscous than brine water with 0.5 cp viscosity

which result high mobility ratio, easily movement in porous media, no slug solution and high permeability when pushing oil forward. Figure7 (A), shows clear viscous finger with unstable contact region between injected fluid and local oil. This result with (Wang et al. 2007), represent clear interface region between two fluids with amount of sharp fingers that result from low liquid viscosity. Parabolic velocity profile of brine water accelerate reach to break through point result less oil extracted, low sweep efficiency and remain high amount of oil in porous media.

Increase concentrations of PAM (1000, 1500, 2000 and 2500) ppm mixed with injected brine water in porous media. Viscosity of aqueous solutions be (4.51, 6.21, 9.11 and 13.39) cp from lower to upper concentration larger than oil viscosity. Therefore, decrease mobility ratio, movement in porous media reduced to release high oil amounts, increase slug for solution and low permeability when pushing oil forward. Figure7 (B, C, D and E), show reduced viscous finger with stable contact region between injected fluid and local oil with increase concentration. This result similar to (Watkins 2009), show fewer viscous finger when viscosity of the introduced fluid was higher than viscosity of oil with stable displacement oil. Decreasing n values as show in table1, result high plug of velocity profile region with increasing concentration of PAM that increase oil recovery.

CONCLUSION

Experimental study for PAM aqueous solutions as non-Newtonian fluid was performed by Cone - plate viscometer with (25-250) s⁻¹ at 25C°. Physical, petro physical properties and core flooding test were examed. Also, numerical simulations to visualize the contact zone between injected fluid and oil in porous media. From this work, it can be concluded as following:-

- 1-Shear viscosity decreases with shear rate increase, temperature and brine concentration for all polymer aqueous solutions.
- 2- Shear thinning effect and non-Newtonian flow behavior increase with the PAM concentration increasing.
- 3-Clear nonlinear relationship obtained between shear stress and shear rate with increasing of PAM concentration.
- 4- Power low index n decrease and viscosity consistency K with increased the PAM concentration increasing.
- 5- Density, surface tension and oil recovery were increased with PAM concentrations increasing.
- 6- Injected 2500 ppm PAM after break through point result, reduced water cut amount and increase oil recovery magnitude.

7-High stability and low viscous finger was appear in contact zone by increase PAM concentrations solution.

8- Good agreement between experimental and numerical study.

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Protection of Agro-Resource Cooperation of Agrolandscapes from Wastewater Pollution

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ABSTRACT

The current paper presents a new approach to the use of waste distilleries, which not only have an environmental effect, but also they should ensure the greatest profits from their processing and disposal. The technology of waste production of alcohol was developed for the distillery OOO «Khutorok 2» of Novokubansky district of Krasnodar region with an average productivity of alcohol and the formation of waste alcohol production of 292 thousand m³ per year. The chemical composition of bards has been investigated and technological processes have been developed, allowing year-round utilization of treated wastewater from alcohol production. Solid waste (the keg) has been mixed at a certain proportion of organic residues (straw of various crops) and hydrated lime. The resulting mixture is boiled. In the pile, the mixture passes exothermic composting. Consequently, the vermiculture food is obtained. Liquid waste is used in the irrigation of the composting process to maintain the necessary moisture in the collar when irrigating the process of vermicomposting and creating the necessary living conditions for the worms, irrigation of agricultural crops on agricultural irrigation fields, refreshing the air by sprinkling to provide the required humidity and outdoor temperature, filling the heating and cooling channel. Completed studies of the availability of soil macronutrients after irrigation of crops with treated drains revealed that the soil of the agricultural irrigation fields has elevated potassium content. For the exploitation of agricultural irrigation fields, it is necessary to select crops, especially those requiring potash fertilizers.

KEY WORDS: Waste, Ecology, Processing, Alcohol Waste, Land Resources, Technology, Irrigation.

INTRODUCTION

Alcohol plants are one of the main enterprises making a significant contribution to environmental pollution. The existing methods of recycling bards are outdated; they do not meet modern requirements for the preservation of the

environment, where the main environmental pollutant is bard. Bard is, at best, stored in lagoons; it accumulates and filters the liquid part into groundwater; most of it evaporates into the environment and the remaining solid part is transported to the fields as organic fertilizers (Kuznetsov et al. 2014; Epov 2015). In this cycle, the bard recycling process takes 2-3 years; the bard poisons the water and air resources of the territories. There are cases of dumping bards into the rivers (Ghadimi and Ebrahimian 2015). Waste from the production of alcohol, falling into reservoirs, degrades the quality of water, causing water to bloom during the hot season, leading to rapid growth of algae, air poisoning by hydrogen sulfide emissions, and overgrowing of the aquatic area with higher aquatic vegetation (Göktaş et al. 2018; Khadzhibi 2012).

In its composition, bard has valuable substances. It contains large quantities of nitrogen, phosphorus, potassium, as well as high biochemical and chemical oxygen consumption, in turn limiting its use in certain sectors of agriculture (Korotkova 2004). There are technologies (Kuznetsov et

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al. 2014; Kuznetsov 2013; Kuznetsov 2017) that divide the bard into fractions using separation. They remove the solid mass from which briquettes are made for heating, compost, etc. These technologies are highly expensive, not adapted to the ecology of the environment, and they do not provide the proper effect in using the remaining part of liquid waste - fugate. The fugate is still sent to the lagoons and it poisons the environment. There is a significant gap between the recycling and disposal of the liquid fraction bards. The liquid part of bards can be used to increase the agro-resource potential (ARP) of agro-landscapes (Kuznetsov, 2018). Soil fertility is constantly deteriorating, introducing a liquid fraction of bards into sprinkling fields that solves several problems; firstly, the introduction of highly nutritive irrigation water to the fields improves the reclamation condition, stimulates soil formation processes, and improves soil fertility; and secondly, irrigation of fodder crops with nutrients is leafy fertilizing for plants, and increasing the yield by 1.5-2 times compared to crops without irrigation (Marinin 2013).

Therefore, new approaches to the use of waste distilleries are required that not only should have an environmental effect, which are fundamental in our opinion, but also they should ensure the greatest profits from their processing and disposal. In addition, waste should not be accumulated, but constantly recycled and disposed annually to increase its profitability of production. An important parameter in the production of alcohol is the temperature of waste from the distillation column, which reaches 94-96 °C. A bard with an initial high temperature is a carrier of considerable energy that must be channeled to new highly efficient processes

of processing and utilization in biotechnology.

MATERIAL AND METHODS

The technology of waste production of alcohol was developed for the distillery LLC "Khutorok 2" of Novokubansky district of Krasnodar region with an average productivity of alcohol and the formation of waste alcohol production of 292 thousand m³ per year. In the production of alcohol, the received waste is lute water. Chemical analysis of the composition of bards is presented in table 1.

As observed in Table 1, alcohol bard is a watery mass of light - brown color with a grain odor and a small amount of dry matter (dry matter: 6 - 8%, moisture: 92 - 94%). The chemical composition of bards contains a high content of nutrients and suspended substances. From the analysis of bards, it must be divided into fractions at the lowest cost, where the speed of the recycling and disposal processes should be important. To separate bards into fractions, the pressing method is used, in which the liquid fraction (LF) is separated from the keg that is the solid fraction (TF) of the pressing waste. After the press LF reaches the average, where it is mixed with lute water, the liquids are deoxidized with slaked lime. The mixture of bards and lute water is called irrigation water (IW), intended after cooling for irrigation of crops on agricultural irrigation fields (LLF). Cooled IW pumps from the pond are fed to the ZPO. On the site of the former lagoon - waste storages: bards and lute water- an irrigation system of ZPO is arranged according to the type of irrigation systems of wastewater (Shokrpour et al. 2018).

Hot OM from a spreader at a temperature of 85-90 ° C is fed to a 3-sectional pond reservoir, where each section performs a specific function in the process of processing

Table 1: Composition of bards for moistening compost.

Indicators	Value
pH	5,3
Temperature, °C	96
Ammonium nitrogen, mg / dm ³	14
Nitrites, mg / dm ³	0,016
Nitrates, mg / dm ³	1,2
Ca, mg / dm ³	72
Mg, mg / dm ³	29
SO ⁻² sulfates, mg / dm ³	106,7
Chlorides, mg / dm ³	39
BOD, mg / dm ³	355
Chemical mg / dm ³	410
Weighted mg / dm ³	80

Table 2: Chemical indicators of the quality of agents according to Budanov MF.

Indicators	Marginal value of irrigation indicators	
	allowable	calculated
Salinity, g / l	1	1
Attitude Na ⁺ /Ca ²⁺ , mg eq / l	≤1,0	0,9
Attitude Na ⁺ / (Ca ²⁺ +Mg ²⁺), mg eq / l	<0,7	0,33
Ratio of Σsols / (Ca ²⁺ +Mg ²⁺), mg eq / l	≤4	2,14
pH	6,5 – 7,5	6,5-7,5

and recycling alcohol waste. In the first pond, the OM is cooled to a temperature of 45-50 °C. In the second pond, OM is intended for the production process of processing waste TF. In the third pond, water is intended for accumulation and supplied to ZPO.

From pond 1 in the winter, OS is fed to heat the area where the keg is being processed into a bio-compost at a site fenced with channels. Hot water from the pond is fed into the channels, moved along the perimeter to the biocomposting sites. This process allows biocomposting all year-round in the open air. S allows to maintain the temperature of the compost at 20-24 °C.

Pond two in the winter period is the accumulator of organic matter for crop irrigation and is a reserve capacity. From the pond three, IW is supplied for irrigation by sprinkling of the PW where crops are grown. The size of ponds two and three are calculated from the reception and accumulation of organic substances in the winter, when no water is used for irrigation.

RESULTS AND DISCUSSION

Measures to protect the environment from alcohol production wastes are expressed in the method of processing and recycling local integrated wastewater treatment plants (LKOS). When developing LKOS for distilleries, it must be considered the existence of this problem, where a number of issues should be solved for the implementation of measures for the protection of land and water resources. The main issues should include:

- Development of effective LKOS for year-round disposal of hazardous substances of IW at ZPO;

- Development of resource-saving adapted technologies for utilization of IW production agents, where it is necessary to consider the resource-saving and rational water consumption, the yield of intermediate products, the amount of production wastes;

- Justification of the irrigation regime, which will be determined by the crop composition of crop rotation, the degree of IW processing, the production program of enterprises for the processing of raw materials, climatic factors, drainage scheme.

From the stated objectives, it follows that in modern technologies, when performing complete waste utilization, there is a gap in the processes of transition from cleaning to recycling phase. This is manifested in the lack of preparation of production agents for complete utilization in biological ponds. Ponds provide biological treatment and purification of organic substances. If this thesis is attributed to other industries, then there is a gap in the technology of cleaning and disposal of wastewater (DM) and waste in processing plants, cleaning and disposal of livestock waste, when cleaning surface and drainage runoff.

For the disposal of industrial wastewater, ZPO should be applied. ZPO are the most effective land reclamation facilities for the reception of cleaned agents and the complete disposal of waste from production. The following technological operations are effectively carried out at ZPO: fertilizer irrigation of agents containing sufficient doses of nutrients for plants; soil purification of organic matter, consisted in its retention, neutralization by the active soil layer due to its absorptive capacity (mechanical,

Table 3: Consumption of raw materials and auxiliary materials.

Raw materials and supporting materials	Consumption	
	per day	in year
Fresh spirit bard, m3	800	292000
Lute water, m3	30	10950
Grain straw, t	13	4745
Biomass of live worms, kg	4,56	1665
Slaked lime, t	0,886	316
Quicklime, t	0,572	208,78
Mineral supplements for cutting collar, t:		
- phosphate fertilizers	0,894	326,34
- potash fertilizers	0,447	163,17

Table 4: Implementations of compost and vermicompost.

Row p / p	Indicators	Amount	
		в сутки	в год
1	Total compost, t including the production of vermicompost, t	85,8	31317
2	For implementation, t	44,7	16317
3	Vermicompost, t	20,55	7500
4	Biomass of live worms, t	0,103	37,5

physical, physicochemical, chemical, biological) and the assimilation of organic and mineral substances by plants, microorganisms and animals.

A significant amount of industrial waste pollutes the environment. The problem of recycling alcohol production waste is particularly acute. Waste is stored in lagoons, in the fields of filtration, dumped on landscapes, in water bodies. This is because there are no sufficiently effective methods of processing, storage and disposal of waste and, as previously noted, preparation of bards for full utilization is not adequate.

It is followed by the discussion of the problem that the most unprepared link in waste disposal technology is the preparation of bards, as well as agents to be used at ZPO.

Irrigation water consists of liquid alcohol waste. The chemical composition of agents is presented in Table 2.

Chemical agents can be used for chemical irrigation of crops. The results of the study of chemical composition of fugate on the total content of toxic salts and the prevention of alkalinity processes in the soil meet the requirements for organic matter for irrigation indicators within acceptable limits. Therefore, it is necessary to develop and improve methods of waste preparation for disposal, which will significantly increase the suitability for soil fertility preservation and crop growing.

Therefore, the development of technical and technological solutions for the qualitative distribution of treated wastewater in irrigation fields will be a promising direction in irrigation of crops. Thus, when developing irrigation systems, it is necessary to consider and justify the basic

technological processes and their elements:

- 1) Irrigation regime of feed (industrial) crops with treated wastewater
- 2) Irrigation equipment for irrigation with treated wastewater sprinklers
- 3) The magnitude of irrigation rates and their adjustment
- 4) Technologies for the environmentally safe distribution of sewage sprinklers on agricultural landscapes
- 5) The norms of runoff and the level of nutrition of plants
- 6) The maintenance and removal of nutrients by the crop of agricultural crops with the introduction of the actual rate of waste
- 7) Influence of runoff volumes on the level of GW and chemical composition of soils.

Year-round method of disposal of agents: Lute water (LW) from the plant is supplied to fill the heating and cooling channel, located around the solids in the disposal site at solid phase. The channel consists of three sections; it provides cooling of the LW in the first section; in the second section of the LW channel, during the winter period, it heats the keg-processing site. In the third section, the LW is mixed with the LF bards, where the OS is obtained for irrigation. LP and LF can be mixed directly at the plant. Then, the cost of transporting agents is significantly reduced. The resulting IW is transported by pipe to the heating - cooling channel.

Solid wastes of production - the keg is mixed in a certain proportion with organic residues (straw of various crops) with slaked lime. The resulting mixture is boiled. In the pile, the mixture passes exothermic composting.

The result is vermiculture food. For the output of the compost and its implementation after composting, overrun collar is produced with the addition of mineral additives in the form of mineral fertilizers. After cutting, a homogeneous and completely fermented mass is obtained - compost.

Irrigation water is disposed of irrigation of the composting process to maintain the necessary moisture in the collar, irrigation of the vermicomposting process and creation of the necessary conditions for the vital activity of the worms - obtaining vermicompost crop irrigation at the ZPO, refreshing the air by sprinkling to provide the necessary humidity and outdoor temperature, irrigation of the substrate for the preparation of compost and fertilizer, and for filling the heating and cooling channel.

These activities provide year-round composting of kegs

Table 5: Production capacity of waste disposal in LLC "Khutorok 2".

Product name	Productive capacity	
	t / day	t / year
Vermicompost, t	20,55	7500
Compost, t	44,7	16317
Mass of live worms, t	0,103	37,5
Winter wheat grain, t	-	30
Hay alfalfa 1 year, t	-	30
Alfalfa hay 2 years, t	-	36

and industrial cultivation of worms. Irrigation is carried out by a sprinkler with fine sprinklers.

The described technology of year-round alcohol waste recycling (bards) is part of an adapted and resource-saving technology allowing to comprehensively use fresh bard - clarified bard (fugate) to create a microclimate, compost and cultivate vermiculture irrigation of crop rotation crops, and keg in its raw form, as feed for farm animals (Thraveersi 1995; Yarovenko 1999; Kuznetsov 2013; Kuznetsov 2014).

For the process of processing and disposal of alcohol waste, the consumption of raw materials and auxiliary materials is established (Table 3).

Maintaining the required ambient temperature will be carried out using a heating and cooling channel: in January, February, March, October, November, December, when the temperature of hot water is 80-900 °C, in April, May, September, when the temperature of warm water is 300 °C, in June, July, August, when the temperature of cold water is 20-250 °C.

The work of vermiculture is year-round: processing of compost per 1 m² of beds is 2.16 tons. The area of beds is 1.5 x 37 m². The number of beds is 100. Removal of verticality from 1 ton of compost is 50%. Eating biomass of live worms from 1 ton of compost is 2.5-10 kg. The considered coefficient for the reproduction of vermiculture in the summer and winter period is equal to 1,126.

The result of the technology is the output of compost and vermicompost (Table 4).

Resource-saving adapted recycling technology includes

irrigation of agricultural crops at ZPO and obtaining alfalfa hay for animal feed and getting vermicompost and keg compost.

FINDINGS

Due to the development of technology for processing and recycling alcohol wastes, the example of Khutorok 2 LLC in the Novokubansky District of the Krasnodar Territory has been used to determine the distribution of the annual quantity of fugate, considering evaporation from the water surface, evaporation from the earth's surface and precipitation:

- 1) Irrigation of keg compost and vermicompost 41,510 m³ / year
- 2) Irrigation of crops 2983 m³ / ha
- 3) Volume of the heating and cooling channel is 30972 m³ / year.

This provides year-round keg composting and industrial production of vermicompost. Irrigation is carried out by a sprinkler with fine sprinklers. The developed recycling technology allows the complex use of bard:

- 1) A fugate for creating a microclimate, making compost and cultivating vermiculture and irrigating crop rotation crops at ZPO.
- 2) Keg:
 - Keg in the raw form as feed for domestic animals;
 - Vermicompost fertilizer (the most valuable fertilizer) - 7500 tons / year
- 3) The rest of the compost is 16317 tons / year

Table 5 shows the production capacity of the disposal of alcohol bards.

An analysis of the results of data in Table 5 shows that the

Table 6: Provision of soil by the irrigated area with macronutrients after wastewater disposal.

Batteries	Content NPK		Plant availability macronutrients
	mg / kg	kg / ha	
Nitrogen hydrolyzed Movable	67,2	859	High
Phosphorus (P ₂ O ₅)	120,7	1542	Elevated
Exchange potassium (K ₂ O)	628,8	8034	Elevated

waste from the production of alcohol is valuable for growing crops. Concentrations of substances do not exceed the standard maximum permissible concentrations for fishery bodies of water with the exception of sulfates, chemical oxygen consumption, as well as pH. Organic substances are available in small quantities, but they are useful for plants. Fresh bard contains 92.4% of moisture, partially used to bring the keg to moisture content of 75%; when pressed, it produces about 245,000 m³ of clarified bards per year.

Completed studies of the availability of macro-elements in the soil of agricultural irrigation fields made it possible to determine the reclamation condition of the soils of the agricultural landscape after the utilization of irrigation water. The results of the study are shown in Table 6.

Studies have shown that the soil ZPO has a high content of potassium. Therefore, for the operation of ZPO, it is necessary to select crops, especially those in need of potash fertilizers; for example, potatoes, which can be used in the production of alcohol.

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Change of Phytoalexin Stilbenoids of Grape Skin Rkatsiteli (*Vitis vinifera* L.) in Condition of Powdery Mildew

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ABSTRACT

It has been studied a change of Georgian genome main white vine variety Rkatsiteli grape skin phytoalexins-stilbenoids in the condition of the disease Powdery mildew (*Uncinula nec.*). The samples of health and infected grapes –with 50% Powdery mildew, were taken in Beginning of September in 2018 year until the technical maturity, from the same vineyard planted in eastern Georgia. The vineyard soil belongs to meadow cinnamonic –Calcaric cambisols and calcic kastanozems type. Vineyard is 32 years old. Based on the HPLC/MS analysis are established the stilbenoids profiles of healthy and infected skins and has been revealed phytoalexin stylbenoids - accumulated as a result of the action of downy mildew. The concentration of stilbenoids increased during the diseases. The dominant stress-metabolites Stilbenoides are trans-resveratrol and trans- ϵ -viniferin. At the same time it was revealed as stress-metabolites: trans-piceid, cis-piceid, trans-piceatannol and oligomeric stilbenoids. The variability of these stilbenoids concentrations in the condition of the disease -Powdery mildew, is different: trans-resveratrol 27.7mg/kg \rightarrow 58.92 mg/kg (53,0%); trans- ϵ -viniferin 11.22 mg/kg \rightarrow 32.55mg/kg (65,5%); trans-piceid 5.36 mg/kg \rightarrow 7.27mg/kg (26,3%) ; trans-piceatannol 1.45mg/kg \rightarrow 2.04 mg/kg (28,9%); cis-piceid 17.75 mg/kg \rightarrow 17.79 mg/kg (0,2%); trans-astringin 14.45mg/kg \rightarrow 16.93 mg/kg (12,9%); cis-astringin 15.02 mg/kg \rightarrow 16.78 mg/kg (10,5%). The stress-metabolite stilbenoids in the conditions of the disease with Powdery mildew, is a scientific novelty for the grape of Rkatsiteli variety. The results of the research are important for determination the correlation of the vine immunity with the phytoalexins-stilbenoids.

KEY WORDS: Grape; Stilbenoids; Powdery Mildew; Rkatsiteli.

INTRODUCTION

The gene pool of Georgian vine incorporates up to 525 white- and red-grape varieties. According to the major requirements of vine-growing and wine-making, these

fields can be developed only by increasing the harvest of high quality and ecologically pure grapes what on its turn needs protecting the vine against bacterial and fungicidal diseases. The chemical content of vine and grape includes compounds of different classes. Among this compounds are important phenolic compounds, which characterized with difference biological activities. Phenolic compounds of grapevine are presented with phlavanoids (procianidins, phlavanols, antocians, phlavanols and et all) and nonphlavanoids (stilbenoids, phenolacids and phenolaldehyds). From nonphlavanoids compounds especially important are stilbenoids with high biological activity.

Vine and grape stilbenoids are one of the groups of a wide class of phenol compounds, which incorporates cis- and trans-isomers of monomer resveratrol and their derivatives, as dimmers, trimers, tetramers and glycosides (Aaviksaar et al. 2003; Adrian et al. 2000; Babieva et al.

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2018; Bavaresco, 2003; Bavaresco et al. 2003; Bavaresco and Fregoni 2001; Bavaresco et al. 2002; Bavaresco et al. 1997; Bavaresco et al. 2003). Stilbenoids have diversified high biological activity and these compounds are very important for plants, as phytoalexins. Stilbenoids act against different vine diseases caused by biotic factors. The following stilbenoids were identified in the extract of vine (*Vitis vinifera*) trunk, roots and annual shoots: Ampelopsin A, (E)-piceatannol, Pallidol, E-resveratrol, hopeaphenol, isohopeaphenol, (E)- ϵ -viniferin, (E)-miyabenol C, (E)- ω -viniferin, r- and r2-viniferin. It was established that the extract inhibits the growth of sporulation of fungus *Plasmopara viticola* by 50%, while the most active inhibitor of it turned out to be r2-viniferin (Bavaresco et al. 2007). Under the influence of *Botrytis cinerea* on the mixture of Pterostilben and Resveratrol 7 new stilbens were formed, while 5 new stilbens were formed from Pterostilben under the same terms. The anti-fungus effect of these stilbenoids was fixed against *Plasmopara viticola* (Bezhuashvili, 1994). At three stages of the grape (*Vitis vinifera*) grain development, the grains were infected on purpose with *Botrytis cinerea* spores „in vitro“. In the infected grain, stilbenoids: Pterostilben, (E)- ϵ -viniferin and trans-resveratrol were fixed. Dominating among them was (E)- ϵ -viniferin (Bezhuashvili et al. 2013). The grains of *Vitis Vinifera* L. cv. Barbera in the ripening period were infected with conidial suspension of *Aspergillus jannicus*, *A. ochraceus*, *A. fumigatus* and *A. carbonarius*. The process of formation of ochratoxin A and stilbenoids was supervised. It was found out that all experimental fungi except *A. Fumigatus* significantly increase the concentration of trans-resveratrol and at the same time, trans-Piceid stays unchanged. In the grape grain damaged by *A. ochraceus*, the concentration of piceatannol increased significantly. A large amount of *A. carbonarius* was

synthesized in the grain infected with *A. carbonarius* isolate and the anti-fungicidal activity occurred with the following concentrations: 300 mkg/gr and 20 mkg/gr, what was sufficient for the total inhibition of fungus *A. carbonarius* (Bezhuashvili and Surguladze 2016). Besides above mentioned biological activity stilbenoids have many other functional purposes (Gabaston et al. 2007; Gabastoni et al. 2018; Gindro et al. 2017; Guebailia et al. 2006; Houlline et al. 2015; Jalili et al. 2015; Jeandet et al. 2002; Langcake, 1981; Langcake et al. 1979). The vine and grape impacts some factor (Langcake and Pryce 1976; Larronde et al. 2005; Mattivi et al. 2011; Niesen Daniel et al. 2013). The vine varieties of Georgia are rich in biologically active stilbenoids. trans-resveratrol, trans- ϵ -viniferin, 2 tetrameric stilbens, including hopeaphenol as one of them, were isolated and identified from an annual shoot of Rkatsiteli variety. These stilbenoids and new stilbenoids identified by us were identified in the Georgian red-grape vintage varieties and their wines (Özer et al. 2018; Pawlus et al. 2012; Reniero et al. 1996; Rivière et al. 2012; Sáeza et al. 2018). The study of stilbenoids in Georgian vintage varieties as that of phytoalexins, qualitative and quantitative analyses of their physiological concentrations and stress-metabolites and their impact on the microorganisms causing bacterial and fungus diseases is an urgent issue



Fig. 1: Rkatsiteli grape infected with Powdery Mildew.

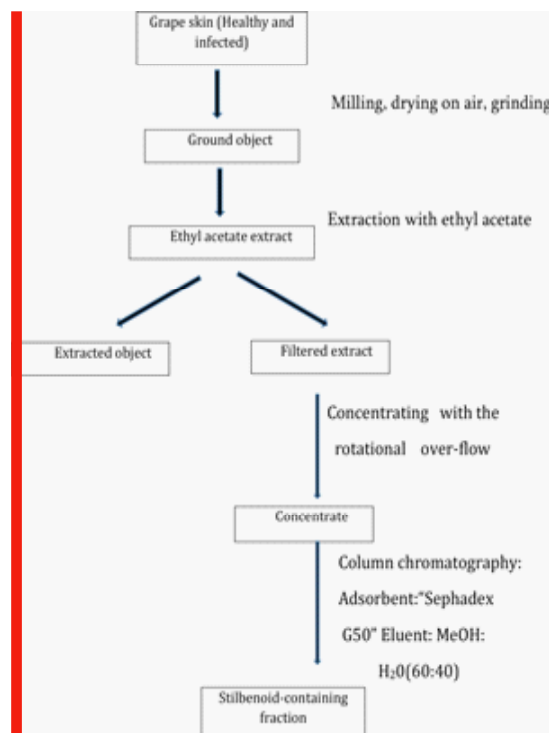


Fig. 1: Rkatsiteli grape infected with Powdery Mildew.

of the research. Consequently, our goal was to identify the vine varieties infected with crown gall disease, identify and determine their stress-metabolite stilbenoids and compare them with healthy vine stilbenoid profile. It is established change of stilbenoids healthy and infected (95% and 50%) vine leaves and canes from 35 years old vineyard of cabernet franc (france). It is identified E- piceatannol, E – resveratrol, E-ε-viniferin, ampelopsin A, E-miyabenol C, E-vitisin B, hopeaphenol, isohopeaphenol. In infected grape skin was identified high quotation of E-ε-viniferin to compare with E – resveratrol. To point of view of authors: “ These findings suppose that the health status in vineyards could modify the composition of stilbenoids in vinter-harvested grape canes and subsequently the potential

biological properties of the valuable extract (Surguladze and Bezhushvili 2017; Surguladze and Bezhushvili 2018; Vergara et al. 2012; Waffo Teguo et al. 1998).

Reason of Study

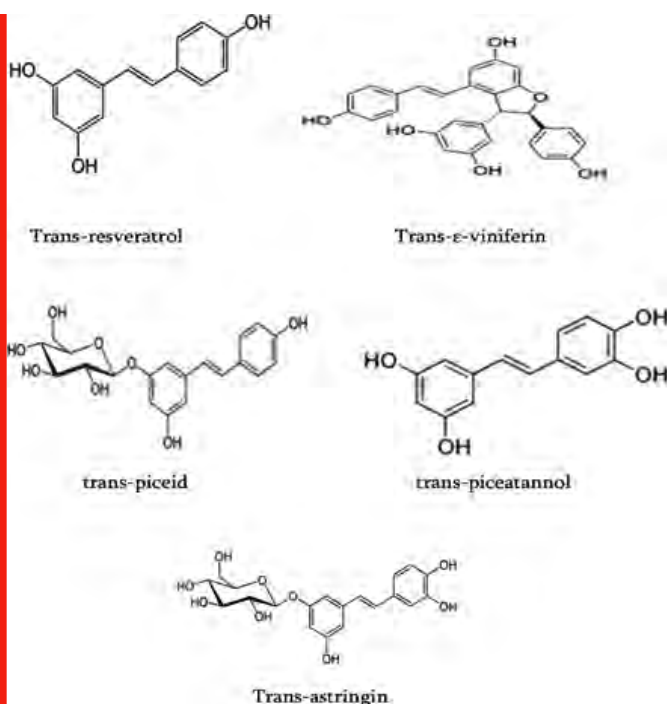
was to identify of stress- metabolites stilbenoids of grape skin Rkatsiteli variety (Vitis Vinifera L.) in condition Powdery mildew.

MATERIAL AND METHODS

Objects of research were health and infected white grape skin of Rkatsiteli variety. The samples of health and infected grapes were taken in Beginning of September in 2018 year until the technical maturity, from the same vineyard planted

Table 1: Content (mk/kg) of stress- metabolite stilbenoids in health and infected grape skin Rkatsiteli.

N.Name of stilbenoids	Health skin	Infected skin	Increase,%
1. trans-resveratrol	27.70	58.92	53,0
2. trans-ε-viniferin	11.22	32.55	65,5
3. trans-piceid	5.36	7.27	26,3
4. cis-piceid	17.75	17.79	0.2
5. trans-astringin	14.75	16.93	12,9
6. cis-astringin	15.02	16.78	10,5
7. trans-piceatannol	1.45	2.04	28,9



in eastern Georgia. The vineyard soil belongs to meadow cinnamonic –Calcaric cambisols and calcic kastanozems type. Vineyard is 32 years old. (fig.1)

We isolated stilbenoid-containing fractions from the healthy and infected grape skin as a result of treatment according to the chart (fig .2)

Stilbenoids were determined by the method of high-performance liquid chromatography (HPLC) (Guebailia et al. 2006). For this purpose, we used the Varion chromatograph SupelcosilPM LC18 Column, 250x4,6mm, eluents: A. 0,025% trifluoroacetic acid, B. Acetonitrile: A80/20. Gradient mode: 0-35 min, 20-50% B, 48-53min, 200% B. Flow rate of the eluent- 1 ml/min; wavelength-306 and 285nm. The samples were analyzed three times and it is presented average results. Analyzed samples: isolated stilbenoid-containing fractions were filtered using a membrane filter (0,45 μ) before the chromatographic procedure. The chromat-mass-spectral investigations were carried out under the above-mentioned conditions; mass-spectra were detected by obtaining of positive ions.

RESULTS AND DISCUSSION

On the basis of HPLC/MS analysis revealed stilbenoides profile of grape skin Rkatsiteli variety. This presented with trans- and cis-isomeric forms of resveratrol derivatives. In particular is identified trans-resveratrol, glucosides cis-, trans-piceids, cis-, trans-astringins; the metabolite of resveratrol trans-piceatannol(trans-astringinin); dimer of trans-resveratrol trans- ϵ -viniferin, trimeric and tetrameric stilbenoids. The grape disease –powdery mildew (*Uncinula necator*) is caused a change of concentration of stilbenoids. As a result, stress-metabolite stilbenoids have been detected, among them are dominant trans-resveratrol and trans- ϵ -viniferin. It is noteworthy their concentration increase. According to table data, concentrations of stress-metabolite stilbenoids are changing with different intensities. The largest quantity 31.22mg/kg increase a trans-resveratrol; concentration of cis-piceid has changed slightly – 0,04mg/kg; Concentration of trans-piceatannol increased by 0.59mg/kg. From oligomer stilbenoids of health and infected grape skin, identified trimeric stilbenoid with [M+H]⁺-681,2; tetrameric stilbenoids: a) [M+H]⁺-907,1(1,81% in total), b) [M+H]⁺-907,2(0,62% in total), c) [M+H]⁺-907,3(1,22% in total). Change of concentration of oligomer stilbenoids of grape skin in condition downy mildew is relatively minor.

CONCLUSION

It is established first researched results is scientific novelty for grape Rkatsiteli variety. Based on the basis of this and future research results will be found out the correlation of vine immunity Rkatsiteli variety with phytoalexins –stilbenoids.

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Agrochemical Substantiation of the Inclusion of Bird Droppings under Grain Maize at Different Tillage In Terms of the South - Western Part of the Central Black Earth Region

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ABSTRACT

The inclusion of organic and mineral fertilizers increased the reserves of productive moisture to the crop in relation to the control (without fertilizers) regardless of the treatments. To harvest grain maize the amount of moisture in the meter layer is substantially decreased. Minimum moisture content was in all variants of fine processing. The effect of applied fertilizers on the stock of productive moisture is insignificant for harvesting. For three years, the yield of corn on plowed plots was higher than on stubble preservation plowing. Bird droppings and compost 20 t/ha in pure form increased the yield by 15.1-18.1% relative to the control. Additional inclusion of nitrogen fertilizers led to the yield increase by 20-24% for plowing, and 17.9-29.4% for the stubble preservation plowing, 23% for small treatment. The quality of corn grain depended on the applied fertilizers. Mineral fertilizers increased the content of nitrogen in grain by 0.11-0.29 %, phosphorus by 0.1-0.13%, and potassium – by 0.02-0.04 %. Inclusion of organic fertilizers (bird droppings and compost 20 t/ha) increased the content of nitrogen and phosphorus in the grain compared to the control by 0.08-0.22% and 0.04-0.06%, respectively.

KEY WORDS: Bird Droppings, Bird Compost, Mineral Fertilizers, Tillage, Productive Moisture, Yield, Corn Grain Quality, Nutrient Removal, Nitrogen, Phosphorus, Potassium

INTRODUCTION

important role belongs to corn – one of the main crops of diverse use (Akinchin, 2004; Kurbanov 1998). In the process of growth and development plants impose certain

requirements to the conditions of the environment, which are associated with the nature and intensity of physiological and biochemical processes occurring in them. As a result of these processes, plants accumulate proteins, fats, starch, sugar, vitamins and other substances that characterize the quality of the crop, which, depending on the growing conditions, can vary widely (Melnik et al. 2018). Increasing the yield of corn in combination with improving its biochemical composition is an urgent problem of modern crop production. The most effective and fast-acting factor contributing to the improvement of crop quality is fertilizers (Özer et al. 2018).

The leading role in improving the efficiency of agriculture belongs to the creation of optimal plant nutrition. Fertilizers are one of the fastest means of forming high yields of all crops. Due to the significant detachment of organic matter with the harvest, the use of various organic ameliorants (organic fertilizers) is necessary to maintain the fertility of degraded soils (Orlyansky 2007). The effect of bird

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droppings exceeds the effect of the equivalent amount of NPK put into the soil in the composition of mineral fertilizers. When a minimum dose of bird droppings is put, the total yield increase is 42 % to the control, and the maximum dose is 105 %. The content of nitrogen and phosphorus in crop production increased with increasing doses, with organic fertilizers having a greater impact on the accumulation of nitrogen by crops (Chebotarev 2004). In the formation of the crop the main tillage plays an important role. Basic tillage is the most important and labor-intensive process in modern agriculture. Depending on the methods and depth of the main processing, it accounts for 30 to 60 % of the money spent on the cultivation and harvesting of crops (Dubov 2000). Mechanical impact on the soil by working bodies of machines and tools improves physical, chemical

and biological processes, creating optimal conditions for plant development. The moisture reserve depends primarily on the water permeability of the soil. The greatest water permeability is noted in the fields where the plow was used. This allows the soil to swim less away, resulting in a decrease in its density during heavy precipitation or irrigation (Chebotarev 2004). In the application of small and deep stubble preservation plowing there is an improvement in soil structure (Asyka 1990; Benedichuk 1991; Potryasaev 2009; Stebut 1957; Suskevic 1994; Tolstousov 1974; Varlamova 2007).

The aim of our research was to study the influence of the main methods of tillage, the action of organic and mineral fertilizers on the yield and quality of corn grain. The studies

Table 1: Reserves of productive moisture in the meter layer of soil depending on the methods of basic tillage and fertilizers on average for 2010-2012, mm.

Experience options	Method of tillage		stubble preservation fine			
	plowing		sowing		harvesting	
	sowing	harvesting	sowing	harvesting	sowing	harvesting
1. Without fertilizers – control	141,7	45,7	133,7	44,3	144,0	39,0
2. Bird droppings – 20t/ha	151,3	49,3	151,0	47,0	150,7	41,3
3. Bird droppings – 20t/ha + N ₆₀	147,0	47,0	146,3	46,0	150,0	37,0
4. Compost (bird)- 20t/ha	152,0	56,0	152,7	47,0	145,0	43,7
5. Compost (bird)- 20t/ha + N ₆₀	144,3	45,0	148,3	46,7	147,3	35,7
6. N130P130K130 +N100	148,7	42,3	146,3	47,0	142,0	49,0
SSD0.5 Factor A	3,7	4,3				
SSD0.5 Factor B	5,2	6,2				

Table 2: Corn grain yield depending on the methods of basic tillage, organic and mineral fertilizers, t/ha (2010-2012).

Experience options	Урожайность, т/га									Average 2010-2012		
	2010			2011			2012			Bp	бсп	mf
	Bp	бсп	mf	Bp	бсп	mf	Bp	бсп	mf			
Control, without fertilizers	4,80	3,38	3,64	6,90	6,53	6,20	5,68	4,82	4,57	5,79	4,91	4,80
Bird droppings- 20t/ha	5,24	4,15	4,29	8,34	7,57	7,45	6,84	5,48	5,01	6,81	5,73	5,58
Bird droppings- 20t/ha + N60S,21	3,75	4,51	8,41	7,68	7,42	7,35	5,95	5,69	6,99	5,79	5,87	
Bird compost- 20t/ha	5,04	3,65	3,80	7,78	7,71	7,27	7,17	6,04	5,83	6,66	5,80	5,63
Bird compost- 20t/ha + N60	5,29	4,63	4,30	8,77	8,37	7,53	7,64	6,12	5,97	7,23	6,37	5,93
N130P130K130 +N100	4,83	4,61	4,28	9,17	8,08	7,93	6,68	6,27	5,62	6,96	6,32	5,94
SSD0.5 Factor A	0,36	0,61	0,64	0,25								
SSD0.5 Factor B	0,51	0,87	0,9	0,35								

Note: P-plowing; SP- stubble preservation; F-fine processing.

were conducted in the demonstration center of BASF Krasnoyarskiy district of Belgorod region. The soil of the experimental site is represented by typical black earth, with a humus content of 4.6%, heavy-loamy mechanical composition, pH-6.12, Ng-2.16. The content of hydrolyzed nitrogen was 147 mg/kg, movable phosphorus – 51 mg/

kg, exchangeable potassium – 89 mg/kg. The scheme of experience provided three methods of soil treatment: 1.plowing to a depth of 22-25cm; 2. stubble preservation plowing at a depth of 22-25cm; 3.shallow tillage depth of 10-12cm and six backgrounds of fertilizer: 1.without fertilizers; 2.bird droppings 20t/ha; 3.bird droppings 20t/

Table 3: Influence of tillage methods and fertilizers on the chemical composition of corn grain on average for 2010-2012.

Main tillage	Experience options	Content				
		Nitrogen, %	Phosphorus, %	Potassium, %	Crude fat, %	Crude fiber, %
Plowing, 22-25cm	Control (without fertilizers)	1,82	0,31	0,46	4,76	2,67
	Bird droppings 20t/ha	1,95	0,33	0,47	4,82	2,68
	Bird droppings 20t/ha +N60	1,99	0,34	0,50	5,12	2,74
	Bird compost 20t/ha	2,04	0,33	0,46	4,86	2,73
	Bird compost 20t/ha +N60	1,98	0,39	0,45	4,73	2,72
	N130P130K130+N100	2,07	0,41	0,48	4,89	2,94
Stubble preservation plowing, 22-25cm	Control (without fertilizers)	1,88	0,30	0,40	4,87	2,46
	Bird droppings 20t/ha	2,03	0,36	0,43	5,10	2,61
	Bird droppings 20t/ha +N60	2,01	0,36	0,46	5,43	2,63
	Bird compost 20t/ha	1,96	0,40	0,41	5,17	2,66
	Bird compost 20t/ha +N60	1,99	0,38	0,46	5,36	2,64
	N130P130K130+N100	2,07	0,42	0,42	5,38	2,66
Fine processing, 10-12cm	Control (without fertilizers)	1,83	0,31	0,44	4,93	2,31
	Bird droppings 20t/ha	2,04	0,35	0,46	5,17	2,61
	Bird droppings 20t/ha +N60	2,11	0,36	0,48	4,92	2,56
	Bird compost 20t/ha	1,97	0,28	0,45	5,02	2,59
	Bird compost 20t/ha +N60	2,08	0,43	0,48	5,18	2,41
	N130P130K130+N100	2,12	0,44	0,48	5,30	2,70
	SSD05 Factor A	0,06	0,03	0,03	0,42	0,21
	SSD05 Factor B	0,09	0,04	0,05	0,59	0,33

ha+ N60; 4.compost (bird) - 20t/ha; 5.compost (bird) - 20t/ha +N60; 6.N130P130K130 + N100.

RESULTS AND DISCUSSION

Influence of fertilizers and methods of tillage on the yield and quality of corn grain.

Soil Moisture

The reserves of productive moisture during the maize vegetation in 2010-2012 are presented in table 1. In spring, the reserves of productive moisture in the soil ranged from 133.7-144.0 mm in the control variant and 142.0-152.7 mm in the fertilized plots. According to stubble

preservation plowing on the control version in the spring, the moisture reserve was minimal and amounted to 133.7 mm. The inclusion of organic and mineral fertilizers for all soil treatments contributed to an increase in the reserves of productive moisture for sowing to 144.3 – 152.0 mm for plowing, to 146.3 – 151.0 mm for stubble preservation plowing and to 142.0 – 150.7 mm for fine treatment. The maximum value of this indicator was noted in the variant with bird compost of 20t/ha for plowing and amounted to 152.0 mm and for stubble preservation plowing – 152.7 mm.

Factor A- tillage; Factor B- fertilizers

Reserves of productive moisture in the spring depended on the applied tillage. At the stubble preservation plowing on a control variant there was a decrease of available moisture relative to ploughing and shallow processing for 8.0 mm and 10.3 mm, respectively, with SSD0.5-3.7. For fine processing, a similar decrease in moisture reserves occurred in the variant with the inclusion of bird compost by 7.0 mm and 7.7 mm, and in the variant with mineral fertilizers by 6.7 mm and 4.3 mm, respectively, at SSD0.5-3.7.

The use of organic and mineral fertilizers had an impact on the accumulation of productive moisture. For plowing on options with organic and mineral fertilizers, the excess relative to the control option was 5.3-10.3 mm. For stubble preservation plowing, the excess was 12.6-19.0 mm. For fine processing, the inclusion of organic, organic and mineral fertilizers together also contributed to the accumulation of moisture reserves.

By harvesting, the reserves of productive moisture in the meter layer decreased. The maximum decrease occurred

at the minimum tillage. For all variants, except for the variant with mineral fertilizer, the decrease was 3.3-12.3 mm, and in the variant with a full dose of mineral fertilizer, there was a slight increase in the moisture reserve in relation to the control. The impact of applied fertilizers did not have a significant impact on the reserves of productive moisture. These results were within the error of experience. Consequently, the autumn-winter reserves of productive moisture on the options without fertilization depended on the method of the main tillage. Application of organic, joint application of organic and mineral fertilizers, as well as mineral fertilizers leveled the impact of tillage on the reserves of productive moisture, and this figure changed slightly under the influence of tillage. In all variants, the application of organic and mineral fertilizers increased the reserves of productive moisture to the crop in relation to the control, regardless of the tillage.

To harvest grain maize the amount of moisture in the meter layer is decreased substantially. Minimum moisture content was in all variants of fine processing. Application of organic and combined application of organic and mineral

Table 4: Removal of major nutrients by maize grain on average for 2010-2012, kg/ha.

Main tillage	Experience options	Nutrient removal (kg/ha)		
		N	P ₂ O ₅	K ₂ O
Plowing, 22-25cm	Control (without fertilizers)	105	18	27
	Bird droppings 20t/ha	133	23	32
	Bird droppings 20t/ha +N ₆₀	139	24	29
	Bird compost 20t/ha	136	22	31
	Bird compost 20t/ha +N ₆₀	143	28	33
	N ₁₃₀ P ₁₃₀ K ₁₃₀ +N ₁₀₀	144	28	33
Stubble preservation plowing, 22-25cm	Without fertilizers	92	15	20
	Bird droppings 20t/ha	116	21	25
	Bird droppings 20t/ha +N ₆₀	116	21	27
	Bird compost 20t/ha	114	23	24
	Bird compost 20t/ha +N ₆₀	127	24	29
	N ₁₃₀ P ₁₃₀ K ₁₃₀ +N ₁₀₀	131	26	27
Fine processing, 10-12cm	Without fertilizers	88	15	21
	Bird droppings 20t/ha	114	20	26
	Bird droppings 20t/ha +N ₆₀	124	21	28
	Bird compost 20t/ha	111	20	25
	Bird compost 20t/ha +N ₆₀	123	25	28
	N130P130K130+N100	126	26	28

fertilizers did not have a significant impact on the change in this indicator, however, on the mineral background more moisture was at stubble preservation plowing and fine processing.

Productivity And Product Quality

One of the most significant characteristics in the evaluation of the studied agricultural practices is the yield of crops and the quality of the products. The yield of corn grain for three years of testing depended on the tillage and fertilizers used (table 2).

On average, for three years, the yield of corn grain on plowed plots was higher than on stubble preservation ones. At the control, it was 5.79 t/ha for plowing, 4.91 t/ha for stubble preservation plowing and 4.8 t/ha for fine processing. Bird droppings and compost 20 t/ha in pure form increased the yield by 15.1-18.1 per cent relative to the control. Additional inclusion of nitrogen fertilizers led to the yield increase by 20-24% for plowing, and 17.9-29.4% for stubble preservation plowing, 23% for fine processing. The yield from the joint application of organic and mineral fertilizers relative to organic matter increased by 2-8%. The full dose of mineral fertilizer led to an increase in yield by 20.2-28.7%, while inferior slightly to the options with the joint application of organic and mineral fertilizers. The maximum yield was 7.23 t/ha for plowing in the variant of bird compost - 20t/ha+ N60.

The results of chemical analysis of maize grain indicate that its value was determined by the prevailing weather conditions (table 3). The data of the chemical composition of maize grain showed that the nitrogen content in the grain per dry substance was on the control version – 1.82-1.88%. The content of phosphorus reached 0.31-0.44%, potassium – 0.41-0.5 %. With the inclusion of mineral fertilizers, the nitrogen content increased by 0.11-0.29 %, phosphorus by 0.1-0.13%, and potassium by 0.02-0.04 %. Application of organic fertilizers (bird droppings and compost 20 t/ha) in comparison with the control increased the nitrogen content in the grain by 0.08-0.22%, phosphorus by 0.04-0.06%. The combined application of organic and mineral fertilizers increased the nitrogen content to 1.99-2.03%. The content of phosphorus and potassium changed slightly. The content of crude fat in the grain depended on fertilizers. With the inclusion of mineral ones, its content increased by 0.13-0.51%, organic waste on stubble preservation plowing by 0.09-0.56%. For plowing, the grain contained slightly less fat than for alternative tillage: 0.46% and 0.64% with bird compost 20 t/ha+N60, and 0.42% and 0.49% in the N130P130K130+N100 variant.

The crude fiber levels are not dependent on fertilizers. The average value of the experiment was 2.52%. In the control version, this figure is 2.31-2.67%, for mineral fertilizers - 2.66-2.94%, on the organic background of fertilizer 2.56-2.72%. The influence of the method of tillage on the content of crude fiber in the grain is also insignificant. However, on plowing its content is slightly higher than that of stubble preservation one. The quality of the obtained products corresponded to the qualitative indicators and depended to a greater extent on the used fertilizers and the prevailing weather conditions in the years of the study.

We calculated the removal of phosphorus and potassium nitrogen from the main and by-products crops, the data are presented in tables 4 and 5. In the control version for plowing, the removal of nitrogen by corn grain was 105 kg/ha, for stubble preservation plowing - 92 kg/ha and for fine – 88 kg/ha.

The inclusion of bird droppings and compost, their combined application with nitrogen fertilizers, as well as the introduction of mineral fertilizers increased the removal of nitrogen from 133 to 144 kg/ha for plowing, from 114 to 131 kg/ha for stubble preservation plowing and from 111 to 126 kg/ha for fine processing.

Increase in the removal of nitrogen at all the options for plowing is determined by the increase in the yield of corn and levels of nitrogen.

Phosphorus removal by maize grain was 15 kg/ha in all variants of the experiment on the control of stubble preservation and fine processing and 28 kg/ha for plowing. The application of organic and mineral fertilizers in all soil tillage increased the rate to 20 – 28 kg/ha. Increase in the removal of phosphorus depended on the application of organic and mineral fertilizers, tillage did not cause significant impact on the removal.

The removal of potassium at the control on plowing was 27 kg/ha, for stubble preservation plowing and fine processing removal of potassium was 20 and 21 kg/ha, respectively, which is less than in relation to plowing by 7 and 6 kg/ha. The inclusion of organic and mineral fertilizers also increased the removal of potassium, but the methods of tillage for the removal of this element did not have a significant impact.

The same trend is observed in the removal of nutrients by the plant mass of corn. However, the interval of nitrogen

removal by maize plant mass is higher than the main product. The removal of nitrogen by the plant mass of maize depended to a greater extent on the application of organic and mineral fertilizers, but for plowing, the removal was higher in all options than in stubble preservation and fine processing. The same trend is observed in the removal of phosphorus. Potassium removed in plant material by 4 – 6 times more than corn grain. For plowing removal amounted to the control of 128 kg/ha, 92 kg/ha for stubble preservation treatment, and for fine one - 89 kg/ha. The application of organic and mineral fertilizers increased the removal of potassium to 196 - 218 kg/ha in variant N130P130K130+N100 for all treatments. Consequently, the same trend is observed in the removal of potassium, for all variants of the experiment, the removal of potassium is higher in plowing.

The total removal of nitrogen in grain and vegetative mass of corn in control for plowing was 216 kg/ha, for stubble preservation treatment 179 kg/ha and for fine – 163 kg/ha. Maximum removal of nitrogen in the variant compost 20t/ha+N60 for plowing was 308 kg/ha. For stubble preservation treatment removal of nitrogen ranged from

226 in the variant bird droppings 20t/ha to 261 kg/ha in the variant bird compost 20t/ha+N60, and for fine processing from 224 kg/ha in the variant bird compost 20t/ha to 250 kg/ha in variant N130P130K130+N100.

Consequently, the removal of nitrogen by grain and maize plant mass is mainly influenced by organic and mineral fertilizers, but the removal of nitrogen by plowing is higher in all options, compared to the stubble preservation and fine processing.

The same pattern is observed in the removal of phosphorus by grain and plant mass of corn. The removal of phosphorus by plowing ranged from 29 kg/ha in the control to 51 kg/ha in the variant bird compost 20t/ha+N60, for stubble preservation plowing from 24kg/ha on the control to 44 kg/ha in the variant bird compost 20t/ha+N60 and for fine – from 23kg/ha in the control to 43 kg/ha in variant N130P130K130+N100.

Therefore, by plowing on all variants of experience the removal of phosphorus is higher than in the variants in the stubble preservation and fine treatment, however, the main

Table 5: Removal of basic nutrients by maize plant mass on average for 2010 - 2012, kg/ha.

Main tillage	Experience options	N	P ₂ O ₅	K ₂ O
Plowing, 22-25cm	Control (without fertilizers)	111	11	128
	Bird droppings 20t/ha	142	21	197
	Bird droppings 20t/ha +N ₆₀	153	25	184
	Bird compost 20t/ha	151	19	196
	Bird compost 20t/ha +N ₆₀	165	23	172
	N ₁₃₀ P ₁₃₀ K130+N ₁₀₀	148	19	218
Stubble preservation plowing, 22-25cm	Without fertilizers	87	9	92
	Bird droppings 20t/ha	110	16	145
	Bird droppings 20t/ha +N ₆₀	114	18	145
	Bird compost 20t/ha	121	17	161
	Bird compost 20t/ha +N ₆₀	134	20	151
	N ₁₃₀ P ₁₃₀ K130+N ₁₀₀	122	18	196
Fine processing, 10-12cm	Without fertilizers	75	8	89
	Bird droppings 20t/ha	117	14	136
	Bird droppings 20t/ha +N ₆₀	125	17	140
	Bird compost 20t/ha	113	14	136
	Bird compost 20t/ha +N ₆₀	123	17	161
	N ₁₃₀ P ₁₃₀ K130+N ₁₀₀	124	17	187

Table 6: Removal of basic nutrients by grain and plant weight of maize on average for 2010 - 2012, kg/ha.

Main tillage	Experience options	N	P ₂ O ₅	K ₂ O
Plowing, 22-25cm	Control (without fertilizers)	216	29	155
	Bird droppings 20t/ha	275	44	229
	Bird droppings 20t/ha +N ₆₀	292	49	213
	Bird compost 20t/ha	287	41	227
	Bird compost 20t/ha +N ₆₀	308	51	205
	N ₁₃₀ P ₁₃₀ K ₁₃₀ +N ₁₀₀	292	47	251
Stubble preservation plowing, 22-25cm	Without fertilizers	179	24	112
	Bird droppings 20t/ha	226	37	170
	Bird droppings 20t/ha +N ₆₀	230	39	172
	Bird compost 20t/ha	235	40	185
	Bird compost 20t/ha +N ₆₀	261	44	180
	N ₁₃₀ P ₁₃₀ K ₁₃₀ +N ₁₀₀	253	44	223
Fine processing, 10-12cm	Without fertilizers	163	23	110
	Bird droppings 20t/ha	231	34	162
	Bird droppings 20t/ha +N ₆₀	249	38	168
	Bird compost 20t/ha	224	34	161
	Bird compost 20t/ha +N ₆₀	246	42	189
	N ₁₃₀ P ₁₃₀ K ₁₃₀ +N ₁₀₀	250	43	215

value of the magnitude of the removal of phosphorus has the inclusion of bird droppings and compost, as well as their joint inclusion with nitrogen fertilizers and mineral fertilizers. The removal of potassium by grain and plant mass of corn is lower than nitrogen, but much higher than phosphorus. In the control by plowing the removal of potassium amounted to 155 kg/ha, for stubble preservation – 112 and for fine processing 110 kg/ha. The inclusion of organic fertilizers and the use of nitrogen fertilizers and mineral fertilizers increased the removal of potassium in grain and vegetative mass of corn. For plowing the maximum removal was 251 kg/ha in variant N130P130K130+N100, for stubble preservation treatment – 223 kg/ha in variant N130P130K130+N100 and for fine processing 215 kg/ha in variant N130P130K130+N100. The inclusion of bird droppings and compost, as well as their joint application with nitrogen fertilizers, increased the removal of potassium per one hectare, but the removal for plowing, on all variants of the experience, was higher compared to the stubble preservation and fine treatments.

Consequently, the trend of increasing the removal of potassium is manifested in the same way as the removal of nitrogen and potassium.

Thus, the main influence on the increase in the removal of nitrogen, phosphorus and potassium is the inclusion of bird droppings and compost, as well as the inclusion of mineral fertilizers. We calculated the nitrogen, phosphorus and potassium removal per ton of the main product, taking into account the by-product, as shown in table 7. The data in the table show that grain maize is characterized by high nitrogen removal, slightly less potassium and significantly low phosphorus content. Removal of the nitrogen without fertilizer was for plowing 37.3 kg/t, for stubble preservation treatment – 36.4 and for fine– 34 kg/t. The application of organic and mineral fertilizers increased the removal of nitrogen per ton of the main products for all tillage. The main role in the removal of nitrogen per ton of the main products, taking into account the by-product, was played by the inclusion of both organic and mineral fertilizers; the methods of soil cultivation had little effect on this indicator.

Table 7: Removal of basic nutrients per ton of basic products taking into account the by-products on average for 2010 - 2012, kg.

Main tillage	Experience options	N	P ₂ O ₅	K ₂ O
Plowing, 22-25cm	Control (without fertilizers)	37,3	5,0	26,8
	Bird droppings 20t/ha	40,4	6,5	33,6
	Bird droppings 20t/ha +N ₆₀	41,8	7,0	30,5
	Bird compost 20t/ha	43,1	6,2	34,1
	Bird compost 20t/ha +N ₆₀	42,3	7,1	28,4
	N ₁₃₀ P ₁₃₀ K ₁₃₀ +N ₁₀₀	41,9	6,7	36,1
Stubble preservation plowing, 22-25cm	Without fertilizers	36,4	4,9	22,8
	Bird droppings 20t/ha	39,4	6,5	29,7
	Bird droppings 20t/ha +N ₆₀	39,7	6,7	29,7
	Bird compost 20t/ha	40,5	6,9	31,9
	Bird compost 20t/ha +N ₆₀	40,9	6,9	28,3
	N ₁₃₀ P ₁₃₀ K ₁₃₀ +N ₁₀₀	40,0	7,0	35,3
Fine processing, 10-12cm	Without fertilizers	34,0	4,8	22,9
	Bird droppings 20t/ha	41,4	6,1	29,0
	Bird droppings 20t/ha +N ₆₀	42,4	6,5	28,6
	Bird compost 20t/ha	39,8	6,0	28,6
	Bird compost 20t/ha +N ₆₀	41,5	7,1	31,9
	N ₁₃₀ P ₁₃₀ K ₁₃₀ +N ₁₀₀	42,1	7,2	36,2

The phosphorus removal at the control was 5.0 kg/t for plowing, 4.9 kg/t for stubble preservation and 4.8 kg/t for fine processing. The inclusion of bird droppings and bird compost increased this figure in relation to the control by 1.5 and 1.2 kg/t respectively for plowing, by 1.6 and 2.0 kg/t for stubble preservation and by 1.3 and 1.2 kg/t respectively for fine processing. The combined application of bird droppings and compost with nitrogen fertilizers increased this figure compared to the control by 2.0 and 2.1 kg/t, respectively, for plowing, by 1.8 and 2.0 kg/t for stubble preservation and by 1.7 and 2.3 kg/t for fine processing. Application of mineral fertilizers increased phosphorus removal for plowing by 1.7 kg/t, for stubble preservation by 2.1 kg/t and for fine processing by 2.4 kg/t.

the main products, taking into account the by-product, also had a major impact on both organic and mineral fertilizers. The potassium removal at the control for plowing was 26.8 kg/t, for stubble preservation treatment – 22.8 kg/t and for fine one – 22.9 kg/t. The inclusion of bird droppings and compost, as well as their joint application with nitrogen fertilizers increased this figure to 28.4 kg/t -34.1 kg/t for plowing, to 28.3 kg/t – 31.9 kg/t for stubble preservation treatment and to 28.6 kg/t – 31.9 for fine processing. On the

basis of these data, it can be concluded that the removal of potassium is determined not only by the inclusion of organic and mineral fertilizers, but also by soil tillage, the highest rates of potassium removal were obtained in plowing options.

CONCLUSION

1. Autumn-winter reserves of productive moisture on the options without fertilization depended on the method of the main tillage and the minimum reserve of it on the control during the tillage. According to the stubble preservation treatment on the control version, there was a decrease in productive moisture relative to plowing and fine processing by 8.0 mm and 10.3 mm, respectively. Application of organic, joint application of organic and mineral fertilizers, as well as mineral fertilizers leveled the impact of treatments on the reserves of productive moisture, and this figure changed slightly under their influence. In all variants, the application of organic and mineral fertilizers increased the reserves of productive moisture to the crop in relation to the control (without fertilizers), regardless of the tillage. To harvest grain maize the amount of moisture in the meter layer is substantially decreased. Minimum moisture content was in all variants of fine processing.

The effect of applied fertilizers on the stock of productive moisture is insignificant for harvesting.

2. Over the years of research, the maximum yield in all variants of the experience was obtained by plowing, and the minimum – by fine processing. The inclusion of bird droppings, compost and the joint inclusion of bird droppings and compost with nitrogen fertilizers, as well as the inclusion of mineral fertilizers had a positive effect on the yield of corn grain for all studied tillage. For plowing the maximum yield was obtained in the variant of bird compost - 20t/ha+ N60 and made up 7.23 t/ha, for stubble preservation treatment - in the form of bird compost - 20t/ha+ N60 and amounted to 6.37 t/ha, for fine processing in the variants bird compost - 20t/ha+ N60 and N130P130K130 +N100 was 5.93 and 5.94 t/ha, respectively.

3. The level of crude protein content in corn grain is largely determined by the inclusion of mineral and organic fertilizers. The maximum content of this indicator in the variant N130P130K130+N100 (12.4 -12.7%) for all soil tillage. The fat content in the grain varies from 4.76% for plowing to 4.93% for fine processing. The application of organic, combined application of organic and mineral fertilizers and mineral fertilizers increase the fat content to 4.82 – 5.12% for plowing, to 5.10 – 5.43% for stubble preservation and to 5.02 – 5.30% for fine processing. The fiber content of the corn grain in the control amounted to 2.67% for the plowing, 2.46% for stubble preservation treatment, 2.31 for fine processing. Inclusion of bird droppings and compost, their joint inclusion with nitrogen fertilizers and mineral fertilizers increase the fiber content to 2.94% for the plowing, to 2.66% for stubble preservation treatment and to 2.70% for fine processing.

4. Methods of tillage did not have a significant impact on the content of nitrogen, phosphorus and potassium in grain and maize plant mass. The main role in changing these indicators played organic and mineral fertilizers.

The application of organic and mineral fertilizers increased the content of nitrogen, phosphorus, potassium in grain and maize plant mass.

6. The main influence on the increase in the removal of nitrogen, phosphorus and potassium has the inclusion of bird droppings and compost, the joint inclusion of bird droppings and compost with nitrogen fertilizers, as well as the inclusion of mineral fertilizers. Tillage also affects the removal of these elements by grain and plant mass of corn, but much lower than fertilizer. The removal of

nitrogen, phosphorus and potassium per ton of the main products, taking into account the by-product, depended on the application of organic and mineral fertilizers, soil tillage methods had little effect on this indicator.

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Muscular Shell of the Body of the Stomach of Rabbits and Cellular Composition of the Epithelial Layer and Its Own Plastics

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ABSTRACT

This paper deals with the correlation of the cellular composition of the epithelial layer and its own plastics of the muscular shell of the body of the stomach of rabbits. To determine the peculiarities of the tissue composition of the stomach walls, histochemical research methods were used. The study was conducted on 40 stomachs. Fixed in a solution of 5% formaldehyde, pieces of the stomach were embedded in paraffin according to the standard technique. The nature of the correlation links between the indices of the cellular composition of the epithelial layer and the prosthetic plastics of the gastric mucosa of the rabbits of the control and experimental groups did not differ in both groups, the number of interepithelial lymphocytes positively correlated with the number of stromal lymphocytes, the number of mast cells, fibrocytes, endothelial cells and stromal neutrophils. The number of stromal lymphocytes was positively correlated with the number of stromal neutrophils, stroma macrophages, fibroblasts, eosinophils.

KEY WORDS: Rabbits, Mucous Membrane, Stomach, Morphology, Histology, Correlation.

INTRODUCTION

The strategic goal of food security is the provision of safe agricultural products. Small husbandries, which produce more than 50% of all kinds of products, can provide the population of the country with environmentally safe products. However, small forms of management, including personal subsidiary farms, both in Russia in

general and in Tyumen region in particular, face a huge number of problems constraining their further growth and development (Boiko 2009; Jafarian et al. 2018).

Additional introduction of animal feed supplements to the diet contributes to better digestion and assimilation of essential nutrients in the gastrointestinal tract. Supplements stimulate the processes of digestion, metabolism, stimulates the functional reserves of the body, contributes to the formation of stable immunity (Chasovshchikova 2017; Deniz et al. 2018; Kozlova 2018; Rais Rohani and Bastanfard 2016; Veremeeva 2017). The agroindustrial complex requires innovative development in all branches through the development, modernization of educational laboratory, research and experimental production base of the university itself. Consequently, it is necessary to radically change the process of training specialists at the university by strengthening its practical component (Bogdanova lu 2014; Dragich 2018; Glazunov 2018; Skipin 2016).

Achieving food independence is only one of the key elements necessary to ensure the country's food security.

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In this regard, all possible ways to improve the systems of feeding animals to increase productivity, taking into account the preservation of the quality of their products (Glazunova 2018; Goncharenko 2018; Kovaleva 2018; Rais Rohani and Bastanfard 2016; Sheveleva 2013; Sidorova 2008; Sidorova 2014; Stolbova 2018), remain topical issues.

The successful development of rabbit breeding needs to know the biological characteristics of rabbits, the physiological processes of their nutrition, that is, the assimilation and use of their dietary nutrients, which will help the breeders to find a rational way to use feed and reduce their costs in raising animals.

Objective. Objective of the research is to find out the histological features of the stomach of Californian rabbits in normal state and upon the application of Bio-Mos feed supplement.

Task. The research task was to study the structure of the wall of different parts of the stomach in rabbits in normal state and upon the application of Bio-Mos feed supplement.

MATERIAL AND METHODS

The research material was carcasses of clinically healthy

male rabbits (slaughtered at the age of 4 months). The animals of the control group were on an experimental diet, which consisted of granulated feed, the formula was developed at the farm and made at the Tyumen flour mill. The rabbits of the experimental group, in addition to the basic diet, received the Alltech Bio-Mos feed supplement designed to increase the overall resistance, productivity and safety of rabbits at a dose of 2 g per kg of granulated feed, starting from 2 months of age.

To determine the peculiarities of the tissue composition of the stomach walls, histochemical research methods were used. The study was conducted on 40 stomachs. Fixed in a solution of 5% formaldehyde, pieces of the stomach were embedded in paraffin according to the standard technique.

RESULTS AND DISCUSSION

Rabbits are animals with a single-chambered stomach, horseshoe-shaped, about 200 cm³ in volume, vegetable feeders.

A morphometric study of the gastric superficial-foveolar epithelium revealed no statistically significant differences in the bottom and the body, while the depth, width of the gastric pit and the height of epithelium cells in the pyloric part in animals of the experimental group exceeded the same parameters of the control group by 6.1, 4.6 and 6.8%, respectively. The differences are not large, but they are statistically significant, and are presented in Table 1. Therefore, we can conclude about the effect of the food supplement on the structural and functional state of the gastric superficial-foveolar epithelium.

A morphometric study of the glands of the gastric mucosa in animals of the control and experimental groups revealed statistically significant differences in the bulk density of the glands, in the number of main and mucous cells in the gland; the results are presented in Table 2.

Animals of the experimental group had the bulk density of the glands higher by 11.7% than in animals of the control group. Animals of the experimental group had a greater number of main cells by 18.9% and less mucous cells by 27.7%, which is presented in Table 2. This also indicates the influence of the food supplement on the structural and functional state of the epithelium of the glands of the gastric mucosa. A slight increase in the number of main cells in the gland can help increase the number of specific enzymes and improve digestion.

Table 1: Morphometric parameters of the gastric superficial-foveolar epithelium of rabbits, M±s.

Parameter	Control group	Experimental group
Gastric bottom and body	100.4±12.7	106.5±10.2
Gastric pit depth, μm		
Gastric pit width, μm	32.4±2.8	29.8±5.4
Epithelial cell height, μm	22.1±1.8	23.4±2.5
Epithelial cell width, μm	7.2±0.9	7.4±0.8
Total numerical density of epithelial cells, 1 mm	131±15	127±17
Pyloric part		
Gastric pit depth, μm	126.1±11.8*	131.3±12.6*
Gastric pit width, μm	19.6±2.1*	20.5±4.3*
Epithelial cell height, μm	16.1±1.2*	17.2±2.1*
Epithelial cell width, μm	7.3±0.8	7.5±0.9
Total numerical density of epithelial cells, 1 mm	128±16	125±18

Note. * -Statistically significant differences between sections of the stomach at p<0.05. M±s □ mean ± standard deviation (sigma).

Thus, the histological pattern of the stomach walls of rabbits of the experimental group shows the following features: the mucous membrane occupies $\frac{3}{4}$ of the stomach wall, the muscular layer is thicker in the pyloric region, as it forms the pyloric sphincter, also a well-developed connective tissue-vascular environment; cells of the mucous membrane of the stomach of rabbits of the experimental group have a pronounced mitosis, which indicates good regeneration of the membranes of the stomach of rabbits.

On the basis of the data obtained, it is possible to conclude that the Bio-Mos feed supplement changes the histological pattern of the stomachs of rabbits: rabbits of the experimental group have an increase in their cross-sectional area of the mucous and muscular membranes, as well as in the number of glands in the field of view of the gastric mucous membranes. Karyokinesis (mitosis) is better manifested in the cells of the gastric mucosa of the rabbits of the experimental group; it promotes self-reproduction of cells, that is, generation of young cells. The number of cells increases upon division so that the body grows, dead cells are replaced and damaged organs are restored.

In order to assess the cellular components of the stroma and the possible reaction of the mucous to nutritional supplements, a morphometric analysis of our own plastics

of the mucous membrane of the gastric body in animals of the compared groups was carried out; the results are presented in Table 3.

We established statistically significant differences in the cellular composition of the epithelial layer and the native plastics of the gastric mucosa at the level of the pit, cervix and gland body. At the level of the pit there are more interepithelial lymphocytes and neutrophils. More lymphocytes and macrophages are in the lamina propria at the pit level. The remaining morphometric parameters of the cellular composition of the epithelial layer and of the native plastics of the mucous membrane of the body of the stomach did not differ significantly. There were no statistically significant differences between all the studied indicators of the control and experimental groups revealed.

The nature of the correlation links between the indices of the cellular composition of the epithelial layer and the prosthetic plastics of the gastric mucosa of the rabbits of the control and experimental groups did not differ in both groups, the number of interepithelial lymphocytes positively correlated with the number of stromal lymphocytes ($r=0.62$, $p<0.05$, Spearman), the number of mast cells ($r=0.73$, $p<0.01$), fibrocytes ($r=0.58$, $p<0.05$), endothelial cells ($r=0.61$, $p<0.01$) and stromal neutrophils ($r=0.65$,

Table 2: Morphometric parameters of the glands of the mucous membrane of the gastric bottom and body of rabbits, M±s

Parameter	Control group	Experimental group
Bulk density of glands, %	56.2±5.3	62.8±4.1*
Outer diameter of glands, μm	39.3±3.6	41.9±4.7
Amount of main cells in the glands, %	51.2±4.8	60.9±3.7*
Amount of parietal cells in the glands, %	28.2±2.2	23.1±2.9
Amount of mucous cells in the glands, %	13.7±1.6	9.9±2.7*
Other cell types (endocrinocytes)	6.9±1.6	6.2±0.8
Cross-sectional area of the main cell nucleus (μm ²)	9.4±0.2	9.2±0.5
Cross-sectional area of the main cell cytoplasm (μm ²)	38.5±5.4	36.2±7.1
Nuclear cytoplasmic relation (NCR)	0.24±0.01	0.25±0.02
Cross-sectional area of the parietal cell nucleus (μm ²)	16.5±1.0	17.2±1.9
Cross-sectional area of the parietal cell cytoplasm (μm ²)	124.5±9.9	121.1±10.5
NCR	0.13±0.01	0.14±0.02
Cross-sectional area of the mucous cell nucleus (μm ²)	12.5±0.6	13.4±0.7
Cross-sectional area of the mucous cell cytoplasm (μm ²)	25.5±2.0	26.4±2.1
NCR	0.49±0.04	0.51±0.04

Note. * - statistically significant differences between sections of the stomach at $p<0.05$. M±s - mean ± standard deviation (sigma).

Table 3: Morphometric parameters of the cellular composition of the epithelial layer and its own plastics of the muscular shell of the body of the stomach of rabbits, M±s.

Parameter	Native plastics level			Friedman's ANOVA (df = 2,)
	Pit	Cervix	Gland	
Interepithelial lymphocytes, %				
Control group	10.4±2.2	6.2±1.2	3.7±0.8	$\chi^2=12.3, p<0.01^*$
Experimental group	11.3±3.1	5.8±1.1	3.3±0.7	$\chi^2=10.1, p<0.01^*$
Interepithelial neutrophils, %				
Control group	0.9±0.2	0.3±0.3	0.05±0.03	$\chi^2=9.4, p<0.05^*$
Experimental group	0.8±0.1	0.4±0.2	0.06±0.02	$\chi^2=8.2, p<0.05^*$
Interepithelial eosinophils, %				
Continuation of Table 10				
Parameter	Native plastics level			Friedman's ANOVA (df = 2,)
	Pit	Cervix	Gland	
Control group	0.1±0.05	0.07±0.04	0±0	$\chi^2=4.3, p>0.08$
Experimental group	0.14±0.04	0.08±0.02	0±0	$\chi^2=5.1, p>0.07$
Total numerical density of the cells of the native mucosal plastic, per 1 mm ²				
Control group	4681±920	4327±899	4124±888	$\chi^2=4.8, p>0.1$
Experimental group	4699±860	4422±787	4282±564	$\chi^2=3.6, p>0.1$
Lymphocytes of the native mucosal plastic, per 1 mm ²				
Control group	469±97	365±75	305±64	$\chi^2=9.8, p<0.01^*$
Experimental group	443±56	338±66	313±79	$\chi^2=7.8, p<0.05^*$
Neutrophilic leukocytes of the native mucosal plastic, per 1 mm ²				
Control group	135±37	124±26	129±28	$\chi^2=3.2, p>0.1$
Experimental group	143±45	131±31	118±59	$\chi^2=2.7, p>0.1$
Eosinophilic leukocytes of the native mucosal plastic, per 1 mm ²				
Control group	84±22	79±15	81±17	$\chi^2=2.5, p>0.1$
Experimental group	89±17	76±12	87±19	$\chi^2=2.3, p>0.1$
Plasma cells of the native mucosal plastic, per 1 mm ²				
Control group	342±98	298±79	279±67	$\chi^2=3.7, p>0.05$
Experimental group	331±87	254±42	294±88	$\chi^2=3.1, p>0.05$
Mast cells of the native mucosal plastic, per 1 mm ²				
Control group	183±48	212±59	202±91	$\chi^2=4.2, p>0.05$
Experimental group	178±55	205±48	211±50	$\chi^2=3.9, p>0.05$
Macrophages of the native mucosal plastic, per 1 mm ²				
Control group	88±12	64±11	58±9	$\chi^2=7.8, p<0.05^*$
Experimental group	85±17	71±13	62±11	$\chi^2=6.9, p<0.05^*$
Fibroblasts of the native mucosal plastic, per 1 mm ²				
Control group	1412±198	1255±205	1126±220	$\chi^2=2.8, p>0.05$
Experimental group	1488±221	1300±222	1188±198	$\chi^2=3.2, p>0.05$
Fibroblasts of the native mucosal plastic, per 1 mm ²				
Control group	778±115	802±115	819±200	$\chi^2=2.4, p>0.05$
Experimental group	743±122	831±127	825±188	$\chi^2=2.2, p>0.05$
Vascular endothelial cells of the native mucosal plastic, per 1 mm ²				
Control group	1190±115	1128±132	1125±120	$\chi^2=0.9, p>0.05$
Experimental group	1111±223	1099±162	1127±215	$\chi^2=0.9, p>0.05$

Note. *-Statistically significant differences between sections of the stomach at $p<0.05$. M±s □ mean ± standard deviation (sigma).

$p<0.05$). The number of stromal lymphocytes was positively correlated with the number of stromal neutrophils ($r=0.71, p<0.01$), stroma macrophages ($r=0.52, p<0.05$), fibroblasts ($r=0.76, p<0.01$), eosinophils ($r=0.65, p<0.01$). The number

of plasma cells positively correlated with the number of eosinophils ($r=0.67, p<0.01$) and fibroblasts ($r=0.53, p<0.05$).

CONCLUSION

Thus, in both groups the quantitative ratios of different types of cells of the own plate of the gastric mucosa were closely related. This, as well as the direct results of the morphological study, indicates the absence of inflammatory changes in the gastric mucosa caused by the used food supplement.

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Physico-Chemical and Microbial Analyses of the Fern for Making Pesto

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ABSTRACT

The purpose of this study was to use fiddlehead fern as an alternative ingredient for basil in making pesto and to enhance its health benefits. The fern pesto product was tested by F.A. S.T. Laboratories, for nutrient content, Physico-chemical properties, and microbial analyses. For sensory evaluation, the 9-point Hedonic scale was used. This study found that fern pesto is a good source of nutrients such as crude protein, % (9.65), calcium, % (0.12), iron, mg/kg (15.51) and potassium, % (0.24). The result indicated that the nutrient of fern pesto is comparable to basic pesto made and basil pesto in the literature. The results of the Physico-chemical analyses showed a pH level of 5.47 and a moisture content of 30.11. This means that the fern pesto is slightly acidic and had a high moisture content that required storing it at a lower temperature to delay any microbial and chemical reactions. The present study also showed that the average results of microbial count for total plate count, cfu/g (1.347×10^4) and yeast and mold count, cfu/g (300) are both lower than the standard TPC (106) and YMC (104) for sauces.

KEY WORDS: Fiddlehead Fern, Nutrient Content, Physicochemical, Microbial Analyses, Sensory Evaluation, Fern Pesto

INTRODUCTION

Aboriginal plants play a crucial role in the economic and social spheres of every locality. Besigan, the farthest barangay of Cagayan de Oro City with approximately 60 kilometres distance from the city, has an ample existence of diverse species of plants, but as yet remained understudied. Some of these indigenous species of plants

are used by the community for their living. Fiddlehead fern (*Diplazium esculentum* (Retz.) Sw.), known locally as "Pako", is a very popular specie of vegetable fern plant that grows abundantly in Besigan due to its humidity and wet season. It is usually prepared as salad, a ingredient in "ginataan" pako (cooked in coconut milk) and other vegetable dishes. The vegetable fern can be eaten raw or cooked. If the latter is preferred, it is ideal to soak it for a few minutes in boiling water, or to cook it directly to remove the bitter taste. The vegetable fern is a good source of vitamin A, vitamin B, protein, phosphorus, calcium and iron. These promising health benefits coming from this vegetable fern has an essential role in preventing nutrient deficiencies and health-related problems (Benefits of Pako Leaves 2013; Bogomolov et al. 2018; Chai et al. 2015; Ganjali and Teimourpour 2016; Koenemann et al. 2011; Lee and Shin 2011; Nwiloh et al. 2014; Özer 2018; Seal 2016; Tongco et al. 2014).

The goal of this research study was to innovate and create a nutritionally superior pesto product out of fiddlehead fern that would be widely accepted based on its nutritional, visual and textual appeal.

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MATERIAL AND METHODS

Research Design

The experimental method of research was used in conducting this study, which included the process flow of fern pesto product, sampling scheme, sensory evaluation and nutritional content, physico-chemical properties and microbial analyses.

Research Setting

This study was conducted at Mindanao University of Science and Technology (formerly, Mindanao Polytechnic State College), C.M. Recto Avenue, Lapasan, Cagayan de Oro City. The experiments and preparation of the product testing was performed in the Culinary Arts Laboratory of the university. The sample was subjected for nutritional content analysis, physico-chemical and microbial analyses in the F.A.S.T. Laboratories, located at Lapasan Highway, Cagayan de Oro City. For sensory evaluation, one hundred consumers evaluated the fern pesto product. The Hedonic Scale Test was used in determining the acceptability of the product.

The source of fiddlehead fern used in this study was from Besigan, Cagayan de Oro City. The supplies and materials of fern pesto product were secured at Cogon Market,

Robinsons, Rustans, and Gaisano Mall, all located in Cagayan de Oro City.

Preparation of the Sample

The recipe used for this experiment is patterned from a basic recipe for making pesto. It was modified by replacing grams of basil leaves with fiddlehead fern. Prior to the selection of fern pesto recipe, three trials of recipe which varied in percentage of added fiddlehead fern was conducted. It was then evaluated by five teachers who decided that 80g of fiddlehead fern was ideal for pesto making (USDA National Nutrient Database for Standard Reference, 2016).

In making pesto, it is very essential to practice high hygienic procedures and follow the correct processes. After sorting the fern vegetable, the fern was blanched in order to clean the surface of dirt and organisms and to brighten the color of the fern. In making the fern pesto sample, 20 g of basil leaves was used, with 4 g chopped garlic, 100 g grated parmesan cheese, 75 g pine nuts, 125 ml olive oil, 1 tsp. salt, ½ tsp. black pepper and 1 tsp. American lemon to enhance the taste. All ingredients were measured according to the proposed requirement and were combined with the used of food processor. Finally, the nutritional

Table 1: The Average Values of Nutritional Content of Pesto.

	Date of Analysis	Parameters	Test Method	Basic Pesto	Fern Pesto
1st Sample	12 July – 12 Aug. 2016	Crude Protein, % (%N x 6.25)	Kjeldahl	10.25	9.65
2nd Sample	26 July – 15 Aug. 2016	CCalcium, mg/Kg	Atomic Absorption Spectrophotometry	0.18	0.12
3rd Sample	4 Aug. – 18 Aug. 2016	Iron, mg/Kg	Atomic Absorption Spectrophotometry	16.20	15.57
		Potassium, %	Atomic Absorption Spectrophotometry	0.25	0.24

Table 2: The Average Values of Physico-chemical Properties of Pesto.

	Date of Analysis	Parameters	Test Method	Basic Pesto	Fern Pesto
1st Sample	12 July – 12 Aug. 2016	pH	4500 H+ B. Electrometry	5.20	5.47
2nd Sample	26 July – 15 Aug. 2016	CMoistu	Vacuum Oven Drying	26.15	30.11
3rd Sample	4 Aug. – 18 Aug. 2016				

Source: F.A.S.T. Laboratories, Cagayan de Oro City, Misamis Oriental

content, physico-chemical, microbial analyses and sensory evaluation of the prepared samples were done.

Analysis of Nutritional Content

The average of the nutritional content during the three sampling periods conducted was the basis for comparing the percent difference of calcium, iron, crude protein and potassium between fern and basic pesto.

Physico-Chemical Properties

The average of the physical properties from the sampling periods conducted was the basis for comparing the percent difference of moisture content and pH level of fern and basic pesto.

Microbial Analyses

The average result of Total Plate Count (TPC) and Yeast and Mold Count (YMC) from the sampling periods was the basis for comparing it to the average standard count for TPC and YMC of fern and basic pesto. On the other hand, the consistent negative result of Salmonella of both fern and basic pesto was the basis for the hygienic procedures and sanitation observed during food preparation.

Sensory Evaluation

The 9-point Hedonic Scale was used to evaluate the sensory quality of basic and fern pesto products. The appearance, color, aroma and flavor, mouth feel and taste are the sensory qualities used in determining the acceptability of the innovated pesto product. The respondents, who evaluated the pesto product were composed of 20 teachers, 5 industry workers and 75 students, a total of 100 consumers.

RESULTS AND DISCUSSION

Findings

Problem No.1. What are the nutrient content, physical properties, microbial analyses and acceptability level of basic pesto and fern pesto? The table above shows the average nutritional content of pesto. Result indicates that the nutrient content of the two types of pesto is quite similar and is comparable with the nutrient content for basil pesto in the literature. The small difference in the nutrient content of experimental basil pesto and with the literature might be due to some varietal or origin of the raw materials. During the preparation of the fern pesto, the fern was subjected to blanching which might be the cause for nutrient loss.

Table 3: The Average Microbial Count and Presence and Absence of Salmonella in Pesto.

	Date of Analysis	Parameters	Test Method	Basic Pesto	Fern Pesto
1st Sample	12 July – 12 Aug. 2016	Total Plate Count, CFU/g	Pour Plate	1.0 6 x 10 ⁴	1.347 x10 ⁴
2nd Sample	26 July – 15 Aug. 2016	Yeast and Mold Count CFU/g	Spread Plate	53.33	300.00
3rd Sample	4 Aug. – 18 Aug. 2016	Salmonella	Conventional	Negative	Negative

Source: F.A.S.T. Laboratories, Cagayan de Oro City, Misamis Oriental

Table 4: Mean Values of the Acceptability Level of Pesto.

Sensory Quality	Types of Pesto (Sample)			
	Basic	Remarks	Fern	Remarks
Appearance	6.17	LS	6.78	LM
Color	5.82	LS	6.58	LM
Aroma	6.00	LS	6.65	LM
Mouth feel	6.03	LS	6.56	LM
Taste	6.09	LS	6.68	LM

Legend: LS – Like Slightly, LM – Like Moderately

Table 5: Calculated t-values for the Nutritional Content of Pesto.

Nutrients	t – value	t tab
Crude Protein, %	0.61	2.78
Calcium, %	1.48	
Iron, mg/kg	0.21	
Potassium, %	0.66	

Moreover, different literature for basil pesto differs in the nutrition facts.

The pH value and moisture content of both pesto is presented in Table 1.2. The results show that that pH of both pesto is slightly acidic with pH 5.20 for basic and 5.47 for fern pesto ,respectively, Moreover, the moisture content of basic pesto is 26.15% compared to fern pesto with 30.11%. The higher moisture content of the sample indicates a non-stable product and must be stored in lower temperature to delay any microbial and chemical reactions.

Results

Table 3 shows the average total plate count (cfu/g) and yeast and mold count (cfu/g) of the two pesto samples as well as the standard limit for sauces. The results indicate that total plate count is 1.06 x 10⁴ and 1.347 x 10⁴ for basic and fern pesto, respectively, which is lower than the 10⁶ standard for sauces. In addition, the yeast and mold count is 53.33 and 300 for basic and fern pesto, respectively. This is also lower than the 10⁴ standard for sauces. Both products are also negative for Salmonella, which means that in the preparation of the product, hygienic procedures and practices were observed. This implies that hygiene and sanitation were observed in the preparation and handling of the product.

The mean values for the acceptability of the two pesto are presented in Table 5. Result shows that basic pesto is rated by the panelist as “Like slightly” (ratings 5.5 – 6.4) while fern pesto was rated as “Like moderately” (ratings 6.5 – 7.4). In all the sensory parameters tested, the result indicated a higher preference of the panelist for fern pesto over basic pesto.

The strong aroma and flavor of the basic pesto could have affected, the consumer’s acceptance since usually they form an opinion based on the initial dark green color appearance and the strong aroma of the basic pesto. Table 1.4 shows fern pesto is acceptable based on visual sensation, light green color, mild aroma, sensory impression, natural flavor, and soft quality. Its unique and

neutral taste as evident on the freshness of the ingredients is recognized and preferred by the consumers.

Problem No.2. Is there a significant difference between basic pesto and fern pesto in terms of nutritional contents, physical properties, microbial analyses and acceptability?

Calculated t-values for the nutritional content of pesto are presented in Table 2.1 The calculated t-values are lesser than the tabular t-value which implies that the samples are not significantly different in their nutritional content. The result indicates that fern pesto is comparable to the standard pesto in terms of its nutritional content. Fern can therefore be a good source of nutrients when processed into pesto.

The table above shows that the pH and moisture content of the two samples do not differ significantly as reflected by a lower calculated t than the tabular t. This simply means that the fern pesto was comparable in terms of its pH and moisture count with the standard pesto.

Table 7 presents the t-value for microbial content of pesto. The results show a non-significant difference in both the total plate count and yeast and mold count of the two samples. Moreover, the total plate count and yeast and mold count results are lower than the standard limit for pesto which is 10⁶ and 10⁴ for total plate count and yeast and mold count, respectively.

Physical Properties	t – value	t tab
pH	-2.57	2.78
Moisture , %	-1.86	

Microbial Content	t – value	t tab
Total Plate Count,CFU/g	0.45	2.78
Yeast and Mold Count, CFU/g	1.10	

Sensory Quality	z – value	Z tab
Appearance	3.53	1.96
Color	3.49	
Aroma	3.86	
Mouth feel	2.70	
Taste	2.79	

Table 8 shows the calculated z-value for the acceptability of pesto in different sensory qualities. The results show that the calculated z-value is greater than the tabular z-value for all sensory qualities. The results indicate a significant difference in the acceptability of basic and fern pesto in all the sensory attributes tested, which means that fern pesto was more acceptable than basic pesto in all the sensory attributes tested as indicated by a higher mean values than basic pesto.

CONCLUSION

Based on the results, the following conclusions are drawn; The nutrient content found in fern pesto may qualify for the Recommended Daily Allowance (RDA) of an individual by including it in a menu plan. The fern pesto nutrients such as crude protein, calcium, iron and potassium are minerals that are essential for maintaining the body structure and also responsible for making it healthy and strong. The percentage of those nutrients taken from fern pesto could supply the minimum requirement needed by the body.

The average acidity level and moisture content present on the fern pesto product signified that it could be stored for a period of time provided that time-temperature would be observed. The pesto product had good results in microbial analyses. It simply proved that the product is safe for the consumers. Hygienic procedures, consideration of external factors in production like its exposure, time and temperature and appropriate containers for the product was strictly observed. However, the fern pesto product must be recommended for a shelf-life test to determine whether the product is ideal for mass production.

Together with these, the acceptability of the fern pesto in terms of appearance, color, aroma and flavor, mouth feel and taste was moderately like by the panellists.

RECOMMENDATIONS

In view of the findings and conclusions, the following recommendations are suggested:

1. Fern pesto is recommended to homemakers for its nutritional content and minerals like crude protein, calcium, iron and potassium which met the recommended daily intake for children and adults, as well as, for health-conscious people.
2. Entrepreneurs like culinary practitioners and food industry may consider fern pesto for business and income generation. Promotion of this unique food innovation is recommended considering its high nutritional values and varied applications in meal planning.

3. The following factors for preserved food product should be strictly observed: hygienic procedures and external factors in production like its exposure, time, temperature, and appropriate container for the product.
4. The shelf-life of fern pesto should also be studied to determine whether the product is ideal for mass production.
5. Further research should be undertaken considering full utilization of fiddlehead fern as alternative to basil pesto production, and more in-depth evaluation and analysis of nutritional content, physical properties, and microbial presence, as well as, acceptability level of fern pesto.

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Morphometric Parameters of Chicken Embryos of Egg Crosses with Different Egg Shell Color During the Incubation Period

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ABSTRACT

In industrial poultry farming, the average value of hatching chickens is 80-85%. And this is on condition that all hatching eggs are pre-selected on the basis of external signs and egg mass. This means that in the industrial poultry industry, the assessment of hatching eggs, increasing hatchability, the viability of young animals during artificial incubation does not lose its relevance. The purpose of the study is to conduct a comparative assessment of the morphometric parameters of embryos of chickens of egg crosses with different eggshell color during the incubation period.

KEY WORDS: Incubation, Breeding Birds, Morphometric Parameters, Chickens

INTRODUCTION

Reproduction of poultry is impossible without eggs incubating. Further intensification of the poultry industry should be accompanied not only by an increase in the volume of egg incubation, but also by an increase in the quality indicators of its results. The purpose of incubation as a science is to find ways to increase the hatchability of eggs and the quality of day-old young stock (Akulova 2011).

The creation of high-yielding breeds and crosses of poultry with a modified genotype led to the need to study the biological characteristics of eggs, the embryonic development and hatched young stock in order to improve the entire incubation technology, and not just the modes. An important condition for this is the control system, which includes the quality control of hatching eggs, the development of embryos, the quality of day-old young stock and its preservation in the first 10 days of growing. This control system is called biological control in incubation. All information obtained in the course of biological control, allows you to control breeding work, feeding the poultry, the conditions of its keeping, the veterinary state of the enterprise and the technology of incubation.

Biological control turns eggs incubation into an active creative process, and its proper and systematic implementation makes it possible to control the embryonic development of the poultry, get high quality young stock well prepared for further growing, predict the results of incubation and promptly eliminate the reasons for their decline, which in its turn increases the profitability of the poultry farm enterprises (Bessarabov 2006; Mahapatra and Pandey 2008; Özer 2018; Shikh et al. 2018; Zeesment 2005).

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Biological control is carried out in three stages (Deeming 2000; Dyadichkina 2003). Specific batches of eggs from known supply sources of 2-3 control trays from the batch, located in the upper, middle and lower zones of the incubator, are subject to control. In cases of composite batches (eggs from poultry of different herds), take two or three trays from each group and the results are compared (Epimakhova 2013; Fisinin 2010).

Biological control includes standard procedures. Based on these standard procedures, a software have been created to regulate the physical parameters of the environment in the incubator in order to create favorable conditions for the development of the embryo. In the conditions of large-scale industrial production, this software is configured to maintain averaged environmental parameters. At the same time, an individual feature in the development of embryos of poultry with different genotypes is practically not taken into account (Clark 2007; Dyadichkina 2003; Kulikov 2006; Lee and Moss 2009).

Relevance of the research topic. Incubation of poultry eggs has many specific features that open up great opportunities in managing the breeding process of poultry. The incubation modes are developed and continue to improve based on the patterns of embryonic development of poultry (Bessarabov 2001; Clark 2007; Dyadichkina 2007).

At the present stage, zootechnical science has achieved significant success in improving the breeding, feeding and keeping of agricultural poultry, which has formed a high yielding and highly profitable poultry farming (Fisinin 2010; Kochish 2007; Mahapatra and Pandey 2008). In the conditions of highly profitable poultry farming, the most important is the issue of improving technological

parameters and improving product quality at all stages of production.

Incubation of poultry eggs has many specific features that open up great opportunities in managing the breeding process of poultry. The incubation modes are developed and continue to improve based on the patterns of embryonic development of poultry (Clark 2007; Dyadichkina 2007).

Nowadays, in the poultry industry, the average value of hatching chickens is 80-85%. Subject to all hatching eggs are pre-selected according to external features and egg mass. This means that in the poultry industry, the assessment of hatching eggs, increasing hatchability, viability of young stock during artificial incubation does not lose its relevance (Dyadichkina 2004).

The purpose of the study - to conduct a comparative assessment of the morphometric parameters of chicken egg embryos of egg crosses with different eggshell color during the incubation period. Objectives of the study: to study the morphometric indicators of brown and white-shell incubated chicken eggs; evaluate the results of biological control of the development of the chicken embryo in eggs with different coloring of the shell and - analyze the results of incubation of chicken eggs with different ratios of mass and volume.

MATERIAL AND RESEARCH METHODS

The experimental part of the work was performed in the incubation laboratories of the Department of Veterinary Medicine of the Agrarian Technological Institute of the

Table 1: Comparative performance crosses.

INDICATOR	Shaver brown	Shaver White
Growing period	0-17 weeks	0-17 weeks
Safety,%	98-99%	97-98
Live weight at 18 weeks, kg	1,47	1,3
Feed intake (0-17 weeks), kg	5,90	5,41
Period of productivity	18-80 weeks	18-80 weeks
Egg production on the initial hen, pieces	349-352	342-352
Age at 50% productivity, weeks	19-20	21-22
Peak productivity,%	95-96	96-98
The average egg weight, g	63,2	60,0
Eggs Mass per initial hen, kg	22,1	21,3

Table 2: Morphometric indicators of hatching eggs of chickens.

Indicator	Cross	
	Shaver brown (n=70) M ± m	Shaver white (n=70) M ± m
Egg weight, g	62,7± 0,32	61,0± 0,16
Large diameter (BD), mm	57,8 ± 0,22	56,9 ± 0,13
Small diameter (MD), mm	44,3 ± 0,22	43,5 ± 0,07
Egg shape index,%:	76,6 ± 0,28	75,9 ± 0,22
Egg volume, cm3	58,1 ± 0,36	56,2 ± 0,21
The ratio of mass and 3 volume, g / cm	1,079± 0,043	1,086 ± 0,021
Marbling, score	2,9 ± 0,29	2,6 ± 0,09

Peoples' Friendship University of Russia in the period from 2017 to 2018.

The material for the research was the eggs of the hens of the "Shaver Brown" cross (brown egg) and "Shaver White" cross (white egg) obtained in LLC "Genofond" VNITIP. For the research, the eggs of the batches that had been previously evaluated by the specialists of the incubator workshop of LLC "Genofond" were selected taking into account the generally accepted requirements for incubation eggs. The shelf life of eggs is not more than 5 days.

At the first stage, a morphometric analysis of 10 eggs of each cross was made at each laid. At the same time, ovoscopic test of eggs was performed. The mass of eggs was determined on an electronic scale HR-200 (Japan), large and small diameters, as well as an egg shape index — using an ИМ-1 index meter. Ovoscopic tests performed with use of the Ovoskop ПКЯ-10. At the second stage of research, eggs were laid for incubation. Total performed 7 egg laying. For each incubation laid 10 eggs of the Cross "Shaver Brown" and "Shaver White". All eggs underwent ovoscopic test. At the third stage, all eggs laid for incubation were opened daily, with 3 eggs of each cross for opening. After opening, photographing of the embryos was performed. At the fourth stage, morphometry (measurement) of the embryos was performed using the GIMP software.

Incubation of chicken eggs was performed in R-COM KING SURO20 incubators.

In the process of incubation, the development of embryos was controlled by ovoscopic tests of eggs. Opening

and photographing of embryos was performed daily. Embryo sizes were determined using graphical software - a graphical editor GIMP, using bitmap processing for individual pixels.

Statistical processing of the data obtained was carried out according to the guidelines for processing the results of measurement materials and material processing algorithms using the pack, and data analysis "MS Excel 2010" and the software "Statistics for Windows" (Fisinin 2009).

Brief description of the productive indicators of the researched crosses.

Shaver" Crosses

General description. Chickens of Shaver Cross are for the egg production. Like other egg-breeding chickens, these are very mobile, small birds with light bones and dense plumage, as well as a well-developed crest and wattles. Chickens of this cross have a white, black or brown color. Chickens with different colors are called respectively: shaver white, shaver black and shaver brown. Hens begin to fledge very quickly, and cockerels are somewhat longer. At the age of one day you can already determine sex on the growth rate of the feather. In one day hens from cockerels can be distinguished by two brown stripes on the back. The hen's crest is leafy, of a bright red color, it stands erect in cockerels, and in hens it hangs slightly to one side. The eyes of the birds are rather expressive, very lively, with a bright dark orange iris in young hens and a paler one in adult specimen. Earrings are usually medium in size, slightly rounded and red. Earlobes of birds are white. The beak is rather long and strong, yellow. The neck is short,

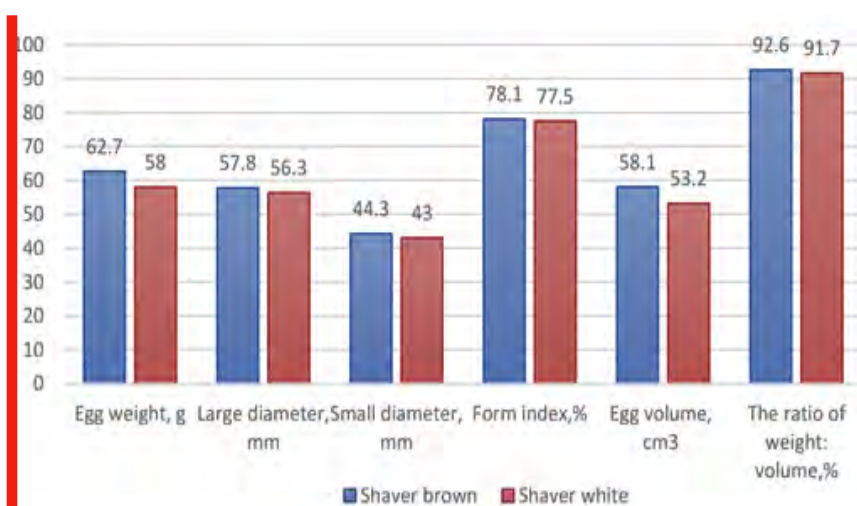


Fig. 1: Morphometric indicators of hatching eggs of chickens.

curved. Roosters have a proud posture. Their breasts are convex and round, and the pectoral muscles are rather well developed. The back is slightly elongated and concave in the middle. The abdomen of birds, especially of hens, is very voluminous. Legs are bare, without plumage, of medium length. In young birds, they are yellow or light orange in color, in more mature and productive birds become white, with a slight bluish tinge. The tail of the hens is slightly lowered, while the roosters are raised (Fisinin 2004; Kochish 2007; Washburn 2004).

Cross features. Poultry are very disease resistant. The latest breeding development has allowed to get chickens that do not suffer from neoplastic diseases, including leukemia, Marek's disease and reticuloendotheliosis. The laying period is very long - about 80 weeks. The eggs of this cross contain a large amount of healthy Omega-3 acids, when flax seed is introduced into the nutrition of the bird. Laying birds are very calm and strong; they easily adapt to different climatic conditions. Very favorable feed conversion compared to other breeds of chickens. The eggshell is very smooth and durable. The rapid increase in egg mass during the productive period. Very high production quality and stable performance. The average life expectancy of 3-4 years (Clark 2007).

Keeping features

The cross is very strong, 96-98% of the chicks survive under proper care. 80–82% of young stock survive. It is very important to protect young chickens from drafts, because at a young age they are rather tender. On average, the bird consumes 100-110 g of feed per day. This is 5-10% less than chickens of other egg breeds. The bird is almost not picky in nutrition. However, it is important to maintain approximately the same level of caloric intake. On average, it should be 2900 kcal per kilogram of feed.

Cross "Shaver Brown"

Cross - four-line, autosexing.

The parental forms of AB and CD are sexually sliced at the age of one day based on the speed of growth of wing feathers: cockerels - slow- feathering, chickens - fast-feathering. The daily chickens of the paternal parental form AB are brown, the maternal form of CD is white. By crossing the cockerels of the paternal form AB with the hens of the maternal form of CD, they get the final hybrid, autosex in the color of fluff, at day old. The cockerels are mostly yellow in color, the hens are usually brown. Accuracy of sexing of daily young of the final hybrid is 99.0 - 99.5% (Golant 1989; Shokri 2016).

Cross "Shaver White"

Highly productive cross-egg breed, producing a large number of eggs with a relatively low feed intake. Specimen are characterized by increased viability and excellent egg quality. The safety of specimen reaches 95%. The sexual maturity of hens begins at 4 months of age. Half of the potential productivity of the hens reach at 20 weeks of age. The peak of egg production is observed from 27 to 46 weeks of life and is 235 eggs per year. The productive age lasts up to 90 weeks. The average egg weight is 62.9 g. The shell is strong, white. The average daily feed intake rate is 104 g. The maximum live weight of the hen is 1.67 kg (Golant 1989), table 1.

Research Results

Characterization Of Morphometric Parameters Of Hatching Eggs Of Hens

Eggs of the studied hen's crosses had the form of an asymmetrical ellipse or Cassinian oval, one end of which is somewhat dumber than the other. The standard incubation chicken egg has the following parameters: mass 58.0 g, volume 53 cm³, density 1.09 g / cm³, long circumference 15.7 cm, short circumference 13.5 cm, shape index 74, surface area 68 cm².

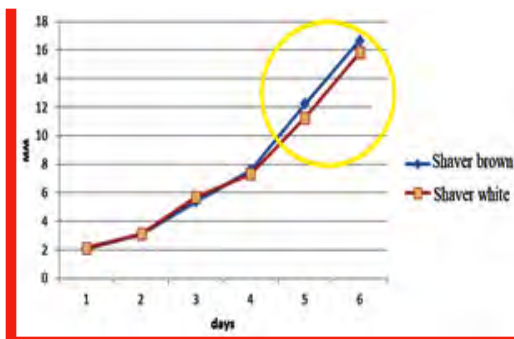


Fig. 2: Chicken embryo size at 1-6 days.

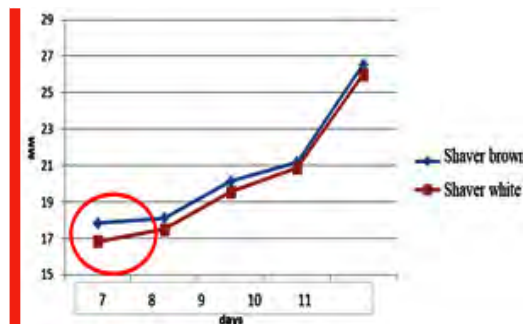


Fig. 3: Morphometric indicators of hatching eggs of chickens.

The results of the morphometric evaluation of eggs are presented in table 2.

Processing the results of a preliminary assessment of the geometric indicators of hatching eggs (table 2 and figure 1) shows that the eggs according to the above parameters, mainly met the regulatory requirements (table 2).

Based on the shape index value (an average of 76.0%), it can be stated that the eggs corresponded to the standard ovodi for the eggs. Brown eggshell eggs were on average larger than white-shelled ones. They surpassed the white-shelled in mass by 1.7 g ($P \geq 0.95$), in large and small diameter, respectively, by 0.9 and 0.8 cm ($P \geq 0.9$). (figure 1).

This, in its turn, affected a larger volume of brown shell (58.1 cm³) compared with white shell (56.2 cm). In terms of the mass-to-volume ratio, the Shaver White cross eggs exceeded the Shaver Brown cross eggs by an average of 0.8%. In terms of marbling, the eggs examined did not have significant differences. Although it should be noted that the variability of the feature "marbling" in the eggs of the Shaver Brown cross was significantly higher.

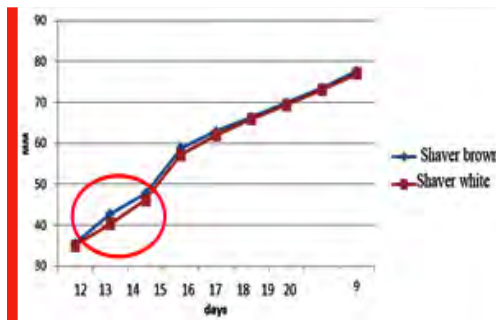


Fig. 4: Chicken embryo sizes at the age of 12-20 days.

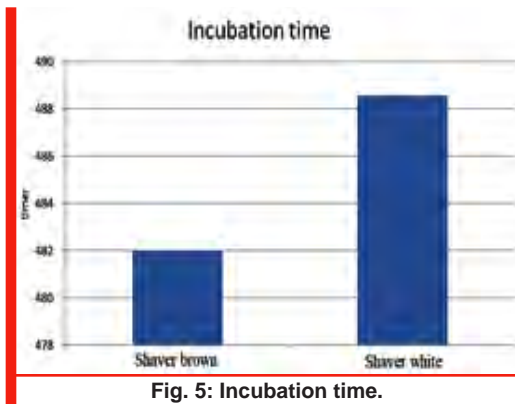


Fig. 5: Incubation time.

Age-Related Changes In Chicken Embryos

The appearance, size and structure of the embryo vary. If in the first days of incubation of the embryo, a neural tube, a notochord, and primary vertebrae characteristic of all vertebrates appear, then, later there are signs of a class of birds, species and breed features. The embryo also has temporary (provisional) organs located outside of its body and functioning only until the eggs are released. They are called embryonic shells. During embryonic development, a constant metabolism occurs between the embryo, the yolk, the protein and the shell, the characteristics of which change with age. The embryo assimilates the nutrients of the egg, releases and partially reserves in it the products of dissimilation, absorbs and releases heat. At the opening of the eggs of both crosses before incubation, the fertilized disc had a rounded shape. In the center of the disk there was a clearly distinguishable transparent zone surrounded by an opaque whitish ring, the size of the blastodisc was 4 mm. By the end of day 1, 5-7 somites, blood islands are visible. The primary strip increases to 2.5 mm, and the germinal disc - to 3.5-5 mm.

By the end of day 2 a heart is formed. By the end of day 3, the head of the embryo is separated from the blastoderm, the rudiments of limbs appear, 28-40 pairs of somites are seen. By the end of day 4, the embryo is separated from the yolk and closed with amnion, you can see 48-50 pairs of somites. Begin to pigment the eyes. Allantois is like a bubble. Germ reaches 8 mm.

In the period from 4 to 6 days, a significant difference in the size of the embryos was noted. Moreover, although the embryos are still very small and poorly distinguishable, as they are immersed in the yolk, but during ovoscopic tests on the day 6, and at the opening, the well-developed and filled with blood vascular blood network of the yolk sac is seen. It can be noted that the embryos of both crosses develop normally, but the linear growth of the embryos of the brown shell cross is more intense. By the day 5, the Shaver Brown cross embryos significantly exceed the Shaver White cross embryos by an average of 8.8%, on the 6th day - by 5.4%. (Figure 2).

That is, it can be stated that the Shaver Brown cross embryos are characterized by more intensive growth in the period from 3 to 7 days of incubation. At the same time, the development of all the major organs and tissues of the Shaver White cross embryos is similar, but not as fast as in a quieter form. The head of the embryo reaches a considerable size, the body and neck are extended. Differentiation of the bones of the foot is observed in

the rudiments of the limbs. The extracorporeal vascular field covers 2/3 of the surface of the yolk. The amount of amniotic and allantoic fluids is noticeably increased. Allantois covers more than 1/3 of the vascular field of the yolk sac .

On the day 7 of development, the difference averages 3.8% in favor of Shaver Brown cross embryos. By this age, the head takes the form characteristic for birds. The beak is elongated, the nostrils are noticeable and the egg tooth is more pronounced at the tip of the beak. The ulnar bend of the wing is clearly pronounced. The rudiments of feathers weakly protrude above the surface of the skin, along the middle region of the body, especially on the shoulder, neck, and on the skin of the thigh.

Between 8 and 11 days of incubation, a reverse trend is observed in the linear growth of embryos (Figure 3). During this period, the growth of embryos of the Shaver White Cross is accelerated, and it slows down the growth of Shaver Brown cross embryos. That is, the growth of the Shaver White cross embryos goes a little ahead.

As a result of this, on the 12th day of incubation the embryo is practically compared in size. The difference is not statistically significant (Figure 3).

It can be stated that with enhanced formation of skeletal muscles in the period of 8-10 days, this process proceeds more actively in the Shaver White cross embryos. This is probably due to the fact that the hens of Shaver White cross were intensively selected for the development of

muscles and this is a feature of the cross. By day 11, allantois reaches its maximum development. Its vascular network is clearly visible during ovoscopic test. Allantois closes at the sharp end of the egg and completely covers the yolk. Feather papillae covered the entire body of the embryo. In the period from 11 to 14 days, the again more intensive development of the Shaver Brown cross embryo (Figure 4).

A second wave of more intensive development of the embryo begins. During this period, the development of the kidneys, the digestive system, and the trachea and the pulmonary bags are differentiated. Body size of the Shaver Brown cross embryo during this period is on average 3.6% larger than the Shaver White cross embryo. The difference is statistically significant ($P>0.95$). In the future, the differences are smoothed out and by the day 18 of incubation, the embryos of both crosses are almost the same in size and exterior features. Embryos are covered with elongated fluff and have a transverse position with respect to the long axis of the egg. Amnion tightly fits the body of the embryo, because protein-amniotic mixture fully utilized. On the 21st day begins the hatching of chickens. It should be noted that, in brown-shell eggs, the curse of the shell was observed on average 4.6 hours earlier. The total duration of incubation of the Shaver Brown cross eggs was also 4.8 hours less (Figure 5).

In general, it can be concluded that during the incubation period there are two periods of more intensive growth and development of embryos. In embryos of the Cross Shaver Brown it is 4-8 and 12-14 days. Embryos Shaver

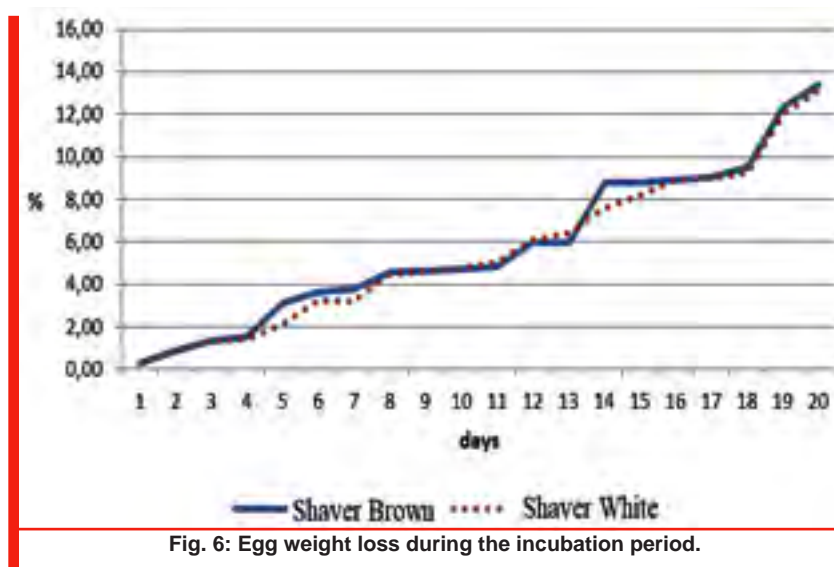


Fig. 6: Egg weight loss during the incubation period.

White cross 9-12 and 15-18 days. The time shift in growth intensity is 3-4 days.

Egg Mass Loss During Incubation

Both large and insufficient mass loss of eggs adversely affects the development of embryos and the quality of young stock hatching (Kolikov and Nikishov 2006). Large losses in egg mass in the first week of incubation and small losses in the second half of the incubation period are very dangerous. According to the control of egg mass loss, it is possible to make adjustments to the incubation mode, and, in particular, to the humidity mode.

The dynamics of egg mass loss largely repeated the linear growth rate of embryos (Figure 6). During periods of intense growth of Shaver Brown cross embryos (4–8 days and 12–14 days), there was also a maximum loss of moisture. In the Shaver White Cross Eggs, these periods were 7-11 days and 15-18 days (Figure 6).

This is probably due to the acceleration of interstitial metabolism in the process of intense differentiation of individual tissues and organs during these periods.

In general, the loss of moisture amounted to approximately 13.4%, which meets the standard parameters (Dyadichkina 2003).

The protein content largely varied by modal classes. with an increase in the absolute value of the ratio "volume to masses. a decrease in the index trolley index value is observed from 0.09 to 0.06 and the value of the unit Howe from 87, 74 to 76.5, indicating a decrease in the quality of egg white. in eggs with a smaller ratio of volume to mass, the quality of the yolk is significantly higher. in terms of yolk index, the difference averages 7% ($P > 0.95$).

H. Between the ratio of the volume of the mass of eggs and indicators of egg quality (protein index, Howe units, yolk index), a reliable average strength and inverse in the direction correlative dependence with fluctuations of the correlation coefficient is determined from - 0.34 to - 0.56).

In the modal classes, 91.5-93.0 and less than 91.5% were bred, respectively, by 8.5 and 4.7% more chickens compared to the modal class with a volume: weight ratio of more than 93%. In terms of hatchability, the differences were 1.4% and 3.0% respectively. a visual assessment of day-old calves did not show a significant difference in

live weight between chickens, assigned to different modal classes.

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Concomitant Use of Hmg-Koa-Reductase Inhibitors and S- (2-Boro-Ethyl) -L-Cysteine (Bec)

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ABSTRACT

Study of endothelium protective properties of several statins and their combination with S-(2-boro-ethyl)-L-cystein (BEC) on the models of endotoxin-induced and L-NAME-induced endothelial dysfunction was carried out. Endothelium dysfunction modelling was accompanied by increased CED—coefficient of endothelial dysfunction, NO metabolites levels increased with decreasing eNOS expression level. Atorvastatin 4.3 mg / kg, Rosuvastatin 8.5 mg / kg, and Nano-rosuvastatin 11.6 mg / kg contribute to reducing CED 1.76, 2.2 and 2.5 times, respectively. Also statins monotherapy showed normalization of eNOS expression up to 38% (Atorvastatin 4.3 mg / kg), 56% (Rosuvastatin 8.5 mg / kg) and 74% (Nano-rosuvastatin 11.6 mg / kg) from that of the intact group.

KEY WORDS: Hmg-Coa Reductase Inhibitors, Endothelial Dysfunction, Systemic Inflammatory Response Syndrome, Statins

INTRODUCTION

The range of programs used to treat the syndrome of the systemic inflammatory response (SIRS) does not include remedies to correct endothelial dysfunction (ED). At the same time, the endothelium is one of the most vulnerable parts in case of systemic inflammation. This dictates the need to consider it as an important target in the pharmacological correction of SIRS to prevent delayed cardiovascular complications (Gevorkyan 2008; Khadieva et al. 2016). Since modern pharmacology is known for a

wide arsenal of agents with endothelioprotective properties, it seems reasonable to choose the most appropriate (Malkova et al. 2011; Molchanova et al. 2016; Peresyphkina et al. 2016; Ragulina et al. 2017; Savelev 2010; Sirtori 2014).

Based on the pathogenetic principles, to correct ED associated with inflammation, it seems appropriate to use drugs from the group of statins. In addition to the classical hypolipidemic, they have anti-inflammatory, antioxidant and antithrombotic properties, which is of great importance in case of cytokine imbalance and nitric oxide (NO) deficiency (Malkova, 2011; Shabelnikova et al. 2016; Soleimanha et al. 2018; Zamani 2016). The combination of statins with other remedies aimed to restore the function of the endothelium, such as S- (2-boro-ethyl) -L-cysteine (BEC), can have a positive effect when treating and preventing ED in SIRS (Akdeniz et al. 2018).

MATERIAL AND METHODS

Male Wistar rats weighing 200-250 g were used in the experiment. Cardio- and endothelioprotective activity of the drugs was studied in two models: endotoxin-induced endothelial dysfunction (EIED) and L-NAME-

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Table 1: Effect of monotherapy with HMG-CoA reductase inhibitors, HMG-CoA reductase + BEC on the change in the parameters studied in animals with EIED.

Groups	BDsyst	BPdiast	CED	Adrenoreactivity, mmHg	Mycocardial reserve depletion, %	NOx	eNOS expression	C-reactive protein	IL-6	TNF-α
Intact	129.4±2.2	89.2±1.1	1.1 ± 0.1	201.5±9.4	112.7±10.9	116.8±10.3	5.4±0.21	0.05±0.01	0.43±0.17	8.42±2.51
EIED	117.6±2.3*	85.0±2.1*	3.7±0.5*	240.3±8.7*	79.4±3.9*	182.3±12.4*	0.04±0.01*	0.38±0.01*	6.87±1.93*	17.83±3.79*
EIED+ Atorvastatin	130.0±3.3	85.8±2.2	2.1±0.3#	222.1±8.5#	97.0±4.9*	130.0±10.9#	2.07±0.21#	0.09±0.01#	1.27±0.33#	9.89±1.79#
EIED+ Rosuva statin	135.0±3.8	83.1±2.1	1.7±0.5#	221.0±8.4#	109.4±5.7#	122.1±9.9#*	3.04±0.35#	0.11±0.01#	1.17±0.33#	10.80±1.99#
EIED+Nano- rosuvastatin	129.6±4.3	84.9±2.0	1.5±0.2#							
rosuvastatin 219.1±8.7#	99.9±6.3#	132.1±10.3#	4.01±0.56#	0.18±0.01#	1.48±0.24#	9.56±1.87#	1.97±0.10#	0.21±0.02#	2.78±1.79#	10.23±2.08#
EIED+BEC	115.3±2.4	79.1±2.2	2.5±0.4*	220.7±8.3*	92.4±5.7*	141.4±12.7#	2.41±0.34#	0.42±0.08#	1.94±0.19#	8.79±0.91#
EIED+BEC+Atorvastatin	125.3±3.2	82.3±2.0	2.5±0.3*	231.9±8.4#	88.9±3.9#	143.5±9.9#	2.52±0.41#	0.57±0.09#	1.89±0.21#	8.42±0.87#
EIED+BEC+Rosuvastatin	126.3±3.1	81.9±2.1	2.7±0.4*	223.9±9.6#	88.5±4.9#	139.1±9.5#	2.97±0.41#	0.83±0.09#	1.87±0.20#	7.56±0.79#
EIED+BEC+Nano- rosuvastatin	127.3±3.2	84.2±2.4	2.5±0.3*	226.5±8.4#	90.1±5.0#	117.8±10.0#				

induced endothelial dysfunction. The drugs under study: atorvastatin 4.3 mg / kg, rosuvastatin 8.5 mg / kg, and nanoparticulated rosuvastatin 11.6 mg / kg were administered intragastrically; S-(2-boro-ethyl)-L-cystein (BEC) 10 mg / kg, was administered intraperitoneally once a day for 7 days. There were nine groups of 10 animals each for both models: 1) intact without a modelled pathology, 2) untreated, 3) ED (endothelial dysfunction) + atorvastatin, 4) ED + rosuvastatin, 5) ED + nanorosuvastatin, 6) ED + BEC, 7) ED + BEC + atorvastatin, 8) ED + BEC + rosuvastatin, 9) ED + BEC + nano-rosuvastatin. All studies were carried out in compliance with the principles set forth in the the Convention for the Protection of Vertebrates used for experimental and other purposes (Strasbourg, France, 1986) and in compliance with the rules of laboratory practice of the Russian Federation (Order No. 267 of the Ministry of Healthcare of the Russian Federation of 19.06.2003). A program for statistical analysis of Microsoft Excel 7.0. was used for calculations.

RESULTS

Simulation of EIED leads to the development of endothelial dysfunction, which is manifested in increased CED, decreased myocardial reserve and increased adrenoreactivity, and increased number of NO metabolites,

inflammatory markers of C-reactive protein (CRP), cytokines IL-6 and TNF- α in the blood. Statins administration leads to the development of endothelial and cardioprotective action, which manifests itself in the normalization of CED, prevention of increased adrenoreactivity and the depletion of the myocardial reserve, as well as in the normalization of biochemical parameters: a decreased number of NO metabolites, normalization of eNOS expression, a decreased level of CRP and pro-inflammatory cytokines. The most effective was a nanoparticulated form of rosuvastatin. The use of a combination of a nonselective arginase BEC inhibitor with statins demonstrated an improvement in hemodynamics and myocardial contractility, but showed no additive effect (Table 1).

BP_{syst} - systolic blood pressure (mmHg), BP_{diast} - diastolic blood pressure (mmHg), CED - coefficient of endothelial dysfunction (c. u.), NO_x - final NO metabolites ($\mu\text{mol} / \text{L}$); eNOS expression (%); level of CRP-C-reactive protein (mg / l); IL-6 - interleukin 6 (pg / ml) TNF- α -tumor necrosis factor α (pg / ml), * - significant difference from a group of intact animals ($p < 0.05$).

The model of L-NAME-induced endothelial dysfunction was characterized by persistent hypertension, a 1.2-time

Table 2: Effect of monotherapy with HMG-CoA reductase inhibitors, as well as combination therapy with HMG-CoA reductase inhibitors and WEB on changes in hemodynamics, myocardial contractility and biochemical blood markers in animals with L-NAME-induced pathology.

Groups	BD _{syst}	BP _{diast}	CED	Adrenoreactivity, mmHg	Myocardial reserve depletion, %	NO _x	eNOS expression
Intact	137.7 \pm 3.7	101.9 \pm 4.3	1.1 \pm 0.1	199.2 \pm 8.3	83.6 \pm 4.3	114.1 \pm 10.5	72.9 \pm 3.8
L-NAME	190.3 \pm 6.7*	145.0 \pm 3.9*	5.4 \pm 0.6*	247.3 \pm 4.8*	66.0 \pm 4.6 *	61.2 \pm 8.5*	21.4 \pm 4.7 *
L-NAME+							
Atorvastatin	140.3 \pm 9.6*	114.2 \pm 6.6*	2.5 \pm 0.3*#	199.0 \pm 10.1#	91.7 \pm 6.3 #	84.3 \pm 9.6*#	35.6 \pm 4.2*#
L-NAME+							
Rosuva							
statin	132.2 \pm 7.7*#	101.1 \pm 5.3*#	2.1 \pm 0.1*#	187.9 \pm 10.2#	92.4 \pm 6.7#	65.7 \pm 9.3*#	35.1 \pm 4.2*#
L-NAME+							
Nano-							
rosuvastatin	120.1 \pm 6.4*#	95.1 \pm 3.9*#	1.9 \pm 0.6*#	186.4 \pm 10.7#	93.5 \pm 7.4#	63.6 \pm 8.7*#	43.6 \pm 4.5*#
L-NAME+							
BEC	167.1 \pm 9.8	131.7 \pm 3.6	2.5 \pm 0.5	229.4 \pm 7.5	78.4 \pm 3.8	94.1 \pm 11.4	42.1 \pm 3.1
L-NAME+							
BEC+							
Atorvastatin	139.1 \pm 8.1*#	115.7 \pm 7.4*#	2.7 \pm 0.4*#	217.4 \pm 7.0#	77.1 \pm 4.8#	79.2 \pm 7.0#	48.1 \pm 5.2#
L-NAME+							
BEC+							
Rosuva							
statin	137.2 \pm 8.2*#	102.3 \pm 5.8*#	2.6 \pm 0.3*#	219.4 \pm 9.7#	78.5 \pm 5.6#	69.1 \pm 6.7#	49.5 \pm 5.8#
L-NAME+							
BEC+							
Nano-rosuvastatin	135.1 \pm 9.0*#	103.7 \pm 6.8*#	2.5 \pm 0.3*#	219.8 \pm 10.5#	99.4 \pm 7.3#	68.9 \pm 7.1#	47.0 \pm 6.9#

depletion of the myocardial reserve. QED increased from 1.1 ± 0.1 to 5.4 ± 0.6 c. u. The cardioprotective effect of HMG-CoA reductase inhibitors also showed in the improvement of myocardial contractility under resistance load, which is significantly higher than that in the control group and does not differ from the values in intact animals. HMG-CoA reductase inhibitors caused a dose-dependent endothelioprotective effect, which was expressed in preventing an increase in the values of the final NOx metabolites and reduction of eNOS expression. The concomitant use of a nonselective arginase BEC inhibitor with statins showed no pronounced pharmacodynamic interaction (Table 2).

SBP - systolic blood pressure (mmHg), DBP - diastolic blood pressure (mmHg), QED - coefficient of endothelial dysfunction (c.u.), NOx - final NO metabolites ($\mu\text{mol} / \text{L}$); eNOS expression (%); level of CRP-C-reactive protein (mg / l); IL-6 - interleukin 6 (pg / ml) TNF- α -tumor necrosis factor α (pg / ml), * - significant difference from a group of intact animals ($p < 0.05$).

CONCLUSION

The use of atorvastatin HMG-CoA reductase inhibitors, rosuvastatin and nanorousvastatin against the background of modeling the EIED and L-NAME-induced pathology leads to the development of endothelial and cardioprotective action, which is expressed in CED normalization, prevention of increased adrenoreactivity and myocardial reserve depletion (nanorousvastatin); there was also identified a positive dynamics of NO metabolites (rosuvastatin), eNOS expression (nanorousvastatin), CRP (atorvastatin). The concomitant use of a nonselective arginase BEC inhibitor with statins did not reveal a positive pharmacodynamic interaction in either model of pathology.

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Observations of Deformations of Engineering Structures with the Help of Modern High-Precision Geodetic Devices

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ABSTRACT

The article considers the determination of the deformation of the engineering structures and other facilities located in area of mining operations and evaluation of their technical condition. Significant changes in the theory and practice of the engineering and surveying for determination of the deformation of the engineering structures and other objects of industrial and civil construction have taken place in recent years. New techniques, tools and methods for determining the deformation and the geodetic regulations have been developed. However, at the same time, some information stagnation is observed in recent years: the number of the published technical literature on special engineering issues has sharply decreased, in particular, in the geodetic measurement methods. The authors conducted the geodetic monitoring of the facilities located in the industrial area in Kazakhstan. The monitoring was conducted using modern surveying instruments: satellite technologies, electronic total stations and laser levels. On the research basis, the authors suggest the methods of determination of the facilities settlement and faulting. The geodetic methods, suggested by the authors, provide information about the current deformations with the high degree of accuracy. The ultimate goal of the work is to ensure the safety of the engineering constructions.

KEY WORDS: Mining Operations, Industrial Sites, Engineering Structures, Deformations, Monitoring, Monitoring Station, Monitoring Prism, Sedimentary Mark, Datum Lines, Geodetic Instruments, Electronic Total Station, Laser Levels, Laser Scanner, Elaboration, Evaluation of the Technical Condition

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INTRODUCTION

The modern mining industry is characterized by the steady growth of the plant capacity, intensification of industrial process, increasing of the depth and life service of the open-casts. In these conditions, maintenance of stability has particular importance as of the open-cast high walls and well as the civil engineering and communications in the mining operations affected area. The industrial site should be understood as the complex of buildings (processing plants, mini plants, electrical substations) and facilities, which provide the mining production with energy and transport.

In this regard, there is a need to develop new integrated programs of geo-monitoring and reliable calculation

methods to ensure the long term stability of the open-cast high walls and serviceability of the industrial site facilities. For that purpose, the researches of the mass stability were conducted in open-casts with the assessment of the technical condition of the industrial site facilities, located in the mining operations area, where the strata movement and the mass deformations are possible, to ensure reliability, safety and functional fitness of the operated facilities.

The need to address the stability of the open-cast high walls with the assessment of the technical condition of the industrial site facilities and communications, located in the on the industrial site in the mining operations affected area, occurs at all stages of the mineral deposit development. This task is complex and includes a wide range of issues. Therefore, the industrial site buildings and facilities, as well as any major geotechnical system, is a result of blending technological factors. Timely forecast of these factors is necessary to ensure the stability and safety operation of not only of the engineering structures, but also of the mining plant in the whole. According to this position, the aim is set, the idea is proved and the research tasks are formulated.

The work idea is to develop the methods of the high precision survey geodetic measurements using the modern equipment to conduct an integrated monitoring of the mass

to determine the actual parameters of the engineering structures.

The practical significance of the work is to develop the recommendations for stability management of the open-casts high walls, providing their long-term stability, as well as civil engineering.

An integrated method of the instrumental observation based on a common system of the reference points, which eliminates the initial errors of the closure and orientation and to establish a direct connection between the mass displacement and the deformations of the engineering structures, was developed in this article for the first time.

The review of the published references, patent searches and the results of the implementation lead to conclusion that the level of the performed work corresponds to the modern scientific and technical level in this field.

METHODS

We used an integrated research method, including: analysis and synthesis of science, techniques and practice to provide the long term stability of the high walls on the Kazakhstan mining plants and abroad; high precision geodetic observations; improved methods of observation; assessment of stability of the engineering structures and facilities; practical application of the techniques for observing the stability of building and constructions of various structural features of the Maykain mine industrial site.

To conduct observations, the Kazakh National Technical Research University has developed the project (Cherepanov, 1986), according to which in 2011 the observation stations were designed to periodically perform the instrumental observations. The observation stations are datum lines system, pledged on lines perpendicular to the high wall.

The length of the profile lines should be such that both or one end of it should be outside the expected displacement. With a shallow depth, the profile lines can be directed all through the open-cast. The datum lines were laid so that the safety of the observer should be provided while working on them.

There are key datum lines at the ends of the profile lines. Prior to the observation station construction, at least three initial datum lines are laid in such a way to guarantee their safety. The key datum lines are attached to the initial lines.

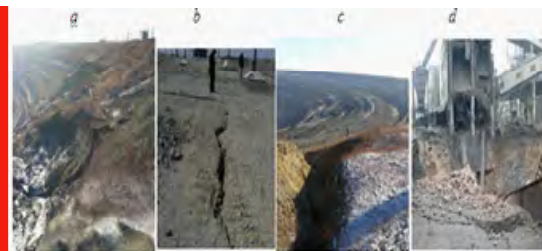


Fig. 1: Deformations on the upper ledges of the bead (a), cracks (b) of their disclosure up to 1.5m (c) and engineering deformations (d)



Fig. 2: The overpass of the industrial site of the open-cast in the Maykain mining affected area

Methods of processing and analysis of the monitoring results include integrated geodetic measurements of the facilities various parameters, taking into account their design features. Survey geodetic monitoring system is based on instrumental geodetic observations of displacement and deformations of the control observed points and the changes in the spatial position of the structures in general (Almaty 1998; Egger 1980).

Instrumental geodetic monitoring of the facilities stability condition on the industrial site on the Maykain mine is held by the laid datum lines of the observation stations in the pit and industrial site facilities with the set deformation control benchmarks. Established monitoring system is carried out using modern electronic surveying equipment- electronic total station Leica TCA 1201 and high precision laser level DNA03.

Developed observing system, installed in the object, consider the monitoring aims and give the ability to forecast the intensity of the deformation processes development. Methodology and the scope of observations for monitoring

ensure the accuracy and completeness of the obtained information for preparation of a valid conclusion on the current condition of the facilities. For complex processing and analysis of the monitoring results, the specialized software systems are used, which handle data of the instrumental measurements and allow a comparative analysis with the maximum permissible values of the deformations and deviations.

The attained data are used to develop measures to eliminate the negative phenomena, occurred in the structures or facilities or in the shift of the ground surface and rocks.

For early diagnosis of the technical condition of the buildings and localization of the variance of the stress-strain points: in the most critical nodes, the systematic control of the deformations is performed with the identification of their character. Upon detection of the critical changes in the individual elements of construction, additionally, the high precision measurements should be conducted and by these results, the final conclusions of the facilities technical conditions should be made. The causes should be determined and the measures to restore or eliminate the deformations in the structures should be established.

This technique should be applied not only to the industrial sites facilities but also to the unique buildings such as the "Kazakhstan Temir Zholy Administrative building" in Astana. The benchmarks, monitoring prisms and sedimentary marks are mounted on the controlled objects by which the further observations are performed over the deformations in the buildings and constructions, providing the required accuracy in accordance with the requirements (Elanidze 1983; Elanidze 1983; Fisenko 1965; Golushkevich 1968).

Literature Riview

The stability of the high walls and pits is affected by the following factors:

- geology and hydrogeology of the mine;
- physical and mechanical properties of the rocks;
- structural and tectonic features of the rock mass;
- the effect of the mass explosions on the stability of the slopes and sides.

Based on the above-mentioned main factors, affecting the stability of the benches, sides and on the structures in the industrial site, the references review is given below

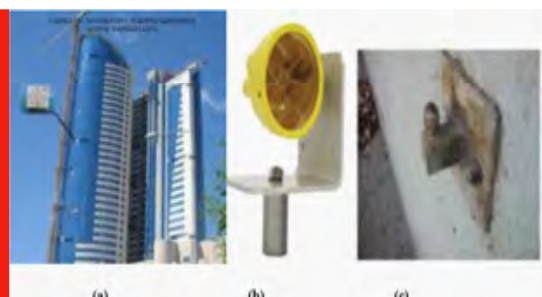


Fig. 3: Location of the benchmarks on the object (a); Monitoring prism (b) and sedimentary mark (c) Systematical instrumental observations at the geo-monitoring stations mean determination of the benchmarks position in space at a given time with the fixation of the geological factors using the total electronic station Leica TCA 1202.



Fig. 4: The deformation control benchmarks were installed in September, 2011 on the ETL supports and caving coil in the monitoring station No 1 area

summarizing the experience of the leading companies and foreign practice of the studied subject.

Issues of the rock masses stability have more than two centuries history and originate from the research of prominent French scientists C.A. de Coulomb and C. Colomb, who proposed in 1773 a method to calculate the stability of retaining walls and soil slopes. Important milestones in the development of this research should be considered the works of W.Rankine (GOST), A. Nadai (Guidelines for monitoring of the sides, slopes and dumps on the open-casts and developing the measures to ensure their stability 2008), K. Terzaghi (Maier 1971), V.V. Sokolovsky (Nadai 1954), S.S. Golushkevich (Nurpeissova and Beck 2015), D.Sh.Mikhelev (Nurpeissova and Beck 2014), A.P.Karpik (Nurpeissova and Kyrgyzbaeva 2014) and other authors (Nurpeissova and Kyrgyzbayeva 2015; Pevzner 1978).

Researches on the stability of the pit slopes are associated with intensive development of opencast mining in the twentieth century and increasing of the depth of the pits. In the Soviet Union, the most important results and achievements in this branch are related with the activities of the research and design institutes, the institutes of mining

and the leading universities. To address this urgent and applied problem, the specialized departments were created, laboratories, sectors and groups, involving many prominent scientists. In this time, the foundation of the national school of the stability of the pits and slopes research was laid, with the large contribution of the works of N.N. Melnikov, V.V. Rzhovsky, K.N. Trubetskoy, G.L. Fisenko, I.I. Popov, M.E. Pevzner, G.G. Poklad, V.A. Gordeev, F.K. Nizametdinov, V.N. Dolgonosov, O.T. Tokmurzin, T.T. Ipalakov, M.B. Nurpeissova and many others (Piskunov 1980; Rankine 1872; Slutsky 1978; SN 2003).

Despite the achieved progress of many researches, the problem of stability of the pit slopes in area of the industrial sites buildings and facilities is far from being studied fully and requires further development and improvement. This is evidenced by the results of the researches in 2010- 2015 of the actual condition of the slopes of the Maykain mine, executed with participation of the author.

There are facilities on the industrial site on the sides of the pit with a view to ensure a number of technological processes. Under the influence of the industrial and human made factors, the buildings and facilities during operation may change their position in the vertical and horizontal

Table 1: The surveying results of the ETL substation building columns

Marking	Coordinates of the alignment feature points		The columns displacement from the vertical plane along the axis		The absolute value of the roll
	Y,m	X,m	$\Delta Y,mm$	$\Delta X,mm$	
\Axis, Column#	2	3	4	5	6
K-5/1c, Д/1c	97.381	100.134	8	-3	8.54
97.373	100.137				
K-5/1c, Г/1c	96.22	104.477	-14	-2	14.14
96.234	104.479				
K-3/1c, Г/1c	101.686	105.293	7	3	7.62
	101.679	105.29			
K-3/1c, Д/1c	101.787	101.314	-15	-9	17.49
	101.802	101.323			
K-1/1c, Д/1c	106.632	101.625	-5	-4	6.40
	106.637	101.629			
K-3/2c, Г/2c	104.156	100.444	0	10	10.00
	104.156	100.434			
K-3/2c, Д/2c	101.083	97.855	1	9	9.06
	101.082	97.846			
K-5/2c, Г/2c	100.916	104.249	-3	-14	14.32

planes, which is evident in the form of cracks, bulges, sags and roll. If these events are not detected in a timely manner and the steps for their elimination are not taken, the building may be destroyed. Therefore, the buildings and facilities should be observed during operation and the survey and geodetic measurements should be conducted (SNIp; SNIp 2002).

Upon a gradual settlement, building, facility move vertically the same in all parts and do not affect significantly on their durability and stability. In cases when the soil compressibility or the load on the soil under the foundation varies, sediment is uneven and this may lead to significant deformations of the building or facility, cracks and even splits occurrence.

Deformations in the foundations of buildings and facilities cause not only roll in the framings but also the cracks, which are divided into active, when there is expansion process and inactive, when this process is stopped.

Irregular settlements occur primarily as a result of a various compression of the different parts of the structure and an unequal soil compressibility under the foundations,

which in turn causes non-uniform displacements in over foundational constructions and facilities.

In fact, there is almost no gradual settlement on the compressible soils, because the geological structure of the foundation is not similar in the vertical and horizontal planes.

Gradual settlements itself do not reduce the strength and stability of structures, but significant settlements may lead to changes in the physical and mechanical properties of the foundation soil, which in turn can cause foundation failures. In addition, gradual settlement can cause disturbance of the utility communications of the structure. In the impact on the structures, the foundation failures are more dangerous. This danger is greater when the difference between the parts settlement is greater and the greater is the sensitivity of the construction and technological elements.

RESULTS

The purpose of monitoring of the industrial site facilities is to ensure reliability, safety and functional fitness of the operated facilities; analysis of the stress condition, deformations and displacements of the structures; monitor

Table 2: Monitoring results of the deformation control benchmarks on the ETL supports

Number of the control point	The first observation, m November,8, 2011			The second observation, m April,12, 2012			Horizontal and vertical displacements of the deformation control benchmarks between the cycles, mm $\Delta Y, mm \quad \Delta X, m \quad m$			
	$\Delta Z, mm$	Y	X	Z	Y	X	Z			
1										
2		6465.571	4628.48	157.419	destroyed					
3		6318.395	4347.09	159.114	destroyed					
4		6333.535	4347.09	159.114	6333.58	4347.109	159.105	43	19	-9
5		6452.786	4351.89	177.507	6452.81	4351.921	177.4877	22	36	-19
6		6354.327	4418.59	157,105	destroyed					
7		6320.206	4390.76	157,105	6320.25	4390.787	157.062	43	28	-43
8		6372.178	4357.96	159.745	6372.19	4357.974	159.7305	14	13	-14
9		6313.535	4347.09	159.252	destroyed					
10		6324.953	4609.26	158.614	6324.99	4609.302	158.574	36	38	-40
11		6324.595	4542.69	159.743	6324.65	4542.728	159.679	58	41	-64
12		6427.811	4120.7	172.146	6427.85	4120.765	172.123	38	66	-23
OP1		6358.441	4231.84	174.527	6358.45	4231.872	174.469	10	58	-36
OP2		6390.654	4244.12	162.323	6390.68	4244.137	162.299	29	15	-24
OP3		6414.258	4185.55	161.616	6414.28	4185.563	161.599	23	12	-17
OP4		6385.571	4173.11	175.182	6385.6	4173.125	175.148	25	14	-34

the overall deformations and cracks of the operated constructions by systematic observation and instrumental control.

In solving the monitoring tasks, all engineering, geological and mining factors, types, characteristics and requirements of the protected facilities (Elanidze 1983; Elanidze 1983; SNiP 2002; SNiP 2002; SNiP 2004; SNiP 2005; Sokolowsky 1960).

Recommendations for making the observation stations and observation methods are set out in VNIMI Instructions (SNiP 2002).

Results of research and analysis of the mining and geological documentation show the following strained

areas in the open-cast are identified:

there is a caving of the upper ledges in the south western side of the open-cast (Fig.1,a); there are a crack in the south side (Fig.1,b); cracks with wide opening(Fig.1,c); the deformations on the ground surface and on the engineering structures (Fig.1,d); the overpass of the industrial site of the open-cast in the mining affected area (Fig. 2); ровод промплощадки рудника, находящегося в зоне влияния горных работ(рис.2).

The system of geo-mechanical monitoring of the stability condition of the side masses and the engineering constructions is developed in the project (Cherepanov

Table 3: The determination surveying results of the COG displacement alignment of the overpass round support.

Nos. mark of support, point	The actual diameter of the axial column, m	The radius of the axial column, m	The reference sight in diameter direction, degree	Coordinates of the column center	
				Y, m	X, m
A 1, lower	0.595	0.298	25.147447	151.934	69.369
A 1, lower					
A 1, upper	0.601	0.301	79.503316	151.855	69.397
A 1, upper					
Axis displacement of the central support		0.079	-0.027		
Б 1, lower	0.607	0.304	88.012839	624.193	974.030
Б 1, lower					
Б 1, upper	0.606	0.303	3.128582	624.212	973.944
Б 1, upper					
Axis displacement of the central support		-0,019	0,086		
В 1, lower	0.600	0.300	4.876663	455.393	1081.833
В 1, lower					
В 1, upper	0.604	0.302	19.020959	455.420	1081.832
В 1, upper					
Axis displacement of the central support		-0.027	0.001		
Г 1, lower	0.602	0.301	15.685199	137.439	164.221
Г 1, lower					
Г 1, upper	0.612	0.306	78.246975	137.414	164.253
Г 1, upper					
Axis displacement of the central support		0,025	-0,032		
Д 1, lower	0.606	0.303	17.625486	536.007	1029,709
Д 1, lower					
Д 1, upper	0.603	0.302	53.558207	535.997	1029.779
Д 1, upper					
Axis displacement of the central support		0.010	-0.070		

1986). The initial and key benchmarks are laid in concrete and the operational benchmarks are laid precast for monitoring stations.

The benchmarks, monitoring prisms and sedimentary marks are secured on the protected objects for further monitoring of the buildings and facilities deformations, providing the required accuracy (Fig.3).

For each of the created monitoring station in the open-cast, there are identified the schemes of location reports and orientation of the profile lines key and link marks, that allows quickly and accurately locate the initial points and stick to a single orientation system in different series of monitoring.

The surveying geodetic monitoring of the displacements and the deformations of the observation benchmark are performed at least 2 times a year in accordance with.

Complete series of monitoring include the following activities: the binding of the initial and key benchmarks (coordinates determining X, Y, Z) to the nearest points of the surveying geodetic network; conducting the initial observation to determine the starting position of the benchmarks and the deformation control benchmarks of the monitoring stations on the horizontal and vertical planes; conducting the systematic observations of the benchmarks displacement.

The binding of the initial and key benchmarks of the profile lines to the points of the surveying geodetic network and determining the coordinates (X, Y, Z) in a single system is performed automatically by the Leica TCA1202 total station. This Leica TCA1202 total station is set to the initial (key) benchmark of the monitoring station and is focused on the other 1-2 points of the network.



Fig. 5: a- determination of the deformations of the ETL substation b- determination of the beams sag of the PP building covering

All Leica TCA 1202 measurements, to improve the accuracy and elimination of the gross errors, performed at two positions of the vertical circle in 6 manners. The measuring receiving includes one reflecting on the reflector, in which the measurement is performed several times (2-3). The average measurement is taken for the final result, and the difference between the individual samples should not exceed ± 2 mm.

Position of the link benchmarks is determined automatically by the Leica TCA 1202 total station from the initial (key) benchmarks of the created system or from the network.

Initial observations on the station consist of two independent series of measurements within 3-5 days. Using Leica TCA 1202 electronic total station, the coordinates of the initial position of the profile lines benchmarks, coordinates of the same benchmarks in subsequent observations, horizontal traversing between the benchmarks and their displacements are being determined. By the difference of the coordinates of the benchmarks ΔX , ΔY , ΔZ relative to their initial position, we can determine the direction of displacement vector in space in digital form, as well as the difference of horizontal traversing ΔS between benchmarks relative to baseline values may judge on the stability (movement) of rock mass.

When using the Leica TCA 1202 total station, the processing of the surveying measurement results is performed automatically.

It should be noted that the processing of the surveying measurement results with the calculation of the movement and deformation parameters is possible only in the case of defining the displacements exceeding the instrumental accuracy.

Therefore, when receiving the displacement values within the instrumental accuracy, it is convenient to determine deviations in the horizontal and vertical planes through the benchmarks coordinates between the initial and

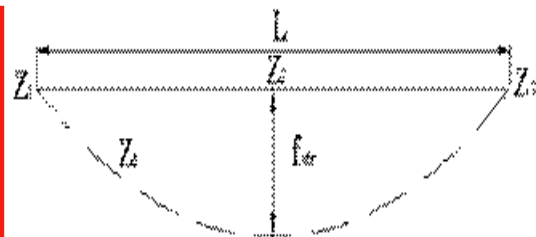


Fig. 5: The geometric layout of the beams sag

subsequent measurements $\Delta X, \Delta Y, \Delta Z$.

Diagrams of the vertical displacements of the engineering structures are shown in the Fig.7 .

Table 4: The surveying results of the ETL substation building covering beams

Covering beams marks	Results by the digital rod	The absolute value of the beams sag f, m
B-337-7	0.5187	-0.0014
	05205	
B-336-8	0.5195	-0.01525
	0.3749	
B-335-8	0.3858	-0,00955
	0.3662	
B-334-8	0.381	-0.0051
	0.3833	
B-325-6	0.3665	0.00085
	0.3819	
B-323-6	0.3873	-0.0052
	0.3825	
B-322-8	0.5117	-0.00655
	0.5113	
B-321-8	0.5126	-0.00855
	0.3651	
B-320-8	0.3763	-0.005
	0.3771	
B-281-6	0.368	-0.0042
	0.3817	
B-208-8	0.3823	-0.01965
	0.3683	
B-207-8	0.3854	-0.02185
	0.3854	
B-206-8	0.3742	-0.01765
	0.3805	
	0.3768	
	0.5069	
	0.5114	
	0.5075	
	0.5001	
	0.5215	
	0.5036	
	0.4979	
	0.5228	
	0.504	
	0.4986	
	0.5148	
	0.4957	

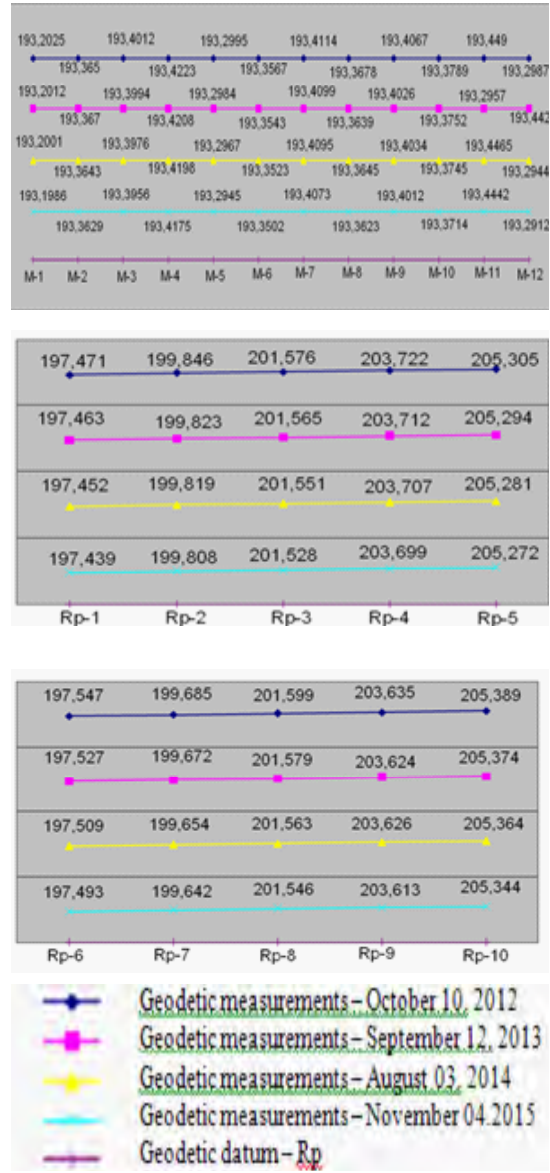


Fig. 7: a – Results by the settlement marks of the industrial building; b,c– Results of the observations by the fill up facility benchmarks. FIGURE 7. The vertical displacements diagrams

An additional control of the benchmarks displacement in the horizontal and vertical planes is the calculation of dS- changing of the interval length, ΔL - benchmark displacement, as well as amount of dS and ΔZ for the observation period.

The result of the two series of the surveying observations processing is making the tables, which show the changes in elevation marks of the profile lines, as well as changes

in the interval length between the benchmarks and the intervals total length from the key benchmark to the operating one.

When the deformations are in the active stage, using the proposed method allows the quick (within one day) getting a full picture of displacements and to develop in timely manner the measures to ensure stability.

To perform monitoring and integrated evaluation of the industrial site facilities, the modern high precision electronic equipment produced by Leica Geosystems (Switzerland): high precision electronic total station TCR 1201series and digital high precision laser level DNA03, a laser scanner Scanstation and specialized software, which allows to produce data computer processing.

The facilities displacements in the vertical plane (immersion) are determined by geometric leveling using the digital laser level DNA 03 and the digital invar-surveying rod.

Data from TCR 1201 Leica total station may be incorporated into any process flow of the geodetic data handling. The field measurements can be easily transferred to various processing and equalizing programs of the geodetic measurements: Liscad, CREDO-DAT, RGS, AutoDesk Survey. Next, the equalized three dimensional point coordinates are transferred into programs: CREDO-MIX, CAD-Relief, TOPOCAD, AutoDesk Land Development Desktop.

Digital laser level DNA 03 automatically corrects any displacement of the laser beam within setting and warns about changing of its position by turning on and off the laser.

The laser level DNA 03 is intended for measuring the elevation and transmission of the elevation marks. The level emits visible light beam, with respect to which the elevation measurements are being conducted.

While monitoring the settlement of the industrial site facilities by geometric leveling using digital laser level DNA 03 and digital surveying rod, the need to address the issue of the performed work accuracy occurs.

The mistake of a viewpoint is the main in the geometric leveling. It means a set of elementary errors caused by the influence of instrumentation (a level and a rod), construction of the benchmarks and the link points, external environment, instability of the object being measured, the

measurement processing procedure and personal errors that surely shall enter into the equalized ratio.

According to the schedule of the research, the following works have been conducted in 2012 - 2017:

1. Based on the analysis of the side and dump rock masses of the open-cast, according to the developed projects in 2010, the profiles benchmarks of the geo-mechanic monitoring stations of the pit slopes stability, were laid: There is one constructed monitoring station on the pit, consisting of three profile lines.
2. Two series of surveying geodetic observations by the laid benchmarks of the profile lines have been performed. The first series of the surveying geodetic observations were conducted in the period from October 30, 2013 until November, 8, 2013. The second series of the surveying geodetic observations of the side masses condition were conducted in the period from April 11, 2013 until April, 19, 2013. Monitoring results are presented in the tables and figures, the results of monitoring of the industrial site buildings and facilities are presented in the tables 1-3.
3. To evaluate the technical condition of the facilities, the complex of high precision surveying geodetic measurements of the bearing and enclosing structures of the industrial site facilities using developed surveying observations, is united in a single system of side mass condition and structural elements of the buildings and civil engineering of the industrial site.

The observations are based on a common system of reference points, which eliminates the initial errors of binding and orientation and establish a direct connection between the rock displacement and deformation of the bearing structures to ensure the reliability and safety of their operation. According to the above procedure, the deformation control bench-marks were installed in the investigated objects (Fig.4).

According to the results of the industrial site facilities monitoring, the following is detected:

- a) in the upper horizons of the southwestern side of the open-cast there are the power pylons which are in area of dangerous deformations. Upon the results of the deformation control benchmarks, it can be concluded

that the ETL supports are vertically displacement up to (-) 36mm, 4 benchmarks are in the caving area. The maximum displacement of the ETL supports in direction of the open-cast is 58mm and the results are presented in the table 2;

b) the definition of the columns roll of the processing plant was performed by the procedure of the non-reflective coordinates method using TSR 1201 electronic total station. According to the obtained values and coordinates increment of the points in the same vertical plane, the linear value of the roll (Fig.5, a) by the formula:

$$L = \sqrt{(X_1 - X_2)^2 + (Y_1 - Y_2)^2} \quad (1)$$

Where, X_1, X_2, Y_1, Y_2 – coordinates of the facility feature points respectively in the lower and upper sections. The results are shown in the table 1;

c) determination of the COG displacement alignment of the overpass round support from the points of the industrial site geodetic network with reference to the surveying network was performed by a similar method and the results are presented in the table 3;

d) determination of the beams sag of the processing plant cover (PP) was performed using digital high precision level DNA 03 (Fig.5, b) and a digital invar rod. To solve this task, the invar rod was installed in the points of the beginning, middle and end of each beam span. The results are presented in the table 4.

To determine the sag of span f_{abs} and the deflection the formulas were used:

$$f_{abs} = \frac{2Z_2 - (Z_1 + Z_3)}{2} ; \quad (2)$$

$$f_{def} = \frac{f_{abs}}{L} , \quad (3)$$

where Z_1 and Z_3 - elevations of extreme points of the structure in this section of the straight line.

To determine the sag of span f_{abs} and the deflection the formulas were used:

$$f_{abs} = \frac{2Z_2 - (Z_1 + Z_3)}{2} ; \quad (4)$$

$$f_{def} = \frac{f_{abs}}{L} , \quad (5)$$

where Z_1 and Z_3 elevations of extreme points of the structure in this section of the straight line.

The obtained results of the industrial site facilities technical condition evaluation by the method described above were compared with the permissible values in SNiP SN RK 1.04.04-2002 –“Examination and evaluation of technical condition of buildings and structures”, SNiP RK 5.04-18-2002 “Metal constructions” (Almaty 1998; Fisenko 1965; SNiP 2002; SNiP 2004; SNiP 2005; Sokolowsky 1960; Tertsagi 1961; Zaitsev et al. 1991).

The permissible beams sag is $1/300 L$, where L , m – length of the beam (Fig.6). Permissible displacement value of the processing plant is 15mm, if the height is up to 4 m (The guidelines of determination of the angles of the sides, ledges 1989; The project of the monitoring station of the side mass and the industrial site facilities stability condition 2009).

The developed integrated monitoring program of the stability condition of the side rock masses and the industrial site facilities allows to establish a direct link between the mass displacements and the facilities displacements, excluding the errors of the binding and orientation, allowing to identify on the early stage the stressed and strained condition of the mass and the most dangerous areas of the industrial site engineering structures

DISCUSSION

1. The integrated geo-monitoring program of the stability condition of the side rock masses and the industrial site facilities is developed.

2. The monitoring results of the side masses displacements and the industrial site facilities deformations:

- analyzing the data of the table 2 of the ETL substation columns, it may be concluded that the column K-3/1c, D/1c has an axis displacement of 17.49 mm. The obtained value exceeds the permissible value by the SNiP RK 5.04-18-02, table 26 p.4 (permissible value is 12 mm).

- analyzing the data of the table 1 upon the ETL facilities deformation control benchmarks, it may be concluded that the ETL supports have the vertical displacement is up to (-)

36 mm, the maximum horizontal displacement of the ETL in direction of the open-cast is 58 mm.

- analyzing the data of the table 3 upon the geodetic surveying of the COG displacement alignment of the overpass round support, it may be concluded that the maximum value of the absolute roll is 86 mm. The obtained value exceeds the permissible value by the 2.0107-85*, table 22 p.6 (permissible value is 40 mm).

- analyzing the data of the table 4 upon the beams of the ETL substation building a covering, it may be concluded, that the beams B-208-8, B-207-8 have a sag of 0.01965 mm, 0.02185 mm respectively. The obtained results do not exceed the values from the SNiP 2.0107-85*, table 19, p.2 (permissible value is 37mm).

- the developed integrated monitoring program of the stability condition of the side rock masses and the industrial site facilities allows to establish a direct link between the mass displacements and the facilities displacements, excluding the errors of the binding and orientation, allowing to identify on the early stage the stressed and strained condition of the mass and the most dangerous areas of the industrial site engineering structures.

3. According to the SNiP high requirements to the buildings and facilities to ensure their functional fitness, the obtained results upon the monitoring may be used to forecast the process of the side rock masses displacement.

4. The results of investigations in this article and the monitoring of the side rock mass and evaluation of the facilities technical condition have been introduced at the mining plants in Kazakhstan and unique facilities of the construction corporations in Almaty and Astana.

5. The level of the performed work is in line with the best achievements in this field. The algorithm and corresponding software for the applicable surveying tasks using modern and computer technologies has been developed.

Thus, the integrated procedure of the surveying monitoring is developed for the first time, based on a common system of the reference points, that eliminates the initial errors of binding and orientation, and establish the direct link between the mass displacement and the engineering constructions.

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Biodegradable Polymer Compositions Based on the Waste of the Agro-Industrial Complex

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ABSTRACT

This paper presents the results of studies of polymeric materials based on polyethylene, waste from the agro-industrial complex and modifying additives as complex compounds based on iron and manganese, as well as issues related to the creation of biodegradable materials. In the methodological part, ways and methods of research of the selected objects of study are indicated. In the experimental part studies of deformation and strength characteristics of materials in the process of artificial aging of polymeric materials and the introduction of the additives that accelerate the process of biodegradation are held; weight change of the compositions upon the contact with water and in the process of composting, to identify biodegradability of the studied materials are shown. The research was supported by the Ministry of Education and Science of the Russian Federation, the unique identifier of the project is RFMEFI57418X0191.

KEY WORDS: Biodegradable Polymer Compositions, Waste Of The Agro-Industrial Complex, Oxydegradable Polymer Compositions

INTRODUCTION

Most synthetic polymers are not biodegradable. At the moment, millions of tons of such polymers are produced in the world, and annual growth is 8-10%. At the same time, their burial has negative impact on the environment.

That is why, lately more attention has been paid to polymer recycling and creation of biodegradable polymeric materials (Bakhaeva and Ivanovsky 2015). The creation of biodegradable polymeric materials involves adding to them special additives that accelerate the destruction of polymer macromolecules. Polysaccharides are used for this, and the contents in the finished polymer can reach 60%.

Biodegradable polymeric materials have many obvious benefits. They are made from renewable plant materials, which in turn, allow you to save non-reproducible resources. Active use of plant materials is opening up more and more growth opportunities in the agricultural industry. Also such materials have low barrier properties for oxygen and water vapor; they are fully destructible in natural conditions and have high resistance to decomposition under normal conditions. Adding of the original synthetic polymer substances of plant origin the following source of raw materials is used: potatoes, beet, corn, tapioca, cereals and legumes, cellulose. Often starch is used as an additive. As the polymer matrix the composition of ethylene

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copolymer with vinyl acetate and polyethylene is often used. Therefore, the purpose of this work is to develop biodegradable polymer materials based on polyolefins and the study of properties of specific compositions (Shteinberg and Zenitova 2015; Zakharova et al. 2018; Zakirova et al. 2014).

The Choice Of Objects Of Study

Today, the creation of biodegradable polymeric materials is one of the most promising areas in the field of the recycling of polymer waste. This is due to their ability to complete decomposition in environmental conditions, which significantly facilitates its recycling. Creating of a



Fig. 1: Laboratory twin screw extruder

Table 1: Presents the characteristics of PE.

№	Наименование показателя	Значение
1.	density, g/sm ³	0.950-0.955
2.	melt index, g/10 min	0.40-0.65
3.	interval of melt index, %	±10
8.	Tensile strength at break, MPa (кгс/см ²)	29 -30
9.	Elongation at break, %	700-800

Table 2: Selection of optimal fillers.

№ n/n	Name of filler	The maximum concentration of filler ($\sigma \leq 4 \text{ MPa}$)
1.	Rice husk	23-25
2.	Beet pulp	20-23
3.	Cacaovella	20-23
4.	Buckwheat husk	12-16
5.	Sunflower husk	7-9
6.	Millet husk	7-9

biodegradable polymer based on synthetic polymers is possible using the following additives:

- accelerating photo-oxidative degradation processes;
- accelerating processes of oxidative destruction;
- accelerating decomposition under the action of microorganisms.

Based on the analysis of the literature data in the work additives based on iron complex and manganese, polycaprolactone, additive in the form of starch, materials containing AIC waste have been selected as the objects of the research. In this experiment, the objects granule HDPE brand 273-83 GOST 16338-85, modifying in the form of metals (1%) are used.

Starch and waste of the sugar production – beet pulp have been used as a natural filler. HDPE mark 273-83 GOST 16338-85 have been used as the polymer matrix. PE without additives and polycaprolactone, such as biodegradable material has been used as control samples.

Obtaining experimental samples

Polymer compositions used in the work were obtained on laboratory twin screw extruder (figure 1). The extruder on which the compositions were prepared is twin-screw with the barrier screw. It provides complete melt homogenization. A strand type extrusion head was used.

Temperature treatment modes are divided by zones: T1 =

Table 3: Determination of physic-mechanical properties of samples before the ultraviolet radiation

Name of additive	σ_p , MPa	E_p , %
PE	17±1	920±90
PE +Mn100	16±1	775±770
PE +Mn107	11±1	494±49
PE +Mn108	6±1	945±90
PE +Mn109	7±1	315±30
PE +Mn110	14±1	465±46
PE +Mn111	11±1	220±22
PE +Fe100	17±1	980±98
PE +Fe107	15 ±1	460±46
PE +Fe108	17±1	850±85
PE +Fe109	22±1	590±59
PE +Fe110	13±1	500±50
PE +Fe111	12±1	920±92

115 ° C; T₂ = 120 ° C; T₃ = 135 ° C; T₄ = 140 ° C.

RESEARCH METHODS

The method of studying of the mass of the samples in the contact with water was carried out in accordance with GOST 4650-2014 "Plastics. Methods of determination of water absorption". The method consists in determining the change of the mass of samples placed in water for a specified period of time with maintaining a certain temperature (23 ± 2 ° C; C). Sample changes occur due to the absorption of water by the sample. The mass of the absorbed water is determined by the difference of the mass of the sample before and after placement in water. The mass change of the sample is calculated by the following formula:

$$Q = \frac{(m_i - m_0) * 100}{m_0} (\%) \quad (1)$$

where m_i is the mass of the sample in the research process, g

m_0 is the initial mass of a sample of a polymeric material,

Q - weight change upon the contact with water.

Then dependencies are built $a = f(t)$, where t is time.

When conducting a study using the method of composting of the obtained polymer compositions the land with biohumus TU 0391-11158096-2002 with a humidity of 60% of the maximum possible was used. In the process of the research the samples were placed in petri dishes at the bottom of which there was already the ground and they were completely covered with soil. This provided constant soil access to the air. In the study of the rheological properties of polymer compositions the method of capillary viscometry was used to determine melt flow rate (MFI). The device IIRT was used during the work. In the course of the work, the IIRT camera was heated to 190 ° C, then a sample of the material was loaded into the chamber. The calculation of the melt flow index (Im) was carried out according to the following formula:

$$Im = \frac{600 * m}{t} [g/10min], \quad (2)$$

Where m is the mass of the sample, g;

t is the time interval between successive cuts of samples.

In the work the determination of physico-mechanical properties of GOST 14236 was carried out. This method is based on the uniaxial tension of the subject sample with

the established size with the certain speed of deformation. During testing samples in the form of strands with a diameter of 10 mm and a length of 100 mm were used. Tests were conducted on the machine RM-50, at the temperature of 20 ° C and the relative humidity of 50%, with the speed of 50 mm / min to the complete destruction.

The method of the artificial aging by irradiation of polymer compositions with ultraviolet light was also used in the work. Samples were exposed by ultraviolet irradiation for 55 hours.

RESULTS AND DISCUSSION

To create biodegradable polymeric materials, it is advisable to use the waste of the agro-industrial complex (APC) as filler, because it contains substances that contribute to decomposition of the resulting compositions. The following wastes were used in the work:

- Buckwheat husk;
- Sunflower husk;
- Millet husk;
- Rice husk;
- Cacaovella;
- Beet pulp.

Most methods for assessing the biodegradability of polymeric materials have a long test period. In this regard, we developed an express method for assessing the ability of a polymer composition to biodegradation. Accelerated

Table 4: Determination of physic-mechanical properties of samples after ultraviolet irradiation

Name of additive	σ_p , MPa	Ep, %
PE	12±1	128±12
PE +Mn100	12±1	106±10
PE +Mn107	6±1	87±10
PE +Mn108	26±1	38±3
PE +Mn109	18±1	175±17
PE +Mn110	23±1	24±2
PE +Mn111	27±1	41±4
PE +Fe100	23±1	15±1
PE +Fe107	13±1	26±10
PE +Fe108	16±1	80±8
PE +Fe109	27±1	25±2
PE +Fe110	12±1	19±2
PE +Fe111	10±1	134±13

method of biodegradation of polymeric materials consists of assessing the biodegradability of polymeric compositions with simultaneous action of microflora and mechanical load. The evaluation criterion for this method is to determine deformation of the polymer sample in the bioreactor under the action of a constant mechanical load and under continuous renewable conditions of contact of the surface with aggressive environment. Express method is unique as it provides a simultaneous exposure to the subject sample placed in a bioreactor, corrosive environment and mechanical load. The beginning of biodegradation is taken as the point at which a change in the linear dimensions of the samples, different from control value by more than 10% is observed.

As a result of using this method, it was revealed that for creating biodegradable compositions based on polyethylene and waste from the agro-industrial complex the minimum amount of filler should be at least 20%. After analyzing a group of fillers, to create biodegradable polymeric materials optimal waste with low particle size - beet pulp, cocoa-rice, rice husk (table 2) was chosen.

Based on the presented results, 3 types of filler: beet pulp, rice husk and cocoa-nut were selected. Carried out research, at creating polyethylene compositions containing, as a filler, all the listed wastes showed that the filler in the form of wastes of the agro-industrial complex poorly distributed in the polymer matrix, namely, filler agglomeration occurs, which reduces productivity of the extruder and leads to a sharp decrease in the deformation-strength properties of the materials. In this regard, bentonite was used in the work, as the modifier for dispersing the filler in the polymer matrix, in the amount of 2%.

Table 5: Comparative characteristics of physico-mechanical properties of the samples.

Name of additive	Ep, %, before the UV-exposure	Ep, %, after the UV irradiation	ΔEp, %
PE	920	560	39
PE +Mn100	775	106	86
PE +Mn107	494	87	82
PE +Mn108	945	26	97
PE +Mn109	315	175	50
PE +Mn110	465	24.47	94
PE +Mn111	220	41	81
PE +Fe100	980	15	98
PE +Fe107	460	24	94
PE +Fe108	860	80	90
PE +Fe109	590	26	95
PE +Fe110	500	20	96
PE +Fe111	920	134	85

Table 7: The change in the mass of samples of PCL and PE with starch at the contact with water.

Name of compositions	Q, % After 4 weeks	Q, % After 21 weeks
polycaprolactone	13	9
polyethylene containing starch in the amount of 25%	15	18

Table 6: Determination of the change in the mass of samples with AIC at the contact with water.

Name of filler	Name of additive	Q, % After 21 weeks	Q, % After 42 weeks
Rice husk	-	40	54
Rice husk	Mn100	34	98
Rice husk	Fe107	48	75
Beet pulp	-	47	58
Beet pulp	Mn100	54	92
Beet pulp	Fe107	57	70

Table 8: Results of the rheological experimental samples study based on PE with additives.

Name of additive	Im, g/10min
PE	0.55
PE +Mn100	0.61
PE +Mn107	0.60
PE +Mn108	0.60
PE +Mn109	0.60
PE +Mn110	0.62
PE +Mn111	0.61
PE +Fe100	0.70
PE +Fe107	0.72
PE +Fe108	0.73
PE +Fe109	0.70
PE +Fe110	0.78
PE +Fe111	0.71

As a result, the following ratio of components of the mixtures was determined Polyethylene - 68%, Filler (agro-industrial complex waste) - 30%, Bentonite - 2%/

The introduction of bentonite in the polymer compositions allowed to increase the deformation and strength characteristics of polymer compositions twice compared to compositions without bentonite.

Recently, interest in various methods of modification of polymers has increased including additives that accelerate the processes of oxidation of the polymer matrix. Therefore, in the work polyethylene compositions based on additives (manganese complexes or iron): Mn 100, Mn 107, Mn 108, Mn 109, Mn 110, Mn 111, Fe 100, Fe 107, Fe108, Fe 109, Fe 110, Fe 111 were investigated.

The first stage of the study was the study of physical and mechanical properties of polymer compositions, in accordance with GOST 14236.

It implies uniaxial tension of the test specimen set size with a certain rate of deformation, up to its destruction. Tables 3-4 show the results of the physic-mechanical studies of the properties of samples in the uniaxial tension mode. Characteristics in this study are the value of the breaking voltage and the elongation at the break formula:

$$\Delta E_p = \frac{E_{p1} - E_{p2}}{E_{p1}} * 100\% \quad (3)$$

where E_p - relative elongation at the break; l_1 - sample length before the rupture; l_2 - sample length after the rupture.

From the results of the study of PE after the introduction of additives there can be seen that they changed physic-mechanical properties in different ways compared to the control sample. Further, the samples were exposed to UV exposure. Changes in their physic-mechanical properties can be observed in the following table 4.

After analyzing the data obtained after the ultraviolet irradiation of the samples, the difference in voltage of the elongation at break shown in table 5 can be determined and calculated by the formula:

$$E_p = \frac{l_2 - l_1}{l_2} * 100\% \quad (4)$$

Where ΔE_p is the change in relative elongation at break; E_{p1} - an indicator of relative elongation at break before the UV- exposure; E_{p2} - the indicator of relative elongation at break after the UV irradiation.

Based on the results, it can be judged that all samples after the UV irradiation lost previous physic-mechanical characteristics. Based on this, a change in the specimens for breaking voltage and elongation at break can be noted. The most dramatic changes can be noted in the compositions based on additives Mn108, Mn100 and Fe100, Fe107.

Further selected additives were used in the manufacture of polyethylene compositions containing waste AIC. Content of the AIC waste in the compositions was 30%, oxide supplement - 1%. Further studies were conducted to

Table 9: Determination of the rheological properties of polymeric compositions.

Name of filler	Name of additive	Im, g/10min
Rice husk	-	0.11
Rice husk	Mn100	0.22
Rice husk	Fe107	0.20
Beet pulp	-	0.18
Beet pulp	Mn100	0.25
Beet pulp	Fe107	0.34

Table 10: The results of the study by the method of composting of the polymer compositions.

Name of filler	Name of additive	the results of the study by the method of composting of the polymer compositions (1 year)
Rice husk	-	reduction of physical and mechanical properties of the sample by 75%
Rice husk	Mn100	sample destructed
Rice husk	Fe107	sample destructed
Beet pulp	-	reduction of physical and mechanical properties of the sample by 82%
Beet pulp	Mn100	sample destructed
Beet pulp	Fe107	sample destructed

determine the change in the mass of polymer compositions during the contact with water (table 6).

For comparison, samples of polycaprolactone and polyethylene containing starch in the amount of 25% were studied. The results are presented in table 7.

During the first week, samples had high water absorption indicators, but later they began to fall. Based on the results, it can be judged that in 6500 hours the greatest increase in the mass of prototypes can be traced in beet pulp # 1 with the addition of Mn 100 and cocoavella.

In the course of the work, the measure of the flowability

Table 11: The results of the study of the samples of PCL and PE containing starch by the method of composting.

Name of compositions	the results of the study by the method of composting of the polymer compositions (2 months)	the results of the study by the method of composting of the polymer compositions (1 year)
polycaprolactone	sample destructed	-
polyethylene containing starch in the amount of 25%	reduction of physical and mechanical properties of the sample by 43%	reduction of physical and mechanical properties of the sample by 67%

melt index of the obtained samples was conducted (Tables 8.9).

The data obtained indicate that the additives used in respect of HDPE change in PTR compared to the control samples within the confidence interval. The next stage of the work was the study of the materials using the method of composting. During the study the following samples were used: polycaprolactone (PCL), PE with starch, PE with AIC waste.

Based on the data obtained, it can be noted that all the samples under investigation are indeed subject to a biodegradation process.

Thus it is proven that to create biodegradable polymer compositions, it is advisable to apply additives accelerating biodegradation process (Mn108 and Fe100) natural fillers (waste APC and starch). It is advisable to use as biodegradable film PCL.

CONCLUSION

Based on the results of studies of the literary and the experimental data the following conclusions can be made:

1. Today, the production of biodegradable polymeric materials is relevant due to the fact that the volume of polymer production is constantly growing, as well as the need for their disposal.
2. The most popular additives in the production of

biodegradable polymeric materials are oxibiodegradable additives.

3. In the course of the study, it was determined that AIC waste is an extremely effective biodegradable additive. All the samples exposed to the study method of composting demonstrated a high degree of destruction.
4. As a result of the study of the mass of samples of polymeric materials on water absorption, it was found that polymers using fillers based on agricultural waste and additives based on metals manganese and iron show higher rates of water absorption than samples without additives. And samples in which only fillers were used demonstrate more water absorption than ordinary low pressure polyethylene. Thus, it was proved that when creating polymer compositions with adjustable shelf life it is advisable to add not only a natural filler to synthetic polymer, but also additives accelerating destruction process.
5. The most effective fillers are beet pulp N1 and cocoavella, as the samples with these fillers demonstrated the greatest change in mass upon the contact with water.
6. Based on the results of the study on polycaprolactone it can be judged that PCL is one of the best biodegradable polymers on the market. This is due to its high rate of decomposition in the earth, low indicator of water milling, as well as low price.
7. During the study of additives from starch composting method and the method of changing the mass of the samples upon contact with water were used. During the work the additive demonstrated low indicator of the water absorption and high relative change of stretching. Based

on this, it can be judged that this additive really promotes biodegradation.

8. To determine the effect of additives on the properties of the composition physic-mechanical studies were conducted. Based on their results, it can be judged that the use of an additive worsens the physic-mechanical properties of the original polymer. Also, the most effective supplements can be considered Mn110 and Fe100.
9. A complex of studies allows us to conclude that all the applied additives allow us to create biodegradable material.

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Prediction of Improving Outcomes in Upper Urinary Tract Tumor Patients Treated with Enhanced Recovery After Surgery in The Artificial Neural Network System

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ABSTRACT

To explore the clinic value of ERAS (enhanced recovery after surgery) in postoperative recovery (laparoscopic surgery) for curative treatment on UUTC (upper urinary tract tumor), and predict the outcomes with an artificial neural network (ANN) system. After laparoscopic surgery for curative treatment on UUTC, patients were randomly assigned to the two groups ERAS and control group, the perioperative and postoperative short-term outcomes were compared. Clinical characteristics, handling methods, and clinical outcomes data were analyzed using an adapted ANN model. The strength of the ANN prediction was measured between -1 and 1 with -1 representing bad outcome and 1 representing good outcome. In ERAS group, postoperative exhaust and defecation time, as well as the time of beginning taking food or off bed activities for patients were shorter obviously than control. Moreover, the length of hospital stay and post-operative pain in ERAS patients were obviously less than in control group. The ANN applied here was able to accurately predict all patients outcomes.

KEY WORDS: Artificial Neural Network (Ann); Enhanced Recovery After Surgery (Eras); Laparoscopic Surgery; Curative Treatment; Upper Urinary Tract Tumor (Utcc)

INTRODUCTION

Cancer is a disease caused by a change in the protein content of the cell nucleus, the "DNA". The DNA contains the genetic commands required for the development of all organisms, hence the "book of instructions in the body".

Changes in the DNA cause an uncontrollable growth of a normal cell. This abnormal growth results in invasive cancer cells invading the tissues around the body, blood vessels, and lymph nodes, resulting in the spread of disease to other parts of the body. This is the case in the body of "metastasis," or the spread and transfer of cancer cells from one tissue to another.

The genitourinary apparatus includes the kidneys, the bladder, the tubes that collect urine from the kidneys and shed in the bladder (ureter), the tube that leads urine from the bladder to the urethra, and also in the testicular and prostate men. Urogenital and genital cancers are cancers that grow on the penis or in the adrenal gland. Female genital cancers include cancers that grow in the ovary, uterus, cornea, or vagina.

A series of papers had been published by Kehlet et al. in the late 1990s, it was about colorectal surgery involved in fast-track multimodal programme. It could shorten the LOS

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(length of stay) and reduce complications (Aarts et al. 2012; Bardram et al. 1995; Behrman et al. 2015). Consequently, ERAS (Enhanced Recovery after Surgery) was evolved into a commonly multidisciplinary instrument in this notion. It integrates a few of elements about perioperative, and now it is well known that the protocol of ERAS. In recent year, a lot of official guidelines were published from Society of ERAS. Moreover, a few of meta-analyses investigation indicated the benefits of ERAS through comprising other surgical disciplines (Chen et al. 2014; Conlon et al. 2001; Coolson et al. 2013). The philosophy of ERAS involved in multidisciplinary team of physiotherapists, dieticians, nurses, anaesthetists, and surgeons. All they want to facilitate care quality through shifting knowledge based on evidence into practice of clinic (Dumont et al. 2011).

Therefore, the value of ERAS programmes on useful evidence in laparoscopic surgery for UUTC (upper urinary tract tumor) is sparse. Moreover, there are limited benefits of modern multimodal perioperative care and no official guidelines of ERAS come from documenting papers. Nonetheless, it has been suggested that the majority of

general principles used in laparoscopic surgery may be applicable (Dumont 2016; French et al. 2009; Greco et al. 2014). But, there are a number of published reports demonstrated that was widely used of its elements of perioperative in other types of surgery. However, the unified protocol of laparoscopic surgery, especially for the curative treatment of upper urinary tract tumor has been not indicated.

This work wants to evaluate systematically and perform a prospective random control study of the available evidence on pathways of ERAS compared to traditional care in perioperative patients treated with laparoscopic surgery for the curative treatment on UUTC, and predict outcome with ANN.

MATERIAL AND METHODS

Participant Recruitment And Selection Criteria

Inclusion criteria:

(1) These patients were 45-78 years old; (2) had a diagnosis of upper urinary tract tumor, such as kidney cancer, carcinoma of the renal pelvis or the ureter; (3) were

Table 1: Compare clinical characteristics between the two groups.

Clinical characteristics	ERAS group (n=80)	Control group (n=68)	Statistic value	P value
Age (±s)				
64.94±5.45	63.51±6.27	t=1.46	0.445	
Gender (Male/Female)	34/46	31/37	χ ² =0.142	0.706
BMI (kg/m ² , ±s)				
20.4±2.1	19.8±2.7	t=1.49	0.248	
ASA grade [n (%)]				
I	14 (17.5)	19 (27.9)	χ ² =2.313	0.128
II	45 (56.25)	36 (52.9)	χ ² =0.162	0.687
III	21 (26.25)	13 (19.1)	χ ² =1.057	0.304
Operation method [n (%)]			χ ² =0.03	0.862
Kidney cancer [n (%)]	59 (73.75)	51 (75)		
Carcinoma of the renal pelvis or the ureter [n (%)]	21 (26.25)	17 (25)		
Operation time (min)	133.2±35.8	141.8±30.7	t=1.57	0.412
Intraoperative blood loss (ml)	108.6±55.1	127.2±69.8	t=1.78	0.256
Tumor stage [n (%)]				
T1	7	5	χ ² =0.096	0.756
T2	62	49	χ ² =0.58	0.446
T3	11	14	χ ² =1.224	0.269

Note: ASA, American Society of Anesthesiologists.

performed laparoscopic surgery for the curative treatment of tumors; (4) were without serious complications of heart, lung, brain or metabolic disease.

Excluding criteria:

(1) There were damage of other viscera, and receipt of blood transfusion or conversion to laparotomy; (2) had a history of abdominal or chest surgery; (3) with primary

Table 2: Compare handing methods between the two groups in perioperative period.

Handing methods	ERAS group (n=80)	Control group (n=68)
Before operation		
Health education	Received the education intervention	None
Gastrointestinal preparation	Free fasting in normal at the night before surgery, but have 12.5% carbonated drink for 500 ml at 9 pm; oral warm sugar water (warm water for patient with Diabetes) 300 ml at 6 am in the morning of surgery day	Deprivation of fasting and water for 12 h
Mechanical bowel preparation	Oral lactulose to promote natural defecation in the afternoon (3 pm) before surgery	Enema at the night before surgery
In operation		
Anesthetization	Received general anesthetization with short-acting anesthetic, and using infusion and transfusion as little as possible	Routine
Heat preservation	Keep body temperature of patient as soon as possible with insulation measure	No intervention
Drainage tube	Using latex tube as little as possible, remove at 1-3 d after surgery	Using silicone tube, remove at 5-8 d after surgery
After operation		
Analgesic methods	Subcutaneous injection of ropivacaine at the end of surgery, and intravenous injection unselective inhibitor of COX-2, Liposomal Flurbiprofen Axetil (50mg) at 6 h, 18 h, and 30 h after surgery	Intramuscular short-acting paregoric Dolantin or patient controlled intravenous analgesia (PCIA)
Catheter	Retention catheterization in operation, remove at 1-4 d after surgery	Retention catheterization before operation, remove at 5-7 d after surgery
Off bed activities early	Encourage off bed activities at 1 d after surgery	Encourage off bed at 4-6 d after surgery
Diet	With lipid at 1 d after surgery	With lipid post-surgery anal-exsufflation

disease of heart, lung, brain, liver, or kidney, primary diabetes, abnormal glucose tolerance, severe obesity (body mass index-BMI > 30 kg/m²), or severe malnutrition (BMI < 15 kg/m²).

According to the above criteria, a total of 148 patients after laparoscopic surgery for the curative treatment of upper urinary tract tumor were included in this analysis, and assigned to the ERAS group (80 cases) and control group (68 patients treated with traditional protocols) at random from January, 2015 to December, 2017. The perioperative and postoperative short-term outcomes were compared between the two groups. The clinical characteristics, such as gender, age, body mass index (BMI), operation method, operation time, intraoperative blood loss, and tumor stage were compared between the two groups, as shown in Table 1.

This study was approved by the Ethics Committee of People's Hospital of Jilin Province according to the Declaration of Helsinki. The use of patients' documents in this research was approved by the Ethics Committee of People's Hospital of Jilin Province according to the Declaration of Helsinki. And we clearly confirm that we had consents from any patients. We had record and document participant consent in People's Hospital of Jilin Province. And the ethics committees of People's Hospital of Jilin Province hospital had approved this consent procedure.

Observable Indicators

The perioperative and postoperative short-term outcomes were compared between the two groups, including postoperative exhaust and defecation time, as well as the time of beginning taking food or off bed activities for patients, and length of hospital stay (Table 3).

VAS (visual analogue scale) was used to evaluate the pain at the admission, or assess the post-operative pain at 2 h, 12 h, 24 h, and 48 h while patients were fully awake following surgical anesthesia (Table 4).

Follow-Up Of The Data Evaluation

The routine clinic follow-up was performed in this study every 4 weeks during the first 6 months after surgery. Blood or urine routine, liver and kidney function, abdominal CT and cystoscopy were re-examination for all patients. Other test items were determined according to the judgment of clinician. The mainly vital signs and symptoms of patients, including food intake, appetite, the change of BMI, the status of abdominal distention and pain or urine.

Ann Model

The ANN modeling utilized in this study was adapted from Dumont and was built with a commercially available program (Günay et al. 2018; Gustafsson et al. 2013; Karimpour et al. 2016). Twenty-six variables spanning clinical characteristics (10 items, Table 1), handing methods (10 items, Table 2), and clinical outcome data (6 items, Table 3-5) utilized by this ANN served as predictors for improving postoperative outcomes of UUTC with ERAS. The prediction of ERAS was presented by the ANN as a scaled value where outputs greater than 0 predicted in favor of ERAS and values less than 0 predicted the absence of ERAS.

Let $p(x) = P(Y = 1|X = x)$, the logistic regression model is expressed as follows:

$$p(x) = \frac{\exp(\beta_0 + \beta x)}{1 + \exp(\beta_0 + \beta x)} + \frac{1}{1 + \exp(\beta_0 + \beta x)} \quad (1)$$

$$\text{logit} [p(x)] = \log \frac{p(x)}{1 - p(x)} = \beta_0 + \beta x, \quad (2)$$

Equivalently, the log odds, called the logit, show the linear relationship as follows:

Statistical Analysis

Data analysis was carried out using SPSS 18.0 software (Inc. Chicago, SPSS, IL). The demographic data and disease characteristics of patients were compared between the two groups. The qualitative data was showed as frequency and rates. The quantitative data was analyzed using t-test, and the differences between the two groups were analyzed with chi square test or Fisher test. $P < 0.05$ was considered statistically significant.

RESULTS

Clinical Characteristics

The clinical data of age, gender distribution, BMI, operation method or time, ASA grade, the location or stage of tumor, intraoperative blood loss etc. were not statistically different between the two groups ($P > 0.05$) (Table 1).

Handing Methods

The patients and their family in ERAS group received the education intervention (face to face and booklet) before operation, but not in control group. The health education included the operation plan and the details of ERAS program. Additionally, these patients were assisted with the

use of postoperative guidance for early off bed activities. The different handing methods were conducted in the two groups, and shown in Table 2.

Perioperative And Postoperative Short-Term Outcomes
 The perioperative and postoperative short-term outcomes were compared between the two groups. In ERAS group, postoperative exhaust and defecation time, as well as the time of beginning taking food or off bed activities for patients were significantly shorter than control group (Table 3).
 Vas (Visual Analogue Scale) And Degree Of Pain

VAS (visual analogue scale) was used to evaluate the pain at the admission, or assessed the post-operative pain at 2 h after fully awake following surgical anesthesia, and 12 h, 24 h, and 48 h after surgery (Table 4). Our results showed that, in ERAS group, the VAS at each observable time were significantly lower than control group (Table 4). Moreover, patients without or with mild pain in ERAS group were obviously more than that in control group (P=0.001, Table 5). Additionally, patients with moderate or severe pain in ERAS group were obviously less than that in control group

(P=0.001, Table 5).

The Predict Outcome With Ann

Twenty-six input variables were applied in the ANN. All outcomes of patients were correctly predicted by the ANN. The mean strength of prediction for those who did not exhibit SCV was -0.89, (where -1 represented bad outcome and 1 represents good outcome). The prediction strength for the one patient in this cohort who had good outcome was 0.92.

DISCUSSION

The preoperative treatment with ERAS, it is mean that health, painless, individualized education, which can make patients relief, reduce the fear of surgery, especially the fear of pain (Kehlet and Mogensen 1999). ERAS advocated simple intestinal preoperative preparation, such as oral lactulose, promote natural defecation of patients. Moreover, the simple intestinal preparation does not increase the risk for postoperative intestinal infection and prolonging the postoperative defecation time. Additionally, patients were more likely to accept ERAS, because of which could reduce

Table 3: Compare postoperative short-term outcomes between the two groups.

Postoperative short-term outcomes	ERAS group (n=80)	Control group (n=68)	t value	P value
The time of the first post-surgery anal-exsufflation (h, ±s)	28.1±3.45	36.5±5.24	11.67	0.012
The time of post-surgery infusion (h, ±s)	30.3±2.19	48.4±4.12	32.3566	0.004
The time of the first post-surgery off bed activities (h, ±s)	21.6±2.46	54.2±5.38	46.03	0.001
Length of hospital stay (d, ±s)	5.2±1.26	8.6±2.77	9.338	0.031

Table 4: Compare VAS (visual analogue scale) between the two groups.

VAS (visual analogue scale) (score, ±s)	ERAS group (n=80)	Control group (n=68)	t value	P value
2 h after fully awake following surgical anesthesia	3.86±1.45	4.91±1.31	4.587	0.031
12 h after surgery	4.05±1.39	5.64±1.63	6.417	0.036
24 h after surgery	4.15±1.52	6.32±1.78	8.002	0.042
48 h after surgery	4.21±1.64	5.83±1.21	6.7348	0.034
The time of the first post-surgery off bed activities	4.69±1.27	6.57±1.54	8.14	0.037

fear and nervousness come from surgery. But, traditional mechanical bowel prepare before operation cause fluid loss and electrolyte disorder (Kehlet, 1997), and that increase fear and blood pressure fluctuations of patients.

In addition, the rule of traditional perioperative management thought patients should receipt deprivation of fasting and water for 12 h before operation, and just can eat after postoperative while thoroughly recovery of gastrointestinal function. But many studies have shown that preoperative oral carbohydrate and a moderate amount of warm water can prevent hypoglycemia in operation. Moreover, it reduces the risk of insulin resistance, and improve patients to feel comfortable, promote restoration of intestinal peristalsis and exhaust (Khoury et al. 2014). In this research, the patients of ERAS group receipt free fasting in normal at the night before surgery, but have 12.5% carbonated drink for 500 ml at 9 pm and oral warm sugar water (warm water for patient with Diabetes) 300 ml at 6 am in the morning of surgery day. A piece of chewing gum was administered after awake anesthesia, which stimulate production of saliva. Our results indicated that the time of postoperative anal exhaust, feeding, and off bed activities in patients of ERAS group was all earlier than those of conventional group ($P < 0.05$). Moreover, the postoperative complications in ERAS group were lower than control group, which is consistent with the literatures reported (Loghmani and Monfared 2018).

About intraoperative treatment of ERAS, ERAS advocates the minimally invasive surgery, accurate operation, but especially pay attention to the protection of temperature intraoperative, restricted the amount of fluids and the application of a short-acting anesthetic drugs. Some researchers identified that intraoperative low body temperature rise 2-3 times in incidence of wound infections, and lead to a marked increase in the incidence of arrhythmia, etc, and even abnormal coagulant function. However, the intraoperative preservation of body

temperature can reduce the postoperative stress reaction, which is beneficial to reduce the body catabolism and promote recovery of patients (Lu et al. 2014). Intraoperative excess fluids and blood transfusion can cause cardiac insufficiency or peripheral tissue edema, and increase the formation of postoperative thoracic and abdominal cavity effusion (Ni et al. 2015). Excessive application of long-short acting anaesthetic drugs is not conducive to patients with rapid awakening and recovery at an early date after surgery, even cause auditory and visual hallucination in some patients.

The postoperative treatment of ERAS is an important link in course of ERAS (Palani Velu et al. 2015), adequate analgesia can effectively reduce stress of patients, promote early ambulation and recovery of gastrointestinal function, prevent formation of deep vein thrombosis in lower limbs and complications such as atelectasis, pulmonary infection, shorten the length of hospital stay, and reduce hospitalization expenses. In this work, the combined method of analgesia was adopted, ropivacaine was subcutaneous injected around the wound at the end of surgery, and intravenous injection unselective inhibitor of COX-2, Liposomal Flurbiprofen Axetil (50mg) at 6 h, 18 h, and 30 h after surgery. Our results showed that, in ERAS group, the VAS at each observable time were significantly lower than control group (Table 4). Moreover, patients without or with mild pain in ERAS group were obviously more than that in control group ($P = 0.001$, Table 5). Additionally, patients with moderate or severe pain in ERAS group were obviously less than that in control group ($P = 0.001$, Table 5). It is shown that the combined analgesia scheme brought patients satisfactory analgesia effect, and make the patients get better rest, provides favorable conditions for early postoperative ambulation. Early postoperative off bed was also advocated by the traditional idea in nursing, but as a result of inadequate postoperative analgesia, off bed of patients is restricted in the subjective and objective, which lead to bad patient compliance. In this study, on the basis of effective analgesia for patients, medical staff gave effective education about the benefits of early postoperative ambulation, so relieve patients' anxiety and fear of negative emotions. Therefore, positive cooperation was obtained, then the compliance of postoperative off bed activities were improved, then it speeded up the process of recover. The concept of ERAS of perioperative nursing has played a very positive role.

The retention of drainage tube increases the patient's pain, and limit the patient's subjective activity, influence the intestinal peristalsis, also increases the chance of infection

Table 5: Compare the degree of pain between the two groups after surgery.

The degree of pain	ERAS group (n=80, %)	Control group (n=68, %)	χ^2 value	P value
None	22 (27.5)	2 (2.9)	16.31	0.001
Mild	49 (61.2)	6 (8.8)	43.26	0.001
Moderate	9 (11.3)	38 (57.4)	33.78	0.001
Severe	0	22 (30.9)	30.40	0.001

(Ripley et al. 1998; Scott et al. 2015; Sido et al. 2005; Thorell et al. 2016). Hence, ERAS advocate a reduction the number and the time of retention of drainage tube, which will decrease the pain feeling of patients, and be easily to their early actively movement and diet, furthermore, accelerate rehabilitation process, also improve patient satisfaction of operation.

In conclusions, enhanced recovery after laparoscopic surgery used in perioperative management for the curative treatment of upper urinary tract tumor is safe and effective, it can improve postoperative recovery process in ERAS group patients, shorten the length of hospital stay, and then reduce hospitalization expenses. The successfully implemented ideas about ERAS are the common effort of multidisciplinary collaboration, including medical, nursing, anesthesia, etc., each link closely connect to each other, but none is dispensable. Moreover, the scientific understanding of clinicians to ERAS is the most critical, we hope that with the development of the surgery, the multidisciplinary communication increase gradually, more and more doctors could realize the scientific nature of ERAS and its advancement, and then early apply its clinical benefit to more patients.

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Declaration of Conflict of Interest

None.

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Photosynthetic Activity of Early-Ripe Potato Variety

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ABSTRACT

The purpose of the research is to improve the techniques of early ripe potato variety Zhukovsky early cultivation, which ensure the yields at the level of 30 t/ha. Two-factor field experiment was performed on sod-podzolic light loamy soil with low humus content of 2%, a weakly acidic medium (pHKLC -5.4), a high phosphorus content and elevated potassium content. Results showed that small planting tubers are 14% less than the eyes on the tuber as compared to large ones and the same with medium ones, but the ratio of stems to ocelli is smaller for small tubers by 11% as compared to medium ones and 15% as compared to large planting tubers. This means that small planting tubers with the weight 30-50 g have fewer viable eyes and, accordingly, fewer stems.

KEY WORDS: Potatoes, Yield, Density, Leaf Area, Photosynthetic Potential, Net Productivity Of Photosynthesis

INTRODUCTION

Thus, scientists do not have clear recommendations concerning planting tuber weight, planting rate and, moreover, the rate of planting with the tubers of different size should take into account the achievement of optimal stalk density per unit area, since it was established that seed tubers of different mass form different number of stems in the bush and different areas of leaves.

METHODS

Field experiments were conducted in a private sector within the central zone of the Perm Territory during 2001-2003.

The purpose of the research is to improve the techniques of early ripe potato variety Zhukovsky early cultivation, which ensure the yields at the level of 30 t/ha. Two-factor field experiment was performed on sod-podzolic light loamy soil with low humus content of 2%, a weakly acidic medium (pHKLC -5.4), a high phosphorus content and elevated potassium content. The scheme of the experiment is presented in Table 1. The repetition of the experiment is fourfold, the experiment was laid down by the method of split plots, the location of the options in the experiment is systematic, the estimated plot area is 18 m² (Shashkarov and Grigoriev 2017). The test agrotechnology is generally accepted for the Perm region. Sideral steam was the precursor. Fertilizers were applied in NPK dose: 122: 133: 180 kg of active ingredient per 1 ha. The planting was carried out manually according to the experiment design, into crests of 0.7 m wide, and potato reproduction was elite. Harvesting was done by potato digging when leaves started to become yellow. The weather conditions of vegetation periods differed by their heterogeneity during the years of research. The vegetation period of 2001 was characterized as warm and dry, which adversely affected the yield of potatoes. The weather conditions of 2002 were more favorable for the growth and the development of early ripe potato varieties. The weather was warm and moderate with plenty of rain. In 2003, the beginning of the growing season was favorable for the growth and the development

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of potatoes, but during the period of intensive tuber formation the weather was hot and dry, which adversely affected the yield of potatoes.

RESULTS

The purpose of the research is the yield of 30 t/ha for early ripe potato variety Zhukovsky Early was achieved in the variants with the planting tuber weight of 30-50 g and the thickening of 71.4 thousand tubers, 50-80 g - with the thickening of 40.8 thousand tubers, 80-100 g - with the thickening of 35.7 thousand tubers (Table 1). The thickening limit for different weights of planting tubers differed from each other. Thus, small tubers did not increase the yield over the planting rate of 47.6 thousand tubers (the yield in this variant was 28.6 t/ha, HCP05 = 3.9 t/ha), medium and large planting tubers more than the planting rate of 35.7 thousand tubers/ha, the yield of 28.5 and 31.8 t/ha, respectively.

The main effects by the mass of planting tubers revealed a significant increase of yield by 4.0 t/ha (HCP05 = 3.8 t/ha) for large tubers as compared to small ones. The main effects on the rate of planting revealed the tendency of potato yield increase from 28.4 to 32.2 t/ha from the sparsest 35.7 to the densest planting rate of 71.4 thousand tubers/ha.

The working hypothesis of our research was the assumption that with the same stem of an early ripe potato variety, seed tubers of any mass will provide the same yield

with the right placement. On the average, during 3 years of research, in order to achieve optimal yields, small tubers formed 149 thousand stalks/ha and 47.6 thousand tubers thickened, and the maximum yield of 32.5 t/ha (Table 1) was formed at 206.2 thousand stalks/hectare (tab. 2). Average seed tubers with an optimal thickening of 35.7 thousand formed 131.3 thousand stalks/ha, and with the yield of 30 t/ha - from 157 to 293 thousand stalks. Large tubers formed 164.7 thousand stems to achieve an optimal yield of 31.8 t/ha. The increase of the number of stems to 325 thousand/ha did not increase the yield of early ripe potato varieties. It was noted that small tubers have 14% fewer eyes on a tuber, 5.6 pcs, as compared to large ones - 6.5 pcs., but almost the same as the average tubers - 5.9 pcs. However, the ratio of stems to ocelli in small tubers is 11% less in comparison with medium ones and 15% less in comparison with large ones. This means that small tubers with the weight of 30-50 g have less viable ocelli and fewer stems subsequently.

It has been established that the increase of modern potato variety yields is associated with the photosynthetic potential increase and the outflow of photosynthesis products into tubers. In this case, the best results are achieved during the plantings with optimal leaf areas (Tiznobaik et al. 2018; Vasiliev 2009).

The leaf area during the period of maximum development in the optimum yield variants (Table 3) makes 30.9 thous. m²/ha for small tubers, 24.1 thous. m²/ha for average ones, and 25.3 thous. m²/ha for large ones. The maximum

Table 1: The yield of potato varieties Zhukovsky early, depending on the rate of planting and the mass of planting tubers, t/ha. Average for 2001-2003. Planting rate,

thousand tubers/ha (B)	Planting tuber weight, g (A)			Average by factor B
	A1	A2	A3	
	30-50	50-80	80-100	
B1 (35,7)	24.8	28.5	31.8	28.4
B2 (40,8)	24.4	30.3	31.9	28.9
B3 (47,6)	28.6	31.3	31.0	30.3
B4 (57,1)	28.4	30.9	31.5	30.3
B5 (71,4)	32.5	31.8	32.2	32.2
Average by factor A	27.7	30.6	31.7	-
NCP05 of private differences				
	According to factor A		8.7	
	According to factor B		3.9	
NCP05 of main effects				
	According to factor A		3.8	
	According to factor B		2.3	

Table 2: Stalk stands density development of potato variety Zhukovsky early. Average for 2001-2003.

Variant	Planted tubers, Thous./ha	Average number of eyes on a tuber, pcs. thous./ha	Number of bushes for harvesting,	Number of stems		Stalk/eye ratio, %	
				Pcs per 1 bush	thous./ha		
A1	B1	35.7	5,6	35.3	3.2	111.7	57
	B2	40.8		40.5	3.1	124.2	55
	B3	47.6		45.8	3.2	149.0	57
	B4	57.1		54	3.3	176.8	59
	B5	71.4		66.1	3.2	206.2	57
Average by A1			-	3.2	153.6	57	
A2	B1	35.7	5,9	34.6	3.8	131.3	64
	B2	40.8		40.6	3.9	157.3	66
	B3	47.6		46.4	3.9	182.5	66
	B4	57.1		56.3	3.9	222.0	66
	B5	71.4		68.0	4.3	292.6	73
Average by A2			-	4.0	197.1	68	
A3	B1	35.7	6,5	35.6	4.6	164.7	71
	B2	40.8		40.7	4.9	201.5	75
	B3	47.6		47.3	4.5	212.3	69
	B4	57,1		57.0	4.9	282.7	75
	B5	71.4		69.1	4.7	324.7	72
Average by A3			-	4.7	237.2	72	

yield of 32.5 t/ha for small tubers was achieved with the maximum leaf area of 37.6 thousand m²/ha. Medium and large tubers of 30 t/ha were formed at the leaf area of about 25-26 thousand m²/ha. The leaf area growth to 35-38 thousand m²/ha did not increase the yield of potato tubers of Zhukovsky early variety.

A similar situation with the photosynthetic potential (PSP), the yield of 30 t/ha and more was formed at the PSP of small tubers making 1623 thousand m² × day/ha, average - 1275, large - 1253 thousand m² × day/ha.

On the average, according to the variants, the productivity of photosynthesis (PPF) is almost the same for different planting tubers with the weight of 21-22 kg/1000 m² × day/ha. There is the tendency that the photosynthesis productivity in all planting tubers decreases with thickening.

CONCLUSION

The purpose of the research is the yield of 30 t/ha of early ripe potato variety Zhukovsky early in different weather

conditions during the growing season, was achieved in the variants with the planting mass of 30-50 g and the sowing rate of 71.4 thousand, 50-80 g at 40.8 thousand, 80-100 g at 35.7 thousand tubers/ha. The limits of small tuber thickening is 47.6 thousand, medium and large ones - 35.7 thousand tubers/ha. To achieve the goal, small tubers need to form 200 thousand stalks/ha, medium and large planting tubers - about 160 thousand stalks. At the same time, the leaf area of small tubers makes 38 thousand m²/ha (PSP is 1623 thousand m² × days/ha), and medium and large ones are about 26 thousand m²/ha (PSP makes 1275-1253 thousand m² × days/ha, respectively). The net productivity of photosynthesis is almost the same in terms of options and does not depend on the mass of planting tubers 21-22 kg / 1000 m² × day / ha. It is noted that small planting tubers are 14% less than the eyes on the tuber as compared to large ones and the same with medium ones, but the ratio of stems to ocelli is smaller for small tubers by 11% as compared to medium ones and 15% as compared to large planting tubers. This means that small planting tubers with the weight 30-50 g have fewer viable eyes and, accordingly, fewer stems.

Table 3: Photosynthetic activity of potato variety "Zhukovsky early". Average for 2001-2003.

Variant	Planted tubers, Thous./ha	Leaf area For one plant, cm ²	PSP,		PPF,	
			Thous. m ² /ha	Thous. m ² × day /ha	kg/1000 m ² × day/ha	
A1	B1	35.7	4329	23.0	1019	25
	B2	40.8	5209	29.1	1176	22
	B3	47.6	4950	30.9	1313	23
	B4	57.1	4570	33.1	1440	19
	B5	71.4	4163	37.6	1623	20
	Average by A1	4644	30.7	1314	22	
A2	B1	35.7	4743	24.1	1119	25
	B2	40.8	4485	26.1	1275	24
	B3	47.6	4609	30.0	1419	23
	B4	57.1	3989	31.6	1551	21
	B5	71.4	3729	35.0	1730	19
	Average by A2	4311	29.4	1419	22	
A3	B1	35.7	5098	25.3	1253	27
	B2	40.8	5323	29.7	1459	22
	B3	47.6	5007	32.5	1564	20
	B4	57.1	4306	34.7	1695	19
	B5	71.4	3818	37.9	1832	17
	Average by A3	4710	32.0	1561	21	

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Myographic Analysis of Muscle Prevention Reactions to Physical Exercises in Stroke Patients

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ABSTRACT

The article presents the results of a study of 85 patients in the early recovery period of ischemic stroke in the carotid pool with the leading hemiparesis syndrome. 51 men and 34 women aged 42 to 65 years, average age 57.3 years. The control group of 20 conditionally healthy people, matched by sex and age. The aim of the study was to study the characteristics of the adequacy of the activation and coordination relations of muscles in patients in the early recovery period of ischemic stroke in the carotid pool, depending on the severity. The amplitudes of the maximum arbitrary muscle activity of the antagonists of the shoulder, forearm, and hand were determined with the counting of the spacecraft and cardiac radiation on both sides using the surface EMG method. All patients were divided into 2 groups according to the value of the Barthel index. The first group of 29 patients with mild dependence in everyday life was interpreted as mild severity. The second group of 56 patients with moderate severity. The severity of hemiparesis in all patients was assessed from mild to moderate (with a muscular strength of 3 - 4.5 points). In patients of the first group on the side of paresis, we observed an increase in the reciprocity coefficient to 104% in the patients' extensors of the forearm and the adequacy ratio to 85% in the flexors of the forearm. Patients of the second group showed an increase in CR in the flexors of the shoulder and extensors of the sensor forearm to 89%, as well as SV in the extensors of the shoulder to 76% on the side of the paresis. In non-parietal extremities in patients of the first group, the coefficients of reciprocity (up to 68%) and adequacy (up to 53%) were the highest. In patients of the second group, the CR and CA in nonparetic limbs ischemic were higher than in the first group (up to 72%). The method of surface EMG with measurement of spacecraft and radiation therapy objectifies both the therapy severity of paresis and tonus disorders in moderate paretic and non-parietal limbs. It can also be used to predict the degree of recovery of a motor defect and assess the effectiveness of rehabilitation in patients with mild and moderate severity and the predominant syndrome of central hemiparesis.

KEY WORDS: ischemic stroke, hemiparesis, electromyography, Barthel limbs scale.

INTRODUCTION

Despite the active efforts of the world medical community, cerebrovascular diseases remain third in the mortality structure, while being the leading cause of disability among adults (Akimov, 1997; Vein, 1999; Gekht, 1990). In Russia, mortality among stroke patients is much higher than in other developed countries, especially in the acute period of ischemic stroke (II). Only 14% of patients who survived after a stroke manage to restore their impaired motor function. The rest, the majority of patients, remain with motor disorders of varying severity (Kipervas & Lukianov, 1991; Shtulman & Levin, 2005; Hatybovich et al., 2017). Despite significant achievements in disclosing the etiology and pathogenesis of acute cerebrovascular accidents (ACVA), the outcome of this disease remains unfavorable so far, which indicates the need for further improvement

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of medical care for stroke patients, especially at an early stage of the disease (Averochkin et al., 1995; Akimov, 1997; Shtulman & Levin, 2005). The most common symptom of ischemic stroke is various hemiparesis, however, this group of patients has a complex motor defect, different in nature and severity. Data on the effect of the affected side is contradictory. Some authors note that patients with right-sided damage have a worse prognosis in terms of recovery [8, 10, 17, 19] (Gekht, 1990; Kipervas & Lukianov, 1991; Perry, J., Garrett & Gronley, 1995; Kimura, 2013). Other researchers suggest that worse recovery is observed in damages of the left hemisphere (Akimov, 1997; Perry, J., Garrett & Gronley, 1995). One of the methods of objectifying motor disorders is surface myography with a change in the amplitudes of the maximum bilateral arbitrary activation of the muscles of the forearm, hand, and shoulders and the calculation of the coefficients of adequacy (CA) and

reciprocity (CR) (Baikushev et al., 1974; Vein, 1999; Gekht et al., 1997; Skvortsov & Kasatkina, 2007; Iudelson & Gribova, 2006).

The ratio of the amplitude of the muscle during its involuntary activation (with the active maximum tension of the antagonist) to the amplitude of the same muscle in the mode of maximum arbitrary tension is called CA. CR characterizes the interaction of muscle antagonists and is calculated for a muscle in antagonistic tension. It shows the degree of its activation as a percentage in relation to the activity of the agonist muscle. Under normal conditions, the extensor muscles have a higher coefficient of adequacy and reciprocity than in the flexor and are up to 20%.

Objective

The study of the adequacy of activation and the coordination

Table 1: Distribution of patients with ischemic stroke, depending on the severity.

Group of patients, n=85	Sex		Female		Barthel index M±m	Side of ischemic damage			
	Male		Female			Left		Right	
	Abs.	%	Abs.	%		Abs.	%	Abs.	%
Mild severity n=29	15	51.7	14	48.3	89.3±9.1	17	58.6	12	41.4
Moderate severity n=56	32	57.1	24	42.9	78.4±6.9	31	55.4	25	44.6

Table 2: The value of the coefficients of adequacy and reciprocity in paretic limbs in patients of both groups compared with the control group.

Parameter	Study areas					
	Forearm, %		Hand, %		Lower leg, %	
	Patients	Control	Patients	Control	Patients	Control
Group 1 Extensor CA	71.5±7.2	39.1±4.4	69.4±9.3	35.1±5.2	59.5±6.4	30.4±3.7
Group 2 Extensor CA	65.4±7.3	76.4±8.5		35.1±5.2	57.5±8.2	
Group 1 Extensor CR	104.2±10.9	43.8±2.5	75.3±9.2	38.3±4.8	71.4±8.1	35.1±4.1
Group 2 Extensor CR	89.2±9.3		81.4±10.2		66.2±7.1	
Group 1 Flexor CA	85.3±9.5	35.4±3.8	61.3±8.2	31.7±3.4	51.1±5.3	25.2±3.2
Group 2 Flexor CA	78.3±7.8	35.4±3.8	67.5±7.2		47.1±3	
Group 1 Flexor CR	93.7±9.5	41.2±4.1	78.4±8.1	36.2±4.7	61.1±2.1	29.5±3.2
Group 2 Flexor CR	86.1±7		89.6±10.5		54.3±6.7	

muscle movements in patients in the early recovery period of ischemic stroke in the carotid system, depending on the severity. Determination of the amplitude of the maximum voluntary muscle activity of the antagonists of the shoulder, forearm, and hand with the calculation of CA and CR on both sides.

MATERIAL AND METHODS

The studies were conducted in the Neurology Unit, City Clinical Hospital No. 7 of Kazan. We examined 85 patients with ischemic stroke in the early recovery period with the neurological syndrome in the form of spastic hemiparesis. They were 51 men and 34 women aged 42 to 65 years, the average age was 57 years. The severity of hemiparesis in all patients was evaluated from mild to moderate (with muscle strength - 3-4.5 points). The control group consisted of 20 conditionally healthy people comparable in age and sex.

To conduct surface EMG, we used an electromyograph developed on the basis of the Myoware Muscle Sensor (AT-04-001). The activity of the maximum arbitrary contraction was recorded using a two-channel lead from the agonists and antagonists of the forearm, shoulder, and lower leg alternately on both sides. The duration of the registration of the curves was 5 seconds, during which the subjects developed the maximum voluntary activation of the flexors and extensors alternately for each studied zone.

The average value of the amplitudes of the maximum arbitrary activation of agonists and antagonists of the forearm, hand, and lower leg was substituted into the formulas for calculating CA and CR. In our work, the values of CA and CR in the control group were calculated as the average of the values on both sides for each of the studied zones. The range of values of CA and CR in the control group ranged from 22% to 47%. The values of CA and CR depended not only on the study area but also, probably, on the technique of superimposing surface electrodes, which cannot exclude the phenomenon of volumetric propagation of excitation and coactivation of adjacent muscle groups with maximum arbitrary effort.

To assess the significance of differences, standard values of Student t-test were used.

RESULTS AND DISCUSSION

Patients were conditionally divided into 2 groups according to the value of the Barthel index. The first group of 29 patients with mild dependence in everyday life was interpreted as mild severity. The second group of 56 people

patients with a moderate dependence in everyday life was interpreted as moderate severity.

There was no significant statistical dependence of the severity of hemiparesis on the localization side of the ischemic damage in the examined patients. The values of CA and CR in the examination of paretic limbs in patients of both groups are presented in Table 2.

Considering the data presented in Table 2, it should be noted that patients of the 1st group had on the paresis side an increase in the reciprocity coefficient up to 104% in the extensors of the forearm and the adequacy coefficient up to 85% in the flexors of the forearm. The saturated and hypersynchronous types of EMG prevailed. Patients of the 1st group had on the paresis side the amplitude of the maximum voluntary activation of the anterior fibular, gastrocnemius, and extensor and flexor muscles of the hand at the lower boundary of the control values equal to 329 μV (norm - 300-600), while it was reduced to 380 μV for the finger extensor and to 410 μV for the superficial flexor of the fingers (norm - 600-1500 μV). Patients of group 2 showed an increase in CR in the flexors of the fingers of the hand and extensors of the forearm up to 89%, as well as CA in the extensors of the fingers of the hand up to 76% on the side of the paresis. In both groups, the greatest increase was noted in CR. Patients of group 2 had on the paresis side the amplitude of maximum voluntary activation reduced to $240 \pm 31.3 \mu\text{V}$ for the anterior fibular, to $110 \pm 30.8 \mu\text{V}$ for the calf muscles, $139.5 \pm 20.3 \mu\text{V}$ for extensors, and $257 \pm 57.2 \mu\text{V}$ for flexors of the hand; $178 \pm 53.2 \mu\text{V}$ for finger extensor, $167.5 \pm 45.6 \mu\text{V}$ for superficial finger flexor; saturated and hypersynchronous types of EMG also prevailed. The data obtained during the examination of non-parasitic limbs in patients of both groups are also presented in Table 3.

Thus, the values of CR and CA in paretic limbs in patients of the first group are higher than in patients of the second group due to the greater preservation of voluntary activation of muscles on the paretic side. In non-paretic limbs in patients of the first group, the coefficients of reciprocity (up to 68%) and adequacy (up to 53%) were the highest. Patients of the second group also showed an increased CR in non-paretic extremities with an emphasis on extensors of the forearm and fingers (61% and 72%, respectively). Changes in the values of CA and CR in non-paretic limbs, in the form of their increase in all examined muscle groups, prevailed in patients of the second group. Such a distribution of coefficient values can probably be associated with a violation of the state of the contralateral efferent

Table 3: The value of CA and CR in non-paretic limbs in patients of the first and second groups.

Parameter	Study areas					
	Forearm, %		Forearm, %		Forearm, %	
	Patients	Patients	Patients	Patients	Patients	Patients
Group 1	53.5±7.4		48.1±5.6	35.1±5.2	39.1±4.3	
Extensor CA					30.4±3.7	
Group 2	62.5±5.6	39.1±4.4	55.4±6.3		46.2±5.7	
Extensor CA						
Group 1 Extensor CR	68.2±6.9	43.8±2.5	53.4±6.1	38.3±4.8	44.2±4.	35.1±4.1
Group 2 Extensor CR	72.4±8.1		61.5±6.8		50.7±6.1	
Group 1 Flexor CA	51.4±6.5	35.4±3.8	48.4±5.3	31.7±3.4	32.6±3.7	25.2±3.2
Group 2 Flexor CA	60.3±5.8		54.1±5.1		39.1±4	
Group 1 Flexor CR	56.7±6.3	41.2±4.1	66.2±7.2	36.2±4.7	37.4±4.8	29.5±3.2
Group 2 Flexor CR	68.1±7.7		59.8±6.1		46.1±4.8	

pathways, which is aggravated with an increase in the severity of the general condition.

SUMMARY

Surface EMG with the measurement of CA and CR objectifies both the severity of paresis and tone disorders in paretic and non-paretic limbs and can be used to predict the degree of recovery of a motor defect and evaluate the effectiveness of rehabilitation measures in patients with mild to moderate severity of the prevailing central hemiparesis syndrome.

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The Right of Persons With Disabilities to Health in International and Domestic Law

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ABSTRACT

In modern science, disability is considered as any restriction or lack of ability to carry out one or another activity. This definition is associated with worsening health conditions, physical and functional disorders of a body with various characteristics, causes and degree, as well as with the fact that disability is a social phenomenon caused by the interaction of a disabled person with the state and society. Therefore, when the rights of persons with disabilities are implemented, consideration must be given to all special needs of persons with disabilities. According to Russian law, a disabled person is "a person who has a health disorder with persistent dysfunction of a body caused by diseases, the consequences of injuries or defects, leading to the limitation of life and the need for social protection." In the modern world, the rights of people with disabilities should be on a par with the problems of the whole society, since the accessibility of all human rights for people with disabilities also means the accessibility of the same rights to healthy people. Persons with disabilities, as a vulnerable group of the population, have certain privileges, which are enshrined in a number of international and domestic acts, as well as the rights of persons with disabilities. Only the observance of these rights in practice does not comply with the established norms. The purpose of this article is to analyze the legal regulation and the observance of disabled person right to health. For any category of people with disabilities, the entire future life of a disabled person depends on the implementation of the right to health in many aspects. Today, it is difficult for people with disabilities to defend their right to health, protection and medical care.

KEY WORDS: Disabled person, disability, right to health, World Health Organization, International Covenant on Economic, Social and Cultural Rights, medical services, human rights.

INTRODUCTION

According to the World Health Organization (WHO) data, there are more than 1 million people with disabilities in the

world, and this figure increases by about 3% every year (World report on disability 2011).

In modern world, people with disabilities are more vulnerable to the quality of health services, as well as their quantity, since the health needs of people with disabilities can change. Depending on the social environment and environment, disabled persons may also be vulnerable to age-related disabilities, related conditions, secondary health problems, health-hazardous behaviors, and higher rates of premature death (World report on disability 2011).

In accordance with these factors, it should be noted that disabled people are much more likely to seek medical help than people without disabilities and have more unmet health needs. For example, a recent survey of people with serious mental disorders showed that 35% - 50% of people in developed countries and 76% - 85% of people

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in developing countries did not receive any treatment during the year preceding the survey (Disability and health, 2018).

METHODS

The methods of comparison and description were used in the work. They also used scientific methods, such as comparative legal method and the method of interpretation of legal norms.

RESULTS

The right to health has a legal status similar to the right to life, as it is one of the basic human rights. The right to health is enshrined in various international and domestic acts.

The Constitution of the World Health Organization (WHO) 1946 defines health as "a state of complete physical, mental and social well-being, and not just the absence of diseases and physical defects" (Lykhina, 2010; Official Records of the World Health Organization, 1964). The principle of non-discrimination in the field of the right to health is also enshrined in the WHO Constitution: "The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being" (Official Records of the World Health Organization, 1964). A similar formulation of this provision is also found in one of the articles of the American Declaration of the Rights and Duties of Man (1948). This article suggests that everyone has the right to maintain his health through the adoption of the necessary sanitary and social measures in relation to food, housing, clothing and medical care, based on the capabilities of public and community resources (Abashidze et al., 2012).

The article 25 of the Universal Declaration of Human Rights (1948) refers to the right to health as an essential aspect of the right to an adequate standard of living.

Further, the International Covenant on Economic, Social and Cultural Rights (1966) established "the right of everyone to the highest attainable standard of physical and mental health" as one of the fundamental human rights recognized in international law. In the future, subsequent international documents will also confirm the right to health as fundamental. It should also be noted that the International Covenant on Economic, Social and Cultural Rights (1966) for the first time speaks not only about physical health, but also mental health (World Health Organization, Office of the United Nations High Commissioner for Human Rights, 2008).

The right to health is recognized in some regional documents, such as the African Charter on Human and Peoples' Rights (1981), the Additional Protocol to the American Convention on Human Rights in the Field of Economic, Social and Cultural Rights, known as the San Salvador Protocol (1988) and the European Social Charter (1961, revised in 1996), the American Convention on Human Rights (1969) and the European Convention for the Protection of Human Rights and Fundamental Freedoms (1950). These documents contain provisions that directly concern health, such as the right to life, the prohibition of torture and other cruel, inhuman and degrading treatment, as well as the right to private and family life (Lykhina, 2010; International law, 2018).

Since disabled people are a vulnerable group of the population, it should be noted here that certain provisions of international acts are reserved for disabled people right to health (Lykhina, 2010). For example, the article 25 of the UN Convention on the Rights of Persons with Disabilities (CRPD) confirms "the right of persons with disabilities to the highest attainable standard of health without discrimination" (The Convention on the Rights of Persons with Disabilities, 2006).

As was previously noted, the International Covenant on Economic, Social and Cultural Rights enshrined the "right to health for all" and emphasized that persons with disabilities should be provided with the same level of medical care as other members of society (Article 12) (International Covenant on Economic, Social and Cultural Rights, 1966). They have the right to access and benefit from medical and social services, in particular, from orthopedic equipment, which can enable them to become independent and prevent further development of disability, as well as contribute to their social integration.

According to the paragraph 6 of the Declaration of the Rights of Persons with Disabilities (1975), "the persons with disabilities have the right to mental or functional treatment, medical care, including prosthetic and orthopedic devices, to restore health and social status, to education, vocational training and rehabilitation, to assistance, consultations, employment services and other types of services "that will allow them to show their capabilities and abilities as much as possible and accelerate the process of their social integration or reintegration (Universal Declaration of Human Rights, 1948).

The Convention on the Elimination of All Forms of Discrimination against Women, adopted in 1979, also has

separate provisions regarding the medical care of women with disabilities.

The right to health is enshrined in various domestic acts. Let's consider this with the example of the Russian Federation. So, in the Russian Federation, the Article 41 of the Constitution of the Russian Federation states that "Everyone has the right to protection of health and medical care. Medical assistance in state and municipal healthcare institutions of the Russian Federation is provided to citizens free of charge, at the expense of insurance premiums, the corresponding budget or other income." It should be noted here that "everyone" means not only a healthy person, but also a person with disabilities, a disabled person.

By consolidating the right to protection of health and medical care, the Constitution of the Russian Federation is based on the provisions of universally recognized international documents. Since international acts proclaiming the right to health protection do not establish clear boundaries of the individual's right and the obligations of states to exercise this right, it can be concluded that there is no single international standard for the content of the right to health care (Kolotsey, 2011).

There are also several fundamental federal laws of the Russian Federation that enshrine the mechanism for the implementation of disabled person rights, including the right to health: Federal Law No. 323-ФЗ "On the Basics of Protection the Health of Citizens in the Russian Federation" (November 21, 2011) and the Federal Law No. 181-ФЗ On Social Protection of Persons with Disabilities in the Russian Federation (November 24, 1995), the Federal Law No. 710-ФЗ On Veterans (July 17, 1995), and the Federal Law N 61-ФЗ On Circulation of Medicines funds" (April 12, 2010) and the Decree of the Russian Federation Government N 95 "About the order and conditions of a disabled person recognition" (February 20, 2006) (Federal Law, 2011).

The laws of the subject are in force in the Republic of Tatarstan: the Law of the Republic of Tatarstan N 1659 (18.06.1998, as amended on 03.11.2011) "On the protection of public health", the Law of the Republic of Tatarstan N 87-3PT "On the regulation of certain issues in the field of public health in the Republic of Tatarstan" (dated on 22.12.2012) (Law of the Republic of Tatarstan, 2012).

According to the law "On the basics of protecting the health of citizens in the Russian Federation," the right of persons with disabilities includes the following. The state guarantees people with disabilities not only compliance with the

basic principles of health care, but also all the necessary conditions to receive decent medical care. Also, this federal law also regulates the compulsory nature of health insurance for all citizens of the Russian Federation.

General medical care for the persons with disabilities is provided with exemption from payment for medical services corresponding to the list of medical services, equipped, if necessary, with special medical equipment, and in specialized educational institutions and is regulated by the legislation of the Russian Federation and the legislation of the constituent entities of the Russian Federation.

The state shall ensure proper accessibility and quality of medical care, including transport accessibility of medical organizations for all population groups, including the persons with disabilities and other population groups with limited mobility (Yakovleva, 2015). But, despite this, nowadays buildings (including public places, hospitals, medical centers) and transport systems, as well as information in many countries of the world is not accessible to everyone, not just for disabled people. It should also be noted that the accessibility of a building (a structure) does not meet all the criteria of accessibility principle, namely, not only the building (the structure) should be accessible, as well as the adjacent territory and access to it. With regard to accessibility of transport, the lack of access to transport and accessibility of the vehicle itself is a common cause of untimely provision of medical care for disabled persons (World report on disability 2011).

On the basis of the Federal Laws "On the Social Protection of Persons with Disabilities in the Russian Federation", "On the Circulation of Medicines", as well as the list of medicines subject to free leave from pharmacies approved by the Government of the Russian Federation, medications are provided to disabled people by prescription. Disabled people with diabetes should be provided with a glucometer and test strips to measure blood glucose, as well as insulin needles (Federal Law, 2015).

A modern approach to the right to health requires studying not only the extent to which universal access to basic medical services and medical facilities is ensured, as well as the quality of these services, but also whether treatment is applied on the basis of free and informed consent of a disabled person (World Health Organization).

Children with disabilities have the opportunity to use specialized foods in accordance with the list, which is approved by the commission every year. The commission

includes the representatives of the Ministries of Health, Labor and Social Protection, Finance, and other departments. But it should be noted here that the implementation of these standards is not normal and if the necessary medicine is not available, the administration of a pharmacy institution must make a request for it and these medicines must arrive in 10 days, and in case of emergency within 48 hours then the actual dates of arrival of the necessary medicines most often exceed the due dates (Federal Law, 2015).

As for the procedure of disability record obtaining, there is a Medical and Social Expertise in Russia, which, on the basis of the opinion of doctors and specialists, appoints I, II or III disability group (The Decree of the Russian Federation Government No. 95, 2006). At this stage, the procedure has many pitfalls: from how and what kind of diagnosis a person will be given to the opportunity to remain without disability at all. In practice, there are the cases when people who have lost a limb are forced to undergo an examination to confirm their diagnosis and disability every year. In the Republic of Tatarstan, they made a single Main Center for Medical and Social Expertise, which is located in the city of Kazan. And disabled people living not in Kazan, but in the districts, are forced to come for re-examination once a year, if they are given disability record for only 1 year. In fact, this actually extremely complicated the overall procedure for disability obtaining or re-examination (Yakovleva, 2015).

CONCLUSION

The analysis of international and domestic acts in the field of protection the right of persons with disabilities to health has shown that, although the right to health is an inalienable human right, its implementation is insufficient especially concerning the persons with disabilities.

SUMMARY

In our opinion, in order to eliminate the gaps in our legislation and gradually, finally, to implement the rights of people with disabilities fully, to integrate them into society fully, we need first of all:

1. To inform the disabled about their rights and methods of their implementation, including their right to health (access to information, access to international acts and domestic acts, free legal advice in medical institutions and insurance companies, etc.)
2. To analyze the problems encountered during medical care, when the general principles of accessibility are implemented;
3. To improve the legislation of the Russian Federation in the

field of healthcare, in particular concerning the persons with disabilities. To distinguish disability groups into categories, indicating specific diseases and disorders, which will further facilitate the employment process;

4. To amend the state program "Accessible Environment", in terms of accessibility of medical facilities in remote settlements, both in the Russian Federation and in its constituent entities;
5. It is necessary to use the positive experience of other states in order to improve the implementation of disabled person right to health.

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Influence of the Health Care Reform on the Formation of a Socio-Professional Group of Medical Workers (Based on the Materials of Specific Sociological Studies in the Volga Federal District)

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ABSTRACT

The article considers the position of medical workers in the social structure of Russian society, the quality of life, regional specifics. Based on the results of the author's specific sociological researches, the types of labor behavior and peculiarities of motivation of labor of separate socially-qualifying groups are systematized; priority directions of improvement of human capital of medical workers of the region are defined.

KEY WORDS: socio-professional group, stratification, medical workers, health care reform, social state of health, labor behavior, labor motivation, human capital.

INTRODUCTION

The urgency of the research is determined by the need for theoretical and empirical understanding of the socio-economic processes taking place in a society with a high economic, scientific and technical potential, especially in the field of health care. Under the conditions of the contradictory formation of a market economy, this sector of the national economy can both contribute to and interfere with its development via positive or negative effects on the state of health of the nation.

In our country, by the beginning of radical socio-economic changes, serious scientific, technical, qualification and educational potential has been accumulated. But the lack of further progressive advance of human capital, the stagnation of its types and reserves of improvement may encumber the progress of the Russian economy, slow down the social and cultural development of society.

The reforms of recent years in the Russian health care system have counted against the social status of medical workers. Against the backdrop of global trends of an increasing role in the production of a highly skilled worker in the health care sector, the opposite situation has developed when the loss of already accumulated high-quality human capital is taking place. The crisis in the health care system has led to a critical shortage of professional personnel connected with their massive outflow to higher-paying sectors.

During the socio-economic and political transformation of Russian society, the human capital of health care has undergone significant qualitative changes, which includes the regional level. The problem of rational use and reproduction of previously created human capital of high-tech medical institutions has remained relevant for a long time. We must not allow the loss of human capital, since its constituent employees, possessing advanced technologies, high discipline and innovative sensitivity, should play a strategic role in ensuring the new quality and pace of socio-economic development

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of Russia, in the progressive consolidation of its economy, social stability and security. The relevance of this study is determined by the need to identify the ways of forming and developing the human capital of the health care system in the context of a reforming Russia.

The degree of scientific elaboration of the problem is connected with the formation of a social demand for the quality of human capital, which is a decisive factor in domestic modernization. The first sociological ideas about professional groups formulated in the classical works by M. Weber, E. Durkheim, T. Parsons are conceptually productive for this paper (Weber, 1990; Durkheim, 1996; Parsons, 2002). Moreover, according to T. Parsons doctors act as the representatives of the ideal type of profession, in which he analyzes the values and motivation of work. Of particular interest in the study are the works related to social status, the position of medical workers in the social structure of Russian society (Reshetnikov, 2003; Rosenbaum, 1993; Silkina, 2002; Frolova, 2005), and also works analyzing the problem of health care reform at the theoretical and empirical level (Bocharov & Vaskina, 2008; Khayrullina et al., 2018; V.A. Chernets et al., 2008).

A highly important place in the framework of the research topic is filled by the works that are concerned with the problem of labor activity of workers, the peculiarities of labor behavior of doctors and nurses under modern conditions at the regional level. (Kuznetsova et al., 2000; Yarskaya et al., 2009; Mishakin, 2011; Ulumbekova, 2010; Khayrullina et al., 2016). Further theoretical and practical study of the problem is determined by the necessity to identify the contradictions and problems of the domestic health care reform and its optimal organizational support.

METHODS

The provisions and conclusions of the study are based on the results of author's empirical studies of the social state of health of medical workers as a special social and professional group, conducted under the guidance of prof. Khayrullina Y. R., in the Republic of Tatarstan and the Ulyanovsk Region as part of the study of the quality of life of the population of the region during the reform of domestic health care (2008-2018).

A concrete sociological study in the Republic of Tatarstan was conducted by the quota sampling questionnaire (N₀ = 900), in the Ulyanovsk Region (N₀ = 766), a person, representative, sample error ($e = \pm 5\%$). The proportions within the sampling frame correspond to the general one in vocational qualification, socio-demographic and gender characteristics.

The object of study is medical workers as a special social and professional group. The purpose of the study is to reveal the directions of influence of domestic health care reform on medical

workers, the characteristics of the labor behavior of individual socially-qualified groups, their social health and the features of interaction at the regional level.

At the stage of generalization and analysis of empirical information, the method of typologization was used. Within its framework, the characteristics of the typical figure of a modern doctor and medical worker and their real distribution in the region are obtained.

The applied research procedure was developed taking into consideration the approaches of sociological research present in works by D. N. Alexandrova, I. I. Frolova, R. K. Yagudin (Alexandrova, 2006; Frolova, 2005; Yagudin, 2014). Empirical information was processed using the IBM SPSS Statistics 22 software.

RESULTS AND DISCUSSION

Consider the results of health care reform in the Republic of Tatarstan and the opinion of medical workers on the implementation of the national project "Health". As a result of the implementation of the main lines of the national project "Health" in the republic, according to the respondents, positive changes are expressed in the following: maintenance of a patient care institution 43.3%, raise in salaries 21.9%, improvement of working conditions, 21.1%, improvement of the quality of primary health care 19.7%, facilities, supply with new medical facilities of all departments of the medical institution 17.7%, improving public health 13.5%, increasing labor incentives 11.6%, opening new buildings 10.7%, a decrease in the mortality rate of the population of 10.4%, the use of modern information technologies 10.3%, rise in the standard of living of health workers 8.8%, an increase in health workers 3.2%, nothing is observed 1.3%, paid services – medicine is paid 0, one%. That is, the reform affected the conditions and nature of labor, salaries a little, motivation to some extent, as a component of labor capital. Also, it turned out to be almost not focused on the development of the intellectual and educational capital of medical workers, for example, only 10.3% of the respondents noted the use of modern information technologies.

According to the answers of the respondents, the health care project was implemented in the following areas: consolidating the preventive line of health care 30.7%, developing primary health care 28.6%, staffing the district service with qualified doctors and nurses 25.9%, meeting the population's need for high-tech 25, 4%, providing the district service with the necessary equipment 22.6%, creating conditions for the birth of healthy children 12.9%, the results are not answerable to their hopes 3.5%. Also, less than one percent of the respondents answered: I don't know anything about it 0.5%, just for show, the real quality of medical care is low 0.4%, provision of medicines, medical equipment 0.2%, addition to paperwork 0.1%, practically nothing has not changed, there

have been more inspections, inspectors' antics; only threats, small punitive measures, etc. 0.1%.

To the question related immediately to the development of intellectual and educational capital of medical workers, the following answers were received: the qualification level within the framework of the national project "Health" was increased by 33.3%, 54.2% of the respondents did not improve their qualifications. Among doctors, the level of proficiency was raised by 33.5%, but 53.5% of them did not advance in skills. Nursing staff raised their qualification level by 33.3%, but 54.7% of them did not.

Concerning labor capital, 58.1% noted that they did not work overtime, but among them 28.5% would like to work overtime, but 35.3% said they did not want to work overtime. Among doctors, 46.1% of them have extra work, 50% do not work extra, as for the paramedical personnel, one third of them works overtime, - 30.9%, 62.4% of them do not work overtime. At the same time, we know that within the framework of the Health project, including at the regional and municipal levels, the structure of medical institutions is being rationalized and medical workers are actually being reduced.

Consider the results of the study of the impact of health care reform on the social state of health of medical workers in another subject of the Volga Federal District. According to the answers of the respondents in the Ulyanovsk Region, 61% of the doctors and 87% of the medical respondents have extra work and earnings, and at the same time in areas not related to medicine, 54% of the medical workers and 32% of the doctors have additional earnings.

In the past five years, advanced training courses have been taken by 76% of doctors and 57% of medical workers, while 75% of those surveyed in the first group and 86% in the second one report that refresher courses are unnecessary and in vain. The organizations in which the medical workers work paid for the courses they took. According to the results of the study, 86% of the doctors chose their profession consciously, among the medical workers the number of such respondents is 54%. The main motive and the main reason for doctors' satisfaction with their work in 82% of cases is social significance and the desire to help people. Concerning medical workers, the main motive for choosing a profession was the guarantee of employment (76%) and the ability to help relatives and friends (56%). A comfortable schedule (67%), the possibility of concurrent employment (70%), and a good team (40%) are more likely to influence job satisfaction among health workers.

Dissatisfaction with work is influenced by such factors as insufficient salaries – 75% of the doctors and 70% of the medical workers, and imperfection of the regulatory framework – about 60% in both groups. It was also revealed that 76% of the respondents in both groups noted strained relations between doctors and medical

workers. 23% say that these relations can be characterized as conflicting. According to the answers, 48% of health workers believe that they have a very high risk of job loss. Despite the fact that 23% are confident that they can find an equivalent job. Among doctors, the number of such respondents is 54% and 24%, respectively.

More than 70% of the respondents in both groups recognized the results of the project "Health" as negative. The main negative changes were the transition from free medicine to commercial medicine (45%), job cuts (60%), the so-called healthcare optimization, and additional paper work (73%).

The respondents' current situation in healthcare – 46% in the first group and 56% in the second group – was characterized as critical, while 23% and 26% in the first and second groups, respectively, characterized it as uncertain. The main problems of Russian health care, according to the respondents, are lack of funding (about 60% in both groups), the aging of medical personnel and a decrease in the influx of young personnel (43% of doctors and 57% of medical workers think so), and the deterioration of the drug supply of the population (38% in the first group and 59% in the second), slow updating of medical technologies and medical equipment (about 75% in both groups), insufficient medical personnel (about 68% in both groups).

SUMMARY

According to the results of a concrete sociological study, we can assemble the following sociological portrait of socio-professional groups – a doctor and an advanced practice nurse. The doctor has such features as professionalism, responsibility, exactingness as a specialist, dedication. There is also a high level of dissatisfaction with their work, including dissatisfaction with government measures to reform health care. Relations with patients and healthcare workers are characterized as strained. This gives a pessimistic coloring to the general mood and social well-being. Medical workers are more inclined to search for additional income, focused on material needs. Like doctors, they are skeptical about the measures taken as a part of the reforms.

CONCLUSION

The formulated conclusions and results can be used by regional and municipal health organizers, heads of medicoprohylactic institution to improve working conditions and organization, rationalize functional responsibilities and create an effective system of advanced training, exchange advanced experience and gain self-education of all socially qualified groups of medical workers. Relying on the results of applied research, it is necessary to develop and implement effective motivational strategies and innovative behaviors of medical workers that can be used to build up their labor and intellectual-educational capital, and contribute to social and economic growth and stability in the region.

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Neural Motor Condition of Upper Limb Patients in the Postmobilization Period

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ABSTRACT

The results of studies of the functional state of the neuromuscular structures of 27 patients with fractures of the forearm bones at the post-mobilization stage after plate osteosynthesis are presented. Investigated the neurophysiological state of the muscles of the forearm and hand in patients with fixation of the fracture zone plate and screws after removing the plaster splint. It was revealed that the localization and size of the formed defect in the bones of the forearm do not have a reliable and significant effect on the state of the neuromotor apparatus of the limb. Formation as a result of trauma, surgery, and plaster immobilization of acquired contracture was usually combined with changes in the muscular structures of the forearm that are organic in nature, while disorders of the nerve structures of the segment were functional. The use of plaster immobilization in the treatment of patients in the postoperative period worsened the functional state of the neuromuscular structures of the limb.

KEY WORDS: Fracture of the Forearm bones, plaster immobilization, plate osteosynthesis, electromyography, static and dynamic movements.

INTRODUCTION

About 80% of all injuries are of the musculoskeletal system, about half of which are injuries of the upper limbs. The correctness of treatment depends on qualified first aid provided. Injuries to the upper extremities can be of a different nature. A fracture of the radial bone of the arm accounts for 1/2 of traumatic injuries of bones of the upper limbs and more than 15% of the total number of injuries

of the skeleton (Kapandji, 1998; Weiland et al., 1984). Much more often, such fractures occur in postmenopausal women, when bone tissue undergoes involutional changes and loses mineral substances. The leading factor in the mechanism of fractures is a fall onto an outstretched arm. The position of the hand at this moment often determines the displacement of fragments: an unbent hand makes the fragment move posteriorly and to the radial side (the so-called extensor fracture, which occurs in most cases); a bent hand leads to the shift to the palmar side (Smith's "flexion" fracture). Fractures are, as a rule, intraarticular, often accompanied by a separation of the styloid process of the ulna (half of the cases), damage to the distal radicular elbow joint, fractures of the head of the ulnar bone, wrist bones, etc. Fractures bone tissue damage vary greatly in nature. The data presented indicate the need for a careful individual approach to the treatment of such patients, rejecting the opinion of the "typicality" of injuries (Andreyeva & Trotsenko, 2006; Baskevich, 1999; Goldman, 1981). Despite significant advances in medicine, the percentage of unsatisfactory outcomes in the treatment of patients with fractures of the forearm is high enough. In the case of conservative treatment, they reach 13-60%, and in the

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case of surgical methods - 10-70%. In addition, disability in patients with radial fractures is quite significant and ranges from 6 to 8 months, after which 10% of patients are forced to change their profession, and 6% to 17% become disabled (Afaunov et al., 2005; Koshima et al., 1992).

The development of post-traumatic complications is due to both damage to the articular cartilage during a fracture and degenerative changes in the capsular-ligamentous apparatus of the joints. At the same time, degenerative and dystrophic changes in soft tissues, in turn, are associated both with their injuries and with prolonged immobilization in the post-traumatic period. The negative effects of prolonged immobilization and the need for early mobilization and activation of the patient are determined by the structure and function of the connective tissue, which is present in any segment of the body and performs many functions such as mechanical support, participation in movement, metabolic processes, and interstitial transport (Afaunov et al., 2005; Goldman, 1981).

The main components of connective tissue - collagen and elastin - are presented in the fibers of the ligaments and tendons; they provide their ability to adapt to power loads

on the joints. Connective tissue prevents the destruction of joint tissues, which occurs during osteoarthritis, when massive destruction of the articular cartilage, as well as the capsule-ligamentous apparatus, occurs. In this case, an injury and manual reposition itself cause additional damage to the connective tissue. Since the fibers of the injured connective tissue are parallel to each other, their structure and function largely depend on how the healing process itself occurs (Andreyeva & Trotsenko, 2006; Zoria et al., 1999).

During prolonged immobilization in the early postoperative period, these fibers are restored and arranged randomly in various directions - a cross-linking limb (a cross-linking phenomenon). Such a combination of fibers leads to adhesion of soft tissues and the loss of passive and active movements in the joint. Immobilization in the early postoperative period has a confirmed adverse effect on the capsule-ligament apparatus of the joint, often causing a shortening of connective tissue fibers, loss of strength to overcome stretching, edema, venous stasis, and atrophy. All this leads to muscle weakness, loss of range of motion, and joint dysfunction in general (Kapandji, 1998; Koshima et al., 1992).

Table 1				
Muscles	Type of load	EMG average amplitude (mV)	EMG average amplitude (mV)	
			Injured limb	Contralateral limb
m.extensor digitorum communis	Dynamic	M	0.53	1.14
		?m	0.10	0.22
	Static	M	0.61	1.31
		?m	0.24	0.52
m.flexor carpi radialis	Dynamic	M	0.33	0.80
		?m	0.12	0.29
	Static	M	0.35	0.69
		?m	0.06	0.12
m.flexor carpi ulnaris	Dynamic	M	0.26	0.61
		?m	0.05	0.12
	Static	M	0.37	0.88
		?m	0.11	0.26
m.thenar	Dynamic	M	0.77	1.69
		?m	0.10	0.21
	Static	M	0.84	1.15
		?m	0.14	0.19
	Dynamic	M	0.66	1.39
		?m	0.10	0.21
Static	M	0.68	1.26	
?m	0.13	0.24		

All of the above speaks in favor of actively mobilizing the patient in the early postoperative period, which can be carried out in an active mode – with the help of a kinesiotherapist or simulator, in a passive mode - using CPM, and in an active-passive mode - using both techniques.

According to some authors, the frequency of fractures of the forearm bones ranges from 11% to 53% of the total number of fractures of the long tubular bones, while diaphyseal fractures account for 12-15% (Andreyeva & Trotsenko, 2006; Baskevich, 1999; Goldman, 1981). Despite significant advances in medicine, the percentage of unsatisfactory outcomes in the treatment of patients with diaphyseal fractures of the forearm is high enough. In the case of conservative treatment, they reach 13-60%, and in the case of surgical methods - 10-70%. In addition, disability in patients with diaphyseal fractures of the forearm bones is quite significant and ranges from 6 to 8 months, after which 10% of patients are forced to change their profession, and 6% to 17% become disabled (Afaunov et al., 2005; Koshima et al., 1992). In total, unsuccessful outcomes in the treatment of diaphyseal fractures of the forearm bones reach, according to various authors, 83%, and dysfunctions in the form of rotational restrictions occur in 30-83% of cases; the formation of a false joint is noted in 20-25% of cases with respect to all pseudoarthrosis of long tubular bones (Kapandji, 1998; Weiland et al., 1984).

Particular difficulties in the treatment of fractures of the forearm bones arise when they are localized in the diaphysis, when bone fragments often shift in width, length, and angularly, which greatly complicates the process of their reposition and fixation. One of the leading causes of the emergence of rotational contractures is the inadequate immobilization of fragments. The complex anatomical and functional relationship of the ulnar and radial bones requires an ideal comparison of bone fragments, therefore, any types of remained dislocations lead to a limitation of the radius rotation around the ulna (Baskevich, 1999; Goldman, 1981; Zoria et al., 1999).

Among the existing methods of treating fractures of the forearm bones, the method of osseous fixation is one of the most widespread. Despite the obvious advantages of the method of bone osteosynthesis, it has several disadvantages. One of which is the need for gypsum immobilization in the postoperative period. This prevents from beginning early rehabilitation and recovery of movements. Adverse treatment outcomes that led to disability are largely due to the fact that traditional treatment

methods do not always provide the necessary set of biomechanical conditions for a favorable course of bone tissue regeneration and early functional restoration of the affected limb (Afaunov et al., 2005; Vahitov et al., 2018; Vakhitov et al., 2018).

All of the above indicates that the improvement and development of new devices and techniques that boost the results of favorable treatment of fractures of this localization are urgent challenges of modern traumatology.

The objective of the research is to study the neuromotor state of the injured and contralateral load on the limb in the post-immobilization period, as well as to determine the average amplitude of the global EMG during dynamic and static exercises.

MATERIAL AND METHODS

The study involved 27 patients with fractures of the forearm bones. 10 patients (37%) had ulnar fractures, 7 patients (26%) had radial fractures, and 10 patients (37%) had fractures of both forearm bones.

To conduct surface EMG, we used an electromyograph developed on the basis of the Myoware Muscle Sensor (AT-04-001). Disposable cutaneous electrodes were applied in accordance with the standards for biomechanical studies. The average amplitude of EMG recorded in the abduction from the muscles of the forearm and hand (m. extensor digitorum communis, m. flexor carpi radialis, m. flexor carpi ulnaris, mm. thenar, mm. hypothenar) of the injured and contralateral limbs was used as the analyzed parameter. The mean sample value (M) of EMG parameters and the mean error (m) were calculated.

Examinations were carried out 6 weeks after the injury and the surgical treatment (osteosynthesis with a plate and screws) after removal of the gypsum immobilization. Patients had to perform a number of movements: 1) at rest; 2) flexion and extension of the hands; 3) maximum abduction of the hand and further retention in a static position, and 4) maximum adduction of the hand and its further retention in this position.

RESULTS AND DISCUSSION

During the course of the study, it was found that in the post-immobilization period, the lead from all the muscles of the affected limb showed a significant difference between the analyzed parameters and the similar ones recorded during the study of the limb muscles. The data presented in Table 1, showed that the severity of functional disorders in the

postoperative stage did not depend on the volume of bone loss and the magnitude of the formed bone defects. During treatment, all patients, regardless of the size of the defect, showed restoration of the average amplitude of EMG in the lead from the muscles of the forearm. In the leads from the muscles of the hand, the difference between the indicators of the affected and intact limb remained. After removal of the gypsum immobilization, a restoration of the average amplitude to the initial level in the leads from the muscles of the forearm and to the level characteristic of the intact limb in the leads from the muscles of the hand was observed. The recorded frequency of oscillations in all leads at different stages of the study did not undergo significant changes, which allowed excluding synchronization of motor units.

Key indicators of total EMG in the post-immobilization period

Thus, the use of gypsum immobilization caused a reversible deterioration in the functional state of the neuromuscular apparatus of the affected segment. Neurological disorders observed at the post-immobilization stage were due to damage to muscles and tendons, as well as a change in biomechanical relationships in the affected segment.

SUMMARY

The study showed that the greatest dysfunction of the neuromuscular apparatus of the limb was observed in patients with fractures of both bones of the forearm. Changes in the functioning of the neuromuscular apparatus in patients with a fracture of both the radius and ulna were of the same type. The greatest changes were observed in the group of flexor muscles of the hand. The use of gypsum immobilization caused a deterioration in the functional state of the neuromuscular apparatus of the upper limb in all patients.

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Neuromatic Condition of the Injured Limb at the Stages of Rehabilitation

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ABSTRACT

Injuries to the upper limbs may be of a different nature. A fracture of the radius of the arm accounts for 1/2 of the traumatic injuries of the bones of the upper limb and more than 15% of the total number of injuries of the skeleton. The results of studies of the functional state of the neuromuscular structures of 46 patients with extensor fractures of the distal radial bone metaepiphysis (wheel fracture) are presented. Investigated the neurophysiological state of the muscles of the forearm and hand in patients after manual reposition of the fracture site under local anesthesia and removal of the plaster splint. It was revealed that the localization and size of the formed defect in the bones of the forearm do not have a reliable and significant effect on the state of the neuromotor apparatus of the limb. Formation as a result of injury, manual reposition and plaster immobilization of the acquired contracture was usually combined with changes in the muscular structures of the forearm, which are of an organic nature, while violations of the nerve structures of the segment were functional. The use of plaster splints in the treatment of patients in the immobilization period worsened the functional state of the neuromuscular structures of the limb. An analysis of a five-week course of recovery after the treatment of preference fractures of the forearm bones allows us to conclude that the digitorum combined use of static and dynamic exercises in the rehabilitation process allows us to achieve significant growth rates of the total EMG, and therefore an earlier improvement in the physical qualities and level of the patient's overall performance. According to the results of the use of separate dynamic and static exercises, total preference is given to the latter.

KEY WORDS: Radial Metaepiphysis Fracture, Gypsum Immobilization, Closed Reposition, Rehabilitation, Electromyography, Static and Dynamic Static Exercises

INTRODUCTION

The diverse collections of organisms that reside in large water bodies and which are unable to swim against the

water current are called as planktons. They provide an important source of food to many aquatic organisms like fishes. Planktons include algae, bacteria, protozoa, zooplanktons etc. Rotifers are a group of zooplanktons and 90% of the rotifer species inhabits in freshwater habitats. They feed mainly on microscopic organisms like algae, bacteria and protists etc. They seldom reach 2mm in body length. They are broad, flattened or spherical in shape. It shows distinct sexual dimorphism. Females are fully developed.

About 80% of all injuries are of the musculoskeletal system, about half of which are injuries of the upper limbs. The correctness of treatment depends on qualified first aid provided. Injuries to the upper extremities can be of a different nature. A fracture of the radial bone of the arm accounts for 1/2 of traumatic injuries of bones of the upper limbs and more than 15% of the total number of injuries

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Changes in the indicators of total EMG in patients with a fracture of the radial bone doing static exercises

Table 1								
Muscles			Weeks					
			0	I	II	III	IV	V
m.extensor digitorum communis	CG	M	<u>0.53</u>	<u>0.64</u>	<u>0.73</u>	<u>0.86</u>	<u>0.95</u>	<u>1.07</u>
		±m	0.10	0.06	0.05	0.04	0.07	0.08
	EG	M	<u>0.52</u>	<u>0.68</u>	<u>0.82</u>	<u>0.94</u>	<u>1.06</u>	<u>1.12</u>
		±m	0.08	0.06	0.14	0.12	0.11	0.14
m.flexor carpi radialis	CG	M	<u>0.33</u>	<u>0.41</u>	<u>0.59</u>	<u>0.67</u>	<u>0.75</u>	<u>0.79</u>
		±m	0.12	0.09	0.10	0.08	0.10	0.11
	EG	M	<u>0.34</u>	<u>0.46</u>	<u>0.54</u>	<u>0.66</u>	<u>0.78</u>	<u>0.82</u>
		±m	0.10	0.08	0.06	0.09	0.11	0.10
m.flexor carpi ulnaris	CG	M	<u>0.26</u>	<u>0.34</u>	<u>0.42</u>	<u>0.49</u>	<u>0.54</u>	<u>0.58</u>
		±m	0.05	0.03	0.04	0.03	0.07	0.06
	EG	M	<u>0.24</u>	<u>0.44</u>	<u>0.56</u>	<u>0.58</u>	<u>0.61</u>	<u>0.64</u>
		±m	0.07	0.09	0.07	0.04	0.08	0.06
m.thenar	CG	M	<u>0.77</u>	<u>0.94</u>	<u>1.11</u>	<u>1.28</u>	<u>1.45</u>	<u>1.62</u>
		±m	0.10	0.08	0.12	0.10	0.09	0.11
	EG	M	<u>0.80</u>	<u>0.98</u>	<u>1.24</u>	<u>1.48</u>	<u>1.64</u>	<u>1.71</u>
		±m	0.06	0.12	0.16	0.14	0.19	0.21
m.hypothenar	CG	M	<u>0.66</u>	<u>0.79</u>	<u>0.90</u>	<u>1.06</u>	<u>1.21</u>	<u>1.31</u>
		±m	0.10	0.08	0.07	0.09	0.10	0.12
	EG	M	<u>0.68</u>	<u>0.87</u>	<u>1.08</u>	<u>1.21</u>	<u>1.34</u>	<u>1.42</u>
		±m	0.08	0.06	0.10	0.07	0.14	0.18

of the skeleton (Kapandji, 1998; Weiland et al., 1984). Much more often, such fractures occur in postmenopausal women, when bone tissue undergoes involutional changes and loses mineral substances. The leading factor in the mechanism of fractures is a fall onto an outstretched arm. The position of the hand at this moment often determines the displacement of fragments: an unbent hand makes the fragment move posteriorly and to the radial side (the so-called extensor fracture, which occurs in most cases); a bent hand leads to the shift to the palmar side (Smith's "flexion" fracture). Fractures are, as a rule, intraarticular, often accompanied by a separation of the styloid process of the ulna (half of the cases), damage to the distal radioulnar joint, fractures of the head of the ulnar bone, wrist bones, etc. Fractures bone tissue damage vary greatly in nature. The data presented indicate the need for a careful individual approach to the treatment of such patients, rejecting the opinion of the "typicality" of injuries (Andreyeva & Trotsenko, 2006; Baskevich, 1999; Goldman, 1981). Despite significant advances in medicine, the percentage

of unsatisfactory outcomes in the treatment of patients with fractures of the forearm is high enough. In the case of conservative treatment, they reach 13-60%, and in the case of surgical methods - 10-70%. In addition, disability in patients with radial fractures is quite significant and ranges from 6 to 8 months, after which 10% of patients are forced to change their profession, and 6% to 17% become disabled (Afaunov et al., 2005; Koshima et al., 1992).

The development of post-traumatic complications is due to both damage to the articular cartilage during a fracture and degenerative changes in the capsular-ligamentous apparatus of the joints. At the same time, degenerative and dystrophic changes in soft tissues, in turn, are associated both with their injuries and with prolonged immobilization in the post-traumatic period. The negative effects of prolonged immobilization and the need for early mobilization and activation of the patient are determined by the structure and function of the connective tissue, which is present in any segment of the body and performs many functions such as mechanical support, participation in movement,

Table 2

Muscles			Weeks					
			0	I	II	III	IV	V
m.extensor digitorum communis	CG	M	<u>0.61</u>	<u>0.74</u>	<u>0.97</u>	<u>1.12</u>	<u>1.24</u>	<u>1.28</u>
		±m	0.14	0.12	0.08	0.10	0.09	0.14
	EG	M	<u>0.62</u>	<u>0.79</u>	<u>0.99</u>	<u>1.20</u>	<u>1.33</u>	<u>1.35</u>
		±m	0.16	0.08	0.12	0.18	0.21	0.16
m.flexor carpi radialis	CG	M	<u>0.35</u>	<u>0.41</u>	<u>0.47</u>	<u>0.53</u>	<u>0.59</u>	<u>0.66</u>
		±m	0.06	0.04	0.08	0.07	0.10	0.12
	EG	M	<u>0.34</u>	<u>0.49</u>	<u>0.62</u>	<u>0.77</u>	<u>0.85</u>	<u>0.88</u>
		±m	0.08	0.04	0.06	0.09	0.11	0.10
m. flexor carpi ulnaris	CG	M	<u>0.37</u>	<u>0.51</u>	<u>0.58</u>	<u>0.67</u>	<u>0.74</u>	<u>0.84</u>
		±m	0.11	0.09	0.06	0.08	0.10	0.16
	EG	M	<u>0.38</u>	<u>0.58</u>	<u>0.72</u>	<u>0.84</u>	<u>0.92</u>	<u>0.96</u>
		±m	0.09	0.11	0.08	0.06	0.12	0.08
m.thenar	CG	M	<u>0.84</u>	<u>0.86</u>	<u>0.89</u>	<u>0.95</u>	<u>1.01</u>	<u>1.12</u>
		±m	0.14	0.08	0.12	0.10	0.09	0.11
	EG	M	<u>0.82</u>	<u>0.89</u>	<u>0.97</u>	<u>1.05</u>	<u>1.19</u>	<u>1.24</u>
		±m	0.12	0.09	0.08	0.11	0.14	0.18
m.hypothenar	CG	M	<u>0.68</u>	<u>0.70</u>	<u>0.81</u>	<u>0.94</u>	<u>1.07</u>	<u>1.23</u>
		±m	0.11	0.07	0.08	0.10	0.14	0.12
	EG	M	<u>0.70</u>	<u>0.75</u>	<u>0.95</u>	<u>1.20</u>	<u>1.32</u>	<u>1.36</u>
		±m	0.04	0.06	0.10	0.12	0.11	0.14

Changes in the indicators of total EMG in patients with a fracture of the radial bone doing both dynamic and static exercises

metabolic processes, and interstitial transport (Afaunov et al., 2005; Goldman, 1981; Vahitov et al., 2018; Vakhitov et al., 2018).

The main components of connective tissue - collagen and elastin - are presented in the fibers of the ligaments and tendons; they provide their ability to adapt to power loads on the joints. Connective tissue prevents the destruction of joint tissues, which occurs during osteoarthritis, when massive destruction of the articular cartilage, as well as the capsule-ligamentous apparatus, occurs. In this case, an injury and manual reposition itself cause additional damage to the connective tissue. Since the fibers of the injured connective tissue are parallel to each other, their structure and function largely depend on how the healing process itself occurs (Andreyeva & Trotsenko, 2006; Zoria et al., 1999).

During prolonged immobilization in the early postoperative period, these fibers are restored and arranged randomly in various directions - a cross-linking limb (a cross-linking phenomenon). Such a combination of fibers leads to adhesion of soft tissues and the loss of passive and

active movements in the joint. Immobilization in the early postoperative period has a confirmed adverse effect on the capsule-ligament apparatus of the joint, often causing a shortening of connective tissue fibers, loss of strength to overcome stretching, edema, venous stasis, and atrophy. All this leads to muscle weakness, loss of range of motion, and joint dysfunction in general (Kapandji, 1998; Koshima et al., 1992).

All of the above speaks in favor of actively mobilizing the patient in the early postoperative period, which can be carried out in an active mode - using a kinesiologist or simulator, in a passive mode - using CPM, and in an active-passive mode - using both techniques.

The objective of the study is to compare the neuromotor state of an injured upper limb in the control and experimental groups of patients at different stages of rehabilitation during dynamic and static exercises.

MATERIAL AND METHODS

The study was conducted in 46 patients with extensor fractures of the distal radial metaepiphysis (Colles fracture). The control group included 12 patients whose recovery

Table 3

Muscles			Weeks					
			0	I	II	III	IV	V
m. extensor digitorum communis	CG	M	<u>0.61</u>	<u>0.74</u>	<u>0.86</u>	<u>0.98</u>	<u>1.15</u>	<u>1.30</u>
		±m	0.11	0.14	0.09	0.10	0.11	0.12
	EG	M	<u>0.62</u>	<u>0.98</u>	<u>1.28</u>	<u>1.32</u>	<u>1.35</u>	<u>1.37</u>
		±m	0.12	0.10	0.14	0.18	0.21	0.17
m. flexor carpi radialis	CG	M	<u>0.35</u>	<u>0.37</u>	<u>0.42</u>	<u>0.47</u>	<u>0.55</u>	<u>0.76</u>
		±m	0.06	0.04	0.08	0.07	0.10	0.10
	EG	M	<u>0.34</u>	<u>0.53</u>	<u>0.77</u>	<u>0.82</u>	<u>0.88</u>	<u>0.94</u>
		±m	0.06	0.08	0.06	0.07	0.10	0.12
m. flexor carpi ulnaris	CG	M	<u>0.36</u>	<u>0.52</u>	<u>0.57</u>	<u>0.68</u>	<u>0.75</u>	<u>0.89</u>
		±m	0.09	0.11	0.10	0.06	0.08	0.11
	EG	M	<u>0.38</u>	<u>0.58</u>	<u>0.87</u>	<u>0.96</u>	<u>1.02</u>	<u>1.06</u>
		±m	0.10	0.11	0.08	0.06	0.14	0.12
m. thenar	CG	M	<u>0.84</u>	<u>0.87</u>	<u>0.90</u>	<u>0.94</u>	<u>1.04</u>	<u>1.10</u>
		±m	0.14	0.08	0.12	0.10	0.09	0.12
	EG	M	<u>0.82</u>	<u>0.89</u>	<u>1.07</u>	<u>1.16</u>	<u>1.24</u>	<u>1.32</u>
		±m	0.10	0.12	0.11	0.08	0.10	0.14
m. hypothenar	CG	M	<u>0.66</u>	<u>0.72</u>	<u>0.84</u>	<u>0.96</u>	<u>1.10</u>	<u>1.24</u>
		±m	0.08	0.11	0.09	0.10	0.12	0.10
	EG	M	<u>0.67</u>	<u>0.75</u>	<u>1.20</u>	<u>1.34</u>	<u>1.38</u>	<u>1.42</u>
		±m	0.06	0.08	0.09	0.11	0.14	0.12

was carried out according to the general principles of rehabilitation. The experimental group was divided into 3 subgroups. The first experimental subgroup consisted of 9 patients performing dynamic exercises. The second experimental group consisted of 14 patients performing static exercises. Patients of the third experimental subgroup, which included 11 patients, performed a combination of dynamic and static exercises throughout the rehabilitation.

The examinations were carried out at the post-immobilization and recovery stages of rehabilitation from the moment of injury and the closed reposition, after removal of the plaster cast and at various stages of rehabilitation with a weekly interval. Patients of the first experimental subgroup performed dynamic exercises: flexion and extension of the hands. The second experimental subgroup performed static exercises: maximum abduction of the hand and its further retention in a static position; maximum reduction of the hand and its further retention in this position. The third experimental subgroup combined dynamic and static exercises. Patients in the control group received physiotherapeutic treatment, exercise therapy, therapeutic massage.

To conduct surface EMG, we used an electromyograph developed on the basis of the Myoware Muscle Sensor (AT-04-001). Disposable cutaneous electrodes were applied in accordance with the standards for biomechanical studies. The average amplitude of EMG recorded in the abduction from the muscles of the forearm and hand (m. extensor digitorum communis, m. flexor carpi radialis, m. flexor carpi ulnaris, mm. thenar, mm. hypothenar) of the injured and contralateral limbs was used as the analyzed parameter. The mean sample value (M) of EMG parameters and the mean error (m) were calculated.

RESULTS AND DISCUSSION

To assess the benefits of our recommended method of restoring physical performance after manual reposition of fractures of the distal radius, we performed a comparative analysis of the dynamics of restoration of the functional capabilities of the injured limb, restoration of muscle excitability and the overall performance of patients in the control and experimental groups.

Examination of patients after removal of the plaster cast revealed restricted and painful movements in the wrist joint, swelling of soft tissues, pain during axial load and palpation. An objective study of all operated patients showed a significant increase in muscle tone of the injured limb,

recorded a drop in strength and speed-strength capabilities compared to a healthy limb. An X-ray of the injured limb was used to determine the formation of bone callus in the fracture zone, which indicated a fusion of the fracture and allowed starting active rehabilitation.

Due to the restriction of physical activity caused by trauma and immobilization, all patients had very low levels of total EMG. Thus, there were no significant differences between the subjects of the control and experimental groups according to clinical symptoms, the degree of physical fitness, which allowed us to compare the results of the restoration of physical performance of patients of the respective groups.

By the end of the first week of rehabilitation, the functional capabilities of the damaged limb in patients of the experimental subgroups significantly differ from the control in terms of total EMG. A difference in these indicators between patients of different experimental subgroups was also noted. The best results were noted in the subgroup of patients who performed static and dynamic exercises, the lesser dynamics of the indicators of total EMG was recorded when performing only static exercises. The smallest changes in the experimental group were found in patients of the first subgroup who performed dynamic exercises only during rehabilitation.

In the course of further rehabilitation, identical changes were observed in the indicators of the total EMG of the control group and experimental subgroups. It should be noted that in the third experimental subgroup, by the end of the second, beginning of the third week of rehabilitation, the studied parameters did not have significant differences with the control group at the end of the rehabilitation course. This allows us to state that the use of a set of static and dynamic exercises accelerates the process of restoring the excitability of muscles of an injured limb.

An interesting fact is that two weeks before the end of rehabilitation, that is, by the end of the third week, in the second experimental subgroup of patients, the indicators of total EMG did not statistically differ from the parameters of the control group at the end of rehabilitation. This fact indicates a more favorable effect of static exercises on restoring the excitability of an injured limb.

Further work on the restoration of physical properties and overall physical performance strengthens the gap between the experimental group itself. The reliability of the differences in the functional state and articular apparatus

of the damaged limb is maintained during the remaining rehabilitation time. In the first experimental subgroup, the indicators of total EMG by the end of the fourth week of rehabilitation reached the indicators of the control group by the end of rehabilitation.

Thus, the integrated use of static and dynamic exercises allows achieving an earlier restoration of the functionality of an injured limb.

Changes in the indicators of total EMG in patients with a fracture of the radial bone doing dynamic exercises

SUMMARY

The analysis of the five-week course of neuromotor recovery measures after treatment of fractures of the forearm bones allows us to conclude that the combined use of static and dynamic exercises in the rehabilitation process ensures significant growth rates in the indicators of total EMG, and therefore an earlier improvement in the physical properties and level of the patient's overall performance. According to the results of doing separately dynamic and static exercises, preference is given to the latter.

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Removal of Heavy Metal Ions Reverse Osmosis in Wastewater

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ABSTRACT

After the process of separation of waste water-oil emulsions (cutting fluids) by the method of ultrafiltration, an aqueous phase containing heavy metal ions is formed whose concentrations exceed the standards. Heavy metal ions were removed using reverse osmosis roll membranes. When the filtrates of the emulsion are separated by the film «FilmTec TW30 1812 50» and «EMO-H 45 300» membranes, after 50 minutes of emulsion separation, a decrease in productivity is observed by a factor of 2. The optimum working pressure of membrane separation was established at the level of 0.3-0.4 MPa. In the process of concentrating the emulsion up to 7.5 times the mineralization of the filtrate is increased by 4 times compared with the mineralization of the original filtrate. The capacity of the used membranes of the brand «FilmTec TW30 1812 50» and «EMO-H 45 300» on the emulsion filtrate was 3 and 3.5 dm³ / h, respectively, and 7.2 and 5 dm³ / h on distilled water. The holding capacity of heavy metal ions of the «FilmTec TW30 1812 50» and «EMO-H 45 300» membranes averaged 61% when the emulsion filtrate was concentrated 2 times, and 57%, when the emulsion filtrate was concentrated 7.5 times, respectively.

KEY WORDS: Emulsion Filtrate, Heavy Metal Ions, Reverse Osmosis, Concentration, Retention, Performance.

INTRODUCTION

Pollution of the environment with heavy metals makes great danger to the biosphere. Heavy metals falling into the objects of the natural environment tend to accumulate in these objects. They have an acute toxic effect on animals and plant organisms, including humans. In addition, they

can be accumulated in food chains, which enhances their negative impact.

The main sources of heavy metals in the environment are industry, motor transport, agricultural production, electricity enterprises, etc. Among industry, it is possible to distinguish ferrous and non-ferrous metallurgy, metalworking, mechanical engineering, paint and varnish production, etc. In agriculture, fertilizers and pesticides can serve as a source of heavy metal emission into the environment.

In large cities with a diversified industry, complex environmental pollution by heavy metals is observed. They can be present as a polluting ingredient in atmospheric air, soil, and water bodies. In such cases, their complex effect on plants, animals and humans is observed.

Some heavy metals are the part of biological processes, and in some quantities they are necessary for the normal functioning of various organisms by microelements. At that, heavy metals can make a negative effect on organisms. If the limits of normal regulation of organisms are exceeded, heavy metals can make acute toxic, allergic, carcinogenic

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effects, cause structural and functional disorders, and cause mutations. Thus, they are dangerous not only for separate individuals, but also for entire populations and generations.

The relevance of environmental pollution by heavy metals is explained by a wide range of effects on human body. The negative effect of heavy metals on living organisms and human health is manifested not only in the direct effect of high concentrations, but also in the long-term consequences associated with their cumulative effect. The biological activity of heavy metals makes this group of pollutants the priority in environmental monitoring studies.

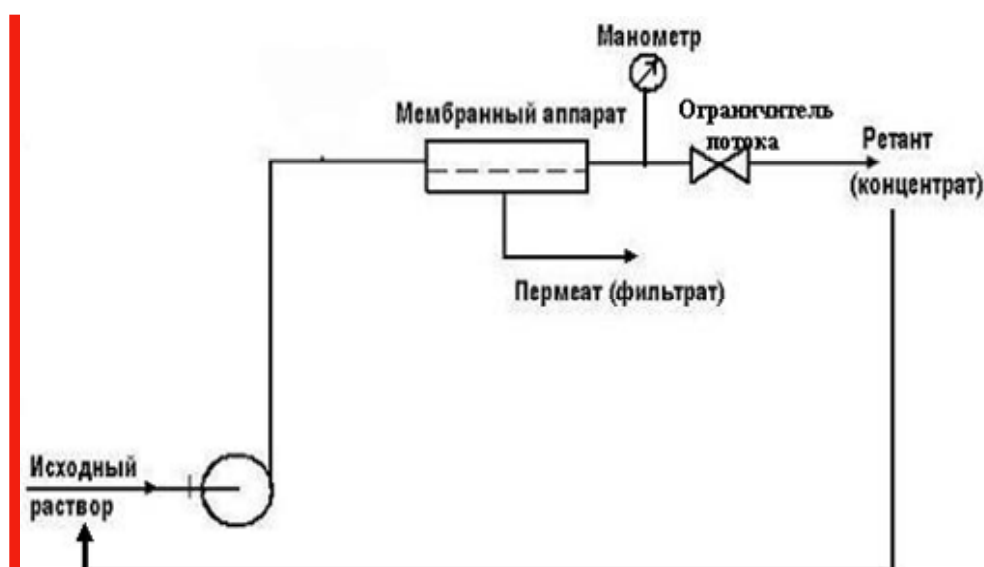
Nowadays, it is relevant to prevent the ingress of heavy metals into the natural environment objects. Here, a special place is occupied by the treatment of wastewater from heavy metals, as they are one of the main sources of heavy metals in the environment.

The existing methods of heavy metal removal from wastewater have several drawbacks, they do not ensure compliance with the standards for maximum permissible discharge into water bodies, they require a large amount of reagents, they consume a large amount of electricity, some methods require dilution of wastewater, etc. In this regard, there is a need to develop new wastewater

treatment methods that will allow to achieve the best wastewater treatment. One of these methods is the membrane methods of wastewater separation (Chitpong & Husson, 2017; Fazullin et al., 2015; Fang et al., 2017). The main advantages of membrane wastewater treatment methods are their compactness, high degree of purification, and low operating costs. Along with the obvious advantages of membrane technologies, they also have certain disadvantages associated with the loss of membrane performance during operation, the decrease in their selectivity and strength properties over time. The further development of membrane technologies requires the search for new membranes that provide high separation efficiency with maximum selectivity and permeability.

Thus, the relevance of this work is conditioned by the need to develop new non-standard solutions in the field of methods and methods for wastewater treatment due to the annual large-scale discharges of wastewater into surface water bodies, into filtration fields, and also into sewage systems.

Membrane methods are widely used in water treatment and water preparation. This is due to their high efficiency (Fazullin et al., 2018; Fazullin & Mavrin, 2017; Fazullin & Mavrin, 2017; Farnosova, 2011). In addition, membranes are constantly being improved, their operational qualities are improved, and their areas of application are expanding



Манометр - Pressure gauge / мембранный аппарат - membrane device / ограничитель потока - flow limiter / ретант (концентрат) - retant (concentrate) / пермеат (фильтрат) - permeate (filtrate) / исходный раствор - original solution

Fig. 1: Diagram of the membrane separation laboratory unit

(Fazullin et al., 2019; Fazullin et al., 2019). Based on the foregoing, one can assume that membranes are very promising materials.

METHODS

An experimental study of reverse osmosis processes was carried out on a laboratory membrane unit using domestic and imported membranes.

The membrane unit is designed to separate SW into filtrate and other components that have not passed through the membrane pores (concentrate).

The complete set of membrane separation unit for wastewater containing heavy metal ions.

- 1 - Capacity for the initial liquid with a submersible pump of 4 dm³.
Submersible pump:
 - maximum pressure - 0.05 MPa;
 - productivity - 900 dm³ / hour.
- 2 - Pressure increase pump Atoll UP-7000:
 - maximum discharge pressure - 0.7 MPa;
 - maximum productivity - 60 dm³ / hour;
 - fluid working temperature - from +5 to +40 °C;
- 3 - Membrane module made of polyethylene with one input and two outputs of filtrate and concentrate.
The dimension of installed roll and hollow fiber membranes - 4.5 x 30 cm;
- 4 - pressure gauge with pressure measuring range from 0 to 1.6 MPa;
- 5 - concentrate flow limiter for pressure regulation;
- 6 - filtrate collection capacity, 1 dm³.

The membrane separation process is carried out according to the following scheme, which is presented below on Figure 1. The initial wastewater containing suspended particles, emulsified petroleum products and automatic surfactants as impurities is pumped to the membrane module by a pump. Under the action of working pressure, the flow is divided into two parts: partially purified filtrate

from contaminants, which is collected in a receiving tank, and concentrate, which is constantly returned to the original tank. There is a gradual concentration of impurities to the maximum possible values in the process. Pressure is recorded by the manometer (Fazullin et al., 2015).

TFC - Polyamide

PSF - Polysulfonamide

The specific productivity of the membranes was determined as the ratio of the amount of filtrate formed to the product of the membrane area and the process time in terms of dm³/m²•h.

The measurements of the studied metal ion concentration in the initial solution and the filtrate were performed by atomic absorption spectrometry (AAS) with electrothermal atomization "Quantum Z.ETA". The spectrometer measures the concentrations of chemical elements, the analytical resonance spectral lines of which are in the spectral range of the unit (190 - 850 nm), by atomic absorption analysis using electrothermal atomization.

Selectivity was calculated according to the results by the following formula:

$$\gamma = \frac{C_f}{C_p} \cdot \frac{V_p}{V_f} \quad (1)$$

where C_f is the concentration of metal ions in the initial solution and C_p is the concentration of the solute in the filtrate.

RESULTS AND DISCUSSION

After separation of the spent water-oil emulsion by ultrafiltration, concentrate and filtrate are formed. The emulsion filtrate contains heavy metal ions received in the emulsion as the result of metal processing. To remove heavy metal ions, the filtrate was purified by reverse osmosis using the membranes FilmTec TW30 1812-50 and EMO-N 45-300. The technological parameters of the filtrate purification from heavy metal ions using the reverse osmosis membrane "FilmTec TW30 1812-50" are presented in table 2.

Table 1: Characteristics of membrane elements

Membrane desig.	Brand	Material	Pore size, micron	Performance, dm ³ /h	Degree of cleaning, %	Pressure working / max. MPa	pH
Rolled	FilmTec TW30 1812 50	TFC	0,0001	7,6	98 no NaCl	4 -7/21	2-11
	EMO-H 45-300	PSF	0,0001	5,0	95 no NaCl	3/10	3-10

The volume of the ultrafiltrate of 3% emulsion Inkam-1 made 3.6 dm³, the volume of the filtrate after OO made 1.84 dm³. The emulsion concentration coefficient $C_k = 2$ times. The conversion $R = 51,1 \%$.

The performance of the unit with a reverse osmosis membrane "FilmTec TW30 1812 50" was reduced by 2 times after 40 minutes of emulsion separation, the pressure dropped by 0.9 times. The optimal pressure at the unit outlet was established at the level of 0.31 MPa. During the emulsion concentration, the filtrate mineralization increases. The average value of the named filtrate mineralization parameter was 365 mg/dm³.

The filtrate was prepared for quantitative chemical analysis. The unit was washed with distilled water and tests were carried out to determine the membrane permeability: $Q_{water} = 6.6$ dm³/h at $P = 0.7$ MPa, $t = 22$ °C. And the initial productivity of the unit with the membrane FilmTec TW30 1812 50 was 7.6 dm³/h.

At the end of the experiments, the unit was washed with a washing solution. After washing, the unit productivity in distilled water increased and amounted to: $Q_{water} = 7.2$ dm³/h at $P = 0.7$ MPa, $t = 23$ °C. The results of quantitative-chemical analysis of reverse osmosis filtrates (with the membrane "FilmTec TW30 1812 50") of the ultrafiltrate emulsion are shown in table 4.

Next, they carried out the separation of the emulsion initial ultrafilter with the reverse osmosis membrane "EMO-N 45 300". The reverse osmosis membrane was installed in the membrane module and 3 dm³ of water-oil emulsion ultrafiltrate was poured into the container. The technological parameters of the filtrate purification from heavy metal ions with a reverse osmosis membrane "EMO-N 45 300" are presented in table 3.

The reverse osmosis filtrate volume made 2.6 dm³. The emulsion concentration coefficient $C_k = 7,5$. The conversion $R = 87 \%$.

Table 2: Technological parameters of the purification process of an ultrafiltrate emulsion by reverse osmosis, using a «FilmTec TW30 1812-50» membrane.

Process time, min.	Working pressure Pout, MPa	Capacity Q, dm ³ /h t, °C	t, °C	Mineralization (NaCl), mg / dm ³
1	0,35	3,9	23,3	89,0
5	0,35	3,3	23,3	145,0
10	0,35	2,7	24,0	220,0
25	0,31	1,98	24,3	320,0
30	0,31	1,92	24,7	476,0
40	0,30	1,91	24,8	490,0

Table 3: Technological parameters of the purification process of an ultrafiltrate emulsion by reverse osmosis, using an EMO-H 45 300 membrane.

Process time, min.	Working pressure Pout, MPa	Capacity Q, dm ³ /h t, °C	t, oC	Mineralization (NaCl), mg / dm ³
3	0,48	4,8	20,5	106
8	0,38	3,8	20,5	170
12,5	0,40	3,5	20,6	172
22,5	0,41	3,6	22,0	195
37,5	0,35	2,5	22,6	302
52,5	0,36	4,8	24,2	390

Table 4: «FilmTec TW30» membrane retention capacity of heavy metal ions from water-oil emulsion ultrafiltrate

Indicator	Standard	Before cleaning (emulsion ultrafiltrate)	Membrane filtrate "FilmTec TW30"	Membrane retention capacity, %
Total mineralization, mg/dm ³	1000	850±85	380±38	55
Iron ions, mg/dm ³	2,22	6,55±1,63	0,78±0,20	89
Copper ions, mg/dm ³	0,024	0,11±0,03	0,016±0,004	85
Nickel ions, mg/dm ³	0,043	0,005±0,001	0,003±0,001	40
Zinc ions, mg/dm ³	0,215	0,220±0,055	0,107±0,027	51
Chromium ions, mg/dm ³	0,090	0,098±0,025	0,050±0,013	49
Lead ions, mg/dm ³	-	0,031±0,008	0,007±0,002	77
Cadmium ions, mg/dm ³	-	0,003±0,001	0,002±0,001	33

Table 5: The retention capacity of the membrane brand «EMO-H 45-300» heavy metal ions from the ultrafiltrate water-oil emulsion

Indicator	Standard	Before cleaning (emulsion ultrafiltrate)	Membrane filtrate "FilmTec TW30"	Membrane retention capacity, %
Total mineralization, mg/dm ³	1000	850±85	391±39,1	54
Iron ions, mg/dm ³	2,22	6,55±1,63	0,83±0,20	87
Copper ions, mg/dm ³	0,024	0,11±0,03	0,021±0,005	80
Nickel ions, mg/dm ³	0,043	0,005±0,001	0,004±0,001	20
Zinc ions, mg/dm ³	0,215	0,220±0,055	0,120±0,030	45
Chromium ions, mg/dm ³	0,090	0,098±0,025	0,040±0,010	59
Lead ions, mg/dm ³	-	0,031±0,008	0,008±0,002	74
Cadmium ions, mg/dm ³	-	0,003±0,001	0,002±0,001	33

The unit productivity with the membrane OO EMO-N 45 300 was decreased by 2 times after 53 minutes of emulsion separation, the pressure dropped by 1.3 times. The optimal outlet pressure was established at 0.35 MPa. During the emulsion concentration, the filtrate mineralization increases. The average mineralization of the filtrate makes 244 mg/dm³.

Reverse osmosis filtrate was prepared for quantitative chemical analysis. The unit was washed with distilled water and tested: $Q_{\text{water}} = 4.9 \text{ dm}^3/\text{h}$ at $P = 0.34 \text{ MPa}$, $t = 21 \text{ }^\circ\text{C}$. The initial productivity of the unit with the membrane "EMO N 45 300" for distilled water was $5 \text{ dm}^3/\text{h}$.

The results of reverse osmosis filtrate quantitative-chemical analysis (with the membrane "EMO-N 45 300") are shown in table 5.

According to the results of quantitative-chemical analysis of reverse osmosis filtrates, it is evident that during the separation process, heavy metal ions are effectively retained, which are difficult to capture by other methods of emulsion purification. The retention capacity of reverse osmosis membranes is high for iron, copper and lead ions. A low degree of purification is observed for nickel and cadmium ions.

The degree of OO purification in relation to various ions mainly coincides with the series of their hydration energy increase: $\text{H}^+ < \text{Cd}^{2+} < \text{Zn}^{2+} < \text{Fe}^{3+}$ and with ion charge increase. This circumstance is likely due to the fact that each ion in the solution is not free, but hydrated (Gosh et al., 1999). Multivalent ions are retained best of all.

The average retention capacity of heavy metal ions with the membrane "FilmTec TW30 1812 50" was 61% at 2-time emulsion filtrate concentration, the retention capacity

of the membrane "EMO-N 45 300" was 57%, while the concentration of the emulsion filtrate made 7.5 times.

SUMMARY

Heavy metal ions were removed using reverse osmosis roll membranes. During the separation of emulsion filtrates with the membranes FilmTec TW30 1812 50 and EMO-N 45 300, after 50 minutes of emulsion separation, 2-fold decrease of productivity is observed. The optimal working pressure of the membrane separation was established at the level of 0.3-0.4 MPa. In the process of the emulsion concentration up to 7.5 times, the filtrate mineralization increases by 4 times in comparison with the mineralization of the initial filtrate.

The performance of the used membranes FilmTec TW30 1812 50 and EMO-N 45 300 in emulsion filtrate was 3 and 3.5 dm³/h, respectively, in distilled water - 7.2 and 5 dm³/h.

The retaining ability of heavy metal ions of FilmTec TW30 1812 50 and EMO-H 45 300 membranes made 61% on average at 2-time concentration of emulsion filtrate and 57% at 7.5-time concentration of emulsion filtrate, respectively. Iron, copper and lead ions are removed most effectively.

CONCLUSION

It is possible to use these reverse osmosis membranes effectively to purify the filtrates of spent emulsions from heavy metal ions with the filtration capacity of water-oil emulsion from 4.9 to 7 dm³/h and with the retention capacity of about 60%.

ACKNOWLEDGEMENT

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Role of Motor Activity to Change in the Contractive Function of the Laboratory Animal Heart

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ABSTRACT

In experiments on white outbred laboratory rats, it was established that systematic muscle training of rats in 4 weeks, started from 14 days of age, leads to a pronounced increase in indicators of stroke blood volume. Even with the subsequent sharp limitation of the motor activity of these same animals, the growth rate of stroke blood volume remains high. The limitation of the motor activity of rats with a 14-day age inhibits the increase in stroke volume. However, subsequent muscle training of these animals significantly stimulates the rate of increase in stroke volume. In rats exposed to muscle training, in the process of subsequent hypokinesia in the regulation of stroke blood volume, there are no significant changes. In hypokinesia animals, in the process of subsequent muscle training there is a significant decrease in sympathetic influences in the regulation of stroke blood volume.

KEY WORDS: Small Laboratory Animals, Stroke Volume; Various Modes of Motor Activity; Regulation Mechanisms; Blockade.

INTRODUCTION

The laws of the influence of various modes of motor activity on cardiac functions and the mechanisms of its regulation in postnatal ontogenesis has been the subject of research by a number of authors (Vakhitov & Minnakhmetova, 2005; Zefirov & Sviatova, 1998; Conyca, 1980). At the same time, a significant number studied the characteristics of the chronotropic function of the

heart in developing rats (Gilmutdinova & Anikina, 1995; Hamilton et al., 2003; Kubicek, 1966). The mechanisms of regulation of stroke volume in immature animals under transition from one motor regime to another remain insufficiently studied (Vakhitov, 2019; Vakhitov et al., 2018). We studied stroke volume and the mechanisms of its regulation in rats at an early age during the transition from systematic muscle training to hypokinesia, as well as from hypokinesia to subsequent muscle training (Izosimova et al., 2017; Vakhitov et al., 2018).

Changes in heart rate and stroke volume in a developing organism were studied in (Vakhitov & Minnakhmetova, 2005; Gilmutdinova & Anikina, 1995; Zefirov & Sviatova, 1998; Conyca, 1980; Hamilton et al., 2003; Kubicek, 1966; Lehmann et al., 1997). However, the data obtained are fragmented and there is no holistic view of the features of the formation of heart rate and stroke volume. A significant number of works are also devoted to the study of the laws of formation of the mechanisms of regulation of the heart in a developing organism (Vakhitov & Minnakhmetova, 2005; Gilmutdinova & Anikina, 1995; Conyca, 1980; Hamilton et al., 2003). At the same time, the dependence of the chronotropic function of the heart on the sympathetic and parasympathetic systems was studied in more detail. However, to date, researchers have no

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single idea about the establishment of mechanisms of regulation of the chronotropic function of the heart in a developing organism. Moreover, the features of the formation of the sympathetic and parasympathetic divisions of the autonomic nervous system in the regulation of stroke volume in a developing organism remain practically unstudied.

However, most researchers began systematic muscle training of rats aged 21 days. At the same time, the features of changes in the indices of the pumping function of the heart and the mechanisms of its regulation in immature animals performing muscle training at the earlier stages of postnatal development remain poorly understood. In this regard, we were the first to study the indices of the pumping function of the heart and the mechanisms of its regulation in rats performing muscle training starting from 14 days of age.

METHODS

To determine the heart rate and stroke volume, the method of tetrapolar thoracic rheography was used [6]. The studies involved 3 groups of white laboratory outbred small rats that were subjected to various modes of motor activity. The first group consisted of rats with unlimited motor activity. The rats of the 2nd experimental group aged 14 to 43 days old were subjected to forced, increasing swimming loads. Subsequently, the same animals aged from 43 to 70 days, in order to limit motor activity, were placed in special pen cages for 23 hours a day. The third group of animals aged 14 to 43 days was limited in motor activity by keeping in pen cages. Further, the same rats aged 43 to 70 days were subjected to gradually increasing muscle training by swimming. Stroke volume was determined by the method of tetrapolar thoracic rheography according to the Kubicek formula (1974). A differentiated rheogram was recorded in animals anesthetized with Nembutal (40 mg/kg) during natural breathing using an RPG rheoplethysmograph.

The severity of sympathetic and parasympathetic influences was measured by shifts in the stroke volume after pharmacological blockade of the corresponding receptors. To block adrenergic effects, animals received intraperitoneally Obzidan at a dose of 0.8 mg/100 g of body weight. To block M-cholinergic receptors, atropine was administered intraperitoneally at a dose of 0.3 mg/100 g of body weight.

RESULTS AND DISCUSSION

The analysis of the data presented indicates that in the process of growth and development of rats under unlimited motor activity, stroke volume increases and reaches 0.213 ml by the age of 70 days. In rats susceptible to increased motor activity, by the age of 43 days, stroke volume reaches 0.212 ml. Subsequently, motor activity of the same animals performing systematic muscle training began to be restricted from the age of 43 days. At the same time,

stroke volume increased and by the 70th day of life was 0.287 ml, which is 0.074 ml more than in rats of unlimited motor activity of the same age ($P < 0.05$). Consequently, systematic muscle training for 4 weeks, started from the age of 14 days, leads to a pronounced increase in stroke volume and, with a subsequent restriction of motor activity, stroke volume continues to grow.

Limitation of motor activity from 14 days of age led to significantly lower stroke volume growth rate and by 43 days of animal life, systolic ejection rates increased only to 0.105 ml, which is 0.107 ml lower than in trained rats of the same age ($P < 0.01$). Subsequently, from 43 to 70 days of age, the same animals were subjected to muscle training. During 4 weeks of muscle training, stroke volume increased significantly, and by the 70th day of life, stroke volume reaches 0.219 ml, that is, increases by 2 times. Therefore, after a preliminary restriction of motor activity, in the process of subsequent muscle training, an increase of stroke volume is significantly stimulated in the same rats.

The data presented below allow us to make several assumptions. Systematic muscle training started from 14 days of age, contributes to a pronounced increase in stroke volume, which does not undergo significant changes even with a subsequent restriction of motor activity. Apparently, this is due to the fact that an earlier start of systematic muscle training contributes to significantly pronounced hypertrophy of the muscle fibers of the heart.

In the second variant, after the animals start doing muscle loads, after hypokinesia, a significant increase in stroke volume was detected. To a certain extent, this can be explained by the fact that in our experiments, animals were sequentially and gradually accustomed to hypokinesia.

As you know, the pharmacological drug - atropine is used to block the parasympathetic regulatory influences on the heart, and Obzidan is used to block the sympathetic influences. In 14-day-old rats, the administration of atropine caused an increase in stroke volume by 0.014 ml, and the administration of Obzidan caused a decrease by 0.010 ml. In the process of further growth, rats under unrestricted motor activity up to 43 days of age, the reactions of stroke volume are slightly reduced, and by the age of 70 days, on the contrary, are increased.

In 43-day-old rats performing systematic muscle training, the administration of atropine caused an increase in stroke volume by 0.050 ml, and the administration of Obzidan caused a decrease by 0.040 ml. That is, during muscle training up to 43 days of age, there is a decrease in the influence of both parts of the autonomic nervous system defined systems in the regulation of stroke volume of blood. With a subsequent restriction of the motor activity of the

same animals, only a slight increase in parasympathetic effects on the stroke volume was found. Whereas the sympathetic influences do not change significantly.

Restriction of the motor activity of a growing organism at an early age caused a pronounced increase in the influence of both parts of the autonomic nervous system in the regulation of stroke volume by the 43rd day of a life of rats. Moreover, the regulatory effect of the sympathetic division of the autonomic nervous system is much more pronounced than the parasympathetic division. However, in the process of subsequent muscle training of the same animals, there is a significant decrease in these sympathetic influences in the regulation of the time of stroke volume of animals. If hypokinesized rats aged 43 days show high reaction of stroke volume to the administration of Obzidan up to 40.9%, then during subsequent muscle training it decreases to 27.3%.

The data obtained indicate that in hypokinesized rats for 4 weeks, during subsequent muscle training, there is a significant decrease in sympathetic influences in the regulation of stroke volume. Whereas, rats performing muscle training for 4 weeks at an early age showed no significant changes in the regulation of stroke volume despite a subsequent restriction of motor activity.

CONCLUSION

The conducted studies allow us to conclude that systematic muscle training for 4 weeks, started from the age of 14 days, leads to a pronounced increase in stroke volume and, even with a subsequent sharp restriction of motor activity, stroke volume continues to grow. The maintenance of high stroke volume values in trained animals during the subsequent restriction of motor activity is explained, apparently, by the fact that positive changes in the body at the cellular level, which are "triggered" during training at an early age, obviously persist for a long time. As a result, stroke volume continues to grow steadily. It is also necessary to consider that the experiments involved growing animals with an age-related increase in stroke volume.

Animals previously subjected to restricted motor activity, in the process of subsequent muscle training, have a significantly stimulated growth of stroke volume.

Analyzing the regulatory mechanisms of the contractile function of the heart, we came to the conclusion that muscle training increasing in time and in intensity contributes to a more pronounced decrease in the influence of both parts of the autonomic nervous system. There is a steady process of decreasing extracardiac regulatory influences at rest, that is, an organ tends to "self-regulation" (4), which according to our data is stably maintained even with a

subsequent restriction of motor activity. We should at the same time emphasize that in hypokinesized rats for 4 weeks, during subsequent muscle training, there is a significant decrease in sympathetic influences in the regulation of stroke volume.

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The Reaction of the 3-Week-Old Rats Heart to α_2 -Adrenoceptors Stimulation

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ABSTRACT

Heart development is an accurate and complex process controlled by the nervous and humoral regulation of the body. Modern literature presents a sufficient number of results on the formation, development, and growth of sympathetic and parasympathetic nerve fibers in the heart. Adrenergic regulation of cardiac activity is realized through many subtypes of adrenergic receptors (AR). In the heart of mammals and humans, α_2 -adrenergic receptors (α_2 -AR) of presynaptic membranes take part in the modulation of the release of norepinephrine, inhibiting the release of acetylcholine from cholinergic synapses, stimulating platelet aggregation, and narrowing the vessels of certain organs. In the central nervous system, activation of postsynaptic α_2 -adrenergic receptors causes a protective reflex, a sedative effect, and lowers blood pressure. Non-selective stimulation of α_2 -AR in isolated hearts of guinea pigs leads to a drop in pressure developed by the left ventricle during sympathetic stimulation. The objective of the research was to identify the effect of stimulation of α_2 -AR in the heart of rats during the onset of the formation of sympathetic innervation of the heart. Ex vivo experiments were performed on Langendorff-isolated hearts. In vivo experiments were performed on a holistic organism. Studies on the whole organism showed that intravenous administration of clonidine hydrochloride leads to bradycardia in 3-week-old rats. Application of the α_2 -adrenergic receptor antagonist - clonidine hydrochloride in experiments on a Langendorff-isolated heart of 3-week-old rats also causes a decrease in heart rate. The severity of this effect has a concentration dependence. Clonidine had a multidirectional effect on the blood supply to the heart. An agonist at a concentration of 10^{-9} M and 10^{-6} M reduces, and at a concentration of 10^{-8} M increases the coronary flow. Clonidine hydrochloride at a concentration of 10^{-7} M causes the multidirectional effects of heart circulation of 3-week-old rats. The multidirectional effect of stimulation of α_2 -adrenergic receptors on CF can be associated with different localization (pre- and postsynaptic) of different subtypes of α_2 -AR, as well as the ability of these adrenoceptors to bind to different G-proteins.

KEY WORDS: Alpha2-Adrenergic Receptors, Isolated Heart, Heart Rate, Coronary Flow, Sympathetic Cardiac Innervation, Rat

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INTRODUCTION

Heart development is an accurate and complex process controlled by the nervous and humoral regulation of the body. At different stages of postnatal ontogenesis, the receptors and mediators of the autonomic nervous system involved in the regulation of the cardiovascular system vary (Zefirov, 2011; Zefirov, 2015). Modern literature presents a sufficient number of results on the formation, development, and growth of sympathetic and parasympathetic nerve fibers in the heart. Data on sympathetic nerves were obtained in experimental studies on the heart specimens of adult transgenic mice using noradrenergic marker immunohistochemistry (Ernsberger & Rohrer, 2009). However, histochemistry methods in the ventricles of newborn rats showed no signs of sympathetic innervation.

Early signs of the formation of adrenergic innervation in the heart were detected in experiments with radioactively labeled noradrenaline. Norepinephrine was detected in the form characteristic of an adult organism only 5 weeks after birth. The ability to absorb norepinephrine determines the functional maturity of the sympathetic nerves, which is observed 21 days after birth, and then reaches the parameters of mature animals by day 30 of life (Robinson et al., 1997). Fluorescence microscopy of tissues detected no sympathetic fibers up to 3-weeks of life of rats. Only 5 weeks after birth, the formation of sympathetic innervation, characteristic of adult animals, is

observed, which continues to grow until the seventh week (Lipp & Rudolph, 1972).

Parasympathetic innervation of the heart and the main structures of the cholinergic innervation of the heart complete its development by the middle of the embryonic period (Kirby, 2007). Studies have shown that vagal efferent innervation is observed in the heart of mouse embryos and matures in the postnatal period of development (Hildreth et al., 2008; Fregoso & Hoover, 2012). The effects of stimulation of muscarinic cholinergic receptors with carbachol, causing bradycardia, are observed in the

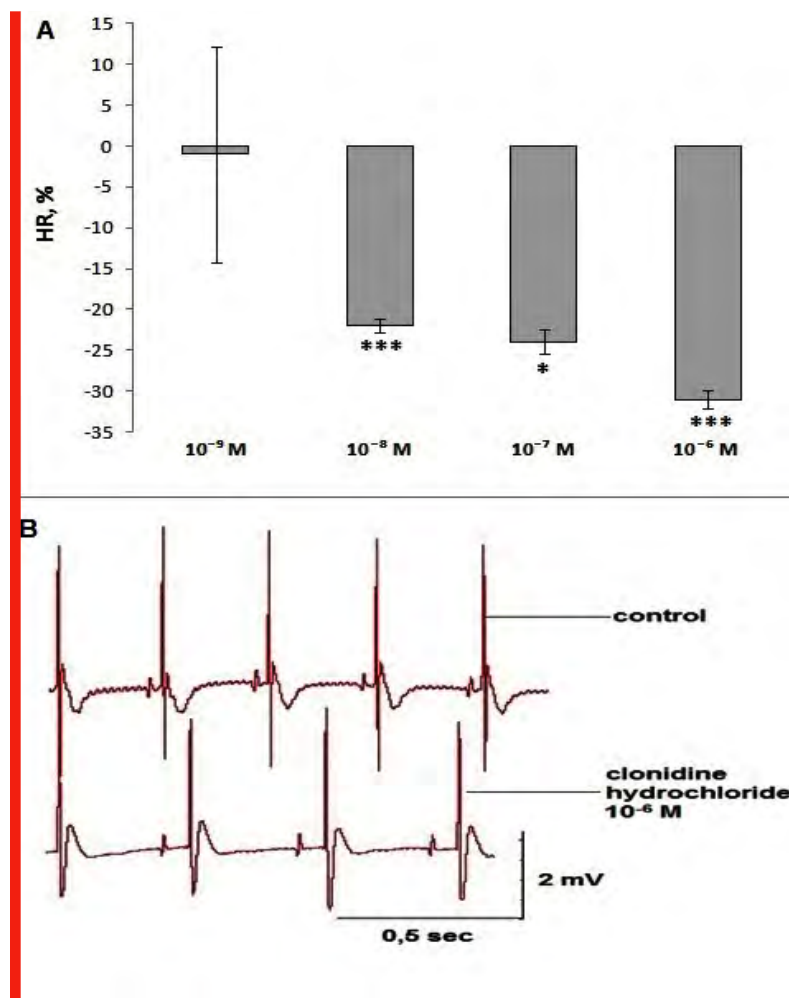


Fig. 1A: Dose-dependent effect of clonidine hydrochloride on heart rate in an isolated heart of 3-week-old rats. The ordinate axis is heart rate (HR, %), the abscissa axis is the concentration of clonidine hydrochloride (mol). Note: the reliability is shown in comparison with the initial values: * - $p < 0.05$, *** - $p < 0.001$. Fig. 1B.

The effect of stimulation of α_2 -adrenergic receptors at a concentration of 10^{-6} M on the heart rate of a Langendorff-isolated heart of 3-week-old rats (original entry).

heart of the mouse on day 10.5 of embryonic development (Chen et al., 2006).

In 1995, a group of authors guided by Hansen C.A. revealed specific features of the expression of specific G-proteins in the heart at different stages of postnatal ontogenesis (Hansen et al., 1995). The second group of researchers believes that the regulation of the development in the postnatal ontogenesis of the relationship of GPCR with various G-proteins may not depend on the presence of certain protein structures (Robinson, 1996).

Adrenergic regulation of cardiac activity is realized through many subtypes of adrenergic receptors (AR) (Hongo et al., 2016). In the heart of mammals and humans, α_2 -adrenergic receptors (α_2 -AR) of presynaptic membranes modulate the release of norepinephrine (Rump et al., 1995), inhibiting the release of acetylcholine from cholinergic synapses, stimulating platelet aggregation, and narrowing the vessels of some organs (Dudek et al., 2015). In the central nervous system, activation of postsynaptic α_2 -adrenergic receptors causes a protective reflex, sedation, and lowers blood pressure (Knaus et al., 2007). Non-selective stimulation of α_2 -AR in isolated hearts of guinea pigs leads to a drop in pressure developed by the left ventricle caused by sympathetic stimulation (Hongo et al., 2016). Changes in the activity of the sympathoadrenal system are one of the main factors in the development of pathologies of the

cardiovascular system. However, there are a few detailed studies of adrenergic interactions in the heart with different levels of adrenergic innervation. Subject to the above facts, the objective of the study was to identify the effect of stimulation of α_2 -AR in the heart of rats during the onset of the formation of sympathetic innervation of the heart.

METHODS

The experiments were carried out in compliance with the animal ethics standards on 21-day-old rats at the early formation of sympathetic innervation of the heart (Robinson, 1996). The experiments were performed on urethane-anesthetized (800 mg/kg mass) white mongrel rats weighing 25-30 g. In ex vivo experiments, the isolated heart of rats was studied using a standard technique on a Langendorff apparatus (ADInstruments, Australia). Details of the method are described previously (Ziiatdinova, 2019). We used a non-selective α_2 -AR agonist - clonidine hydrochloride, manufactured by Sigma, in a concentration range of 10^{-9} - 10^{-6} mol.

In vivo experiment included ECG using an EC 1T-03M electrocardiograph. Steel needle electrodes were superimposed on the rat limbs. The second standard lead was used. Further, for the introduction of a pharmacological agent on the right thigh, the skin was cut out and the right femoral vein was exposed. After stabilization of the

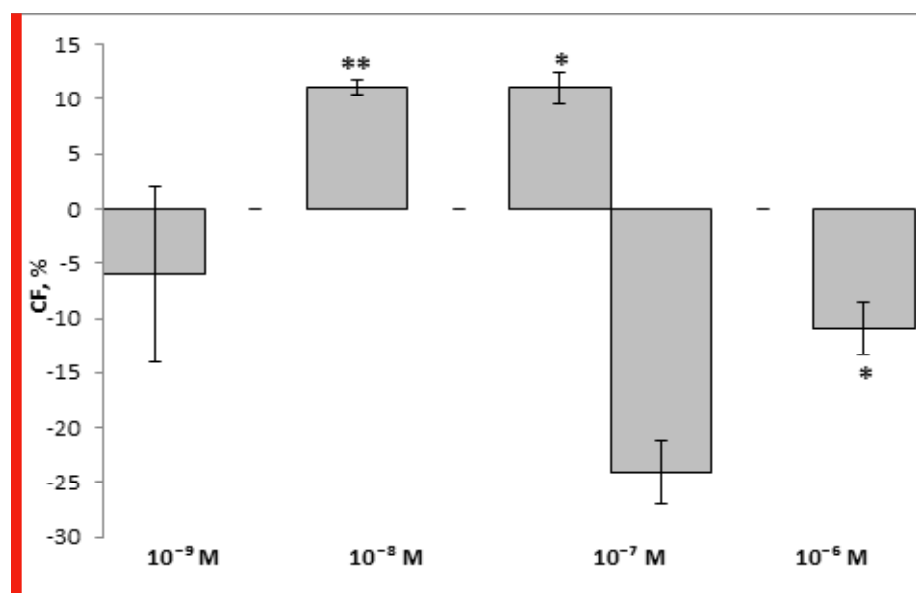


Fig. 2: Dose-dependent effect of clonidine hydrochloride on CF in an isolated heart of 3-week-old rats. The ordinate axis is CF (%), the abscissa axis is the concentration of clonidine hydrochloride (mol). Note: the reliability is shown in comparison with the initial values: * - $p < 0.05$, ** - $p < 0.05$.

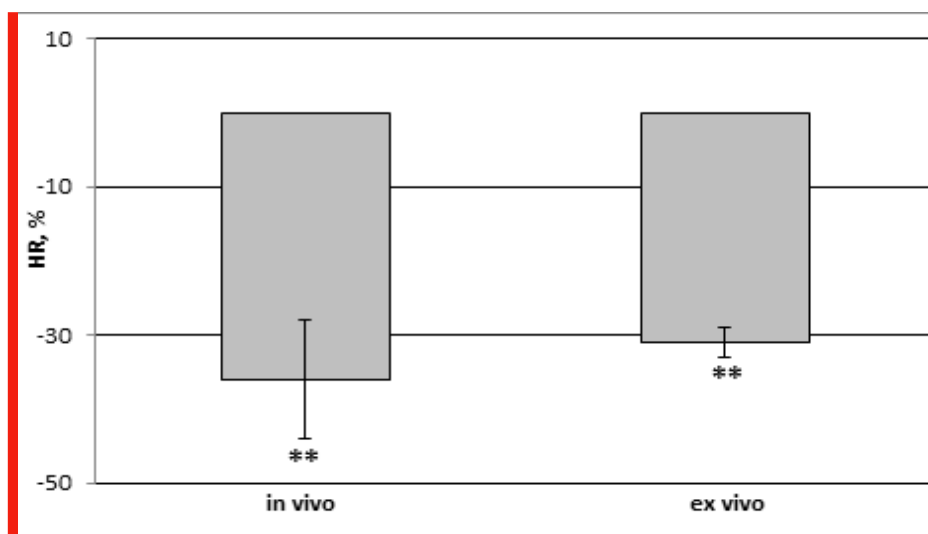


Fig. 3: Changes in the heart rate of 3-week-old rats with the application of an α_2 -adrenoreceptor agonist in vivo and ex vivo. Note: the reliability is shown in comparison with the initial values: ** - $p < 0.05$.

heart rate, the non-selective α_2 -AR agonist - clonidine hydrochloride was administered at a dose of 0.01 mg/kg of animal weight. Mathematical analysis of the results of the study was carried out in Excel using the paired Student's t-test.

RESULTS AND DISCUSSION

A study of the effect of the α_2 -AR agonist on the Langendorff-isolated heart of 3-week-old rats gave the following results. An agonist at a concentration of 10^{-9} M increased the heart rate from 140.4 ± 21 bpm to 163.8 ± 28.7 bpm by the 6th minute of the experiment. Then, by the 15th minute of observation, heart rate was restored to its initial values and amounted to 141.3 ± 19.4 bpm. An α_2 -adrenoreceptor agonist - clonidine hydrochloride 5 minutes after application led to a decrease in CF from 1.1 ± 0.1 ml/min to 0.8 ± 0.1 ml/min ($p < 0.05$), i.e. the decrease was 21%. Then, the coronary flow tended to recover to 0.99 ± 0.1 ml/min by the 15th minute of the experiment.

Administration of clonidine (10^{-8} M) to 3-week-old rats reduced the heart rate from 230.1 ± 19.9 bpm to 200.2 ± 16.4 bpm ($p < 0.01$) at the 10th minute of observation. The maximum decrease in 22% at the final minute of observation was 181.4 ± 18.9 bpm ($p < 0.001$) (Fig. 1A). Perfusion with an α_2 -AR agonist promoted increase (by 10%) in the coronary flow from 1.67 ± 0.1 ml/min to 1.85 ± 0.01 ml/min ($p < 0.01$) by the 15th minute of observation (Fig. 2).

Application of an agonist at a concentration of 10^{-7} M reduced heart rate by 7 minutes from 228.9 ± 18.7 bpm to

185.5 ± 8.6 bpm ($p < 0.05$). By the 15th minute of observation, the decrease was 34%, the heart rate decreased to 175 ± 9.2 bpm ($p < 0.05$) (Fig. 1A, Fig. 4). Perfusion of an isolated heart with an α_2 -AR agonist exerted multidirectional effects on the coronary flow. In one group of animals, agonist-induced perfusion increased (by 11%) the blood supply to the heart from 1.46 ± 0.1 ml/min to 1.63 ± 0.1 ml/min ($p < 0.05$) by the 14th minute of the experiment (Fig. 2). In another group of animals, clonidine hydrochloride reduced the coronary flow from 1.63 ± 0.1 ml/min to 1.24 ± 0.1 ml/min. The reduction in coronary flow in this group of 3-week-old rats was 24%.

Application of an α_2 -AR agonist at a concentration of 10^{-6} M decreased the heart rate from 213.4 ± 15.3 bpm to 172.5 ± 9.6 bpm ($p < 0.01$) by the 7th minute of the experiment. By the final minute of observation, the heart rate was 147.8 ± 8.6 bpm ($p < 0.001$) (Fig. 1A, 1B). Bradycardia was 31% of the baseline. The coronary flow of an isolated heart decreased by 11% when applied with clonidine hydrochloride from 1.37 ± 0.1 ml/min to 1.22 ± 0.1 ml/min ($p < 0.05$) by the 14th minute of the experiment (Fig. 2).

The whole-body studies revealed that an α_2 -adrenergic receptor agonist - clonidine hydrochloride, causes bradycardia in 3-week-old rats. The maximum decrease was observed at the 40th minute of the experiment and amounted to 36% ($p < 0.01$) of the initial value (Fig. 3).

SUMMARY

The whole-body studies revealed that intravenous

administration of clonidine hydrochloride causes bradycardia in 3-week-old rats. Application of an α_2 -adrenergic receptors agonist - clonidine hydrochloride in experiments on a Langendorff-isolated heart of 3-week-old-rats causes a decrease in heart rate. The severity of this effect has a concentration dependence. Clonidine had a multidirectional effect on the blood supply to the heart. An agonist at a concentration of 10–9 M and 10–6 M reduces, and a concentration of 10–8 M increases the coronary flow. Clonidine hydrochloride at a concentration of 10⁻⁷ M causes the multidirectional effects of heart circulation in 3-week-old-rats.

CONCLUSION

Ex vivo results of 3-week-old rats showed that application of an α_2 -adrenergic receptor agonist - clonidine hydrochloride in a concentration range in a perfused solution causes a decrease in heart rate. Comparison of the results of a decrease in heart rate on a whole organism and on an isolated heart showed that the effect of stimulation of α_2 -adrenergic receptors on heart rate is higher in a whole body. Perhaps this is due to the effect on the heart of central and peripheral regulatory mechanisms. The previously obtained results of the influence of an α_2 -adrenergic receptor agonist on the chronotropic function of the heart of adult animals showed that clonidine hydrochloride also causes negative chronotropic and hypotensive effects (Zefirov, 2014). In the isolated heart of adult animals, the α_2 -adrenergic receptor agonist had multidirectional effects on heart rate and CF (Ziatdinova, 2018). Activation of α_2 -adrenergic receptors has a multidirectional effect on the coronary flow of an isolated heart of 3-week-old rats. The multidirectional effect of stimulation of α_2 -adrenergic receptors on CF can be associated with different localization (pre- and postsynaptic) of different subtypes of α_2 -AR, as well as the ability of these adrenoreceptors to bind to different G-proteins. On the one hand, the interaction of α_2 -adrenergic receptors with inhibitory G_i and G_o proteins, which reduce the activity of adenylate cyclase, is known. However, α_2 -AR can also bind to G_s proteins, which increase the activity of adenylate cyclase. Thus, our results suggest possible participation of α_2 -AR in the regulation of the cardiac function at the stage of formation of sympathetic innervation.

CONFLICT of INTERESTS

The author declares that the presented data contain no conflicts of interest.

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Structural Features of the Southern Border of the Caspian Depression According To Geological and Geophysical Data and Prospects for the Search for New Hydrocarbon Accumulations

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ABSTRACT

The southern border of the Caspian depression along the subsalt Paleozoic complex is a complex fault system, formed due to the right-hand shift of the Scythian-Turan plate at the border of the Sakmara and Artin centuries. Prior to this, the long-developing depression was connected with the Tethys Paleo-Ocean and was relatively deep-water: by the beginning of the kungur, the depth in the center exceeded 1.5 km. In the south of the Caspian depression, in subsalt sediments, there are two groups of carbonate massifs and platforms: Astrakhan-Smushkovsko-Karakulskaya and Kashagan-Tengiz-South-Embinskaya. The analysis of the paleo-depths in combination with the available geological and seismic materials allows us to clarify the contours of the zones of carbonate massifs: Astrakhan, Kashagan, Primorsky, Korolevskiy and Tengiz. Between the Kashagan-Tengiz and Astrakhan-Smushkovsko-Karakul groups of carbonate complexes in pre-Martian times there was a connection between the Caspian depression and the Paleotetis Ocean. One of the factors is the inversion of large blocks along the basement and Lower Paleozoic (Devonian). Based on the analysis of the structure and paleobatimetry of the sedimentation depression, the prospects of oil and gas potential and the search for new hydrocarbon accumulations on the periphery of the Zhayylgan carbonate massif are specified. The next direction is the additional exploration of a number of carbonate massifs and the discovery of objects of the Akzhar Vostochny and Karatyube Yuzhnaya type, associated with the proposed extension upstream of the fracture zones.

KEY WORDS: Caspian Depression, Southern Border of the Caspian Depression, Structural Features, Faults.

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INTRODUCTION

The Caspian depression is one of the most important oil and gas provinces of the world with a unique geological structure and rich oil and gas potential. The proven vertical range of petroleum potential covers sediments from the Middle Devonian to Neogene, inclusive. The main share of proven reserves and forecast resources of hydrocarbon raw materials is associated with the Late Paleozoic (pre-Dungur) complex and, mainly, with the Devonian and Carboniferous carbonate rocks. Natural reservoirs are characterized not only by specific areal development, complex combinations of reservoir types and tank-filtration parameters, but also differentiated oil and gas bearing features within local traps and in large areas of carbonate development. These features still cause an

increased interest in these parts of the Paleozoic section on land and in the aquatorial part of the Kazakhstan sector of the Caspian Sea. Modern onboard zones of the Caspian Depression are characterized by a rather wide development of Late Paleozoic carbonate complexes, which in some cases form isolated zones that have been called "introdpression carbonate platforms". Such introdpression carbonate platforms are widely developed in the south of the Caspian Depression (Astrakhan, Tengiz-Kashagan, South Embin), they are also found in the east and in the north of the depression - Temir, Zhanazhol and Karachaganak platforms, respectively.

The increased interest in these introdpression carbonate platforms is related to the fact that oil and gas condensate fields have been identified within them, with four of them characterized by the presence of fields with proven huge gas reserves (Astrakhan), oil (Tengiz and Kashagan) and gas condensate with oil (Karachaganak). In general, the hydrocarbon reserves, concentrated within carbonate massifs, significantly exceed the accumulation reserves associated with terrigenous subsalt complexes. The main prospects for the search for new large deposits,

which will determine the level of production in the coming decades, are also associated with large carbonate massifs (Abilkhasimov 2016).

Thus, the significance of studies of the structure and patterns of development of carbonate platforms, as new large promising objects, for the development of the raw material base of the Republic of Kazakhstan cannot be questioned. An important aspect of the prediction of the spread of platforms is the question of the reasons for the occurrence of conditions of intense carbon accumulation in certain shelf zones. The controlling agents for the occurrence and growth of carbonate platforms, their morphology and the nature of biological communities are the speed of subsidence, sea level fluctuations, and climatic factors. As shown by the study of giant fields - Karachaganak, Tengiz, Kashagan, Zhanazhol - the structure of the reservoir within their limits is very complex, due to numerous reasons. Five the largest in area depression-based carbonate platforms are confined to the southern part of the Caspian Depression, covering both it on land and the aquatorial zone. That is why large natural reservoirs of the Caspian Depression were

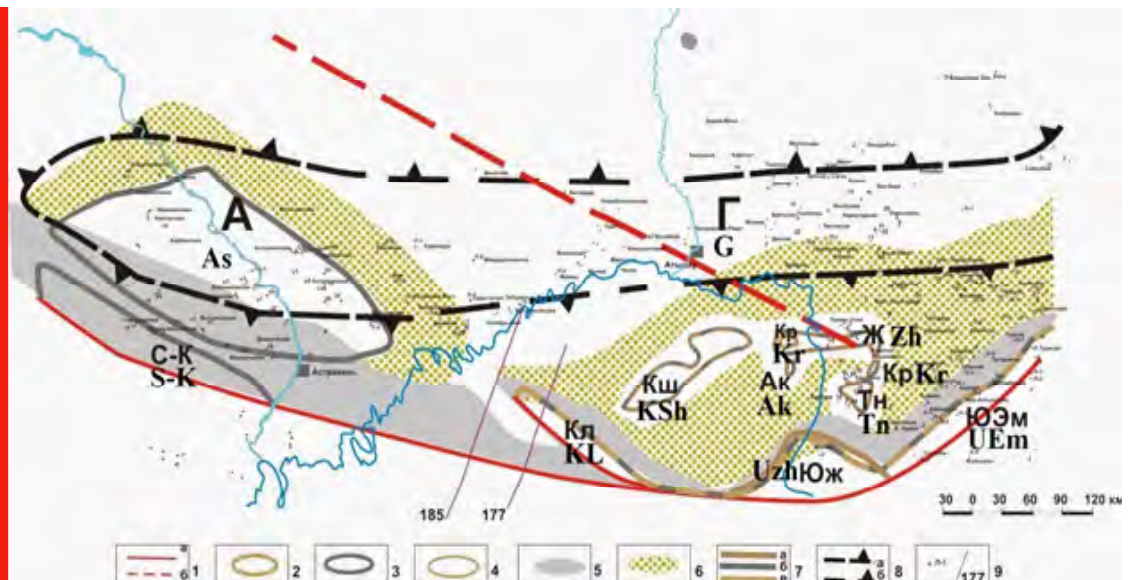


Fig. 1: Tectonic diagram of the Paleozoic complex of the southern part of the Caspian depression.
Notes: 1 - faults: a- onboard and preboard, b-Azgirsky; 2-4 - contours of carbonate massifs (2-Devonian-Tournaisian, 3-Lower Bashkir, 4-Assel-Sakmara); 5 - instrument cones of removal of artinsky terrigenous deposits; 6 - distribution area of oil-bearing clay-carbonate deposition deposits; 7 - age of the boundary of carbonate platforms: a-Devonian-Tournaisian, b-Lower Bashkir, c-Assel-Sakmara; 8 - the border of the Astrakhan-Aktobe zone of elevated bedding: a-confident, b-presumed; 9-well and seismic-geological profiles. Foundation ledges: A - Astrakhansky, G - Guryevsky. Carbonate massifs and platforms: As-Astrakhansky, Ksh- Kashagansky, Zh- Zhylgansky, Kr- Kairansky, Ak- Aktopy, Kr- Korolevsky, Tn- Tengiz, S-K – Smushkovsko-Karaulskaya, Kl- Kalamkas-more, Uzh- Uzhanaya, UEm- South Embin.

chosen as objects of research. The studies analyzed the structure, conditions for the development and development of carbonate massifs of the Caspian depression and modern concepts of sedimentology and tectonics, study the morphological manifestation of carbonate massifs, identify structural and facial zonality, evaluate their role as possible objects for searching for large and giant hydrocarbon accumulations. The generalization and analysis of geological and geophysical data obtained over the past 25 years allowed us to identify new carbonate and terrigenous structures within the Caspian depression, whose prospects are being refined. The potential of terrigenous natural reservoirs is still under-explored. Removal cones have already been installed by some researchers in the Lower Permian and coal deposits. Similar debris cones are predicted in Devonian sediments.

Oceanological studies on the continental slopes of North America show the presence of submarine canyons with large depths filled with coarse sand and gravel sediments. Of particular interest are underwater debris cones, confined to the continental slopes of carbonate platforms, and forming lithological limited natural reservoirs. The discovery of a number of promising structures in the northern part of the Caspian water area and adjacent territories on land, as well as in the northern onboard zone, made it possible

to re-evaluate the potential in the whole of the Caspian Depression.

The obtained new geological and geophysical data proving the distribution to the water area of carbonate massifs of the subsalt Paleozoic sequence make this region very promising in search of new types of natural reservoirs. On the basis of new geological and geophysical data, the author has compiled a diagram of the prospects for the oil and gas potential of the subsalt Paleozoic complex of the Caspian depression. Most researchers draw the southern border of the Caspian depression along the fault, which on the Astrakhan-Kalmyk section is considered as the eastern extension of the North-Donets thrust (Volozh & Parasynov 2008; Zonenshein et al. 1990; Leonov et al. 2010).

To the east, in the northern waters of the Caspian Sea and in the area of the South Emba Rise, a fault is distinguished that is not interpreted as a thrust. The analysis of the history of the geological development of the south of the Caspian depression allowed us to present in a different way the peculiarities of the formation of the large structural forms available here.

The discovery of a large array of carbonate rocks in the lower reaches of the river. The Volga, known as the

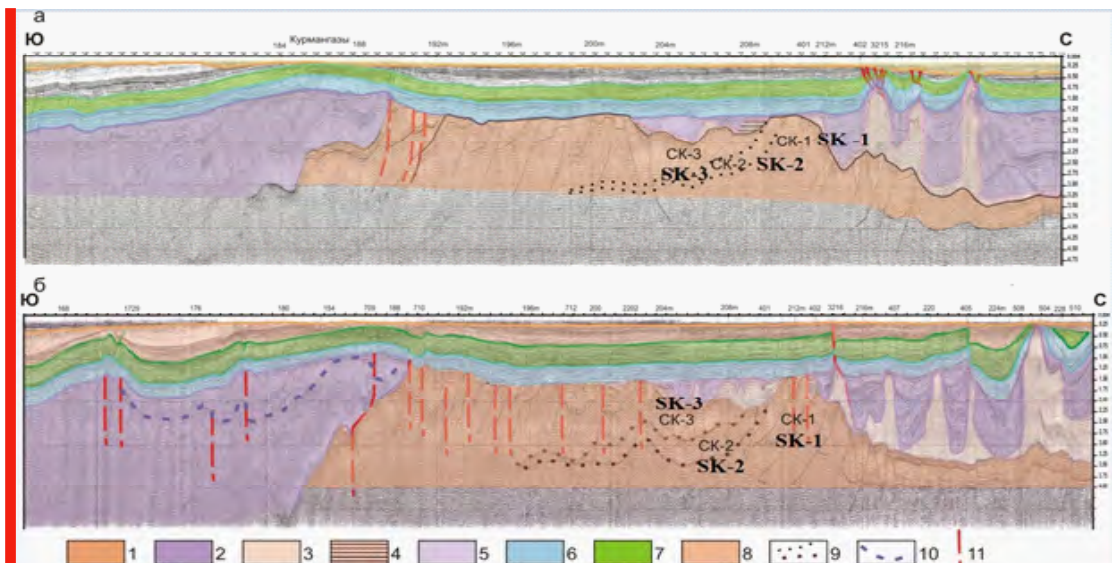


Fig. 2: Regional seismic profiles 185 and 177.

Notes: 1-8 - stratigraphic complexes: 1-pre-Kungur deposits, 2-triassic of the Caspian plate, 3-4-saline sediments of the kungur (3-participating in halogenesis, 4-primary), 5-triassic of the Caspian Sea, 6-yura, 7-chalk, 8 cenozoic; 9 - seismic complexes in the Dokungur Paleozoic; 10 - the estimated folding in the Triassic of the Caspian Plate; 11 - faults.

Astrakhan Arch, has created confusion in the minds of geologists. Some researchers tried to combine it with the zone of the Karaton-Tengiz atoll-like buildings (Volozh & Parasyn 2008; Leonov et al. 2010), although some interpreted the latter as tectonic uplifts (Kozhabaev and others). As an argument in favor of such an interpretation, the fact of the absence in the section of sediments of most of the Middle and Upper Carboniferous and Assel-Sakmarian strata of the Lower Permian was cited. As far back as 1991 in research of Obryadchikov et al. (1991) it was shown that instead of the supposed Pre-Martian uplift and erosion of previously deposited sediments, in the middle of the Bashkir century, the central regions of the Caspian Depression lowered, as a result of which the tops of the carbonate massifs came out from under the level of shallow carbonate sedimentation and, during For about 40 million years, sedimentation did not occur on them.

Literature Review

In the process of preparing the study, it was reviewed the results of the studies of G.M. Avanisyan, A.A. Aksenov, A.D. Arkhangelsky, V.P. Avrov, M.S. Arababai, V.A. Bobukh, G.A. I.O. Brod, A.Ya. Brodsky, Yu.M. Vasiliev, N.V. Voronin, A.G. Gabrielyan, V.V. Zhuravleva, L.V. Kalamkarova, D.P. Kasatkina, Yu. A. Kosygina, N.Ya. Kunin, L.G. Kirshkhina, S.P. Maksimov, N.V. Mizinova, G.A. Maslyayeva, E.V. Movshovich, V.D. Nalivkina, N.V. Nevolina, A.V. Ovcharenko, L.I. Rovnina, R. B. Sapozhnikova, V. L. Sokolova, V. P. Stupakova, D. L. Fedorov, K.E. Fomenko, V.E. Khain, M.O. Khvilevitsky, Yu.L. Tsvedel, N.S. Shatsky, A.E. Schlesinger, A.L. Yanshin and others.

According to the research of Zonenshein L.P., up to the Early Cambrian, the Ural Paleo-Ocean existed on the eastern border of the East European Platform, the passive margin of which is marked by thick sedimentary strata of the Riphean-Vendian of the Western slope of the Urals. The possible breakaway of part of the East European platform and the laying of this ocean in the Riphean-Vendian time are indicated by alkaline volcanics and acidic effusives of the Uraltau. In the Middle and Late Cambrian, occur short-term events of the collision of the East European continent with island arcs and microcontinent, which led to intense folding in accretion complexes and the continent's buildup due to their joining. At the end of the Cambrian, the outskirts of the continent under consideration were a folded structure, which was penetrated before the Ordovician.

N.V. Nevolin and others, taking into account the significant location and compaction of the Lower Carboniferous and Devonian sediments in the central part of the South Emba

Rise, classified this territory as unpromising in the oil and gas bearing. Eisenstadt et al., Who believe that the general geological prerequisites make it possible to count on the discovery of hydrocarbon deposits both on the slopes and in the central part of the South Emba Rise.

Since the second half of the 60s, subsalt deposits of the Caspian basin begin to be intensively studied by geological and geophysical work. Over the past 30 years, a significant amount of geophysical research has been carried out in the region and a number of deep wells have been drilled to reveal the rocks of the Pre-Kungur Paleozoic. The obtained new data are interpreted by researchers from different points of view.

Proponents of the tectonic concept explain the reduction in the thickness of individual stratigraphic units of the Middle-Upper Paleozoic to the inner parts of the syncline by the existence of continental breaks in sedimentation and erosion of sediments.

V.M. Posner and M.G. Aristarkhov proposed the development along the eastern and southern sides of the Caspian depression, large troughs and uplift zones framing them. In the Upper Devonian-Carboniferous deposits north of the Biikzhal zone, the Shubarkuduk trough was distinguished, which developed under conditions of uncompensated sedimentation of the trough. On the northern and southern sides of this trough, a carbonate type of section of subsalt deposits was assumed. The Biikzhalsky trough allocated to the south is filled with a thick terrigenous sequence, similar, in their opinion, to the greywacke formation, filling the Zhanazhol trough located to the east. According to these ideas, the Lower-Upper Carboniferous deposits lying above in the axial part of the Biikzhal trough are represented by facies of uncompensated sedimentation, and on its sides - shallow-water carbonate strata of considerable thickness. According to G.S. Shurkina the most promising for the search for oil and gas is the zone of articulation of the terrigenous and carbonate types of the subsalt field.

N.N. Forsh suggested that there is a wide erosion terrace, which stretches along the eastern and southern sides of the Caspian basin and transgressively overlaps the Upper Artinian terrigenous deposits. He associated the prospects of oil and gas potential with the zone of the Biikzhal basement ledge, where a carbonate section of coal deposits was supposed. The main object of oil exploration was considered the Karaton zone of uplifts and the northern slope of the South Emba Rise. Close views on the structure

and oil and gas potential of subsalt Paleozoic deposits of the study area are held by U.A. Akchulakov, S.U. Utegaliev, K.M. Taskinbaev, A.A. Akkulov et al. The most promising in relation to oil and gas accumulation, according to these authors, are inherited internal marginal uplifts — the Shukatskoye and others — that developed throughout the pre-Kungur Paleozoic.

Also, there are many other works which are of great value in the research area of structural features of the southern border of the Caspian depression and search for new hydrocarbon accumulations. So, during the process of theoretical research we highlighted some interesting works of domestic scientist in the area of our study. Among them Zinkovskiy V.E. (1984) in his work “Geological structure and gas potential of the southwestern part of the Caspian depression according to a complex of geophysical data” provides complex data of his research on geological structure of Caspian depression. Kuznetsov V.G. (2007) with his “Paleozoic reefs of the Caspian depression and their petroleum potential” complexly review data in easy and understandable way.

Some authors also should be highlighted, for example, Khain V.E. (2001); Zholtaev G. Zh. (2003); Kazantsev Yu.V. and Kazantseva T.T. (2003); Li Yuhun (2006); Abilkhasimov Kh. B. (2008); Richter J. A. (2010); Matloshinsky N.G. (2012); Kiinov L.K., Iskaziev K.O., Karimov S.G., Kovrizhnyh P.N. and Shagirov B. B. (2014); Myazina N.G. (2014); Kuandykov B.M. and Volozh Yu. A. (2015); Yin J., Zheng J., Li F., Xu X., Wu H. and Yu X. (2016); Azhgaliev D. K., Kovrizhnykh P. N., Shagirov B. B. and Karimov, S.G. (2018) and others. As it can be seen from our research, the theme of Caspian depression, its features, potential and future development are studied for many years. This is direct evidence that this topic and its aspects do not lose their relevance and require new research in this area.

MATERIAL AND METHODS

The Caspian depression, which covers more than 600,000 km², occupies a regional position within the southeastern part of the East European Platform. The western and northern boundaries of the depression are carried out along the Lower Permian tectonic-sedimentary carbonate ledge separating it from the Volga-Ural province and the

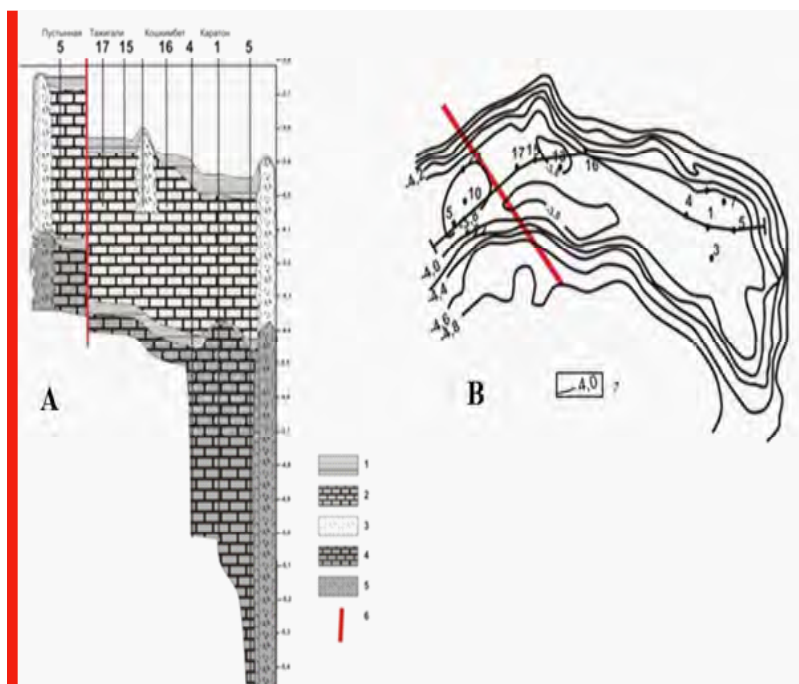


Fig. 3: Zhayylgan atoll-like carbonate massif.

(A - section along the line I-I, B - structural diagram along the reflecting boundary P2)

Notes: 1 - tufous mudstones of the Artinskian stage; 2 - organogenic and organogenic clastic rocks of the Late Viséan-Early Bashkir age; 3 - reef rocks of the Late Viséan-Early Bashkir age; 4 - organogenic and organogenic clastic rocks of the Late Devonian-Tournaisian age; 5 - reef rocks of the Late Devonian-Tournaisian age; 6 - line of the Azgir regional fault

Volga monocline. In the east, the depression is framed by the folded structures of the Urals and Mugodzhur, in the south-west it is separated by the Donetsk-Astrakhan regional seam from the Scythian plate. From the west and north, it is bounded by areas of a shallow basement (3–6 km), the surface of which to its central part increases to depths of 15–22 km.

The depths of the oil and gas horizons range from 200 m to 800-1000 m, rarely up to 2000-3000m. Subsalt deposits (Lower Permian, Carboniferous, Devonian, and probably ancient) certainly possess the main oil and gas potential in the Caspian province. The oil and gas potential of the over-salt sedimentary complex also remains quite high.

Considering the peculiarities of petroleum potential of Paleozoic carbonate platforms, it should be noted a certain spatial distribution of liquid and gaseous hydrocarbons along the side sections of the depression. In the northern and north-western parts, mainly oil and gas condensate, in the eastern and southern parts of the depression - oil-bearing, in the south-west - gas condensate. In the subsalt deposits of the Caspian depression, regional oil and gas potential has been established with a predominant concentration of hydrocarbon reserves in a small number of large deposits in carbonate reservoirs. The development of carbonate reservoirs of various types was recorded in a wide stratigraphic range: from the Middle Devonian to the Artinsky stage of the Early Permian. Late Paleozoic natural reservoirs allocated in the Caspian Depression differ significantly among themselves in terms of the lithological composition and stratigraphic range of the sediments and their oil and gas occurrence.

The main, leading and guiding factor in the formation, placement and preservation of productive strata, zones of oil and gas accumulation and individual deposits is tectonic. This controlling factor in almost all the historical development of the region acted in a positive direction. The long-term tendency to deflection led to the accumulation of thick strata (up to 15–16 km in the central part of the depression) of sedimentary rocks. This circumstance ensured the warming-up of the buried decaying organic matter (DOM) and its passage through all the necessary transformation phases. The powerful salt-bearing complex of Kungur created a reliable insulating thickness for the underlying more ancient sediments.

Regional geotectonic movements largely determined the facial boundaries of the distribution and thickness of sediments of the sedimentary complex of the Caspian

Depression, the sources of demolition at different stages of the depression evolution. All this 181 and created a complex picture of the distribution of terrigenous and carbonate rocks in the Paleozoic complex, which is extremely important for petrogeological zoning and reasonable assessment, and forecasting the prospects for petroleum potential (Kleschev et al. 1995).

Until the first half of the 1960s geological and geophysical study of the southwestern part of the Caspian basin was carried out sporadically. It was associated mainly with the suprasalt Mesozoic complex of rocks. A series of gas deposits (Bugrinskoye, Shadzinskoye, Pustynnoye, Sovkhoznoye, etc.) were identified by prospecting in the supersalt complex. In the period 1991-1996 number of structures were identified in the Karakul-Smushkovskaya zone of uplifts and a forecast was given for the zones of development of oil and gas bearing reservoirs. Exploratory drilling was carried out for subsalt deposits on the Astrakhan arch and the uplift adjoining from the south of the Karakul-Smushkovsky zone.

In 1976, the Astrakhan gas condensate field in the Bashkir carbonate deposits, and then the Alekseevskoye and Tabakovskoye gas condensate deposits, the largest in reserves and unique in composition of reservoir gas, were discovered in the central part of the arch. In recent decades, scientists and geologists have been interested mainly in deeply buried sediments of the subsalt complex of the Caspian Depression. Today, the actual geological material unevenly characterizes the vertical and lateral section within the territory of the southwestern part of the Caspian depression.

Analysis of the vast geological material obtained in the process of exploration related to the study of the subsalt part of the Caspian basin allows us to restore the course of sediment accumulation and to reveal patterns of distribution of hydrocarbon deposits in the suprasalt part of this territory. The influence of tectonic and paleotectonic factors on the formation of oil and gas fields in the Caspian depression occurs under a favorable combination of lithological-facies, geochemical, hydrogeological and thermobaric conditions that control oil and gas formation and oil and gas accumulation in sedimentary basins (Voronin 1999).

In solving the problem of the formation and placement of hydrocarbon deposits, in addition to the tectonic factor, the study of lithological features of deposits, the determination of the laws of their formation, and distribution in space and time are of great importance. A number of

Soviet geological scientists wrote in their works that the clarification of these patterns is most objectively possible on a historical and genetic basis, which allows revealing the process of formation and conservation of oil and gas deposits throughout the history of geological development (Bakirov 1973).

In the history of the formation of the region under consideration, several tectonic boundaries can be distinguished. The first is associated with the end of the formation of the crystalline basement, the second - with the formation of a carbonate subsalt complex, the third - with the formation of a saltiferous stratum in the Meso-Cenozoic sedimentary section. In the Kungur century of early Perm, a stage of development began near the Caspian Basin, accompanied by the formation of a salt basin and the accumulation of precipitation specific for such epochs - a halogen formation.

The Caspian basin is one of the most promising regions of Russia and Kazakhstan for hydrocarbon raw materials. The discovery in recent decades of a number of large hydrocarbon deposits within the Caspian sedimentary basin has put this area into the category of the most significant regions of the fuel and energy complex. However, the assessment of the oil and gas potential of large (starting from 5 km) depths in this area is still far from its resolution. It is known that unexplored hydrocarbon resources of the Caspian Basin exceed 95% of their potential (The structure of the southeast of the East European Platform (Caspian Depression) (Caspian Sea 2006; Caspian Sea Area 2010).

The Caspian basin is unique in that the ancient Precambrian crystalline basement in its center is submerged to a depth of 22-24 km (geophysical data). On the territory of Russia is 1/3 of the Caspian depression, 2/3 - in Kazakhstan. In this regard, it is planned to conduct reconnaissance on land and at sea in Kazakhstan and Russia.

In 2017, after a 4-year delay, Kazakhstan still hopes to form an International Consortium for the implementation of the Eurasia project. The project involves the drilling of an ultra-deep well with a depth of 15 km, which will allow, if successful, to detect hydrocarbon deposits at a depth of 7-9 km in the region of the Caspian Depression. Interest in the Eurasia project was expressed by Rosneft, Rosgeology, Chevron, Burisma, CNPC, NEOS Geosolution and SOCAR (The Caspian depression is attracting increasing interest. Rosgeology will study the hydrocarbon-promising depression region, 2016).

The Caspian basin is one of the largest geological objects in the world. Huge accumulations of hydrocarbons are concentrated in its sedimentary cover, which determines the strategy of exploration for oil and gas in southern Russia in the 21st century. The Caspian basin is the southeastern outskirts of the Precambrian East European platform. This is the largest superordinate negative structure. It is characterized by stable and prolonged subsidence of the earth's crust with the accumulation of thick strata of sedimentary formations of a large stratigraphic range.

The entire course of the geological development of this territory led to the peculiar structure of the platform cover, the formation of a section of the thick stratum of sulfate-halogen deposits of the Kungur age and, as a result, the presence of two large structural floors. The lower, subsalt, is composed of carbonate-terrigenous deposits of the Paleozoic age, and the upper, suprasalt, and is represented by halogen and mainly terrigenous deposits of the Kungur-Quaternary age. In the southwestern part of the Caspian depression, structures such as the Astrakhan arch, the Karasal monocline, the Sarpinsky and Zavolzhsy troughs, and the Karakul-Smushkovskaya zone of uplifts are distinguished (Barmin et al. 2016).

RESULTS AND DISCUSSION

Artinsky argillite-like deposits on the surface of the Astrakhan carbonate bank fell after filling the North Karakul trough. At the Tengiz, Zhayylgan, Korolev, Kashagan and other atoll-like carbonate structures, their appearance is associated with the loss of tuff-argillites transferred by aerobic transport, apparently, coming from the volcanic island arcs located to the south.

From the region of Astrakhan, an arc of elevated basement with the Astrakhan, Guryevsky, Zharkamysky and Enbeksy arches stretches in an arcuate direction towards the Aktobe Ural region (Figure 1).

The Astrakhan and Enbeksy Devonian-Carboniferous carbonate massifs are located above the ledges of the foundation, and the Kashagan, Zhyylgansky, Tengiz massifs and the South Emba carbonate platform fall into the zone of its deep immersion, which indicates the absence of direct connection between them.

The initial position of the carbonate strata of the Karakul-Smushkovskaya and South-Emba zones occupied a much larger area, extending tens or even hundreds of kilometers to the south. The Scythian-Turan plate was unified and was located to the east. In the pre-Sakmar Paleozoic,

the Caspian depression on the southern outskirts had a connection with the Tethys Ocean. In the Karakul-Smushkovsky and South Embin areas during the Visean-Early Bashkir time (on the southern Embin uplift up to and including the Sakmara) carbonate platforms existed with organogenic constructions along the peripheral part.

We assume that on the border of the Sakmar and Artin centuries the Scythian-Turan plate shifted towards the Rostov ledge and blocked the connection of the deep-water Caspian depression with the Tethys Ocean (Obryadchikov & Taskinbaev 2004; Obryadchikov & Taskinbaev 2015; Obryadchikov & Goryunova 2016). The uplifts resulting from this in the Artinian age served as a source of demolition of a large volume of clastic material. The right-side displacement of the Scythian-Turan plate and associated microblocks was also accompanied by their rise and erosion (Obryadchikov & Taskinbaev 2004). Therefore, the presence of the ancient fauna in demolished detrital rocks indicates their redeposition.

An interesting fact is the discovery in Kairan of a reef built of Assel-Sakmar age. Its appearance was facilitated by the loss in the pre-Asselian time of a 30-meter stratum of tuff argillites, which created favorable paleo-shallow-water conditions (the paleobatimetry of the bottom turned out to be higher than the level of shallow carbonating sedimentation) for the formation of an atoll-like carbonate structure. This made it possible to restore paleobatimetric conditions in the Early Permian in the south of the Caspian Depression. If, by the beginning of the formation of the Assel-Sakmarian organogenic structure in Kairan, the sea depth was less than 50 m and plus 30 m of the pre-Assasian tuff argillites, the heights of the Zhayylgan Devonian-Lower Bashkir and Assel-Sakmar atoll-like massifs, paleobatimetry of the Pre-Martian depression would be about 1500 m.

The right-side displacement of the Scythian-Turan plate and the microblocks attached to it changed the structure of the Karakul-Smushkovsky zone of carbonates, which manifested itself in the formation of fold-type folds, and in the Northern Caspian, the torn Kalamkasomorsk block moved northwest from the Bozashi Peninsula. On seismic sections 185 and 177, crossing the southern onboard zone, the position of the ledge along the Artinsky terrigenous deposits is shown, which was also the southern boundary of the Kungur salt-water depression, a small depression between it and the Kalamkas-Sea uplift, to the north of which was a deep-water salt-water, and then the salt-dome Prikaspiy (Figure 2). Profiles 185 and 177 are shown in the

tectonic diagram of the south of the Caspian depression (Figure 1).

The "unification" of the carbonate masses of Astrakhan, Kashagan, Primorsky, Royal and Tengiz into a single carbonate platform, which was supposed by many researchers, seems erroneous. Between the Kashagan-Tengiz and Astrakhan-Smushkovsko-Karakul groups of carbonate complexes in pre-Martian times there was a connection between the Caspian depression and the Tethys Ocean.

At present, the genesis of the formation of unique and large accumulations of oil and gas in the south of the Caspian depression remains unclear. A unique sulfur-gas condensate field was discovered at the Astrakhan carbonate massif, and oil inflows from carbon deposits were obtained. In the northern part of the Caspian Sea and adjacent areas of South Embin, unique oil accumulations have also been explored at the Kashagan, Kairan, Tengiz, Korolevskoye and Aktoty fields. There is convincing evidence that many oil accumulations in suprasalt deposits are associated with vertical migration from the mentioned deposits in the subsalt complex. For example, oil deposits in the salt-dome structures of Tazhigali, Koshkimbet, Terenuzyuk, Karaton were formed due to overflow from a unique cluster on the Zhyyylgan atoll-like carbonate massif. According to conservative estimates, it contained more than 20 billion tons, of which a large accumulation of hydrocarbons was preserved only in the Kairan Assel-Sakmar atoll-like superstructure in the west.

As a result of geodynamic processes at the Paleozoic-Mesozoic boundary, a previously unified Scythian-Turan plate split and the modern Turan part shifted along the Mangyshlak-Central-Ustyurt fault in a southeast direction. A new Caspian Plate arose, and the territory located to the north changed the regional slope from north to south with the appearance of a specific Azgir fault (Obryadchikov & Taskinbaev 2004). It extends from the area of Lake Baskunchak to the Zhyyylgan carbonate massif, which led to the almost complete destruction of the giant accumulation of oil (Figure 3). The parametric well P-1 Mintobe, drilled near the Azgir fault, established a high temperature gradient in the range of 3300-4500 m - more than 120C/100m, reaching 2540C at the bottom.

The high oil and gas potential of this region is due to the increased OM concentration in clay-carbonate sediments in the frame of massive atoll-like carbonate massifs

(Obryadchikov & Taskinbaev 2015; Obryadchikov & Taskinbaev 2012; The Caspian depression is attracting increasing interest 2016). In addition to lateral migration, a vertical variant of hydrocarbon overflow into overlying traps of the suprasalt complex of deposits is also possible, which is abundant in conditions of salt dome tectonics. This occurs along fracture zones arising above the marginal parts of carbonate massifs and ancient ledges of elevated blocks.

Prospects for the discovery of new accumulations of oil and gas are associated with the search for reef superstructures along the edges of the Zhyylgan atoll-like carbonate massif, which lie above the depths of its intersection with the Azgir fault, similar to the opened G-13 Tazhigali well, from which an industrial flow of oil was obtained. Despite their small size, well-targeted well placement will allow them to be evaluated and mastered cost-effectively.

The block structure of the basement and the Devonian sediments allows counting on the possibility of detecting oil deposits in clay-carbonate sediments of the Akzhar Vostochny type and in the pre-salt traps following the example of Karatyuba Yuzhny, formed due to vertical migration from below from depressive analogues on the slopes of atoll-like carbonate massifs and carbonate platforms. In this case, methodological prospecting should be initially aimed at searching for inverted raised blocks in the basement and Devonian sediments. Tracing up the alleged continuation of fracture zones, one should evaluate the probability of the presence of favorable zones with potential traps and in suprasalt deposits.

CONCLUSION

In conclusion, it should be emphasized that the high availability of petroleum potential of the Caspian deposits is due to the cumulative effect of a number of factors and conditions. The results of geochemical studies show that the oil in the subsalt complex was formed by the organic matter of the "marine", "continental" and "coastal-marine" types. This suggests the existence within the Caspian Basin of independent autonomous foci of oil and gas generation. Oil of similar composition was also found in the suprasalt sediments; this may be due to the migration of fluids from older strata to younger ones. Along with this, at great depths, which are in the stage of catagenesis, oil was found with traces of biodegradation, which is probably due to the early stage of formation of the reservoir and its subsequent dissolution. The presence of a powerful salt-screen Kungur age, which is a regional tire. Accumulation of carbonaceous sediments of different age in the inner side zones with a

wide development of reef facies in them. Preservation of high-capacity carbonate reservoirs in the conditions of large depths due to the development of reef-like facies of the Devonian complex.

Thus, the structural features of the southern border of the Caspian Basin were examined according to geological and geophysical data and the prospects for the search for new hydrocarbon accumulations. The structural features of the southern border of the Caspian Basin are highlighted and possible prospects for the search for new hydrocarbon accumulations are provided.

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On Bandwidth of the Symmetrical Six-Tooth-Shaped Monopole Microstrip Antenna

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ABSTRACT

A monopole microstrip antenna with a symmetric six-tooth-shaped radiator is considered. The tooth shape of the radiator is obtained by adding two symmetrical rectangular cutouts on each long side of the rectangular radiator. The dependence of the bandwidth on the base frequency on the geometric parameters of the antenna is studied. As the geometric parameters of the antenna are selected: the length and the width of the radiator, the depth of cutouts, the radiator scale, the thickness of the substrate, the length of the ground plane and the width of the feedline. The graphs of the dependences of the bandwidth on the geometric parameters are given. It established that an antenna with a wide shape of radiator and deep cutouts has a small bandwidth than an antenna with a narrow radiator and small cutouts. The decrease values of the bandwidth are mainly associated with an increase of the radiator width and the thickness of the substrate. It is revealed that a slight influence on the bandwidth is caused by changes of the radiator length. A regression analysis is carried out and a mathematical model is constructed that describes the relationship between the bandwidth and the length and the width of the radiator and the depth of cutouts. The root-mean-square and relative errors of the model are calculated. The proposed formula can be used in the design of a six-tooth-shaped antenna with wide bandwidth.

KEY WORDS: Bandwidth, Microstrip Antenna, Six-Tooth-Shaped Antenna, Bandwidth Enhancement, Regression Model.

INTRODUCTION

Today microstrip antennas are one of the most common and widely used types of antennas (Garg et al., 2001). The most studied of them are microstrip antennas with rectangular and other radiators of simple geometry

(Milligan, 2005; Balanis, 2016). However, the antennas are characterized by a narrow bandwidth and low gain, limiting their use in wireless systems. There are various methods to solve such problems (Elsagheer, 2016; Kumar et al., 2016; Sharma & Sharma, 2016; Goudah, & Yousef, 2012). It is often used the complex shape of its radiator to increase the antenna bandwidth, for example, clover shape (Palaniswamy et al., 2017), and also is made complex slots on the radiator (Ali et al., 2018; Sharma et al., 2019; Azarm et al., 2018, May). For example, slots in the form of the letter L (Mishra et al., 2014), the letters H and U (Ather & Singhal, 2013), the letters E (Sugumar et al., 2011), and also their combinations are used (Rao et al., 2014).

The defected ground structure (Khandelwal et al., 2017; Pokharkar & Bhosale, 2014), and modified ground plane (Mondal & Sarkar, 2017; Prombutr et al., 2009), techniques are used, including metamaterials (Bougoutaia et al., 2016; Daniel et al., 2018). Due to various approaches to antenna optimization, it is achieved not only an increase of the bandwidth, but also improvements in other antenna

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characteristics. One of the promising areas is the designing tooth-shaped antennas (antennas with cutouts on the sides of a rectangular radiator). For example, in (Kaltch & Nikmehr, 2002), such an antenna with cutouts on only one side is considered, and in a symmetrical tooth-shaped antenna is studied (Markina et al., 2017; Pawar et al., 2017).

In Boutejdar et al., (2015), a tooth-shaped antenna with stepped radiating elements is considered, and in (Mandal, 2016), a tooth-shaped microstrip patch antenna with seven operating ranges is presented. However, the design process of any antenna that satisfies certain requirements of a wireless system (Wi-Fi, WLAN, WiMAX, UWB) is quite lengthy and time-consuming. One of the developing approaches is the use of regression models that describe the relationship of the electrodynamic characteristics of the antenna with its geometric shape (Tumakov et al., 2017).

Using these dependencies, it is possible to determine the shape of the antenna, which will be well-matched in a given frequency range. This approach facilitates the antenna design process and allows to get the antenna with the desired characteristics in a short period of time. For example, in works (Markina & Tumakov, 2018; Tumakov et al., 2019), multi-tooth-shaped monopole antennas are designed using regression models.

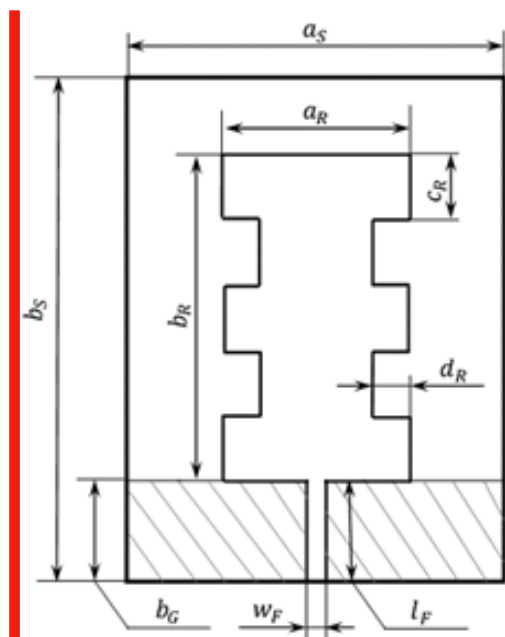


Fig. 1: The construction of the symmetrical six-tooth-shaped microstrip antenna (ST SMA)

The present paper is a continuation of the works (Markina et al., 2017; Markina et al., 2018; Markina et al., 2018; Markina et al., 2018), aimed at studying the relationship between the electrical characteristics and the physical parameters of monopole tooth-shaped antennas. In the paper, we investigate the influence of the radiator geometry on the bandwidth on the base frequency for a symmetrical six-tooth-shaped microstrip antenna. At the beginning of the work, graphs are presented and analyzed, which show the change of the bandwidth with varying dimensions of the radiator and the depth of symmetrical rectangular cutouts. The following the process of constructing a regression model is described, which represents some functional dependence on these three main parameters of the radiator. The relative and absolute errors of the obtained model are calculated. In the last paragraph, the results of studying the change of the bandwidth on the base frequency with increasing feedline width, radiator scale, substrate thickness and ground plane length are analyzed.

Problem Statement

Let us consider in Fig. 1 an antenna from the family of tooth-shaped microstrip monopole antennas. The radiator of the antenna is a thin metal plate and has a symmetrical six-tooth shape described by the parameters a_R , b_R , d_R , c_R ; where a_R and b_R is the width and the length of the radiator, d_R is the depth rectangular cutouts, and c_R is the length of the protruding tooth. A tooth-shaped metal plate is located on the front side of the substrate and is fed from a source with a resistance of 50Ω through the feedline. The dimensions of the feedline are described by its width w_F and length l_F .

On the reverse side of the substrate is a thin rectangular metal plate called as a ground plane. In Fig. 1, the plate is indicated by a shaded area. The width of the ground plane coincides with the substrate width, and the length is specified by the parameter b_G ($b_G = l_G$). The antenna substrate is uniformly filled with a dielectric with the dielectric constant $\epsilon_r = 4.5$, the material density $\rho = 1000 \text{ kg/m}^3$ and the dielectric loss tangent $\tan \delta = 0$. The substrate dimensions are described by the parameters a_S , b_S and thickness t_S .

It is necessary to study the influence of the geometric parameters of the radiator (a_R , b_R , d_R) on the bandwidth on the base frequency f at $S_{11} < -5 \text{ dB}$.

For this, we performed numerical experiments in the FEKO program. The values of the radiator length b_R are changed from 24 mm to 41 mm, the values of the radiator

width a_R are from 10 mm to 24 mm, and the values of the depth of cutouts d_R are from 0.5 mm to $(a_R/2 - 0.1)$ mm (depending on the width of the radiator). Next, we perform a regression analysis for the obtained data and construct a mathematical model of the antenna bandwidth as a function of the length b_R , the width a_R of the radiator and the depth of the rectangular cutouts d_R .

Analysis of the effect of radiator parameter changes on the bandwidth

We investigated the influence of the radiator dimensions and the depth of rectangular cutouts (on its long sides) on the bandwidth on the base frequency. In Fig. 2, we present the dependence of the bandwidth (BW) on the depth of cutouts on the radiator d_R for various plate lengths of 24 mm, 32.5 mm and 41 mm. Curves with white figures correspond to the radiator width of 10 mm, and curves with black figures correspond to the radiator width of 20 mm. According to the behavior of the graphs with white figures, we can conclude that the bandwidth decreases monotonically from about 0.8 GHz to 0.42 GHz with an increase in the depth of cutouts d_R . The behavior of BW is

observed at different values d_R of the radiator length.

However, the curves with black figures show that the values of BW monotonically increase from approximately 0.19 GHz to 0.4 GHz at d_R is changed from 0.9 (0.5) mm to 7.2 (6.5) mm for $b_R = 32.5$ mm and 41 mm, and at d_R from 4.8 mm to 7.2 mm for $b_R = 24$ mm. With a further increase in the depth of cutouts on the radiator, the bandwidth decreases to 0.25 GHz in all three cases of radiator lengths. From this we can conclude that the elongated and with small cutouts radiators is characterized a large bandwidth, and the radiator width and the depth of the cutouts influence the change in its values.

Now we consider the behavior of the bandwidth in Fig. 3, where the curves with white figures correspond to the radiator width of 15 mm, and the curves with black figures correspond to the radiator width of 24 mm. We can immediately notice that the values of BW are less than in Fig. 2 and this is due to the increase of the radiator width. For graphs with white figures, we have a similar decrease of the bandwidth with increasing cutouts depth, with BW changing from 0.58 GHz to 0.34 GHz at $b_R = 32.5$ mm and 41 mm.

However, for a slightly elongated radiator with a size of 15 by 24 mm (see the graph with white circles in Fig. 3), we have an increase in the BW value from 0.47 GHz to 0.62 GHz with a change in d_R from 0.5 mm to 4 mm and a decrease in BW from 0.62 GHz to 0.38 GHz with a further

a_s	b_s	t_s	a_R	b_R	d_R	c_R	b_G	w_F	l_F
30	75	1	10	24	0.5	4,8	15	1	15

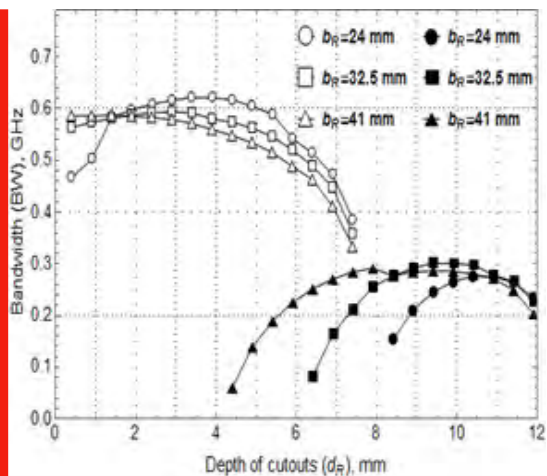


Fig. 3: The dependences of the bandwidth of the base frequency on the depth of the cutouts with various radiator length (white figures correspond to a radiator width of 15 mm; black figures correspond to a radiator width of 24 mm)

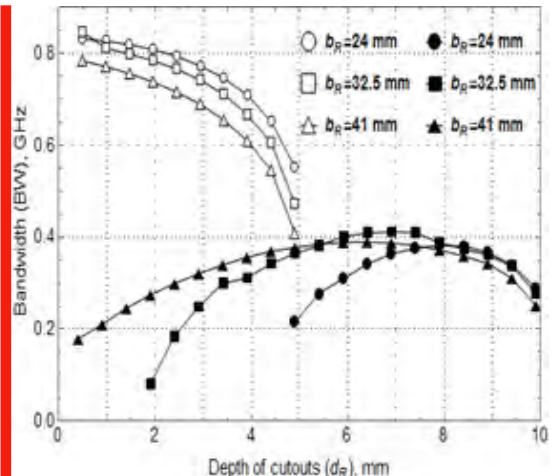


Fig. 2: The dependences of the bandwidth of the base frequency on the depth of the cutouts with various radiator length (white figures correspond to a radiator width of 10 mm; black figures correspond to a radiator width of 20 mm)

increase in values of d_R . The behavior of the curves with black figures is characterized first by an increase of the bandwidth from 0.1 GHz to 0.3 GHz and then by a slight decrease to 0.2 GHz with an increase in the depth of cutouts. Note that a nonzero bandwidth at $S_{11} < -5$ dB appears for the radiator with $d_R = 4.4$ mm for 24×41 mm and $d_R = 6.4$ mm for 24×32.5 mm, and for a square radiator (24×24 mm) we have BW with an even greater depth of cutouts from 8.4 mm to 11.9 mm.

We proceed to the analysis of the curves in Fig. 4, constructed for different radiator widths a_R with the fixed length $b_R = 32.5$ mm. In this figure, we see that with

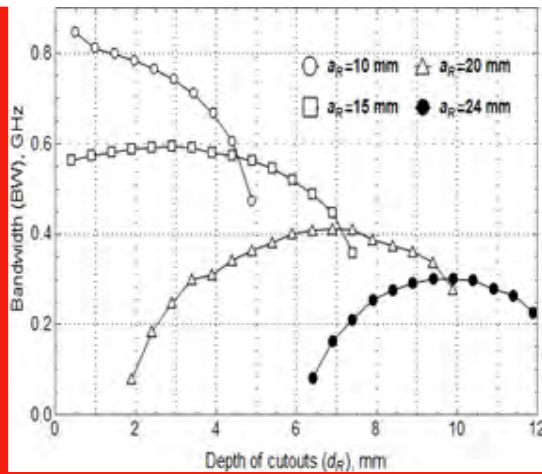


Fig. 4: The dependences of the bandwidth of the base frequency on the depth of the cutouts with various radiator width at the radiator length of 32.5 mm.

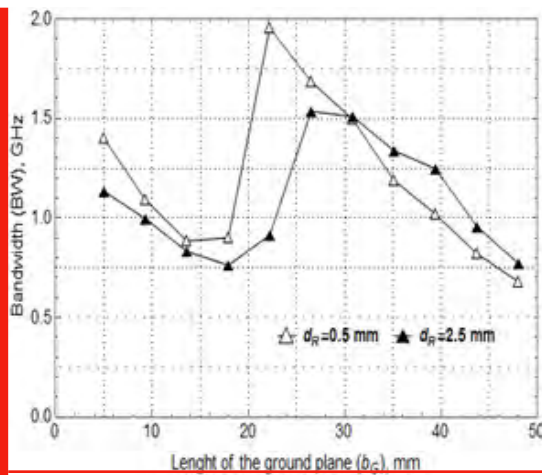


Figure 5. The dependences of the bandwidth (BW) of the base frequency on the ground length b_G at different depths of cutouts d_R

an increase of the radiator width, the bandwidth values become smaller. For slightly elongated radiators (20×32.5 mm, 24×32.5 mm), an increase in the depth of cutouts leads first to a monotonic increase in BW and then to a decrease in it. For a more elongated radiator 10×32.5 mm, we observe a decrease in the bandwidth from 0.85 GHz to 0.47 GHz.

Based on the results of the analysis, the following conclusion can be made: the bandwidth has a weak dependence on the length of the radiator b_R , but it strongly depends on the width of the radiator a_R and the difference in values of $(a_R - d_R)$. Note that the graphs of the BW curves are an inverted parabola for square and slightly elongated radiators and have the form of an inverted logarithmic curve for narrower radiators. Then we can assume that the ratio of the difference between the width of the radiator and the depth of cutouts to its length $(a_R - d_R) / b_R$ also affects the change in the bandwidth.

Regression model for the bandwidth of a six-tooth-shaped antenna

Considering that the results of analyzing the dependence of the bandwidth on the three geometrical parameters of the radiator (a_R, b_R, d_R) of the six-tooth-shaped antenna are close to the results of the study of the bandwidth of the four-tooth-shaped antenna in (Markina et al., 2018), we construct the regression model for BW on the base frequency in the same form:

$$(a_R, b_R, d_R) = c_1 a_R + c_2 a_R^2 + c_3 \frac{a_R - d_R}{b_R} + c_4 \frac{(a_R - d_R)^2}{b_R} + c_5 \ln(a_R - d_R), \quad (1)$$

where BW is measured in GHz, parameters a_R, b_R, d_R are width, length, depth of cutouts, respectively, are measured in mm, the coefficients $c_i, i=(1,5)$ are considered unknown. Using the least squares method, we determine the unknown parameters in (1). Then the desired functional dependence for the bandwidth take the following form:

$$(a_R, b_R, d_R) = -0.1217 a_R + 0.0022 a_R^2 + 1.8781 \frac{a_R - d_R}{b_R} - 0.155 \frac{(a_R - d_R)^2}{b_R} + 0.7726 \ln(a_R - d_R), \quad (2)$$

We calculate the standard error [33]:

$$\epsilon = \sqrt{\frac{1}{n} \sum (BW_i - \overline{BW}_i(a_R, b_R, d_R))^2}$$

and relative absolute error [33]:

$$\sigma = \frac{1}{n} \sum \left| \frac{BW_i - \overline{BW}_i(a_R, b_R, d_R)}{BW_i} \right| \cdot 100\%$$

where BW_i are the known bandwidth values, and $(BW)_i$

(α_R, b_R, d_R) are the values calculated by the formula (2). For the regression model (2), the absolute and relative errors are $\epsilon \approx 0.035$ GHz and $\sigma \approx 8.21\%$, respectively. The formula (2) can be used to find the maximum values of BW with given restrictions on the radiator parameters. It should be noted that this model has a relative error slightly worse than the model for a four-tooth-shaped antenna ($\sigma \approx 7.44\%$) in (Markina et al., 2018).

Influence of the other antenna geometric parameter on the bandwidth

We consider and analyze the effect of the length of the ground plane, the radiator scale, the substrate thickness and the feedline width on the bandwidth of a six-tooth-

shaped microstrip antenna. To do this, we choose two antennas with a radiator $a_R = 10$ mm by $b_R = 24$ mm, at depth of cutouts $d_R = 0.5$ mm and $d_R = 2.5$ mm. The size of the remaining parameters of the antennas is assumed to be the same as paragraph 2.

At first, we consider the change in the bandwidth when varying the length of the ground plane. Figure 5 shows graphs of the dependences of BW on the length of the ground plane (b_G), and the graph with white triangles corresponds to an antenna with cutouts of 0.5 mm, and the graph with black triangles corresponds to an antenna with cutouts of 2.5 mm.

Note that both graphs are close and are characterized by three intervals of change in the BW values: two intervals of decrease and one interval of increase. The BW values increase in the range of b_G changes from 18 mm to 22 mm (graph with white figures) and from 18 mm to 30 mm (graph with black figures). Note that, over such an interval, the value of b_G becomes comparable with the radiator length b_R and the length of the current path along the metal surface of the ground plane approaches the length of the path of passage for the radiator current. We also note that with a further increase of the ground plane length, the base frequency begins to be determined by the length of the current path that it travels along the ground plane (this occurs at $b_G > 25(30)$ mm).

Now we analyze the intervals for decreasing BW values. As is known, the antenna bandwidth is inversely proportional to its quality factor (Q factor). The quality factor shows how many times the energy reserves in the system are greater than the losses, and is proportional to the ratio of the stored energy to the radiated. In the case of a microstrip antenna, the ground plane and radiator are capacitor plates in which the stored energy is proportional to the ground plane area (capacitor volume). Thus, an increase of the ground plane size b_G leads to an increase of stored energy. Since the radiated power does not change much, the Q factor of the antenna increases. The bandwidth is inversely proportional to the Q factor, and therefore, an increase of the ground plane size leads to a narrowing of the bandwidth.

Thus, the following conclusions can be drawn regarding the influence of ground plane dimensions on the bandwidth. When the ground plane length and the radiator length are significantly different, an increase of the linear dimensions of the ground plane leads to a decrease of the BW values. However, the maximum bandwidth is achieved when the

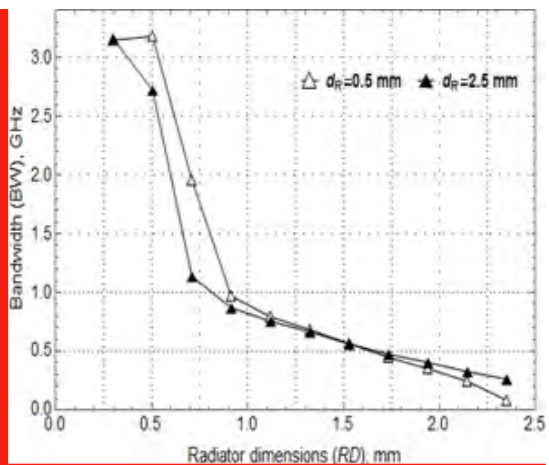


Fig. 6: The dependences of the bandwidth (BW) of the base frequency on the radiator dimensions (RD) at different depths of cutouts d_R

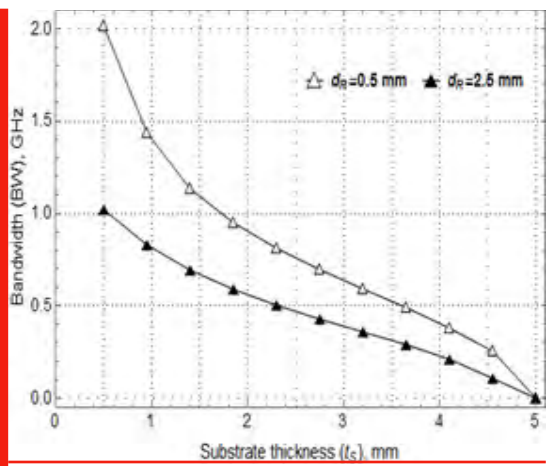


Fig. 7: The dependences of the bandwidth (BW) of the base frequency on the substrate thickness t_s at different depths of cutouts d_R

ground plane length and the radiator length are close to each other.

We proceed to the study of the dependence of the bandwidth on the radiator scale according to the graphs in Fig. 6. Here the radiator scale (RD) varies from 0.3 mm to 2.35 mm. For example, an RD value of 0.5 mm means that all parameters of the radiator (a_r , b_r , d_r) are reduced in two times, RD = 1 means that the parameters of the radiator are remained unchanged (10 mm to 24 mm), and RD = 1.5 are increased by half and so on. In this figure, the symbols of the graphs $d_r = 0.5$ mm and $d_r = 2.5$ mm are made for RD = 1.

According to the graphs in Fig. 6 we can conclude that for small radiators at $RD \leq 0.5$ mm, the bandwidth has the largest values of 2.72-3.2 GHz. The BW values sharply decrease, approximately three times, with an increase of the radiator scale from 0.3 mm to 1.3 mm. A slight narrowing of the bandwidth from 0.6 to 0.2 GHz occurs with a further increase of RD values. Also, as in the case of changing the ground plane length, here the decrease of the BW values is due to an increase of the stored energy (metal area). Thus, the small scales of the radiator give a wide bandwidth. However, it should be noted that the base frequency also decreases significantly with increasing radiator (Markina et al., 2018). changing the scale leads to only a slight increase in the fractional bandwidth.

Now we consider in Fig. 7 the influence of the substrate thickness t_s on the bandwidth. We immediately note that with an increase of the substrate thickness, the BW values rapidly decrease from 2 GHz to 0.2 GHz for an antenna

with cutouts $d_r = 0.5$ mm and from 1 GHz to 0.1 GHz for an antenna with $d_r = 2.5$ mm and reach the zero at $t_s = 5$ mm. Moreover, for an antenna with 0.5 mm cutouts, the bandwidth narrows faster.

Thus, it is preferable to choose a thickness of the radiator substrate of small to 1.5 mm. The influence of the substrate thickness on the bandwidth is due to an increase of the volume (capacity) of the capacitor, which leads to an increase in the stored energy (increase in the Q factor) and to a decrease in the bandwidth.

We proceed to consideration in Fig. 8 the relationship between the feedline width w_f and the bandwidth. Moreover, the values of the parameter w_f vary in the range from 0.5 mm to 3 mm.

From the analysis of the graphs, we note that an antenna with a thin feedline at $w_f < 0.8$ mm is characterized by the small BW values from 0.2 to 0.6 GHz. However, when the feedline width is varied from 0.5 to 2.25 mm, the antenna bandwidth reaches the maximum width of 1.46 GHz at $w_f = 2.25$ mm with cutouts $d_r = 0.5$ mm and BW = 1.05 GHz at $w_f = 2.0$ mm with $d_r = 2.5$ mm. Moreover, for a radiator with small cutouts, the wider bandwidth is characteristic than for a radiator with a cutouts size $d_r = 2.5$ mm. A further increase of the feedline width from 2.0 mm to 3.0 mm does not improve the antenna bandwidth. Thus, the following conclusions can be drawn that the influence of the feedline thickness on the bandwidth of the antenna with large cutouts is less pronounced, and in the designing a broadband antenna, it is undesirable to use both too narrow and wide feedline.

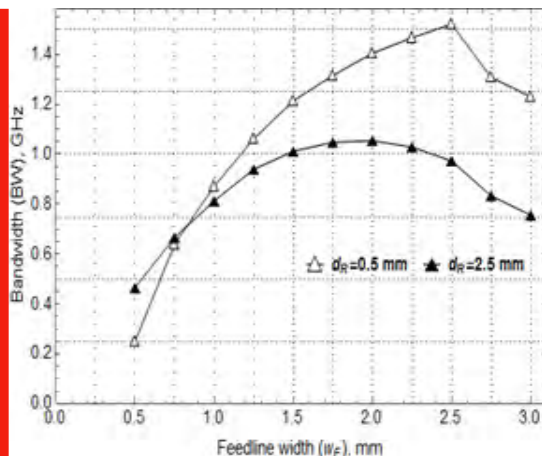


Fig. 8: The dependences of the bandwidth (BW) of the base frequency on the feedline width w_f at different depths of cutouts d_r

CONCLUSION

A monopole microstrip antenna with a symmetric six-tooth-shaped radiator is considered. The dependences of the bandwidth on the base frequency on the geometric parameters of the antenna are investigated. It is graphically shown that the bandwidth decreases with increasing radiator width and depth of cutouts. However, bandwidth changes slightly with increasing radiator length. It is found that the radiator with the most elongated shape and small cutouts is characterized by a large bandwidth. Conversely, a radiator with an aspect ratio close to 1:1 with large cutouts has a lower bandwidth.

In the case of studying the dependence of the bandwidth on the length of the ground plane, the radiator scale, the thickness of the substrate, and the width of the feedline, the following features are noted. When the lengths of the

ground plane and the radiator are different, an increase of the linear dimensions of the ground plane leads to a decrease of the bandwidth. However, maximum values of the bandwidth are achieved when the ground plane length and the radiator length become close. An increase of the radiator scale and the substrate thickness leads to a decrease of the bandwidth. The effect of increasing the feedline width is less pronounced for an antenna with a large cutouts and leads to an increase of the bandwidth.

As a result of the study, we note that it is preferable to use a radiator of the most elongated shape and with small cutouts, a substrate with a thickness of up to 1.5 mm, and it is also undesirable to use a narrow and too wide feedline.

Based on the results of the graphical analysis, the regression model is constructed for the bandwidth in the form of a functional dependence on the width, the length of the radiator, and the depth of cutouts. This regression model (together with the regression model for the base frequency) can be used to determine the maximum values of the bandwidth under given constraints on the radiator parameters. After the dimensions of the radiator parameters are obtained, it is possible to further improve the bandwidth by changing the dimensions of other parameters of the antenna.

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Painless Myocardial Ischemia in Rheumatoid Arthritis (Literature Review)

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ABSTRACT

Authors performed the review and analysis of modern scientific data on the features of coronary heart disease development, including painless myocardial ischemia, among the patients with rheumatoid arthritis. The main cause of painless myocardial ischemia, as a special form of coronary heart disease, is coronary atherosclerosis. Due to the fact that rheumatoid arthritis is a chronic systemic disease, it increases the risk of atherosclerosis development and its complications. This is manifested by a higher incidence of coronary heart disease among such patients compared with the general population. It is proved that changes in lipid metabolism and inflammatory changes in the vascular wall, which are associated with autoimmune mechanisms, lead to the development of atherosclerosis. Hypercholesterolemia remains a significant cause of atherosclerosis development and the patients with rheumatoid arthritis. Cardiovascular diseases and their complications are one of the main causes of death among the patients with rheumatoid arthritis. The first manifestation of coronary heart disease among the patients with rheumatoid arthritis is often painless myocardial ischemia, which increases the risk of sudden cardiac death, cardiac arrhythmias, myocardial infarction and congestive heart failure. Therefore, timely diagnosis and treatment of painless myocardial ischemia among the patients with rheumatoid arthritis is an important task in general clinical practice.

KEY WORDS: Painless Myocardial Ischemia, Rheumatoid Arthritis, Comorbidity.

INTRODUCTION

Painless myocardial ischemia, as one of the forms of coronary heart disease, is associated primarily with atherosclerotic lesions of heart arteries. The risk of atherosclerotic lesion development and this process

complication is increased by systemic inflammatory diseases. The most common disease of this group is rheumatoid arthritis. The inflammatory nature of joint tissue destruction in rheumatoid arthritis increases the risk of atherosclerotic vascular damage and progression among the patients with rheumatoid arthritis, and leads to cardiovascular event development increase compared with the data in the general population. The incidence of coronary heart disease among the patients with rheumatoid arthritis is four times higher than in the general population, the main cause of mortality in it is cardiovascular disease. The risk of cardiovascular mortality in rheumatoid arthritis is higher than in the general population and depends on inflammatory process activity.

METHODS

The analysis of scientific publications about the combination of painless myocardial ischemia and rheumatoid arthritis.

RESULTS AND DISCUSSION

In the structure of total mortality in Russia, the mortality from

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cardiovascular diseases makes more than 56%, of which 80% account for the diseases caused by atherosclerosis. It is expected that in 2020 the death rate from cardiovascular disease will be about 25 million, while half of the deaths will be from coronary heart disease (Shalnova et al., 2005; Babaeva et al., 2017; Waheed & Kafaei, 2018).

Among all forms of coronary heart disease, a special place is taken by painless myocardial ischemia (silent ischemia), when there are the cases of incoming myocardial ischemia with the changes in metabolism, electrical activity, contractile function of the heart muscle without clinical manifestations (pain, shortness of breath, arrhythmias and other unpleasant sensations). These changes can be determined using instrumental research methods, primarily electrocardiographic ones. Painless myocardial ischemia can occur due to myocardial oxygen demand increase ("supply silent ischemia") and/or due to myocardial oxygen supply level decrease ("supply silent ischemia"). Painless myocardial ischemia worsens the prognosis among patients, increasing the risk of sudden cardiac death by 10 times, cardiac arrhythmias - 2 times, myocardial infarction and heart failure - 1-1.5 times (Abdrahmanova et al., 2015; Eslami & Sarlak, 2018).

Being the most common autoimmune disease, rheumatoid arthritis occurs in the population of 0.5 to 1%. Cardiovascular pathology develops among the patients with rheumatoid arthritis much earlier, at a younger age, than in the population as a whole. The inflammatory effect of rheumatoid arthritis is the most important reason for cardiovascular event frequency increase among the patients with this disease, which affects the vascular wall, including coronary arteries. At rheumatoid arthritis, chronic inflammation is a major risk factor for the development of cardiovascular complications among patients. The fact that rheumatoid arthritis has a long undulating course with the periods of increased activity of the disease plays some role in change formation and progression within the intima of the arteries. The atherosclerotic process among the patients with rheumatoid arthritis proceeds aggressively, the growth of atherosclerotic plaques is more intense and widespread. Not only the progression of chronic inflammatory changes occurs in the vessel wall, but also the occurrence of acute coronary syndrome takes place. Violation of atherosclerotic plaque stability is associated with increased activity of the inflammatory process. The toxicity of drugs used for the treatment of rheumatoid arthritis also plays an important role of cardiovascular disease development risk increase (Hurlimann et al., 2004; Goodson, 2002).

Cardiovascular complications of rheumatoid arthritis occur among more than 30% of patients within 10-15 years from the first manifestations. In some cases, they can lead to death. The incidence of myocardial infarction, congestive heart failure and the risk of cardiovascular mortality is 60% more often among the patients with rheumatoid arthritis than in the general population (Kitas & Erb, 2003; Khramtsova & Dzizinsky, 2011).

The patients with rheumatoid arthritis are much less likely to have clinical manifestations of angina pectoris or its equivalents than other patients with coronary heart disease. Myocardial infarction also often occurs in the form of a painless (asymptomatic) myocardial infarction. Painless myocardial infarction is one of the manifestations of coronary heart disease with rheumatoid arthritis. It occurs 2 times more often than among the patients without a history of rheumatoid arthritis. Acute coronary syndrome without classical clinical manifestations occurs among 20% of patients with rheumatoid arthritis (Tsubulkin et al., 2019; Gowda & Kumar, 2018).

The analysis of the relationship between painless myocardial ischemia and risk factors for cardiovascular diseases showed that a reliable relationship exists only with high level of triglycerides and body mass index (Mazurov, 2009). Against the background of rheumatoid arthritis, the level of triglycerides among the patients with painless myocardial ischemia is associated with a high degree of systemic process activity. The patients with rheumatoid arthritis are also characterized by high density lipoproteins, total cholesterol, and the growth of low density lipoprotein level decrease. The predominance of atherogenic fractions of lipoproteins is one of the pathogenetic factors in the development of coronary artery atherosclerosis as the cause of painless myocardial ischemia (Stryuk et al., 2008). The dynamics of such indicators of lipid metabolism as the increase of triglycerides, free fatty acids and the decrease of high-density lipoprotein cholesterol among the patients with a high degree of activity of the autoimmune process is conditioned by the suppression of lipoprotein lipase activity with pro-inflammatory cytokines and acute phase proteins (Stryuk et al., 2008). The high activity of the process, the systematic nature of the lesion in rheumatoid arthritis and the presence of painless myocardial ischemia proves the general inflammatory genesis of these diseases.

The high level of immunological markers used to assess the activity of the inflammatory process in rheumatology is an important risk factor for cardiovascular complications. The patients with painless myocardial ischemia have a high

degree of disease activity, the presence of many systemic extra-articular manifestations of rheumatoid arthritis (Mazurov, 2009). According to widespread beliefs, the pathogenesis of atherosclerosis is based on two interrelated processes. This is the violation of lipid metabolism and the inflammatory process that occurs in the vessel wall, which is associated with autoimmune mechanisms. This indicates the role of atherogenic disturbance of lipid metabolism in the development of painless myocardial ischemia. Rheumatoid inflammation affects on the progression of atherosclerotic change development against the background of rheumatoid arthritis, in addition to generally accepted factors of atherogenesis (Hurlimann et al., 2003; Queirós et al., 2017).

Authors revealed a certain value of the sympathetic-adrenal mechanisms of the autonomic nervous system in the pathogenesis of coronary heart disease and many other cardiovascular diseases. A prolonged increase of the sympathetic nervous system tone causes pathological changes in the cardiovascular system, accelerating its remodeling. The relationship between the degree of inflammatory process activity, the stage of rheumatoid arthritis, the presence of coronary heart disease (painless myocardial ischemia) and the state of the sympathetic-adrenal system is not fully understood.

Among the patients with rheumatoid arthritis and painless myocardial ischemia, the first manifestation of coronary heart disease is precisely myocardial infarction or sudden cardiac mortality (Hurlimann et al., 2003). The detection and analysis of ischemic changes in ST segment without clinical manifestations (according to the results of Holter monitoring of electrocardiography) would be of great importance for the patients with rheumatoid arthritis. According to a number of studies and Holter monitoring it was found that asymptomatic changes in ST segment were detected among 45–48% of the patients with rheumatoid arthritis. These changes manifest painless myocardial ischemia (Novikova et al., 2013). The reasons for painless myocardial ischemia detection are different during Holter monitoring of the electrocardiogram. There is the problem of diagnosing the episodes of painless myocardial ischemia among the patients without clinical manifestations of angina pectoris and its equivalents, and also the problem of identification, description the dynamics of the ST segment among the patients not presenting complaints characteristic of coronary heart disease, and objective documentation of this disease.

Due to the fact that most patients with rheumatoid arthritis

have damaged musculoskeletal system, exercise testing is a problem and therefore the identification of asymptomatic ischemic changes according to Holter monitoring of the electrocardiogram is the first and sometimes the only method for painless myocardial ischemia diagnosing, as a form of coronary artery disease. Atherosclerotic damage of heart arteries during painless myocardial ischemia is detected during coronary angiography or morphologically. Moreover, according to the pathomorphological study of CA, RA patients are less likely to show the signs of critical CA stenosis with the vascular wall inflammation (Warrington et al., 2005).

Among the patients without clinical manifestations of coronary heart disease, there is often no indication for examination in this direction (coronary angiography, stress tests, etc.). There were no studies on the importance of painless myocardial ischemia identification among the patients without documented coronary heart disease. In addition to coronary angiography, radioisotope and other research methods can be more complicated and costly diagnostic methods for the diagnosis of asymptomatic development of atherosclerotic lesions of the myocardial arteries (Novikova et al., 2013; Akinrotoye et al., 2018).

CONCLUSION

One should note the contradictory nature of the available data on the frequency of occurrence of painless myocardial ischemia among the patients with rheumatoid arthritis, on the features of this phenomenon detection during rheumatoid arthritis. This leads to the need for further study of this problem.

SUMMARY

Rheumatoid arthritis is a systemic disease with a chronic course, the inflammatory activity of which plays a crucial role in the pathogenesis of the development of atherosclerosis, increasing the risk of developing complications of atherosclerotic lesions. In this regard, the patients with rheumatoid arthritis, for the most part, suffer from coronary heart disease. A frequent manifestation of coronary heart disease is painless myocardial ischemia. In addition to the traditional way for the development of atherosclerosis, chronic inflammation characteristic of rheumatoid arthritis and the influence of drugs used for its treatment are of great importance.

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Effectiveness of Patient Combined Physiotherapeutic Treatment with Discogenic Radiculopathy of Lumbosacral Part of Spine

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ABSTRACT

The article presents the results of a clinical examination and physiotherapeutic treatment of 110 patients of working age with discogenic radiculopathy of the lumbosacral spine. They presented the results of an optimized treatment system for the patients with the consistent use of low-intensity bioresonant infrared laser therapy (with the wavelength of $\lambda = 0.85 \mu\text{m}$), endonasal electrophoresis with 2% solution of thiamine chloride (B1), the number of 10 procedures in alternation with drug electrophoresis of caripazine (karipain) solution introduced by sinusoidal modulated currents (SMT-phoresis) to the lumbosacral department, in the amount of 10 procedures every other day. Prior to the application of the physiotherapeutic complex developed by the authors, the patients revealed initially low linear blood flow velocity in the veins of the epidural plexus within the area of discogenic radiculopathy (L4 - L5 and S1). The proposed physiotherapeutic complex allows to normalize microcirculation in the corresponding area and increase the effectiveness of pain syndrome treatment during discogenic radiculopathies of the lumbosacral department of spine.

KEY WORDS: Discogenic Radiculopathy of the Lumbosacral Department, Physiotherapeutic Treatment, Vascular Endothelial Risk Factor.

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INTRODUCTION

In the world, especially in highly developed countries, they revealed the increase of spine degenerative-dystrophic diseases. The incidence rate of discogenic radiculopathy among people of working age occupies the leading place and one of the most common complications of dorsopathy of the lumbar spine is intervertebral hernia (Kukushkin et al., 2011; Veselovsky & Bilalova, 1989; Khabirov & Khabirova, 2018). Currently, the progressive growth of degenerative pathology of spine is considered not so much from the perspective of aging, but rather within the framework of genotypic and structural disorder paradigm in neuroglial, connective tissues. Phenotypically significant lifestyle factors, such as overweight, decreased physical

activity, poor nutrition, prolonged being in an uncomfortable position, are primarily reflected in the functional state of the lumbosacral spine, where severe pain syndrome develops, which reduces the life quality among working-age patients (Kukushkin et al., 2011; Veselovsky & Bilalova, 1989; Ivanichev, 2007; Khabirov & Khabirova, 2018; Van Boxem et al., 2010; Kawakami et al., 1998; Mroz et al., 2014; Chiu et al., 2015). It was found that metabolic and vascular changes, including those in epidural venous and arterial vessels, correlate with the functional changes of vascular endothelial risk factor (VEGF-A) and nociceptive pain (Ivanichev, 2007; Khabirov & Khabirova, 2018). At that, pharmacologically low-load physiotherapy methods are crucial during the development of patient treatment algorithm at discogenic radiculopathy (Ponomarenko, 2013; Ushakov, 2013; Eslami & Sarlak, 2018). Scientific data of recent years indicate the multifaceted pathogenesis of this pathology, where in addition to degenerative, autoimmune-inflammatory, compression-vascular, metabolic disorders, the role of the vascular component is high (Kukushkin et al., 2011; Veselovsky & Bilalova, 1989; Ivanichev, 2007; Khabirov & Khabirova, 2018; Gowda & Kumar, 2018; Bagheri et al., 2018; Chemetova et al., 2017). From the abovementioned it follows that the study of the dynamics of these parameters has not been widely considered before and after the use of complex physiotherapeutic treatment in order to increase the effectiveness and reduce the risks of neurovascular disorders in the lumbar. Numerous studies have shown that physiotherapeutic treatment can not only reduce nociceptive activity, but also stop the progression of fibro-cartilage and bone degeneration of the lumbar, which is associated with the pathogenic direction of many physical factors (Ponomarenko, 2013; Ushakov, 2013;

Chang et al., 2017; Waheed & Kafaei, 2018). At the same time, remission is achieved by eliminating the pain lesion and muscle triggers, reducing edema around the affected disc and restoring microcirculation in the pathology zone.

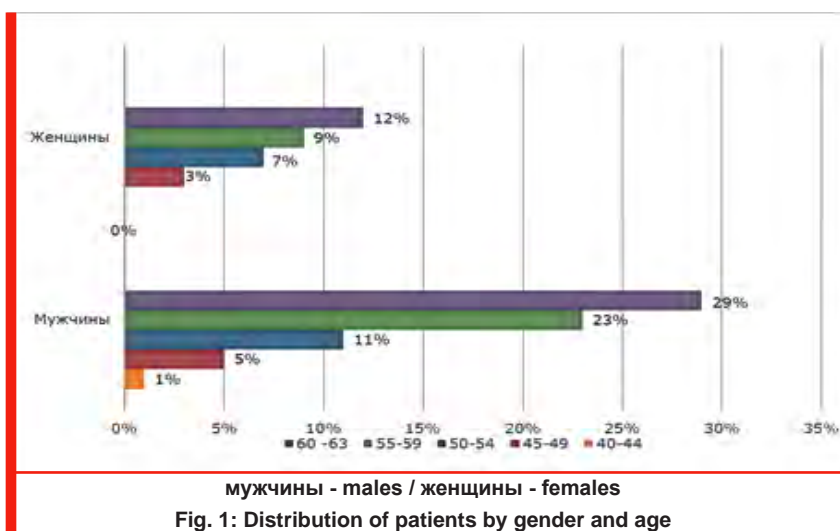
It should be noted that the appearance of modern diagnostic equipment, including optical coherence tomography, allows us to assess the degree of endovascular damage in the area of pronounced nociception before and after the use of complex physiotherapeutic treatment, which was the aim of our study among the patients with discogenic radiculopathy of the lumbosacral spine.

Research Objects and Methods

The aim of our work is to develop a system for optimized treatment of patients of working age with discogenic radiculopathy of the lumbosacral spine, based on the consistent use of low-intensity bioresonance infrared laser therapy (with the wavelength of $\lambda = 0.85 \mu\text{m}$), endonasal electrophoresis of 2% solution of thiamine chloride (B1), carried out in alternation with drug electrophoresis of caripazine (caripain) solution injected with sinusoidal modulated currents (CMT phoresis) into lumbosacral region.

They performed the study of 110 patients of working age with discogenic radiculopathy of the lumbosacral spine. The distribution of patients by gender and age is shown in the diagram (Figure 1).

According to the topical principle, degenerative-dystrophic lesions of spine, nervous and vascular systems are divided into two groups: vertebral and extravertebral. Vertebral



syndromes are those associated with the lesions in various structures of the vertebral-motor segment. Extravertebral disorders are the disorders in the nervous, muscle and vascular systems. The clinical syndromes of the studied patients are shown in the diagram (Figure 2). The percentage of the characteristic syndromes of lumbosacral radiculopathy are presented: pain, sensory, motor, vascular and trophic disorders.

The concentration of VEGF-A was determined by enzyme-linked immunosorbent assay (ELISA) using Thermoscientific analyzer (USA) according to a standard calibration curve with an initial concentration of 2000 pg/ml and the dilution range from 15.6 to 1000 pg/ml.

Discogenic radiculopathy among the patients of working age was treated with the developed physiotherapeutic complex, which included the use of low-intensity bioresonance infrared laser therapy (with the wavelength of $\lambda = 0.85 \mu\text{m}$), endonasal electrophoresis of 2% solution of thiamine chloride (B1). The amount of treatment made 10 procedures in alternation with drug electrophoresis of caripazine (caripain) solution injected with sinusoidal modulated currents (CMT-phoresis) into the lumbosacral region (10 procedures), performed every other day, taking into account modern scientific data on the pathogenesis of discogenic pathology based on neurodegeneration targets and correlation links of vascular endothelial risk factor and linear blood flow velocity (LBFV) in the epidural vessels of

the lumbar spine. The control group consisted of 48 patients with discogenic radiculopathy who did not receive low-intensity bioresonance infrared laser therapy, endonasal electrophoresis of 2% solution of thiamine chloride (B1), carried out in alternation with drug electrophoresis of caripazine (caripain) solution injected with sinusoidal modulated currents (CMT phoresis).

RESULTS AND DISCUSSION

Prior to the application of the developed physiotherapeutic complex, initially low linear velocity of blood flow in the veins of the epidural plexus within the area of discogenic radiculopathy (L4 - L5 and S1) was revealed in all patients of working age ($n = 110$). The initial averages of LBFV at the level of the vessels of the epidural venous plexus (L4 - L5) before physiotherapy treatment made 12.2 ± 1.9 cm/sec., and at the level of S1 - 10.9 ± 1.6 cm/sec., which is lower as compared with the physiological norm among the people of similar age without discogenic radiculopathy, respectively: 6.1 ± 0.6 cm/sec. ($p < 0.01$) and 4.8 ± 0.5 cm/sec. ($p < 0.05$). Visual analogue scale (VAS) before treatment was 7.8 ± 1.7 points. After applying the developed physiotherapeutic complex, the patients with discogenic radiculopathy demonstrated the increase of blood flow rate by 3.4 ± 0.3 cm/s, in radicular veins up to 17.3 ± 2.8 cm/s. ($p < 0.001$), which was highly significant than among patients in the control group on the background of standard therapy with pain syndrome reduction by VAS up to 2.7 ± 0.6 points.



Fig. 2: Clinical symptoms of discogenic radiculopathy of the lumbosacral spine.

CONCLUSION

The data of our study showed that the developed physiotherapeutic complex can significantly reduce the pharmacological and financial burden on people of working age with discogenic radiculopathy, improve blood flow in this area and increase the effectiveness of severe pain removal.

SUMMARY

Currently, not only phenotypically significant factors have been studied (excess body weight, decreased physical activity, poor nutrition, static load, micro and macro injuries), but also the genotypic risks of radiculopathy development (ischemic and atherosclerotic disorders in the epidural vein system, impaired functions of vascular endothelial factor, impaired transmission of nerve impulses along radicular structures, metabolic changes in the central nervous system, etc.), which generally increase the importance of treatment method optimization for degenerative disorders and radiculopathies of the lumbosacral spine, aimed at hernia formation prevention and the pharmacological load reduction.

We have developed the system for optimized treatment of patients of working age with discogenic radiculopathy of the lumbosacral spine, based on the consistent use of low-intensity bioresonant infrared laser therapy (with the wavelength of $\lambda = 0.85 \mu\text{m}$), endonasal electrophoresis of 2% solution of thiamine chloride (B1), and 10 procedures carried out in alternation with drug electrophoresis of caripazine (caripain) solution injected with sinusoidal modulated currents (CMT phoresis) into lumbosacral region, in the amount of 10 procedures performed every other day. The proposed physiotherapeutic complex allows to normalize the linear blood flow velocity in the epidural vessels of the lumbar spine and improve the treatment of pain during discogenic radiculopathies of the lumbosacral spine.

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Obstructive Sleep Apnea Syndrome

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ABSTRACT

The features of the cardiovascular system regulation form a direct relationship between the nature of the nervous system activity during sleep and such indicators as blood pressure and heart rate. Interruption of sleep or its disturbance can have a negative effect on the functional state of heart and vascular bed. The mechanisms of this effect can be both the violations of sleep cyclic phases, and direct decreases of physiological functions, in particular, the development of hypoxia episodes. They determined a reliable relationship between the presence of obstructive sleep apnea syndrome and cardiovascular diseases. The presence of obstructive sleep apnea syndrome increases the risk of cardiovascular disease development by 2.4 times as compared with the population without respiratory disorders during sleep. Significantly higher body mass index values were found in the groups of patients with obstructive sleep apnea syndrome. Repeated hypoxic conditions can cause persistent disruption of gas exchange processes and further sleep impairment. The interdependence of sleep disorders and circulatory functions creates a vicious circle of pathogenetic influences, which ultimately leads to an increased risk of cardiovascular pathology and associated mortality development. The evaluation of drowsiness as a screening method for obstructive sleep apnea syndrome determination among the patients with cardiovascular diseases, especially among those with treatment-resistant forms. The diagnosis of obstructive sleep apnea requires a polysomnographic study.

KEY WORDS: Diagnosis, Polysomnography, Obstructive Sleep Apnea Syndrome.

INTRODUCTION

Every year a huge number of people die from cardiovascular diseases around the world. They predicted that by 2020 the number of deaths from these diseases will reach 25 million worldwide, half of the deaths will be associated with

coronary heart disease (Zyyatdinov et al., 2014; Amirov et al., 2011).

METHODS

The analysis of the medical literature on obstructive sleep apnea syndrome and the diagnostic capabilities of polysomnography.

RESULTS AND DISCUSSION

The syndrome of obstructive sleep apnea / hypopnea is understood as the occurrence of periodic cases of the upper respiratory tract narrowing during sleep in which the air stream penetration decrease or a complete cessation of its delivery takes place. This condition leads to oxygen level decrease in blood and, in some cases, the combination of hypoxemia with carbon dioxide excess (hypercapnia) occurs. Acute hypoxemia provokes the appearance of a response in the form of the sympathoadrenal system activity increase and blood pressure level increase, which, in turn, increases the brain activity and, to some extent, sleep disturbance. The throat muscle control resumes and the airways open. This leads to the restoration of the

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normal level of oxygen in blood, a person falls into sleep again, the vicious cycle resumes. During the night, a cycle with episodes of respiratory arrest can occur up to 400-500 times (Buzunov et al., 2018; Libby et al., 2015; Kapur et al., 2017; Gowda & Kumar, 2018).

According to the patient's complaints (night snoring is loud and intermittent, breath holding during sleep, nocturia, drowsiness during the day), medical history (clinic for 6 months or more, concomitant obesity, arterial hypertension), the presence of obstructive sleep apnea / hypopnea syndrome can be assumed, which leads to the need for additional examination (Palman, 2013;).

According to the literature, mild and moderate degrees of obstructive sleep apnea / hypopnea syndrome are found among 15% of the population, of which 4–5% have a severe form of this condition (Peppard et al., 2013; Young et al., 2008; Eslami & Sarlak, 2018).

With age, the frequency of obstructive sleep apnea / hypopnea syndrome detection increases, so it occurs in 5-7% of cases among the population older than 30 years (1-2% of the total number suffer from severe form). Among the people older than 65 the disease rate reaches 60% (Kripke et al., 1997).

The main risk factors for obstructive sleep apnea / hypopnea syndrome development are the following ones: obesity (60% of patients with body mass index > 40 kg/m² suffer from severe obstructive sleep apnea / hypopnea syndrome) (Palman, 2016; Young et al., 2005), gender (men suffer 2-3 times more often) (Ip et al., 2001), age (2–8-year-old children, people over 65 years old) (Kripke et al., 1997), nationality (Asians) (Ancoli-Israel et al., 1995; Ancoli-Israel et al., 1991), burdened heredity (predisposition to obesity, metabolic syndrome, disturbance of craniofacial morphology, the occurrence of respiratory disorders, etc.) (Redline et al., 2001), smoking (Agaltsov, 2014), anatomical defects (nose, pharynx, jaw) (Kushida et al., 1997; Kolyadich et al., 2014; Kolyadich & Kalinkin, 2014; Komarov & Potapova, 2019; Waheed & Kafaei, 2018), lymphoid tissue volume increase in the neck, drug therapy (benzodiazepine tranquilizers, barbiturates), the history of previous or concomitant diseases (acute cerebrovascular insufficiency, myopathy, myodystrophy, hypothyroidism (due to the infiltration of the upper respiratory tract walls), diabetes mellitus (type 1 diabetes is associated with diabetic neuropathy, type 2 - with obesity) (Drager et al., 2015; Dreval et al., 2013; da Costa et al., 2017).

A direct relationship was found between obstructive sleep apnea syndrome and cardiovascular diseases (Young et al., 2008; Lanfranchi et al., 1999; Sánchez-de-la-Torre et al., 2013), primarily with coronary heart disease (Tarasik et al., 2016; Goncharov et al., 2010; Khodakova et al., 2016), arterial hypertension, and cardiac arrhythmias (atrial fibrillation) (Gurubhagavatula et al., 2013). The relationship of obstructive sleep apnea / hypopnea syndrome with acute coronary syndrome was found in 52.3% of patients, the presence of obstructive sleep apnea / hypopnea syndrome became a significant predictor of serious adverse events among the patients with acute coronary syndrome. Obstructive sleep apnea / hypopnea syndrome increases the risk of death from cardiovascular diseases and increases, with its presence, by more than 3 times (the likelihood of sudden cardiac death increases by 2.6 - 3 times) (Selim et al., 2010; Buzunov, 2010). The risk of death increases in proportion to the severity of obstructive sleep apnea / hypopnea syndrome (Gami et al., 2013; Epstein et al., 2009; Hassen & Asmare, 2018).

The main method for diagnosing obstructive sleep apnea / hypopnea syndrome at the present stage is the polysomnography method (Kapur et al., 2017). It allows you to identify a number of body dysfunctions during sleep, which are the indicators of life-threatening conditions, the symptoms of diseases that do not appear in a person during wakefulness, but reduce working capacity, as well as the effectiveness of concomitant disease treatment (Buzunov et al., 2018; Levin & Poluektov, 2013) With standard polysomnography (18 - 24 channels) they perform an electroencephalogram, an electrooculogram, an electromyogram (chin muscle tonus), the movements of lower extremities (2 channels), an electrocardiogram, a nasal cavity air flow and snoring, respiratory movements of the chest and abdominal wall, saturation and pulse, body position. Electroencephalogram, electrooculogram, electromyogram is used to determine the stages of sleep and sleep patterns. Video - electroencephalogram helps to evaluate motor movements, vocalization, respiratory disorders, behavioral disorders that occur in a dream (Glukhova & Mukhin, 2010; Buzunov et al., 2013).

Stationary polysomnography is necessary for the diagnosis of not only the syndrome of obstructive sleep apnea / hypopnea, but also heart rhythm disturbances, and the changes in sleep structure. Using stationary polysomnography, a differential diagnosis is performed between obstructive sleep apnea / hypopnea syndrome and other sleep disorders. The changes are observed against the background of the prescribed complex treatment,

recording artifacts are eliminated, and high-quality signal recording is ensured. The staff on duty at the somnological laboratory analyzes the readings received from the system to the computer during the observation time (all night). Video and sound recording is carried out all night, during the whole time of sleep. The duty staff, if necessary, quickly responds to the changes in a patient's condition.

The main diagnostic criterion for obstructive sleep apnea / hypopnea syndrome is the occurrence of apnea, respiratory arrest (lasting for 10 seconds or more), frequency (apnea index) - 5 or more per hour. With hypopnea, there is the respiratory air flow decrease by more than 50% during more than 10 s. Moreover, desaturation makes at least 3% of the norm. During obstructive breathing disorders, apnea and hypopnea occur, so the combined apnea / hypopnea index is used. This index refers to the frequency of apnea / hypopnea attacks per 1 hour of sleep, this indicator indicates the severity of the disease. Among healthy patients, this index equal to 5 is considered to be the borderline value. A significant increase in the frequency of cardiovascular complications by 2–3 times was detected with the apnea / hypopnea index > 15, and with the apnea / hypopnea index > 30 it increases 5–6 times (Galyavi, 2010).

Doctors do not always remember about obstructive sleep apnea / hypopnea syndrome, its effect on the patient's condition and, accordingly, do not diagnose it. Perhaps this is due to an incomplete medical history, and the fact that patients do not present characteristic complaints (respiratory arrest in sleep, snoring, etc.). Therefore, obstructive sleep apnea / hypopnea syndrome may not be diagnosed for a long time, treatment is prescribed late, which worsens the patient's overall quality of life and prognosis.

Polysomnography in our country is not used enough, the reasons for this are the expensive cost of the study and the low awareness of doctors about this diagnostic method.

CONCLUSION

Repeated hypoxic conditions can cause persistent disruption of gas exchange processes and further sleep impairment. The interdependence of sleep disorders and circulatory functions creates a vicious circle of pathogenetic influences, leading ultimately to an increased risk of cardiovascular pathology and associated mortality development. The assessment of drowsiness as a screening method to identify obstructive sleep apnea syndrome among the patients with cardiovascular diseases, especially those with treatment-resistant forms.

The diagnosis of obstructive sleep apnea requires a polysomnographic study.

SUMMARY

Obstructive sleep apnea / hypopnea syndrome has a huge impact on the quality and duration of life. It is necessary to pay substantial attention to it. Given the risk factors for the occurrence of this syndrome, you need to start with a complete medical history, if you suspect it, polysomnography is necessary.

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The Application Efficiency of Growth Stimulant Ecopin on Sowing Qualities of Scots Pine Seeds (*Pinus silvestris* L.)

V.Yu. Ostroshenko

ABSTRACT

The influence of the growth stimulator of natural origin Ecopin on the sowing qualities of seeds of coniferous tree species - Scots pine (*Pinus silvestris* L.), which grows in the forest conditions of the southern part of the Far East, is studied. The use of the biological product activates the germination energy and laboratory germination at concentrations of solutions $1 \times 2 \times 10^{-3}$ - $1 \times 5 \times 10^{-3}$ ml/l within 71.3 - 79.9 % and 83.7-96.4 %, exceeding control, respectively by 5.2-17.8 % and 6.9-23.1 % and, as a result - increasing sowing qualities of seeds on one-two classes: from the third - to the second and the first. The concentration of $1 \times 6 \times 10^{-3}$ ml/l had an insignificant effect on the sowing quality of seeds (exceeding the control of 0.6-2.4 %). With the weakening of the concentration of the solution to $1 \times 7 \times 10^{-3}$ ml/l, the germination energy and germination of seeds decreased, relative to the control, by 11.4-13.0 %. A higher concentration of the solution (1×10^{-3} ml/l) had an inhibitory effect on seed germination. The concentration of solutions $1 \times 3 \times 10^{-3}$ - $1 \times 4 \times 10^{-3}$ ml/l (exceeding the control of 22.2-46.7 %) had the greatest effect on the growth of seedlings along the length. In comparison with the control, the concentration of 1×10^{-3} ml/l reduced the growth rate of seedlings by 5.9-11.1 %. Further reduction of the solution concentration to $1 \times 7 \times 10^{-3}$ ml/l was ineffective. Ecopin also had a positive effect on the formation of the mass of sprouts. At concentrations $1 \times 3 \times 10^{-3}$ - $1 \times 5 \times 10^{-3}$ ml/l, the excess to the control was -19.8-59.4 %.

KEY WORDS: Ecopin, Growth Stimulator, Seeds, Germination Energy, Germination, Biometrics of Seedlings, Reliability.

INTRODUCTION

The forests of Primorsky Krai lie on the territory of the south-eastern continental part of the Far East. More than 2/3 of the total forest area is represented by coniferous trees

(Koryakin, 2010). Scots pine (*Pinus silvestris* L.) – the most common of all the pines growing in Russia. Huge national economic importance, its use in landscape architecture and selection, high biological, sanitary-ecological, soil-protective and medicinal properties (Urusov, Lobanova and Varchenko, 2007; Usenko, 2009), allow considering Scots pine as one of the main forest-forming species of the Far East.

However, in the forest fund of Primorsky Krai, Scots pine is represented less than other coniferous tree species. This contributed to the active development of the region in the past, logging, and forest fires. Currently, the age dynamics of pine forests in the region is diverse. So, 48 % of the area are mature and overmature tree stands; 28.5% are middle-aged and ripening, and only 23.5% are the young trees (Koryakin, 2010). It is necessary to carry out active measures aimed at the preservation and reproduction of Scots pine: protection of forests from fires, preparation and sowing of seeds, cultivation of planting material in forest

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nurseries, laying of forest crops, followed by the restoration of forests on non-forested lands.

At the same time, seed years in the pine forests of the region are observed in three to four low-yielding ones (Groz dov, 1952; Urusov, Lobanova and Varchenko, 2007; Usenko, 2009). For the annual sowing of seeds, it is necessary to store them so that it will be possible to reduce the sowing qualities. Treatment with physiologically active substances positively proven in agriculture - growth

stimulators - can increase the germination energy and seed germination (Vakulenko, 2004; Nickell, 1984).

Growth stimulants are substances that stimulate or inhibit growth and development in plants. However, manufacturers' instructions on the use of growth stimulants were compiled for crops. In the forest industry, work on the use of growth promoters is carried out in the experimental procedure. Studies were conducted abroad (Borno and Taylor, 1975; Huang and Bachelard, 1993; Kabar, 1990,

Table 1. The effect of growth stimulant Ecopin on the germination energy and laboratory germination of Scots pine seeds (*Pinus silvestris* L.)

Date of the counting of sprouts, days	Concentration of solutions, ml /l							
	Control (distilled water)	1×10^{-3}	$1 \times 2 \times 10^{-3}$	$1 \times 3 \times 10^{-3}$	$1 \times 4 \times 10^{-3}$	$1 \times 5 \times 10^{-3}$	$1 \times 6 \times 10^{-3}$	$1 \times 7 \times 10^{-3}$
1	2	3	4	5	6	7	8	9
5 th	52,3±2,1	41,4±2,0	48,4±2,0	53,1±1,8	54,0±2,0	51,7±2,4	48,9±2,3	41,8±2,0
% to control		-20,8	-7,5	+1,5	+3,3	-1,1	-6,5	-20,1
Reliability, t_{α}	25,4	20,3	23,7	29,5	26,5	21,2	21,7	20,5
The experience accuracy (F), %	3,0	4,9	4,2	3,4	3,8	4,7	4,6	4,9
7 th	15,5±0,7	16,1±0,5	22,9±0,7	24,5±1,4	25,9±1,8	23,9±1,8	19,3±0,8	17,2±1,4
% to control		+3,9	+47,7	+58,1	+67,1	+54,2	+24,5	+11,0
Reliability, t_{α}	23,8	32,9	32,3	18,1	14,1	13,3	25,7	12,7
The experience accuracy (F), %	8,5	3,0	3,1	5,5	7,1	7,5	3,9	7,8
10 th	6,5±1,6	7,4±0,3	8,1±0,4	7,8±0,2	10,2±0,6	9,2±0,6	7,6±0,5	5,6±0,6
% to control		+13,8	+24,6	+20,0	+56,9	+41,5	+16,9	-13,8
Reliability, t_{α}	4,2	21,8	23,1	32,5	16,5	14,8	16,5	10,0
The experience accuracy (F), %	11,4	4,6	4,3	3,1	6,1	6,7	6,1	10,0
15 th	4,0±0,4	3,8±0,2	4,3±0,4	5,8±0,9	6,3±0,4	7,1±0,5	4,4±0,2	4,8±0,4
% to control		-5,0	+7,5	+45,0	+57,5	+77,5	+10,0	+20,0
Reliability, t_{α}	9,8	15,8	10,2	6,4	16,2	14,5	18,3	13,7
The experience accuracy (F), %	20,5	6,3	9,8	15,5	6,2	6,9	5,5	7,3
Germination energy, %	67,8	57,5	71,3	77,6	79,9	75,6	68,2	59,0
Germination, %	78,3	68,7*	83,7	91,2*	96,4**	91,9**	80,2	69,4
The number of non-germinated, PCs	22	32	17	9	4	9	20	31
healthy	4	13	5	3	2	1	5	8
rotted	1	6	3	-	-	-	-	7
steamed	1	1	1	1	-	1	2	2
empty	5	5	3	3	2	4	4	3
sprouted abnormally	11	7	5	2	-	3	9	11

Note: solution concentrations: 1×10^{-3} - 1ml/1l, $1 \times 2 \times 10^{-3}$ - 1ml/2l, $1 \times 3 \times 10^{-3}$ - 1ml/3l ...

* - reliability of differences in the values of seed germination parameters between the studied concentration of the sample solution and control (Student's t- test, at P = 0.05)

** - reliability of differences in the values of seed germination parameters between the studied solution concentration and control (Student's t- test, at P = 0.01);

1998; Kralk, Psota and Kluovi, 1992; Krawczynska, Kolwzan and Rybak, 2012; Kuneš, Baláš, Linda, Gallo and Nováková, 2016; Magyar, Barancsi, Dickmann and Hrotko, 2008; Salas, Saskova, Mokrickova and Litschmann, 2012; Tredici, 2005; Wort, Severson and Peirson, 1973; Young, 1987), in Ukraine (Belelya, 2014), in Belarus (Ivanova, 2009; Lebedev and Schestibratov, 2013) and in various regions of Russia: the European part (Borisov and Matvienko, 2014; Galdina and Shevchenko, 2012; Ostrobodova and Ulanova, 2014; Pentelkina, 2002; Pentelkin, 2003; Trots, 2016; Ustinova and Chentsov, 2013; Chilimov, 1995; Chukarina, 2014), Siberia (Kirienco and Goncharova, 2016), the Far East (Ostroshenko, Ostroshenko, Klyuchnikov, Ostroshenko and Chekushkina, 2015; Ostroshenko and Poleshchuk, 2016; Usov and Popkov, 2010) with both coniferous and deciduous tree species: Scots pine (*Pinus silvestris* L.), Japanese pine

(*Pinus densiflora* Siebold et Zucc.), Jack pine (*Pinus Banksiana* Lamb.), Red pine (*Pinus resinosa* Sol. ex Aiton) and Monterey pine (*Pinus radiata* D. Don); Siberian larch (*Larix sibirica* Ldb.), Amur larch (*Larix amurensis* and B. Kolesn and Dahurian larch (*Larix cajanderi* Mayr.); Thuja occidentalis (*Thuja occidentalis* L.), Chinese thuja (*Thuja orientalis* L.), Pacific redcedar (*Thuja plicata* Donn ex D. Donn); European spruce (*Picea abies* (L.) H. Karst.) and Siberian spruce (*Picea obovata* Ldb.); Khingan fir (*Abies nephrolepis* Maxim.), Manchurian fir (*Abies holophylla* Maxim.) and Douglas fir (*Pseudotsuga menziesii*); European oak (*Quercus robur* L. = *Q. pedunculata* Ehrh.); European ash (*Fraxinus excelsior* L.); Brittle Gum (*mannifera* Mudie); Rowan (*Sorbus aucuparia* L.); Apple tree "Idared" (*Malus domestica* 'Idared'), Chosenia *arbutifolia* (Chosenia *arbutifolia* Nacai), etc.

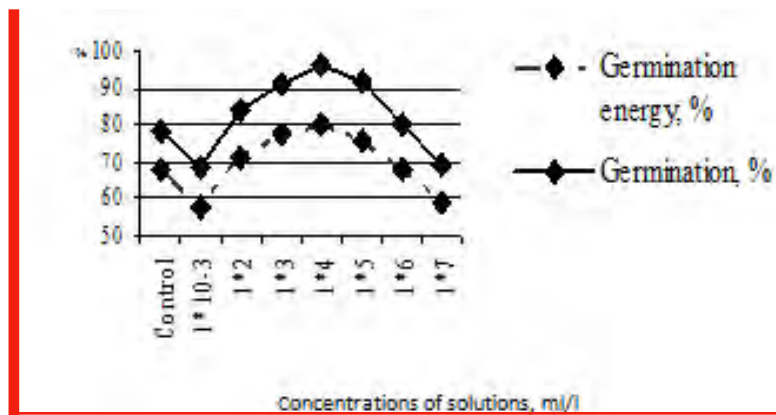


Fig. 1: The effect of growth stimulant Ecopin on the germination energy and laboratory germination of Scots pine seeds (*Pinus silvestris* L.)



Fig. 2: The sprouted seeds of Scots pine (*Pinus silvestris* L.) treated with growth stimulant Ecopin on the 5th day of germination (the author's photo) and laboratory germination of Scots pine seeds (*Pinus silvestris* L.)

The experiments showed the effectiveness of the research. Seeds have increased germination energy and germination; root formation; growth of seedlings in the nursery and the output of standard planting material per unit area activate. The safety of seedlings is high; the terms of their cultivation are reduced. We consider it is expedient to conduct further studies to identify drugs that stimulate the improvement of seed sowing qualities and reforestation of one of the main tree species of the far eastern Primorye – Scots pine (*Pinus silvestris* L.).

The Goal of Research

Study of the stimulatory effect of aqueous solutions of growth stimulant Ecopin were done on the seeds of Scots pine (*Pinus silvestris* L.) and identification of doses that activate the germination energy. Laboratory germination of seeds and growth of seedlings in length and weight based

was the goal. The following tasks were carried out: - soaking of Scots pine seeds in aqueous solutions of growth stimulant Ecopin of different concentrations; - germination of seeds in laboratory conditions; - analysis of the effect of the drug Ecopin on germination energy, laboratory germination of seeds and the dynamics of growth of seedlings in length and weight.

MATERIAL AND METHODS

The object of the study is the seeds of Scots pine (*Pinus silvestris* L.) harvested in the southern part of Primorsky Krai, on the territory of the MTS - Federal Scientific Center of the East Asia Terrestrial Biodiversity FEB RAS. Weather conditions were within the average long-standing ones

(Poleshchuk, 1993). Identification of the stimulating effect of growth stimulant Ecopin on sowing qualities of seeds was carried out in laboratory conditions, according to applicable State Standards (GOST 14161-86, 1986; GOST 13056.6-97, 1997), by the developed technique. For germination, externally intact seeds were selected, which were soaked in aqueous solutions of the drug for 12 hours. In the experiments, 7 variants were studied (concentrations of drug solutions and distilled water were: 1×10^{-3} , $1 \times 2 \times 10^{-3}$, $1 \times 3 \times 10^{-3}$, $1 \times 4 \times 10^{-3}$, $1 \times 5 \times 10^{-3}$, $1 \times 6 \times 10^{-3}$, $1 \times 7 \times 10^{-3}$ ml/l) and control – seeds soaked in distilled water. The accepted ratio of the volume of seeds and solution is 1:5. All experiments were performed in fourfold repetition. 100 PCs of seeds prepared for the experiences were placed

Table 2: The effect of growth stimulant Ecopin on the growth of seedling in length at germination of Scots pine seeds (*Pinus silvestris* L.)

Date of the counting of sprouts, days	Concentration of solutions, ml/l								
	Control (distilled water)	1×10^{-3}	$1 \times 2 \times 10^{-3}$	$1 \times 3 \times 10^{-3}$	$1 \times 4 \times 10^{-3}$	$1 \times 5 \times 10^{-3}$	$1 \times 6 \times 10^{-3}$	$1 \times 7 \times 10^{-3}$	
	Average length of the seedling, cm								
	1	2	3	4	5	6	7	8	9
5 th		1,6±0,1	1,5±0,3	1,9±0,1*	2,2±0,1**	2,1±0,2*	2,3±0,1**	2,1±0,1*	1,7±0,1
% to control			-6,2	+18,8	+37,5	+31,3	+43,8	+31,3	+6,3
Reliability, t_n		17,8	6,0	23,8	27,5	12,4	19,2	23,8	18,9
The experience accuracy (F), %		7,5	16,7	4,2	3,6	8,1	52,4	4,2	5,3
7 th		1,8±0,1	1,6±0,1	1,9±0,1	2,2±0,1*	2,3±1,0**	2,2±0,1*	2,1±0,1*	1,6±0,1
% to control			-11,1	+5,6	+22,2	+27,8	+22,2	+16,7	-11,1
Reliability, t_n		36,0	20,0	14,6	16,9	28,8	16,9	17,5	12,3
The experience accuracy (F), %		4,4	5,0	6,8	5,9	3,5	5,9	5,7	8,1
10 th		1,7±0,1	1,6±0,1	2,1±0,1*	2,3±0,1**	2,4±0,2**	2,1±0,1*	1,9±0,1	1,5±0,1
% to control			-5,9	+23,5	+35,3	+41,2	+23,5	+11,8	-11,8
Reliability, t_n		24,3	20,0	30,0	28,8	14,1	30,0	21,1	8,0
The experience accuracy (F), %		7,1	5,0	3,3	3,5	7,1	3,3	4,7	12,5
15 th		1,5±0,1	1,4±0,2	1,7±0,2	2,1±0,1**	2,2±0,1**	1,8±0,2	1,7±0,2	1,5±0,1
% to control			-6,7	+13,3	+40,0	+46,7	+20,0	+13,3	-
Reliability, t_n		37,5	8,2	8,1	16,2	31,4	8,6	10,0	11,5
The experience accuracy (F), %		5,3	12,1	12,4	6,2	3,2	11,7	10,0	8,7

Note: solution concentrations: 1×10^{-3} - 1ml/1l, $1 \times 2 \times 10^{-3}$ - 1ml/2l, $1 \times 3 \times 10^{-3}$ - 1ml/3l ...

* - reliability of differences in the values of the length of the roots of seed seedlings between the studied concentration of the solution and control (Student's t-test, P = 0,05);

** - reliability of differences in the values of the length of the roots of seed seedlings between the studied concentration of the solution and control (Student's t-test, P = 0,01);

in Petri dishes on the wet bed, made of filter paper which was cut according to the size of Petri dishes.

Germination of seeds was carried out in the thermostat TS-80 – “KZMA” (electric, dry air, made at the Kazan plant of medical equipment). Petri dishes were placed in the working chamber of the thermostat. The bed for seeds germination was kept wet, periodically wetting the filter paper with distilled water. Germination temperature was

within $22 \pm 2^\circ\text{C}$. Accounting of seedlings was carried out, according to the current GOST on the 5th, 7th, 10th, 15th day of germination (GOST 13056.6-97, 1997).

On the day of each counting of seedlings from the bed normally sprouted and rotted seeds were removed and in the analysis card, separately for each sample, the number of seeds was noted: normally sprouted, rotted and left on the bed not sprouted seeds. Germination energy was

Table 3: The effect of growth stimulant Ecopin on the increase in seedling weight during germination of Scots pine seeds (*Pinus silvestris* L.) and laboratory germination of Scots pine seeds (*Pinus silvestris* L.)

Date of the counting of sprouts, days	Concentration of solutions, ml /l							
	Control (distilled water)	1×10^{-3}	$1 \times 2 \times 10^{-3}$	$1 \times 3 \times 10^{-3}$	$1 \times 4 \times 10^{-3}$	$1 \times 5 \times 10^{-3}$	$1 \times 6 \times 10^{-3}$	$1 \times 7 \times 10^{-3}$
	Average seedling weight, mg							
1	2	3	4	5	6	7	8	9
5 th	8,1±0,2	6,5±0,2**	7,7±0,3	10,3±0,3*	9,7±0,9	9,8±0,5*	8,4±0,8	7,1±0,2*
% to control		-19,8	-4,9	+27,2	+19,8	+21,0	+3,7	-12,3
Reliability, t_{α}	36,8	31,0	26,6	16,9	11,3	20,0	10,2	33,8
The experience accuracy (P), %	3,3	3,2	3,8	5,9	8,9	5,0	9,8	3,0
7 th	6,9±0,3	6,4±0,9	8,1±0,9	10,1±0,9*	11,0±0,8**	10,0±1,2*	9,0±0,8*	7,1±0,7
% to control		-7,2	+17,4	+46,4	+59,4	+44,9	+30,4	+2,9
Reliability, t_{α}	28,8	7,1	9,0	10,7	13,4	8,1	11,0	10,8
The experience accuracy (P), %	3,8	14,1	11,1	9,3	7,5	12,3	9,1	9,3
10 th	6,9±0,3	6,7±0,9	8,1±1,0	8,5±0,9	10,0±0,5**	9,1±0,3*	7,9±1,3	6,5±0,9
% to control		-2,9	+17,4	+23,2	+44,9	+31,9	+14,5	-5,8
Reliability, t_{α}	24,6	7,4	8,1	9,0	20,4	18,6	6,0	7,2
The experience accuracy (P), %	3,3	13,4	12,3	11,1	4,9	5,4	16,6	13,8
15 th	6,4±0,3	5,2±0,6	7,5±0,9	8,2±0,5*	9,0±1,2*	7,8±0,9*	7,0±0,8	6,1±1,4
% to control		-18,7	+17,2	+28,1	+40,6	+21,9	+9,4	-4,7
Reliability, t_{α}	24,6	9,1	8,3	16,7	7,3	8,7	8,5	4,5
The experience accuracy (P), %	3,5	11,0	12,0	6,0	13,7	11,5	11,7	22,1

Note: solution concentrations: 1×10^{-3} - 1ml/1l, $1 \times 2 \times 10^{-3}$ - 1ml/2l, $1 \times 3 \times 10^{-3}$ - 1ml/3l ...

* - reliability of differences in the values of the weight of the roots of seed seedlings between the studied concentration of the solution and control (Student's t-test, $P = 0.05$);

** - reliability of differences in the values of the weight of the roots of seed seedlings between the studied concentration of the solution and control (Student's t-test, $P = 0.01$);

determined on the 7th day of germination, germination – on the 15th day. On the day of final accounting of germination, the remaining seeds on the bed for each sample the number of healthy, not normally sprouted, rotted, steamed, germless and empty, infected with pests of seeds were determined (GOST 13056.6-97, 1997). The obtained data were recorded in the analysis card.

The length of seedlings was measured with an electronic caliper. Their mass was determined by weighing on electronic scales. The materials of the experiments were subjected to statistical analysis in the application program Microsoft Excel. The significance of differences in average values was calculated by Student's *t*-test (Doev, 2011).

RESULTS

Biological preparation Ecopin is the growth stimulant of natural origin. It consists of 6.2 g/kg of poly-beta-hydroxybutyric acid + terpenic acids + a set of nutrients and represents a concentrated product of biosynthesis of beneficial soil bacteria + a starter set of nutrients. It is a universal biological growth stimulant of plant growth and development with anti-stress effect. The basis of this biological product contains a concentrated product of the biosynthesis of beneficial soil bacteria and a starter set of nutrients. It is available in the form of viscous paste. The manufacturer of the drug is "NPF Albite". The manufacturer of packing is "Gardener's Green Pharmacy" firm. It has a wide range of actions. It is used for growing plants at all stages of growth: from seed to harvest (URL: <http://grepharm.ru/products/159/390>).

Soaking the seeds in the preparation awakens them and reduces the germination time by a few days. Ecopin stimulates the growth of the root system, improving its mineral and water nutrition; promotes the growth and development of young plants, protects them from adverse

weather conditions, various diseases. It activates the vitality and the revival of the weakened plants. Preventive treatment with Ecopin helps plants to resist diseases (powdery mildew, scab, vascular bacteriosis, etc.), increases yield, accelerates maturation and improves the quality of the fruit (color, vitamin content). It does not have harmful effects on animals and humans, does not irritate the skin and mucous membranes of the eyes, does not accumulate in the soil. It is not dangerous for bees, other insects and fish (URL: <http://www.shebek.ru/ishop/product/252>).

The drug is included in the List of pesticides and agrochemicals allowed for use in the Russian Federation, easily soluble in water and alcohol. It is freely sold by the trading network. However, instructions for the use of a growth stimulant are made up for crops. In the forest industry, these works have been started in the experimental procedure (List of pesticides and agrochemicals..., 2016).

The results of the experiments show that the concentration of the drug solutions $1 \times 2 \times 10^{-3}$ - $1 \times 5 \times 10^{-3}$ ml/l activate the seed germination energy within 71.3-79.9%, exceeding the control, respectively: by 5.2-17.8 % (table 1, fig. 1, 2).

When seeds were soaked in a solution with a concentration of $1 \times 6 \times 10^{-3}$ ml/l, no significant effect on their germination energy was observed (exceeding 0.6% to the control), and the concentration of the solution of 1×10^{-3} ml/l had an inhibitory effect on seed germination.

Soaking of seeds in solutions with concentration $1 \times 2 \times 10^{-3}$ - $1 \times 5 \times 10^{-3}$ ml/l activated their germination, the value of which, depending on the concentration of the solution,

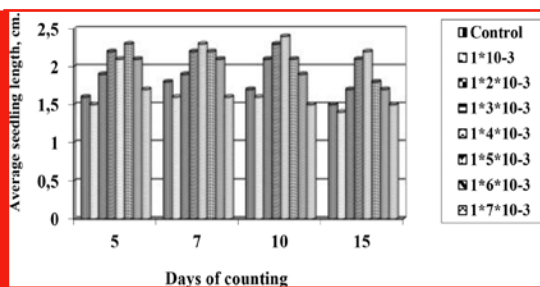


Fig. 3: The effect of growth stimulant Ecopin on the growth of seedlings in the length at the germination of Scots pine seeds (*Pinus silvestris* L.)

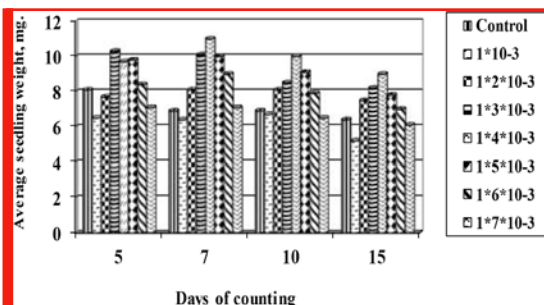


Fig. 4: The effect of growth stimulant Ecopin on the increase of the mass of the seedlings at germination of Scots pine seeds (*Pinus silvestris* L.) and laboratory germination of Scots pine seeds (*Pinus silvestris* L.)

increased significantly to 83.7-96.4 % (excess to the control of 6.9-23.1 %), causing an increase in their sowing qualities by one or two classes: from the third to the second and the first. With the weakening of the concentration of the solution to $1 \times 7 \times 10^{-3}$ ml/l, the germination energy and germination of seeds decreased, relative to the control, by an average of 11.4-13.0%. A higher concentration of the solution (1×10^{-3} ml/l) had an inhibitory effect on seed germination (table 1).

Indicators of seed germination in variants with concentrations of solutions $1 \times 3 \times 10^{-3}$ - $1 \times 5 \times 10^{-3}$ ml/l differ significantly from control: t fact > t table at significance level ($P = 0.05$ % and $P = 0.01$ %). A significant difference in the average value with the control was observed at a high concentration of solution 1×10^{-3} ml/l (t fact > t table at $P = 0.05$ %), in which the drug had an inhibitory effect. Stimulation of seed germination was also observed at concentrations of solutions of $1 \times 2 \times 10^{-3}$ ml/l (6.9 %) and $1 \times 6 \times 10^{-3}$ ml/l (2.4 %). However, the difference between the average values is not reliable: t fact < t table at $P = 0.05$ %.

The general dynamics of growth of seedlings in the length at a solution concentration of 1×10^{-3} ml/l shows a decrease in their growth rates in comparison with the control by 5.9-11.1 %. Activation of growth of seedlings in the length was observed at concentrations of solutions $1 \times 2 \times 10^{-3}$ - $1 \times 6 \times 10^{-3}$ ml/l; excess to control 5.6 – 46.7 %. At a solution concentration of $1 \times 2 \times 10^{-3}$ ml/l, the maximum growth rates of seedlings were observed on the 5th and 10th day of seed germination. The excess to the control was 18.8-23.5 %: t fact > t table at $P = 0.05$ %. The most effective concentration of solutions were $1 \times 3 \times 10^{-3}$ - $1 \times 4 \times 10^{-3}$ ml/l. Indicators of growth of the seedling in length differed significantly from the control for all days of the registration of seeds (exceeding the control to 22.2-46.7 %): t fact > t table at $P = 0.05$ % and $P = 0.01$ %. Solutions of concentrations of $1 \times 5 \times 10^{-3}$ and $1 \times 6 \times 10^{-3}$ ml/l also had a positive effect on the growth of seedlings, but to a lesser extent (11.8 - 43.8 %). The significance of differences with the control was observed on the 5th -10th days of accounting ($1 \times 5 \times 10^{-3}$ ml/l) and the 5th-7th days ($1 \times 6 \times 10^{-3}$ ml/l). Further reduction of the concentration to $1 \times 7 \times 10^{-3}$ ml/l was ineffective (table 2, fig. 3).

Drug Ecopin had a positive impact on the growth of roots of seedlings by mass. The highest activity of solution concentration was observed at $1 \times 3 \times 10^{-3}$ - $1 \times 5 \times 10^{-3}$ ml/l (exceeding 19.8-59.4 %); significance of differences with control: t fact > t table at $P = 0.05$ % and $P = 0.01$ %.

Concentrations of solutions of $1 \times 2 \times 10^{-3}$ and $1 \times 6 \times 10^{-3}$ ml/l were less effective: the difference between the average values with the control is not significant: t fact < t table. The concentration of 1×10^{-3} ml/l had an inhibitory effect on the growth of the mass of seedlings, which was more significant on the 5th day of seed germination and amounted to (-19.8 %): t fact > t table at $P = 0.01$ %. The concentration of the solution of $1 \times 7 \times 10^{-3}$ ml/l was also ineffective (table 3, fig. 4).

DISCUSSION

The obtained results of the studies are in good agreement with the data of the similar experience obtained by us a year earlier during the germination of Scots pine seeds harvested in the neighboring forest area, located 5.6 km southwest from the experimental object [14]. The germination energy of seeds soaked in a solution of a growth stimulant Ecopin the same solution concentration amounted to 71.3-75.3 %, laboratory germination – 85.1-94.6 %.

Similar indicators of sowing qualities of seeds in this study range from 71.3-79.9 % and 83.7-96.4 %. A comparative analysis of the sowing qualities of seeds harvested at the same time at two different sites shows no significant differences.

The experiments in this study were expanded by identifying the efficiency effects of a growth stimulant Ecopin on the biometrics of seeds: the growth of roots of seedlings in length and weight.

CONCLUSION

The experiments allowed identifying the effects of growth stimulant (regulator) Ecopin on sowing qualities of seeds and to make the following conclusions:

1. Growth stimulant Ecopin shows high activity during germination of seeds and the growth of biometric parameters of Scots pine seedlings and can be recommended for use in nurseries in the forest industry.
2. The most effective concentrations of the drug $1 \times 2 \times 10^{-3}$ - $1 \times 5 \times 10^{-3}$ ml/l, in comparison with control, increasing significantly the germination energy and laboratory germination of seeds to 71.3-79.9% and 83.7-96.4% (excess to control by 5.2-17.8% and 6.9-23.1%) and as a consequence – quality classes: from the third to the second and first. The concentration of $1 \times 6 \times 10^{-3}$ ml/l had an insignificant effect on the sowing quality of seeds, exceeding the control by 0.6-2.4 %. The lower concentration of

solution $1 \times 7 \times 10^{-3}$ ml/l reduced germination and seed germination energy by 11.4-13.0 %. A higher concentration of 1×10^{-3} ml/l was ineffective.

3. The concentration of solutions had the greatest effect on the growth of seedlings in length and weight $1 \times 3 \times 10^{-3}$ - $1 \times 4 \times 10^{-3}$ ml/l and $1 \times 3 \times 10^{-3}$ - $1 \times 5 \times 10^{-3}$ ml/l (excess to control 22.2-46.7 % and 19.8-59.4 %). The concentration of 1×10^{-3} ml/l had an inhibitory effect, reducing the growth rate of seedlings in length, compared with the control by 5.9-11.1 % and by weight by 2.9-19.8 %. Reducing the concentration to $1 \times 7 \times 10^{-3}$ ml/l was ineffective.

4. The observed increase in quality classes causes a decrease in the seeding rate in the forest nursery per unit area, increasing the economic efficiency of growing planting material.

5. The main part of the seeds, in most of the used options, germinates in the first half of the germination period, reducing their activity by the end of its term.

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Regulatory and Value-Based Foundations of Bioethics in France: Experience for Russia

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ABSTRACT

The article deals with comparative legal analysis of the elements of legal regulation and value-related orientations of bioethical issues in France. The paper analyzes the theoretical foundations of the research and practical implementation of biotechnologies while citing and assessing some real cases associated with the issue in question. The article also analyses the measure of law in the context of genetic and bioethical research, concluding that additional auxiliary mechanisms of bioethical issue regulation need to be taken into account. For instance, the paper examines the issue of the freedom to use thoughts, opinions and other information as well as governmental control over such information. Both general and special methods of cognition were used in course of the work. The research is performed based on the case studies of the French legal practice over the past 30 years. In particular, the cases Corinne Parpalaix, Nicolas Perruche, Maurice contre France are analyzed. Conclusions: the point of view with regard to the issues under consideration in each particular country should be determined based on the national and cultural peculiarities of the country in question; the possible use of legal Esperanto in resolving the cases related to bioethics should be accompanied by the adjustment of argumentative practices to the realities of the corresponding country; we believe that in future the amount of various-level court proceedings on ethico-biological subject matter will be only increasing; the Russian Federation may, to a certain extent, use the experience of other countries in this area taking into account domestic ethical traditions.

KEY WORDS: Bioethics, Law, Freedom, Russian, Foreign, Genomic Studies, Comparative Law

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INTRODUCTION

The term "bioethics" (ethics of life) was suggested by the American biochemist Van Rensselaer Potter in 1969 (Meshcheryakova, 2010). The emergence of the term is associated with active development of medical and other technologies, which, as Tamara Meshcheryakova aptly pointed out, will allow the people of the Postmodernity not to content themselves with the paradigms of determinateness of being, but to start actively creating themselves (Savoshchikova, 2015).

Today, bioethics is a synthetic concept with a number of key principles and propositions, the first ones to be mentioned among which are the common humanitarian principle of respecting the dignity of an individual, as well as a number

of domain-specific principles: “do good” (beneficence) – the principle addressed to medical personnel, the principle of equitable distribution of health care resources and the principle of autonomy of the patient's will (patient autonomy) (Reich, 1995).

METHODS

Both general and special methods of cognition were used in course of work on this article. The work was based on a comparative legal method realized within the framework of interdisciplinary (comparison of the legal doctrine with the related spheres of knowledge, such as philosophy and sociology), cross-branch (comparative analysis of the approaches used in comparative law, philosophy and the theory of law as well as in branch legal disciplines), cross-border (comparison of different national legal systems with each other and with international law provisions) as well as chronological (historical comparative analysis) approaches. The authors relied on the principle of methodological pluralism in their research, which allowed them to look at the problem under examination from various points of view, thus ensuring a comprehensive nature of cognition.

RESULTS AND DISCUSSION

The regulatory framework of bioethics is closely connected with the value-related elements of a society as a whole. However, the legal superstructure is able to provide only a partial resolution of the problems arising for the society of the 21st century in this sphere. The growing momentum of genetic and bioethical research in 2018 in Russia is a clear manifestation of the need to search for a new measure of law in this sphere (Zakharova & Voronin, 2019).

It is important to emphasize the close connection between the research and the practice in this regard, as bioethical issues are directly linked to learning about (knowledge of) biological material, and sometimes to the genetic material research. In our opinion, the social category which refracts (adjusts) the processes of cognition, acting as some kind of a connecting link between the social and the natural-science knowledge as a whole, is the “measure of law”.

A lot depends on the approaches to understanding law as such and the measure of law. It is important to realize that, irrespective of the measure and irrespective of the limits of human “penetration” into the nature as well as into the process of nature cognition set at the national, integrational, or international level of legal regulation, it is possible to “measure” only the behavior of the subject of law ultimately governed by the will of specific individuals (in the case of a collective subject of law).

The objective of this paper is not to show the genesis of the measure of law – it is the task of another cognitive process. Here we are seeking to emphasize that the measure of law is one of the main elements in the sphere of bioethical research. It is exactly the measure of law – in the unity of quantitative and qualitative characteristics, research and application of biological and genetic material – that comprehensively shows the limits of the possible use of technology in medicine and biology.

Let us refer to Article 10 of the European Convention on Human Rights. It establishes the freedom of expression, providing the right to hold and express opinions, as well as realize own ideas or the algorithm of own actions without interference by any public authority, which is also the case for research activities. Paragraph 2 of the aforementioned article says: “The exercise of these freedoms, since it carries with it duties and responsibilities, may be subject to such formalities, conditions, restrictions or penalties as are prescribed by law and are necessary in a democratic society, in the interests of national security, territorial integrity or public safety, for the prevention of disorder or crime, for the protection of health or morals, for the protection of the reputation or rights of others, for preventing the disclosure of information received in confidence, or for maintaining the authority and impartiality of the judiciary” (The Convention for the Protection of Human Rights and Fundamental Freedoms, 2001). Therefore, based on the example of information use, we can conclude that there exist some governmental restrictions to the measure of freedom of bioethical research and the development of biotechnology (Ovcearenco, 2004). In particular, the information pertaining to the relations between a doctor and a patient in course of applying new technologies, as well as the information that becomes known as a result of special tests, clinical trials or certain vaccinations, should be subject to proper processing and storage.

In this case, in line with a pure normativist understanding (e.g., Kelsen's pure theory of law), one can conclude that it is impossible to restrict and measure the behavioral characteristics of genetic and bioethical research to the full (hundred-per-cent) extent. This is due to the permanent connection of bioethical issues with natural-science knowledge and the impossibility to understand the limits of penetration (as we have already pointed out). However, this certainly does not mean that it should not be restricted. In this connection, we analyzed an example of restriction of the aforementioned bioethical issues through certain means of influencing information. What other ways the government may use to “control” such complex relations

– bioethics and research in the natural science sphere of medicine and biology – is yet to be studied. This is possible only on condition of recognition of the value of human life and a human being as well as a value-based attitude to certain sacred issues.

At the same time, irrespective of the level of assessment of bioethical issues (value-related and/or legal) by a researcher, the methodological foundation for the research shall be the maxims of disciplinary, interdisciplinary and even transdisciplinary knowledge.

The integrational level of the assessment of bioethical issues is manifested at the regulatory level in the famous Oviedo Convention and at the organizational level – in a number of actively functioning institutions under the auspices of UNESCO. In the latter case, we are referring, in particular, to the implementation of the large-scale Global Ethics Lab project. It is a multidimensional database containing information on national, regional and integrational ethical committees; on educational programs in this sphere, as well as on the codes of conduct in various areas of ethics and the legislation on the specified range of issues adopted in different countries of the world.

National points of view and assessments of bioethical issues in different countries vary significantly. This is equally true in terms of both the extent of development of the institution of bioethics at the regulatory level as a whole, and the percentage ratio of “obverse and reverse” (prohibition vs. permission) at its foundation. In particular, we can mention the intellectual center dedicated to the issues of bioethics that was established in Russia back in the 1990s – the Russian National Committee for Bioethics (RNCB) of the Russian Academy of Sciences. Among other things, the tasks of the Committee included expert assessments of draft legislation in any way concerning ethico-medical issues, such as: On Psychiatric Care and Guarantees of Citizens' Rights in course of Provision Thereof (1992), Fundamentals of the Legislation of the Russian Federation on Citizens' Health Protection (1993), On Temporary Ban on Human Cloning (2002). However, a comprehensive Bioethics Law in Russia has not been adopted yet. The doctrinal evaluation of the French experience, which has made the final step in this matter, seems to be appropriate and important in terms of both the cognitive and the forecasting functions of jurisprudence.

So, what is France's point of view on the issues related to bioethics and how has it been evolving over the past 30 years?

First of all, it should be mentioned that even before the adoption of the Bioethics Law in France, the issues related to bioethics were being assessed at the governmental level to a varying degree. In the absence of a regulatory framework for the subject matter in question, the judicial authorities had to determine the boundaries of the due with regard to the corresponding bioethical issues. One of the landmark cases in this regard is the case of Corinne Parpalaix. In 1984, Corinne Parpalaix applied to the Kremlin-Bicêtre hospital in order to obtain the sperm of her deceased husband, who three years before his death had deposited it for storage at the aforementioned medical institution. The hospital authorities rejected her claim for possession of the sperm, explaining their decision by the fact that only the owner of the relevant biological material could obtain it, and the owner was already dead at the time of his wife's application. This was followed by a long litigation culminating into a ruling by the High Court (Tribunal de grande instance): Mrs. Corinne Parpalaix was allowed to obtain her late husband's sperm from the genetic material bank. Some time after the ruling, Mrs. Corinne Parpalaix, after IVF procedure, gave birth to twins.

No less relevant and high-profile in the French judicial law-enforcement practice was the case of Nicolas Perruche, in course of which the term “*préjudice d'être né*”, literally meaning “prejudiced by birth”, was used for the first time in the history of France (in English-language practice the term “wrongful life” is used for similar legal action). The story was as follows: in 1983, Nicolas Perruche, due to a medical error, was born half-blind and suffered mental disorders, because the doctors failed to diagnose that his mother had contracted rubella (German measles) during pregnancy. In his claims Nicolas Perruche stated that life had brought him nothing but suffering, and demanded payment of damages on the basis of the *préjudice d'être né*. The legal assessment of this case became a subject of heated discussions both in France and internationally.

Prior to the final ruling in the Cour de cassation (France's equivalent to the Supreme Court), which became possible, among other things, due to the reference by the French Advocate General (*avocat général*) to the US law enforcement practice in relation to medical errors (Allard & Garapon, 2005). Nicolas Perruche and his family passed several court instances. On 17 November 2000, the French Cour de cassation ruled as follows: “In view of the fact that the error by the doctor and the medical laboratory in performance of the contracts signed with the pregnant woman prevented the latter from deciding in favor of induced termination of pregnancy in order to

prevent the birth of a handicapped child, the latter (the child) may claim damages arising from his disability and incurred as a result of the error". However, the final ruling has not put an end to the discussion of such a complex ethico-legal issue. According to Jean-François Mattei, the French society divided into Perruchists and Anti-Perruchists (Mattei, 2019).

The debates with regard to the wrongful life issue which started in the 20th century found a continuation in the case *Maurice v. France* considered by the European Court of Human Rights. The Maurices (a married couple) applied to court due to the circumstances similar to those of Nicolas Perruche's parents: a medical error resulting in the failure to diagnose a potential birth of a disabled child by the examined pregnant woman. In this case, the ECHR fully supported the claimants and awarded a significant amount in damages: 20,650,000 euros.

The adoption of the Bioethics Law in 1994 became a significant milestone in this respect and partially relieved the judiciary from the challenges of resolving such complex and controversial cases giving rise to legal debate on bioethical issues. The main objectives of the law adoption (as set by the legislators) were improvement of living conditions, protection of individual and family values, as well as protection of children's rights. Each of the aforementioned common humanitarian values acquired a narrow focus in the Law.

For instance, life improvement was considered in the context of establishing the principles of organ and tissue transplantation; protection of individual and family rights – in the context of a ban on eugenics and cloning, as well as establishment of the measures for the organization of reproductive medicine. Children's rights protection also acquired a certain narrow focus. The legislators, in particular, defined the rights and obligations of the parents in the case of conception through artificial insemination. The Law establishes the following key provision in this regard: "When a pregnant woman is inseminated by a donor, her partner, who has agreed to the insemination, becomes the father of the child and cannot evade the obligation of paternity due to the fact that the child was not conceived with his own sperm".

Some other key provisions of the Law are as follows:

1) the issues of organ and tissue transplantation. In particular, the Law stipulates that it is impossible to obtain organs of a deceased person without verifying the fact that such deceased person has not registered with the relevant

registry a refusal to donate his/her organs and tissues for transplantation. Anonymity and non-remunerated nature of the donation must also be confirmed in this instance;

2) anonymity and non-remunerated nature as the principles of sperm donation;

3) basic provisions for the protection of personal data of patients in the sphere of epidemiology and public healthcare.

It is also important to point out that the introduction of the term "cellular products for therapeutic purposes" into the legal assessment sphere is associated exactly with the adoption of the 1994 Bioethics Law, although these issues became the subject of doctrinal assessment in France as early as in the mid-1980s (Tournay, 2006; Fagot-Largeault, 1985).

In course of its evolution, the aforementioned Law experienced several major reforms. For example, as a result of the Law revision in 2004, the set of provisions on living human organ donation was expanded contributing to improvement of the situation in transplantology. The reform of the Bioethics Law in 2011 was preceded by serious analysis of the current legislation with regard to this issue by the French Council of State.

In what way has the legislation been amended? First of all, the innovations consisted in the formal simplification of the order of a number of medical procedures. For example, the 2004 version of the Law stipulated that in order to get IVF treatment, a couple who have not officially registered their marriage must provide proof of the fact that they have been living together for at least 2 years. In the 2011 version of the Bioethics Law, this restriction was lifted (Legifrance, 2019).

In addition, the details of several provisions were altered in the Law. For example, the legislators allowed using donor gametes up to ten times instead of five times, as was previously stipulated. Some aspects of bioethics, after a large-scale parliamentary debate, retained the formal regulation options outlined in previous versions of the Law. We are referring, in particular, to the establishment of the principle of organ and tissue donor anonymity.

SUMMARY

It is important to point out that a point of view on the issues under consideration in each specific country should be determined based on the national and cultural peculiarities of the respective country. At the same time, legal Esperanto

should be introduced into the academic and professional communities for which the issues of bioethics matter. Resolution of the cases related to bioethics should be accompanied by the adjustment of argumentative practices to the realities of the corresponding country. We believe that in future the amount of various-level court proceedings on ethico-biological subject matter will be only increasing; The Russian Federation may, to a certain extent, use the experience of other countries in this sphere, taking into account domestic ethical traditions.

CONCLUSION

With regard to using the French regulatory experience in the sphere of bioethics in other countries (and, in particular, in Russia), as Patrick Verspieren points out, one of the main arguments in favor of non-adoption of such a law in secular countries is the fact that it is beyond the sphere of governmental regulation (Verspieren, 2012). In this respect, we are facing one of the key problems of the jurisprudence of the present, the past and, presumably, the future – that of the limits of legal regulation. The absence of a legislative solution to the problem in this case does not mean that another branch of governmental power or a supranational organization will not have to solve it. And it is better when such a national view on the issues of bioethics (with the so-called big challenges) already exists in the government's portfolio than when there is none. At the same time, the national point of view in each specific country should be determined based on the national and cultural peculiarities of the respective country. For example, it is obvious that a permission to use the sperm of a deceased husband in the secular French Republic is quite possible, but in any of the numerous Islamic monarchies it is not. We fully share the position of the French publicist Aimé Césaire, who wrote that “a civilization that tampers with its principles is doomed”.

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Influence of Co-Use of Mineral, Organo-Mineral Microbiological Fertilizers and Growth Regulator on Oats Yield

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ABSTRACT

*This article presents research materials on the effect of combined use of organo-mineral microbiological fertilizers and a growth regulator on the elements of the structure of spring oats (*Avena sativa*) of the zoned variety Skakun grown on gray forest heavy loamy soil of the Nonchernozem zone of Russia at various sowing dates. Analysis of data from experiments on gray forest heavy loamy soil shows that, according to all research variants, higher and more stable values of the studied parameters of the oats structural elements were noted during the first sowing date (third decade of April) than during the second sowing date (first decade of May). In general, the maximum experimental values of the crop structure parameters were revealed in 2017 with both sowing dates. 2017 turned out to be favorable, especially in terms of the moisture regime. At the same time, the dry, hot summer of 2018 had a negative impact, especially during the second term of oats sowing, on all the studied parameters. The maximum increments for the studied parameters of oats are marked on the variant with plants treatment with Azotovit and Phosphatovitin a dose of 0.5 l / ha and Emistim, Rin a dose of 1 ml / ha. The same positive trend, but with smaller gains in oat plants, is also observed at a later sowing date. However, reduced soil moisture and high temperatures during the growing season of plants (2018) reduce the positive impact of their treatment with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R at a dose of 1 ml / ha on the studied parameters of the oats structure elements to 0.05 %.*

KEY WORDS: Oats, Nonchernozem Zone Of Russia, Fertilizer, Growthregulator, Yieldstructure, Yield

INTRODUCTION

Since the end of the last century, oats in world agriculture is becoming more and more a food crop. According to the Food and Agriculture Organization of the United Nations

(FAO), in 2016, Russia was the world's leading producer of oats (4,761.365 thousand tons), ahead of such major countries as Canada, Poland, Australia and Finland (Saastamoinen et al., 1989; Fedotova et al., 2017).

The problem of increasing yields and improving the quality of grain in modern conditions is important. Its solution is largely determined by the use of zoned, science-based technologies for growing grain crops. Grain production in Ryazan region is still unstable up to the present, due to the insufficiently full use of quite favorable soil-climatic and economic conditions, achievements of science and advanced experience.

The weather conditions of Ryazan region, especially the amount and time of precipitation, are very unstable both by year and during the growing season. Therefore, to stabilize the gross harvest of food grains in the farms of the region, the number of crops and the number of varieties for each

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of them must be increased. To obtain high and stable yields, it is necessary to observe the technology of the crop cultivation. Therefore, measures used when oats growing should be aimed primarily at improving these factors. This is achieved by choosing good precursors, differentiating tillage, establishing optimal nutrients, sowing in the best possible time and, undoubtedly, the use of organo-mineral microbiological fertilizers and growth regulators. Only the right combination of these agricultural techniques will allow to get high yields of grain crops.

Modern grain cultivation is intended to create favorable conditions for realizing the genetic potential of a crop. It is possible to bring the world level of development of oats production possible only when mastering intensive adaptive technologies of grain production, which help reduce production costs, make it competitive and environmentally friendly, and make production highly profitable.

The system of agrotechnical techniques is one of the main factors forming a high yield of grain. Recently, organo-mineral microbiological fertilizers and growth regulators

have been used in agricultural practice as effective, economical and environmentally friendly products that increase the efficiency of growing crops (Vinogradov et al., 2018; Vinogradov et al., 2018; Ilieva & Vasileva, 2013; Vasileva & Kertikov, 2007; Ellmer et al., 2002). Organo-mineral fertilizers, microbiological fertilizers in the Nonchernozem zone of Russia are widely used on crops (Shchur et al., 2016; Shchur et al., 2016; Vinogradov et al., 2018; Zakharova et al., 2019). However, there are practically no scientific developments in terms of their optimal doses and terms of application when combined with traditional mineral nutrition at different dates of sowing spring oats (Vasileva, 2015; Fatykhov et al., 2005; Fadkin & Vinogradov, 2015; Polikarpova & Mizikovskiy, 2018). The yield of spring oats is possible only with the proper implementation of all elements of the technology of cultivation (Vinogradov et al., 2019; Vinogradov et al., 2015; Andreev et al., 2018; Zavgorodnyaya et al., 2018).

The most important problem in oats production is the insufficient knowledge of the agrobiological properties of modern varieties and their reaction to the biological

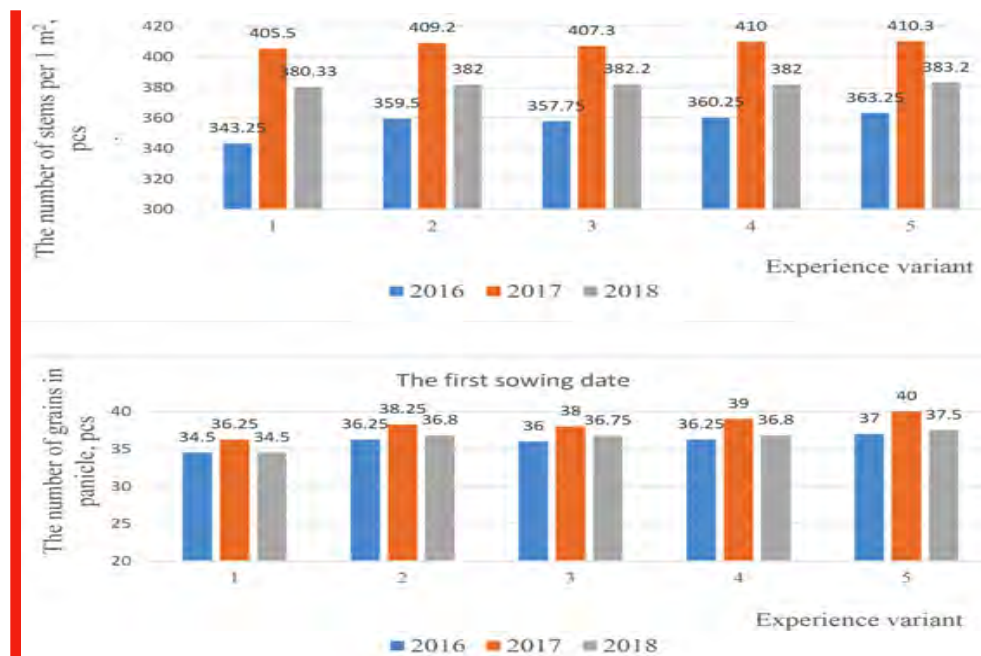


Fig. 1: The elements of the structure of oat by years, depending on the action of mineral, organic-mineralmicrobiological fertilizers and Emistim, R and sowing date (1- mineral fertilizer; 2- mineral fertilizer + Azotovit 1 l / ha; 3- mineral fertilizer + Phosphatovit 1 l / ha; 4- mineral fertilizer + Azotovit + Phosphatovit each by 0.5 l / ha; 5- mineral fertilizer + Azotovit + Phosphatovit each by 0.5 l / ha + Emistim, R 1 l / ha)

methods of cultivating spring grain (Vinogradov et al., 2018; Vinogradov et al., 2018). So far, in the conditions of Ryazan region, there have been no studies of the action of biological preparations and micronutrients Azotovit, Phosphatovit and Emistim, R on spring oats, therefore, these studies seem to be very relevant.

In modern Russian agriculture, among the compounds of chemical, microbial and plant origin, having a regulatory effect, Epin-Extra, Zircon, Humat-Baikal, Agat-25K, Gisinar, Emistim, R and others are often used.

To compare the effect of growth regulators used in pre-sowing treatment, to stimulate the germination of oat seeds, we previously had a laboratory experiment with each of the above mentioned preparations in triplicate. The object of the laboratory study was seeds of spring oats (*Avena sativa*), variety Skakun, grown in the farms of Ryazan region. The greatest stimulating effect was achieved when soaking oat seeds in a solution of growth regulator Emistim, R (Fedotova, 2016).

This is a unique product with an economical dose of 0.01 g / l, containing a balanced complex of phytohormones, amino acids, carbohydrates, fatty acids and microelements. It is

a natural metabolic product of the *Acremoniumlichenicola* symbiotic fungus, isolated from ginseng roots and containing growth substances of cytokinin and gibberellic nature, beta-lactam antibiotics, cyclosporine C, alkaloids with phytoalexin activity and hydroxylated isoprenoids (Fedotova, 2016).

MATERIAL AND METHODS

The purpose of the investigation is to study the effectiveness of the co-use of mineral nutrition, organic microbiological fertilizers and a growth regulator on the elements of the oats structure at different sowing dates. As an object of investigations, spring oats (*Avena sativa*) of a zoned variety Skakun, grown on gray forest heavy loamy soil of Ryazan region, were taken.

Investigations took place in 2016-2018 in the conditions of the Nonchernozem zone of Russia, on the field of an experimental agrotechnological station of Ryazan State Agrotechnological University Named after P.A. Kostychev, Ryazan region.

The fertilizer system was calculated on the basis of an agrochemical analysis when digging a hole of gray forest heavy loamy soil using the elemental balance method



Fig. 2: The elements of the structure of oat by years, depending on the action of mineral, organic-mineralmicrobiological fertilizers and Emistim, R and sowing date (1- mineral fertilizer; 2 - mineral fertilizer + Azotovit 1 l / ha; 3 - mineral fertilizer + Phosphatovit 1 l / ha; 4- mineral fertilizer + Azotovit + Phosphatovit each by 0.5 l / ha; 5- mineral fertilizer + Azotovit + Phosphatovit each by 0.5 l / ha + Emistim, R 1 l / ha)by 0.5 l / ha + Emistim, R 1 l / ha)

(Mustafayev et al., 2018). Fertilizers were applied in accordance with the following estimated dose rates N135P135K75.

The field experiment design included four levels with the location of the variants in each of them according to the Latin square scheme. Agrotechnology is generally accepted for the Nonchernozem zone of Russia. Oats sowing was carried out in the third decade of April (first date) and the first decade of May (second date). The seeding rate is 5 million pcs. of germinating seeds / ha. Mineral fertilizers (background) were applied for presowing cultivation. The sowing of oats at the first and second dates was carried out in the same way: to a depth of 3-4 cm, in a continuous ordinary way, with a width of 15 cm between the rows. The oats treatment with the studied preparations was carried out by spraying in boot stage.

The field experiment design included the following variants:

1. Control - mineral fertilizers.
2. Mineral fertilizers + treatment of plants with Azotovit at a dose of 1 l / ha.

3. Mineral fertilizers + treatment of plants with Phosphatovit at a dose of 1 l / ha.

4. Mineral fertilizers + treatment of plants with nitrogenous and Phosphatovit doses of 0.5 l / ha, respectively.

5. Mineral fertilizers + treatment of plants with nitrous oxide and Phosphatovit at doses of 0.5 l / ha + Emistim, R at a dose of 1 ml / ha.

RESULTS AND DISCUSSION

It is well known that the formation of oats after sowing begins with ensuring high field germination of seeds, safety and survival of plants, optimum planting density for harvesting, that is, according to prevailing conditions for growth and development and depending on agrotechnical methods used.

Figures 1 and 2 show data for three years of investigations on the effect of treating plants with organo-mineral microbiological fertilizers and a growth regulator on oats structural elements, depending on the studied variants. The decisive role in the crop structure goes to the density of the productive stalks, determined by the variants used. In general, over three years of investigations all variants had the number of stems per 1m2 was lower in 2016, and the



Fig. 3: The elements of the structure of oat by years, depending on the action of mineral, organic-mineral, microbiological fertilizers and Emistim, R and sowing date (1- mineral fertilizer; 2- mineral fertilizer + Azotovit 1 l / ha; 3 - mineral fertilizer + Phosphatovit 1 l / ha; 4- mineral fertilizer + Azotovit + Phosphatovit each by 0.5 l / ha; 5- mineral fertilizer + Azotovit + Phosphatovit each by 0.5 l / ha + Emistim, R 1 l / ha)

highest one in 2017, regardless of the sowing dates, due to a wetter and cooler summer of 2017. The highest density of productive stalks during the first date of sowing was in 2017 on the fifth variant with the treatment of plants with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha (410.3 ears per 1 m²), which was 1.2 % higher than the control variant (405.5 ears per 1 m²). At the same time, the fifth variant was more significantly (by 5.8 %) distinguished by the maximum parameter of the density of productive stalks from the control during a wet summer with a slightly increased thermal regime, which was observed in 2016.

The general trend of this parameter for different variants is preserved with the second term of oats sowing (Figure 3).

Thus, the highest density of productive stalks was also on the fifth variant in 2017 with the treatment of plants with Azotovit and Phosphatovitin doses of 0.5 l / ha each and Emistim, R in a dose of 1 ml / ha (405.9 ears per 1 m²), which is only 0.4 % higher than the control one (404.2 ears per 1 m²). In 2016, the fifth variant also differed

most significantly (by 5.7 %) in the density of productive stalks compared to the control. On the whole, the density of productive stalks on the variants with the second date of oats sowing decreased slightly by 0.7 - 2.0 % from the variants with the first date of sowing.

In three years of investigations, the number of grains in a panicle of oats in all variants was lower with the second date of sowing in 2018, while at the same time it was the highest with both sowing dates in 2017. This was due to the more arid summer of 2018, and a wet and cool summer of 2017.

In general, according to the variants for three years with the first sowing date, the maximum parameters were observed in 2017 in the variant with the treatment of plants with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha (40.0 pcs.), which was 10.3 % higher than the control (36.25 pcs.). At the same time, the lowest results for all variants with the first sowing date were obtained in 2016, the parameters of which differed from the variants for 2017 by 5.1 - 8.1 %. With the second sowing date, the number of grains in the oat panicle of the

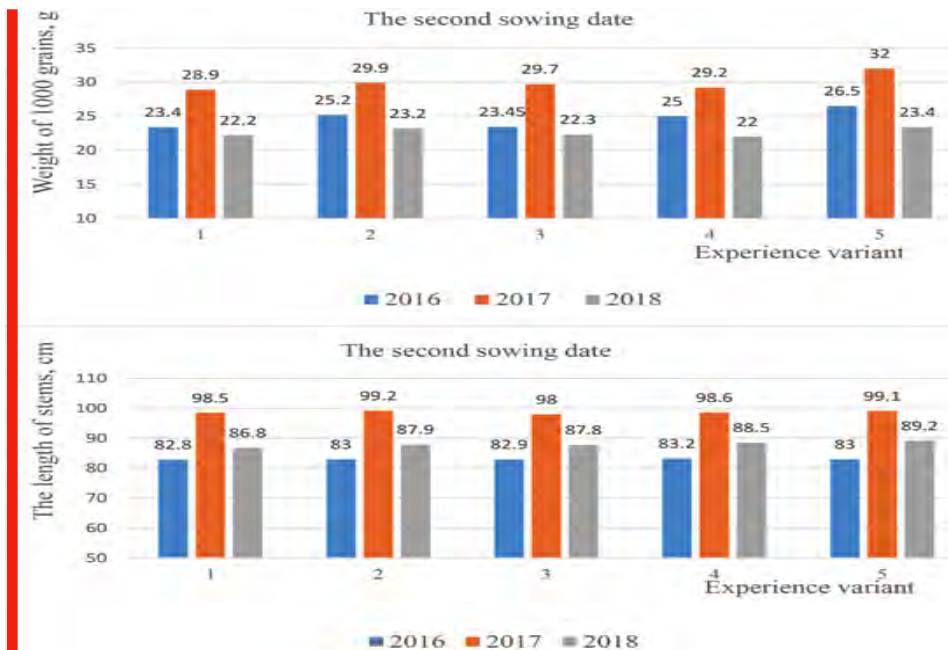


Fig. 3: The elements of the structure of oat by years, depending on the action of mineral, organic-mineralmicrobiological fertilizers and Emistim, R and sowing date (1- mineral fertilizer; 2- mineral fertilizer + Azotovit 1 l / ha; 3- mineral fertilizer + Phosphatovit 1 l / ha; 4- mineral fertilizer + Azotovit+ Phosphatoviteach by 0.5 l / ha; 5- mineral fertilizer + Azotovit+ Phosphatoviteach by 0.5 l / ha + Emistim, R 1 l / ha)

variants in 2016 and 2017 was lower than those of the first sowing date by 1.4 - 8 %.

It should be noted that the parameter of the number of grains in the panicle during the second sowing date for all 2018 variants is significantly lower than that for the first date variants by 15.7-29.1 %, and the variant with treating plants with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha in 2018 (30.5 pcs.) only 2.3 % higher than the control (29.8 pcs.). Thus, the variant of mineral fertilizers + Azotovit + Phosphatovit of 0.5 l / ha + Emistim, R 1 ml / ha.

For three years of investigations, the mass of 1000 oat grains for all research variants (Figure 2 and 4) was lower with the second sowing date in 2018, and the highest with both sowing dates in 2017. This is due to the more arid summer of 2018. The best result for three years was observed in the fifth variant with the plants treatment with

Azotovit and Phosphatovit doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha with the first sowing date (32.5 g), which is 9,1 % more than the control variant (29.8 g). The lowest result was observed in 2018 in the fourth variant with the second date of sowing with the plants treatment Azotovit and Phosphatovit in doses of 0.5 l / ha (22.0 g), which is even 0.9 % below the control variant (22.2 g) of the year under consideration.

It can be noted that the treatment with organo-mineral microbiological fertilizers separately and in combination with Emistim, R as a whole has had some positive effect on the weight gain of oat grains for three years, although this effect is less pronounced during the second sowing date, especially in the arid summer of 2018.

For three years, the height of oat plants as a whole in all variants and both sowing dates was lower in 2016, and the highest in 2017. In general, for three years, the maximum

Table 1. The yield of oats, depending on the sowing date and treatment variants, t / ha							
Variant		Yield, t / ha				Average increase	
		2016	2017	2018	average for 3 years	t / ha	%
1st sowing date (3rd decade of April)							
1	Control	2.30	3.74	2.67	2.90	-	-
2	Mineral fertilizers + Azotovit 1 l / ha	2.77	4.20	3.16	3.38	0.48	16.5
3	Mineral fertilizers + Phosphatovit 1 l / ha	2.64	4.09	3.10	3.27	0.37	12.7
4	Mineral fertilizers + Azotovit + Phosphatovit 0.5 l / ha each	2.86	4.33	3.11	3.43	0.53	18.2
5	Mineral fertilizers + Azotovit + Phosphatovit 0.5 l / ha each + Emistim, R 1 l / ha	3.20	4.53	3.36	3.69	0.79	27.2
2nd sowing date (1st decade of May)							
1	Control	2.36	3.56	2.10	2.67	-	-
2	Mineral fertilizers + Azotovit 1 l / ha	2.87	3.79	2.26	2.97	0.30	11.2
3	Mineral fertilizers + Phosphatovit 1 l / ha	2.46	3.70	2.17	2.78	0.11	4.1
4	Mineral fertilizers + Azotovit + Phosphatovit 0.5 l / ha each	2.77	3.72	2.24	2.91	0.24	9.0
5	Mineral fertilizers + Azotovit + Phosphatovit 0.5 l / ha each + Emistim, R 1 l / ha	2.89	4.10	2.28	3.09	0.42	15.7
LSD05t / ha		1.29	0.56	0.64			

average height of oat plants was recorded in 2017 in the fourth variant with the plants treatment with Azotovit and Phosphatovit in doses of 0.5 l / ha and the fifth one with the plants treatment with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha (108 cm each) for the first date of sowing, which is 7.1 % more than the control variant (100.8 cm). The lowest result as a whole for three years was observed with the second sowing date in 2016 in the third variant with the plants treatment with Phosphatovit in a dose of 1 l / ha (82.9 cm), which is insignificantly (0.12 %) more than the control variant (82.8 cm). It can be noted that the treatment with organo-mineral microbiological fertilizers separately and in combination with Emistim, R as a whole for three years has had some positive effect on the height gain of oat plants, although with the second sowing date this effect is less pronounced.

Analysis of the data of experiments conducted on the gray forest heavy loamy soil of the southern part of the Nonchernozem zone of Russia shows that for all investigation variants higher and stable values of the studied parameters of the elements of the oats structure are noted during the first sowing date (third decade of April) than during the second sowing date (the first decade of May). In general, by experience, the maximum values of the crop structure parameters were revealed in 2017 with both sowing dates. Note that 2017 turned out to be favorable, especially in terms of the moisture regime. At the same time, the dry and hot summer of 2018 negatively affected all the studied parameters, especially during the second sowing date.

In general, over the years of research, the largest increase in such parameters of oats as the number of stems per 1 m² (up to 5.8 %), the number of grains in the panicle (up to 10.3 %), the weight of 1000 grains (up to 9.1 %) and the height of plants (up to 7.1 %) was noted with the first sowing date on the fifth variant with the treatment of plants with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha. The same positive trend is also maintained during the second date of sowing, but the absolute maximum gains of the studied parameters on the fifth variant, with the treatment of plants with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha, lower in different years than in the first date of sowing by 3.3 - 22.9 %.

The smallest increments of the studied parameters of oats from the control variant with both sowing dates are marked on the third variant, with the treatment of plants with

Phosphatovit in a dose of 1 l / ha, the values of which range from 0.7 to 7.8 % depending on a particular year.

The maximum increments in the studied parameters of oats in the gray forest heavy loamy soil of Ryazan region are consistently observed in the variant with the treatment of plants with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha. The same positive trend, but with smaller increments of parameters of oat plants, is also observed with a later date of sowing. However, reduced soil moisture and high temperatures during the growing season of plants (2018) reduce the positive impact of their treatment with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha on the studied parameters of the oat structural elements to 0.05 %.

The data obtained for three years of investigations on the yield of oats, depending on the studied variants and planting dates, when treating the plants with organo-mineral microbiological fertilizers and growth regulator are presented in Table 1.

As it follows from the data of Table 1, for three years of investigations, different in terms of heat supply, the oat yield rate was consistently higher relative to the control for all treatment variants and sowing dates.

It is well known that the moisture content of cultivated plants is largely determined by rainfall, its size and distribution throughout the territory, variability by year and within the growing season. The characteristics of the meteorological conditions in the years of investigations were compiled according to the data of the agrometeorological station in Ryazan. During the years of investigations, the meteorological conditions of the growing season differed and developed as follows: 2016 was characterized as wet with a slightly increased temperature (hydrothermal coefficient of moisture (HTC) - 1.49), 2017 was wet and cool (HTC - 1.57) and 2018 was dry with increased temperature mode (HTC - 0.64).

As it was revealed, during the first sowing date, the yield in all variants was lower in 2016, and the highest one was recorded in 2017. With the second date of sowing in all variants, the yield of oats was the lowest in 2018, and the highest in 2017. However, on average over three years of investigations, the yield increase during the first date of oats sowing for all variants of plants treatment relative to the control was from 12.7 to 27.2 % (from 0.37 to 0.79 t /

ha), and the second date of sowing was much lower - from 2.78 to 15.7 % (from 0.11 to 0.42 t / ha).

Thus, on average over three years of investigations with both dates of sowing, the yield of oats, as well as the parameters of its structural elements of productivity, prevailed in the fifth variant with the treatment of plants with Azotovit and Phosphatovit in doses of 0.5 l / ha and Emistim, R in a dose of 1 ml / ha (3.69 and 3.09 t / ha, respectively). The lowest yield, on average for three years of investigations with both dates of sowing, was noted on the third variant with the treatment of plants with Phosphatovit in a dose of 1 l / ha: 3.27 t / ha with the first date and 2.78 t / ha with the second date, respectively.

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Prevention and Correction of Deviant Behavior by Psychotherapeutic Methods

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ABSTRACT

Nowadays, when it is necessary to recognize that our society lives in an aggressive environment, and adolescents often do not realize and cannot realize that they developed the behavior models in their minds which lead to the manifestation of power and violence. Teachers whose job is to transform modern society into the society free from aggression and violence face the problems of limited pedagogical opportunities in the field of influence on children. In this situation of society social development, no matter how paradoxical this may seem, we must "socialize" the personality of an adolescent to a safe life in the world full of violence. This article attempts to study the possibilities of gestalt therapy for the correction of deviant behavior among minors resulting from the violation of a child's mental development. Preventive and corrective measures in relation to a child with deviant forms of behavior that are used today almost do not take into account the child's mental development, namely, the fact that disruptions in the process of mental development can be the main reason for deviant behavior.

KEY WORDS: Adolescent, Deviant Behavior, Behavior Correction, Behavior Prophylaxis, Gestalt Therapy, Mental Development.

INTRODUCTION

A teenager with various behavior deviations tends to abrupt mood swings, impulsive in making decisions and in his actions, which subsequently leads to difficulties in relationship development with people around him. Deviant behavior of a teenager is usually the result of untreated psychological trauma and, moreover, such

adolescents suffer from various addictions. All these problems, ultimately, lead to the fact that a teenager falls into inappropriate behavior or he is constantly in it, and loses contact with reality (Kuznetsova, 2015).

MATERIAL AND METHODS

What kind of mental development violations can a child encounter, which will subsequently condition and determine his behavioral reactions to the outside world? We will try to consider the problem from the point of view of the phased development of the child's mental functions.

During the first year of life, a child merges with his mother and the main neoplasm of infancy is the basic trust in the world, which determines the child's further interest in the outside world study and removes blocking fears during its study. In the process of growing up and mental function development, the child acquires the ability and opportunity for autonomy from an adult. The separation of own "I" becomes a need that must be satisfied. In the process of satisfying the need for autonomy and gaining "I", the child explores his abilities, his needs, builds safe psychological boundaries of interaction with the environment. By the crisis of 3 years a child develops his own desires and needs,

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which do not depend on the will of adults, there is the desire to prove his right to make independent decisions. If during the described stages of development, the course of the child's natural mental development is disrupted for any objective or subjective reasons, then the prerequisites for the development of a deviant personality arise, that is, there is a danger of inadequate behavioral reactions to the influences from the outside world that will be expressed in various forms of aggression either to yourself or to the environment. This reaction occurs due to the fact that a child does not have a mechanism by which he is able to survive crises and cope with them on his own, and the role of an adult here to support the acquisition of such skills. This is not about imposing ready-made forms against which the child usually protests, but rather in the direction of his own resources for finding new forms of behavior that will help him cope with emerging problems. Without the support of an adult, the child is left alone with a difficult life situation and uses simpler and more primitive forms for himself to eliminate the tension that arises from the inability to solve his problems and, as usual, these are various forms of aggressive behavior. The child is disoriented, he does not see the possibility of receiving help from the outside world, does not know how to get support, how to seek help, a situation arises when the child feels alone, and neglected by environment. In this case, the outside world becomes hostile and threatening for the minor (Vygotsky, 2005).

The situation of mental development is purely individual for each child, but we will try to identify the main models that can lead to deviant forms of behavior among minors. If, for various reasons, a child under 3 years old does not receive proper emotionally expressive communication with his mother, then he will develop a fear of being abandoned or rejected with a greater degree of probability. If a parent is interested and curious about the achievements of his child, he will have a feeling that he is neglected, since a child needs a positive assessment of an adult. An excessive care on the part of parents can lead to the impossibility of acquiring individuality and fear for taking responsibility for any decisions. In all these cases, a child is deprived of the opportunity to experience the process of identifying himself as an independent person, experiencing himself and the environment. The child regards this unhealthy situation as normal, because he does not know anything else.

Often the educational process is focused on satisfying the biological needs of the child and is not taken into account at all. The child experiences the need for love, acceptance, and support. Deprived of such feelings, children are forced to cope with their difficulties and experiences

independently, that is, behave like adults, although they do not have any resources for this. The child grows up and does not feel the strength and ability to cope with various life difficulties or cope with them using children's behavior models (Oaklander, 1988).

There are opposite situations. In such cases, parents try to delay the process of natural maturation and separation of the child from adults artificially. The same interaction models are applied to the child as in early childhood, any attempts of autonomy and independence are suppressed and perceived by parents as disobedience, sometimes they are punished. In this case, we can observe the suppression of the individual's independence, the need for which is necessary and relevant for him. Thus, we can see a matured infantile child, or a child endowed with a child's psyche and childish forms of reaction to emerging problems, or a child avenging all those around him for his unmet need to be independent and for the moral violence that he experiences at an unconscious level but does not realize. It happens that the child goes into a demonstrative protest and the emotional connection with the parent is lost (Oaklander, 1978).

From the point of view of the Gestalt approach, a person with a disturbed course of natural mental development can hardly realize his identity. When such a child feels fear, there is a sense of threat, which provokes him to destructive behavior, to uncontrolled outbreaks of aggression.

Such a child is very distrustful of his environment, or, on the contrary, he seeks a complete merger in relations with other people, but when a partner does not meet expectations, anger and fear arise.

The minors with mental development violations, may demonstrate the manifestations of auto-aggression, such as dependence, self-harm, and suicide attempts.

RESULTS AND DISCUSSION

Based on the foregoing, the techniques of gestalt therapy can be used in order to correct the deviant behavior of a minor caused by the violation of the natural course of his mental development.

The possibility of gestalt therapy use is determined by the principles that are applied gestalt therapists in their work (Kuznetsova & Ibragimov, 2018).

The principle of "now" or "here and now." The principle involves the development of the ability to concentrate your

feelings and manifestations on the present moment. In the process of work, the juvenile develops the ability to learn to determine what a teenager does, feels in the moment "here and now", and to understand what experiences he experiences. If we deal with a specific act and a teenager's action, it is necessary to transfer it now and try to make the teenager understand the reasons for such behavior and help him find resources for a different solution to his problems, help him find a new model of behavior. In fact, the therapist performs the support function that the child did not receive once. As a rule, the problem of such children is the impossibility and intolerance of self-awareness in the contact of the present, and then the teenager seeks to interrupt or avoid the contact by all possible means going into the past or fantasizing about the future. You can offer the teenager a game, the condition of which is a story about a past or future event using the verbs of the present tense (Perls, 1969, 1947; Rubenfeld, 1992; Inside and outside the garbage can, 2016).

Another important principle in the work is the integrity of the processes. The teenager cannot be considered in isolation from his biological, psychophysiological, psychological, social and spiritual aspects. All aspects are interconnected and represent a unique story of an individual. He is a single gestalt, and usually seeks to represent a single gestalt with his environment. Accordingly, it is necessary to teach the teenager to see the environment without fear, to be able to define himself in this environment, to determine the boundaries of safe contact with the environment, to create integrated automated schemes for safe interaction in the process of interaction with the environment. Since any aspect of behavior is the manifestation of the integral being of a person, it is necessary to identify the contact border between the adolescent and the environment in this unity. The problem of the teenager with deviant forms of behavior is that he is in the situation of incomplete gestalt, not experienced problems, and the decisions not adopted independently. The child does not identify himself with the environment and can realize his true needs and the obstacle to this awareness is incompleteness, the lack of response to the situations of the past. It is the panic fear of returning to loneliness arising when a person is deprived of the usual stereotypical forms of behavior. This condition makes it impossible to withstand strong emotions and is expressed in different emotional manifestations, the realization of why this happens marks the rebirth of a person, the reaction of a previously restrained, diverting part of the energy and the ability to live in the present.

The principle of phenomenological approach. F. Perls called gestalt therapy the philosophy of the obvious. He also said that "gestalt therapy is the first existential philosophy, standing on its own feet." The principle lies in respect for the individual's experience or phenomenological state - the way each of us perceives the world, the way we organize our world and ourselves, and the way we create our own meanings. Phenomenology consists in the ability to listen to a teenager "refreshingly", discarding existing values, theories, interpretations, knowledge, as this is the experience introduced by the environment, and not the experience of a teenager. This approach makes it possible to understand and see the origin of the teenager's primary experience and try to understand the causes of behavior by neutralizing own personal stereotypes.

The principle of field theory. The concept of "field" is borrowed from the natural sciences. It is suitable to describe the interaction of a teenager with the environment, which leads to contact, which can interrupt contact, the way the process of contacting with the environment occurs, what forms of contact and contact avoiding are used by the teenager.

The use of the Gestalt approach in the correction of deviant behavior will be more effective, since phenomenological processes occur during the work, new forms of interaction with the environment appear that are safe for him, without changing the child himself. Gestalt therapy relieves the child of the fear of past bad experiences, invites and helps the adolescent to develop new, more adequate and necessary forms of interaction with the environment independently (The theory and practice of gestalt therapy on the threshold of the XXIst century, 2001).

The primary task of working with deviant adolescents is the need to establish preliminary contact. It is necessary to bring an opportunity for trusting interaction into the environment. Here the main difficulties arise, since such a form of communication seems unfamiliar, impossible, and frightening for a teenager. Trust, which implies the acceptance of your desires, as the right to be heard, understood and accepted in all your manifestations without evaluation. Not the opportunity to trust, and therefore ask for help, advice, led to the fact that the teenager fenced off the world by a wall through which only those can pass who are in the same unbearable situation themselves. Teenagers find support in a group that is not support, but just an illusion, because they need support themselves and are not able to help fully due to lack of resources. Confidence can be achieved if we can listen to the child

in a "quality" way, that is, not only monitor the content of words, but also the vocalization of the voice, body position, facial expressions, and gestures. A teenager often has serious problems with feelings, and most often he answers "Nothing", or "I don't know" to the question: "What do you feel now?" That is why, by attracting a teenager's attention to the change in his body, voice, facial expressions, we can approach the feeling that is suppressed. The exchange of feelings is very important in the Gestalt approach, since the teenager needs feedback and it is very useful. In the process of receiving feedback, self-awareness takes place through the understanding of one's needs, feelings, and desires. The world of interpersonal relations becomes more understandable and not so hostile any longer, there is the willingness to accept other people into this world without fear and aggression, and the natural correction of the teenager's behavior occurs as the result of such changes. But it would be a big mistake to wait for an immediate change in behavior and to eliminate the violations in communication quickly. The change of behavior is impossible without a full study of the problem, its awareness, and accordingly, stable results in deviant behavior correction are not achieved. Besides, we can get new problems without excluding old ones and aggravate the situation (Social changes start together, 2016). Such work takes time and is purely individual for each case.

CONCLUSION

Thus, the goal of psychotherapeutic work using the Gestalt approach is to change the entire interaction environment of a teenager. The environment in which the development and formation of the teenager's personality takes place, changes along with the changes that occur in the mind and with this approach an effective long-term result is achieved. The main difference in this approach is that the work is carried out not so much with the content of the problem as with the reasons that impede the establishment of socially acceptable contacts. The psychotherapeutic process is at the level of emotions and sensations. In the traditional correctional work, a teenager is invited to engage in the analysis of his behavior, which at the moment is the only possible and acceptable in this situation. Accordingly, a teenager is not ready to abandon the model of behavior that guarantees him the sense of security at the level of sensations. But the problem is not in deviant behavior, but on a deeper level, where emotions are inseparable from sensations. Accordingly, it is necessary to use techniques in the work that allow the teenager to immerse himself in the experience of his immediate feelings and emotions. Using training exercises, group members learn to define their

needs and the ability to make contact with the environment clearly. As you know, the contact with the environment largely depends on the ability to distinguish between the environment and yourself.

Using the techniques used in gestalt therapy, we can activate the mechanisms of self-knowledge in adolescents, develop a responsible attitude to their own actions, develop constructive communication skills, create positive self-esteem in adolescents, strengthen self-awareness and contact functions.

SUMMARY

Most importantly, you need to understand that the behavior of such a teenager can be adjusted. Their problems are the result of an essentially healthy attempt to survive emotionally as much as possible in an unfriendly environment.

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Validating the Parameters of the Rotary Device for Potato Haulm Removal

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ABSTRACT

Prospects for the development of potato growing are due to the needs of mankind in food resources. Intensification of potato growing will require further mechanical re-equipment of this industry through the creation of new machines. To improve the performance of potato harvesters, you must first remove the potato haulm. When harvesting potatoes by potato harvesters and combines, their productivity largely depends on the quality of potato haulm removal. Therefore, studies aimed at improving the design of rotary-type machines are very important. To improve the performance of potato harvesting equipment in the fields with developed haulm, one must first remove the potato tops. For the purpose of coordinated work of the rotating rotor of the haulm shredder and flail knives, the dynamics of the hinged elements in the field of centrifugal forces was considered and on the basis of this, the parameters of the knives and the rotor were determined. The period of oscillation of the knife in the field of centrifugal forces depends on the parameters of the knife and the angular velocity of the haulm shredder rotor. The quality of the haulm cut increases intensively to the values of the cut speed about 36 m / s, the subsequent increase in the speed provides a good cut. The obtained analytical dependencies of the process of an unsupported cut of potato haulm and the main parameters of the knives will allow for rational dynamic analysis and synthesis of the main working bodies of BD-4M haulm shredder, which will significantly increase its efficiency.

KEY WORDS: Potato Harvesting, Haulm Removal, Rotor, Flail Knives, Cutting Speed, Unsupported Cut, Haulm Shredder.

INTRODUCTION

Prospects for the development of potato production are determined by the needs of mankind in food resources and the possibilities of intensifying this industry in various

countries and regions. In developed potato-producing countries, it is expected to reduce or stabilize the areas under the potatoes with an increase in yield due to the use of intensive factors. In these countries, a reduction in per capita consumption of potatoes is also foreseen. Expansion of areas for potatoes with an increase in its consumption can be expected in India, Australia, Asia, Africa (World Potato Market, 2016).

The demand of the population for potatoes should be satisfied mainly due to its production in areas of consumption. Further development of potato growing will require the creation of large specialized industrial-type farms, which will make a significant contribution to improving the efficiency of potato growing. To provide potato farms with seeds of higher reproductions, it is planned to create special farms, in each of which 350 ... 400 ha will be allotted for potatoes and the proportion of this crop in the structure of sown areas will be 13 ... 16 %, the yield will be 30 ... 35 t / ha with 60...65 marketability

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(Tubolev et al., 2012). To improve the supply of the urban population with high-quality potatoes, it is planned to further deepen the specialization of farms that will not only grow potatoes, but also bring the tubers up to commodity standards with packaging and centralized delivery to stores. With a rational organization of production, such farms can have 500 ... 600 ha of potato crops with its 18 ... 20 % specific weight in the structure of sown areas. The gross yield per farm will reach 13.0 ... 13.5 thousand tons, and on 100 hectares of arable land, the production of tubers will be 380 ... 400 tons (Tubolev et al., 2012; Kostenko, 2011; World Potato Market, 2016). There is a tendency of in-depth specialization of farms for growing potatoes for technical processing, located in the areas around potato processing enterprises. Each farm like that will have 585 ... 600 hectares of potatoes, its share in the structure of crops will be 15 ... 17 %, and the output of tubers per 100 hectares of arable land will be 450 ... 530 tons (Tubolev et al., 2012).

The most important direction of development of the potato industry is the most complete use of biological factors, i.e. priority development of potato breeding and seed production. This least capital-intensive direction with a relatively small material and labor costs provides up to 20 % increase in yield. The breeding and growing of new varieties with higher potential yields, valuable economic and biological characteristics, especially resistant to disease, mechanical damage and extreme climatic conditions will bring great savings and increase the efficiency of potato growing (Byshov et al., 2005; Byshov et al., 2013; Byshov et al., 2018; Byshov et al., 2018).

Optimal supply of nutrients to plants will be carried out mainly by improving the quality of fertilizers, their rational use and balance in nutrients, and improving agrochemical services (Samoilova et al., 2017; Churilov et al., 2018). The development and mass production of complex fertilizers with improved physical and mechanical properties will not only increase the yield, but also greatly simplify the technological process of their introduction into the soil. With increasing concentration and deepening the specialization of potato production, there is a need for wider use of green fertilizers in crop rotations, which will help reduce the incidence of potatoes and increase its profitability (Abramov & Uglanov, 2004; Tubolev et al., 2012).

Intensification of potato growing will require further mechanical re-equipment of this industry by means of creation of new machines, stationary points, automation

equipment, construction of potato storages with a controlled environment depending on the varietal characteristics of tubers and their commodity and economic use (Byshov et al., 2013; Rembalovich et al., 2014; Burger, 2003). New types of machines will minimize the soil tillage in order to preserve its structure, save material and labor costs.

The prospects for potatoes are very broad and favorable. The mankind, increasing in number, intends to rely firmly on the great food resource of this crop in the future and therefore is actively looking for ways to reduce the priceless benefits for people from "the second bread".

When potatoes are harvested by potato harvesters and combines, their productivity largely depends on the state of the potato haulm. With a highly developed and laid down haulm, the productivity of harvesting machines drops sharply due to clogging of the working bodies, and in some cases their work is not possible at all (Byshov et al., 2005; Byshov et al., 2014)

MATERIAL AND METHODS

The appearance of domestic rotary-type machines, such as KIR-1.5, UBD-3 and BD-4, in the late 1950s ... 1960s made it possible to mechanize the process of potato haulm removing. But during operation, it is noticed that rotor machines have a number of disadvantages caused by imperfection of the rotor design, its kinematic modes, insufficient balance and some others.

Therefore, studies aimed at improving the design of rotary-type machines are very important. To improve the performance of potato harvesting equipment in the fields with developed haulm, one must first remove the potato haulm. Let's consider the work of the modernized BD-4M haulm shredder with variable diameter (Fig. 1).

The design of the haulm shredder provides copying of potato beds and haulm crushing in spaces between beds. It gives the possibility of maximum removal of the haulm

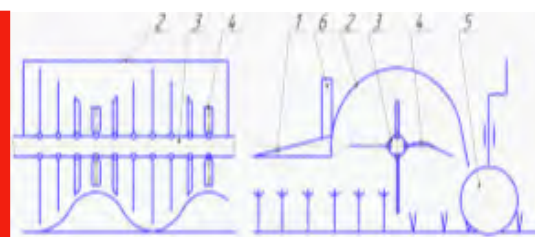


Fig. 1: Diagram of the four-row haulm shredder BD-4M

and plant residues and dumping of the crushed haulm in spaces between beds.

During operation, it is noticed that rotary machines have a number of drawbacks (poor quality cut, increased energy costs, etc.) caused by the imperfection of the rotor design, its kinematic modes, insufficient balance and a number of other reasons.

The main parameters of the rotor with flail elements are the linear speed of the knife V_{kn} with an unsupported cut, variable cutting diameter, the length of the cutting elements and the rotation frequency of the rotor. The linear speed of the knife V_{kn} with an unsupported cut can be determined from the following considerations.

Let's consider cutting a free-standing stem without support. It can be represented as a cantilever beam rigidly fixed at the base and subjected to the action of the shearing force of a knife P_{sh} at a speed at a height H (Fig. 2). When the impact of the knife with the shearing force P_{sh} there are bending resistance forces P_{bend} and inertia forces P_{in} in the stem. The condition for cutting the stem will be:

$$P_{sh} < P_{bend} + P_{in} \tag{1}$$

During the impact of the cutting knife, the stem will deviate by f , the value of the sag of the stem span, which is equal to:

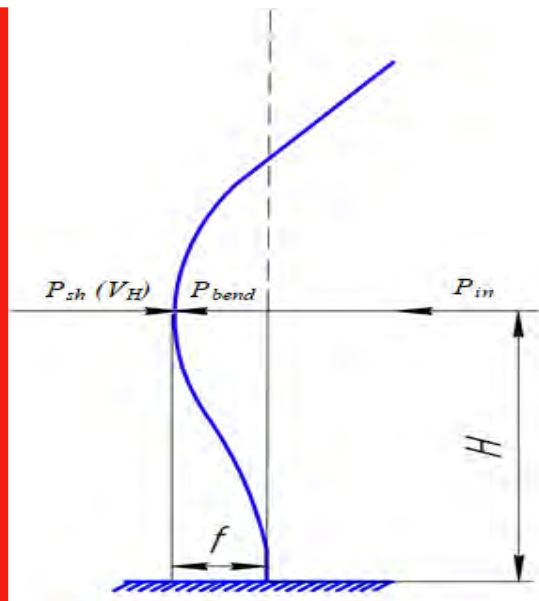


Fig. 2: Diagram of the effect of forces on a Standing stem

$$f = \frac{P_{sh} \cdot H^3}{3 \cdot E \cdot J} \tag{2}$$

where E – elasticity modulus;
 J – moment of inertia of the stem section;
 H – cutting height.
 Hence the force of resistance to bending is found as:

$$P_{bend} = \frac{3 \cdot f \cdot E \cdot J}{H^3} \tag{3}$$

The force of inertia is found like:

$$P_{in} = m \cdot j \tag{4}$$

where m is the stem mass;
 j is average knives acceleration.

The average knives acceleration will be:

$$j = \frac{V_{kn} - V_0}{\Delta t} \tag{5}$$

where $V_0 = 0$, then

$$P_{in} = m \cdot j = \frac{m \cdot V_{kn}}{\Delta t} \tag{6}$$

The sag of span is found as:

$$f = V_{kn} \cdot \Delta t \tag{7}$$

where Δt is the impact time.
 The condition of the stem cut will be:

$$P_{sh} < P_{bend} + P_{in} = \frac{3 \cdot f \cdot E \cdot J}{H^3} + \frac{m \cdot V_{kn}}{\Delta t} = \frac{3V_{kn} \cdot \Delta t \cdot E \cdot J}{H^3} + \frac{m \cdot V_{kn}}{\Delta t} = V_{kn} \cdot \left(\frac{3 \cdot \Delta t \cdot E \cdot J}{H^3} + \frac{m}{\Delta t} \right) \tag{8}$$

Hence the speed of the unsupported cut must be:

$$V_{kn} \geq \frac{P_c}{\frac{3 \cdot \Delta t \cdot E \cdot J}{H^3} + \frac{m}{\Delta t}} \tag{9}$$

Calculations and practical verification showed that the speed of an unsupported cut for thick stems should be 25 ... 30 m / s and for thin stems 40 ... 50 m / s (Mc Randal & Mc Nalty, 1978; Randat & Nutty, 1997). For better haulm removal, especially that lying between the beds, the diameter of the rotor should be variable. The rotor parameters are determined based on the following considerations. Figure 3 shows a rotor with a variable cutting diameter.

For the purpose of coordinated work of the rotating rotor and flail knives, the dynamics of the hinged elements in the field of centrifugal forces was considered and on the basis of this the parameters of the knives and the rotor were determined.

To do this, we make the differential equation of motion of the system according to the Lagrange method, consisting of a rotor and a cutting element. Select a fixed coordinate system XOY, passing through the center of rotation of the rotor and the moving coordinate system X1OY1, rotating together with the rotor and passing through the center

of rotation of the rotor and the axis of suspension of the cutting element.

Let us take as the generalized coordinates of the system the angles of deviation φ and α , where φ is the angle of deviation of the rotor from the vertical and α is the angle of deviation of the cutting element from the equilibrium position. Then the Lagrange differential equations that generalized coordinates must satisfy as functions of time can be written in general form:

$$\frac{d\partial T}{dt\partial\dot{\varphi}} - \frac{\partial T}{\partial\varphi} = Q_1, \tag{10}$$

$$\frac{d\partial T}{dt\partial\dot{\alpha}} - \frac{\partial T}{\partial\alpha} = Q_2, \tag{11}$$

where T is the kinetic energy of the system;

Q_1 and Q_2 are generalized forces;

φ and α are generalized coordinates.

Having determined the kinetic energy T of our system, and presenting this energy as a function of rotation angles φ and α and their derivatives, and calculating the components of equations (10) and (11), one obtains a second-order differential equation:

$$J_B \ddot{\alpha} + mR\rho_c \omega_\delta^2 \sin \alpha = P_c l \tag{12}$$

where J_B is the moment of inertia of the knife relative to the suspension;

m is the knife mass;

ρ_c is the distance from the point of suspension of the knife to its center of mass;

R is the radius of the rotor;

ω_δ is the angular velocity of the rotor;

P_c is the cutting force acting on the knife;

l is the knife length.

During operation, the cutting element of the rotor under the action of centrifugal force is located radially. At the moment of meeting potato haulm, it receives an external impulsive moment of cutting from the haulm, under the action of which the cutting element begins to deviate from the radial position, reach the maximum deflection angle and then moves in the opposite direction. The next haulm impact can be applied at different positions of the cutting element and directions of relative speed. The rotor rotates simultaneously with the oscillatory movement of the cutting elements.

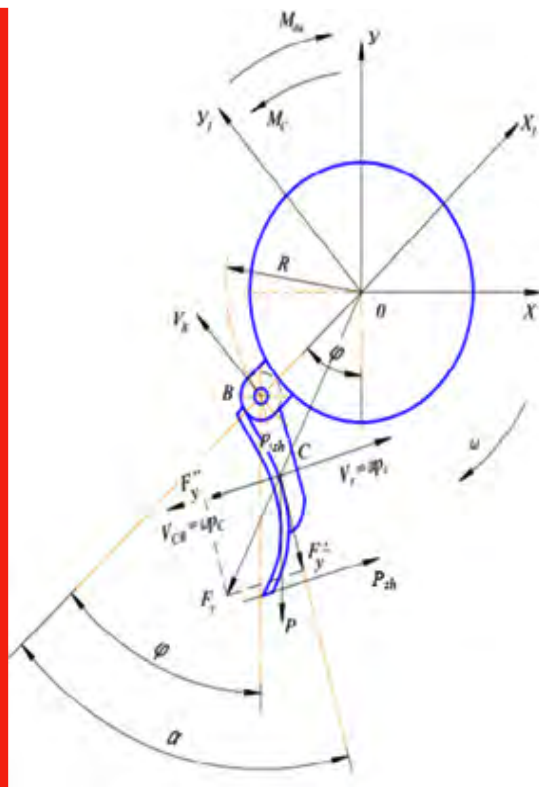


Fig. 3: Diagram of the rotor with cutting hinged knives

In order to obtain stable operation of the rotor, it is necessary to establish some connection between the rotation of the rotor, the oscillatory movement of the cutting elements and the impulsive moment of the cut (Banno & Ogawa, 1979; Lehmann, 1970). On the basis of the analysis of this connection, it is necessary to identify the optimal kinematic mode of operation of the rotor and its rational parameters. To do this, consider the various options for the movement of the knife. Consider three options for the movement of the knife:

- 1) $\alpha_0 \leq \alpha \leq \alpha_{is}$ is the movement of the knife during haulm cutting of the topper, where α_{is} is the angle on which the knife deviates from the radial direction for the haulm cutting time t_c ;
- 2) $\alpha_c \leq \alpha \leq \alpha_{stop}$ is the movement of the knife by inertia after haulm cutting till moment t_{stop} , when its angular velocity becomes equal to zero ($\dot{\alpha} = 0$);
- 3) $\alpha_{ret} \leq \alpha \leq \alpha_{stop}$ is the movement of the knife to the radial position under the action of centrifugal forces, where α_{ret} is

Table 1: Calculation of the deflection angle of the knife with the minimum value of the shear force

Knife number	Knife weight m, kg	One sprout (Psh = 25.8 N)		
		Cut angle α_c , degree	Stop angle α_{stop} , degree	Deflection angle φ , degree
1	1.02	0.94	0.74	1.68
2	0.663	2.08	0.19	2.27
3	0.826	1.67	0.47	2.14
4	1.468	1.35	0.64	1.99

Table 2. Calculation of the knife deflection angle with an average value of the shear force

Knife number	Knife weight m, kg	Onesprout (Psh= 52.5 N)		
		Cut angle α_c , degree	Stop angle α_{stop} , degree	Deflection angle φ , degree
1	1.02	1.9	1.5	3.4
2	0.663	4.23	0.33	4.56
3	0.826	3.4	0.93	4.33
4	1.468	2.75	1.29	4.04

Table 3. Calculation of the knife deflection angle with the maximum value of the shear force

Knife number	Knife weight m, kg	Onesprout (Psh = 79.26 N)		
		Cut angle α_c , degree	Stop angle α_{stop} , degree	Deflection angle φ , degree
1	2	3	4	5
1	1.02	2.89	2.27	5.16
1	2	3	4	5
2	0.663	6.39	0.44	6.83
3	0.826	5.15	1.37	6.52
4	1.468	4.16	1.93	6.09

the angle of the radial direction to the position to which the knife returns in one turn of the rotor.

On the basis of the developed theory, the angles of deviation of the knives, when cutting potato haulm of various weights, from the radial position for each type of knives are determined and their maximum deviation is set to no more than the allowable 30°.

RESULTS

The calculation of the angle of deviation of the knife at the moment of haulm removal from the radial direction till a full stop was carried out using mathematical system MathCAD.

The calculation was carried out with the following data:

- rotor radius R = 0.2 m;
- angular velocity of rotation of the rotor ω = 125 s⁻¹;
- the shearing force Psh varies from 25.8 to 79.26 N;
- the initial deflection angle of the knife α₀ = 0;
- relative initial angular velocity of the knife ω₀ = 0.05 s⁻¹;
- cutoff timetc= 0.02 s;
- the knife stopping time tstop= 0.015 c.

Geometrical characteristics of knives are given in Table 1.

All data for the calculation are taken from the design characteristics of the haulm removing machine BD-4M determined experimentally (Abramov & Uglanov, 2004) The calculation of the deviation angles for different values of the shearing force is presented in Tables 1, 2, and 4.

Let's determine the oscillation period of the knives. It is known that, when the knife is effected by the shearing force, it is deflected by angle α and continues to oscillate back and forth, followed by attenuation. Consider the movement of the knife after interacting with the sprouts of potato haulm. After the impact, the knife deviates from the neutral position and performs free oscillations under the action of centrifugal force, according to the equation:

$$J_B \ddot{\alpha} + mR\rho_c \omega_b^2 \sin \alpha = 0, \tag{13}$$

Given that the deviation angle of the knife from the radial position is not significant, suppose that then expression (13) can be written as:

$$J_B \ddot{\alpha} + mR\rho_c \omega_b^2 \alpha = 0, \tag{14}$$

Equation (14) can be converted to the following form:

$$\ddot{\alpha} + \frac{mR\rho_c \omega_b^2}{J_B} \alpha = 0, \tag{15}$$

This equation describes the law of harmonic oscillations of a knife. The period of oscillation of the knife in this case will be determined by the expression:

$$T = \frac{2\pi}{\sqrt{\frac{mR\rho_c \omega_b^2}{J_B}}} \tag{16}$$

From formula (16) it is seen that the period of oscillation of the knife in the field of centrifugal forces depends on the parameters of the knife and the angular velocity of the rotor of the shredder. We construct the dependence of the oscillation period on the rotor speed and the parameters of the knives. Graphically, it will look like:

Analysis of the figure shows that the period of oscillation largely depends on the magnitude of the centrifugal forces acting on the knife, that is, on the angular velocity of the rotor of the haulm shredder. The period of oscillation is also influenced by the parameters of the knife, especially its length, and to a lesser extent, the mass.

To clarify the parameters obtained, experimental studies were conducted. The study of an unsupported cut of potato haulm was carried out in order to identify the lowest possible speed at which a clean cut of the stem would be

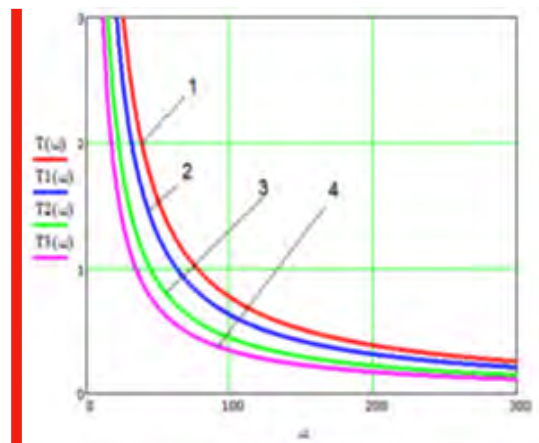


Fig. 4: The dependence of the oscillation period on the angular velocity of the rotor and the parameters of the knife.

obtained (Abramov & Uglanov, 2004; Stoppel, 1961). Before investigations, the characteristics of the site and the crop were taken. The study was conducted at different speeds of the knife, ranging from 17 m / s to 38 m / s. For one experiment, 30 samples were selected. The length of each sample and its diameter at a distance of 100 mm from the clamp were measured. At the same time, the moisture content of the freshly cut potato haulm was determined.

The parameters of the knife are selected according to the results of laboratory studies of the cutting process. The sharpening angle and the cutting angle are taken to be 30°. The sharpness of the knife blade was determined by the lead imprint and was chosen equal to 25° ... 35° (Feller, 1959). The parameters characterizing the potato haulm are presented in Table 4.

Before the experiments, the scale of the amplifier was calibrated at eight linear speeds of the knife: 17, 20, 23, 26, 29, 32, 36 and 38 m / s. By examining the quality of the stem cut, the desired speed was determined without a support cut. According to the results of the investigations, the obtained data were processed in program Statistica v.8. and the following regression equation was derived:

$$\text{Var2} = -194.3049 + 15.7414x - 0.2097x^2, \quad (17)$$

where Var2 is the quality of the haulm cut (percentage of stems cut), %;

U is the cut-off speed, m / s.

The adequacy of the model obtained is proved by determination coefficient $R^2 = 0.98488627$ and regression coefficient $R = 0.99241436$. All coefficients of the regression equation are significant. Based on the regression equation,

the dependence of the quality of the haulm cut on the knife speed is plotted (Fig. 4).

An analysis of Figure 4 showed that the quality of the haulm cut increases intensively to cut-off values of about 35 m / s. The subsequent increase in speed provides a high-quality cut, but may lead to an increase in energy consumption.

The value of one of the main parameters of the knife, the length, is determined from measurements of the beds profile with a special device in the field of Avangard LLC, Ryazan region, Russia. According to the data obtained, a graphic image of the beds profile was constructed. The analysis shows that the bed profile before the installation pass agrees well with the theoretical sinusoid and the standard deviation from the theoretical sinusoid is $\sigma = 2.2\%$.

To determine the length of the knives, knife L4 = 175 mm from the serial machine KIR-1.5 is taken as a basis. To do this, we lowered the rotor of the machine until the upper point of the bed was touched by the middle short knife L4. Then the next knife L3 will be longer than L4 by the value of H1 and it will also touch the bed. The subsequent knives L2 and L1 will be longer by the value of H2 and H3, respectively. H1, H2 and H3 values can be found from the graph in Figure 5. They will be: H1 = 45 mm, H2 = 135 mm and H3 = 200 mm. Thus, we determine the length of the knives: L1 = 375 mm, L2 = 310 mm, L3 = 220 mm and L4 = 175 mm.

The analytical method of determining the center of mass and the moments of inertia of parts and units of agricultural machines is quite complex and cumbersome from the point of view of the mathematical apparatus of calculations. This is due to the complexity of their geometric shape,

Table 4. Results of studies to determine the speed of an unsupported cut

Experiment number	Crop and variety	Diameter of potato haulm, mm	Length, mm	Moisture, %
1	Potato variety "Sante"	9...12	500... 750	84.5
2	Potato variety "Sante"	10...12	510... 730	84.5
3	Potato variety "Sante"	9...11	520... 730	84.5
4	Potato variety "Sante"	10...12	510... 700	84.5
5	Potato variety "Sante"	9...12	490... 465	84.5
6	Potato variety "Sante"	9...12	500... 690	84.5
7	Potato variety "Sante"	9...12	500... 690	84.5
8	Potato variety "Sante"	10...12	485... 460	84.5

the heterogeneity of the material, hidden manufacturing defects, etc. Therefore, the experimental method of determining these parameters is of great practical interest (Table 5).

To determine the centers of mass and moments of inertia of the upgraded knives of BD-4M haulm removing machine, standard methods and laboratory equipment on the theory of mechanisms and machines were used. Thus, experimentally obtained basic parameters of the knives will allow for rational dynamic analysis and synthesis of the main working parts of BD-4M haulm shredder, which will significantly increase the efficiency of its operation.

RESULTS AND DISCUSSION

The principle of an unsupported cutting of the haulm, carried out by the rotor, has been known for a long time, therefore many researchers have studied this issue and derived a number of theoretical assumptions on determining the required cutting speed of the stem without any support.

Academician V.P. Goryachkin gave the main direction in determining the speed of an unsupported cut and the mass of the stem involved in the cut. He proved that not the entire mass of the stem is involved in the cut, but only a part of it, which varies according to the 3rd order hyperbola as a function of the impact point. The formulas for determining

the speed of an unsupported cut cannot be used to determine the angular velocity of the rotor, since they lack the necessary rotor parameters (Goryachkin, 1965).

The issues of cutting an isolated stem without any anti-shearing part were studied by I.F. Vasilenko (Vasilenko, 1936). With regard to the cutting apparatus with reciprocating motion, he derived an analytical relationship to determine the need to select the desired cutting speed.

A number of other researchers, such as Professor E.M. Gutyar, Academician Yu.A. Ishlinsky, E.S. Bosoy and Yu.F. Novikov (Gutyar, 1931; Ishlinsky, 1937; Novikov, 1957; Bosoy, 1953). None of the derived dependencies can be used to determine the cutting speed in relation to the rotor due to the lack of connection between the mass of the stem involved in the impact, the mass of the cutting element and differences in the design of the mower type machine and the rotor. So, for example, B.A. Stoppel, testing the theories of the above-mentioned authors as applied to a rotary machine with a horizontally rotating rotor, found that the cutting speed of the stem V m / s, calculated theoretically, corresponds to an experimental one that is sufficient for cutting 30-50 % of the grass (Stoppel, 1961).

With the development of rotary-type machines, some researchers have been conducting research to identify the cutting speed of the stem without the shearing element. V.A. Konstantinov, examining the cutting speed of the free stem, justified the necessary cutting speed of the corn stalk (Konstantinov, 1964). He argued that cutting the stem without any support, that is in suspension, occurs in the rotary mower KIR-1.5. And, based on this assumption, he determined the speed of the cut. However, the process of cutting in a rotary machine is far from what it was represented by V.A. Konstantinov who considered only a part of the cutting process.

High-speed shooting of the process of cutting showed that it can be divided into three phases:

- cutting the stem attached by the lower end to the soil;
- chopping the cut stalks in the receiving part of the rotor;
- cutting the stem, having no support, that is, when it is in a suspended state.

Professor L.P. Kramarenko investigated the amount of effort required to cut the stems and the dependence of this effort on the nature of the cut. He found that the oblique

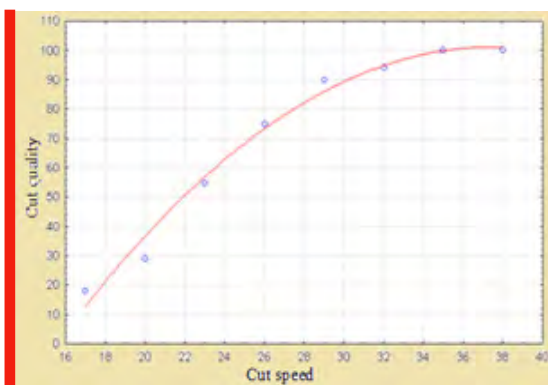


Fig. 5: The dependence of the haulm cut quality on the speed of the haulm shredder knife.

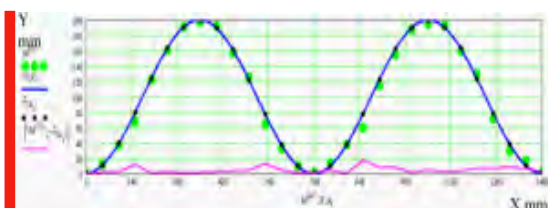


Fig. 6: Comparative graph of laboratory data with a theoretical sinusoid

cut in all its manifestations (oblique, inclined, and inclined-oblique) is much more profitable than a face cut in terms of expended effort and work. Thus, when designing a knife, it is advisable from the point of view of energy costs to use a slice with sliding, i.e. a lancet knife (Kramarenko, 1936). Professor A.N. Karpenko investigated the influence of the character of the cutting edge of the segment and the thickness of the blade on the forces and quality of the cut (Karpenko, 1936). To determine the type of blade segment most effective for cutting the stem (smooth, notched above or notched below), numerous experiments were performed in laboratory conditions with statistical and dynamic slices, as well as field tests. Making a cut of green reed, oat straw, green rye, etc., Professor A.N. Karpenko found that a smooth blade segment had the most advantageous cost of efforts to cut the stem.

Studying the influence of the angle of sharpening A.N. Karpenko proved that with a decrease in the cutting-point angle of the cutting part, the force for cutting the stem also decreases. For the experiment, four segments were taken with angles of 90°, 25°, 18° and 15°. The study was conducted on the installation in the field.

There is also a tendency to reduce the height of the harvest, which indicates a reduced slipping of stems from the scissors of the cutting pair. The percentage of clean cuts increases. It follows from the above that the sharpening angle should be as small as possible, but operational considerations contradict this: a thin segment blade will wear out or crumble faster (Karpenko, 1936; Wilkinson, 1997). Taking into account the analysis carried out, he recommends taking an angle of sharpening equal to 18°.

V. Sysuev investigated the dynamics of the rotor of the hammer fodder grinder (Sysuev et al., 2016). He argued that a rotor with articulated hammers turns into a rigid system when operating. To violate the rigidity of the system,

it is necessary to apply some external force to the hammer that would overcome the friction force in the hinge and the circumferential force that acts on the hammer.

Here he unreasonably introduced a circumferential force acting on the hammer and affecting its stability. In addition, to derive the condition of the hammer stability, he used the static equation, which in no way can be accepted for a dynamic system (Sysuev et al., 2016; Zhao et al., 2014). Professor M.M. Gornet considered the movement of the grinder hammer under the action of final forces. The return of the hammer to the radial position will be impeded by the frictional force. Professor V.A. Goranskikh, analyzing the hammer fodder grinder, indicates that during operation, the angular velocity will vary from impact to impact, but there will be a moment when the process of the fodder grinder operation will settle, and then the hammer will have the same angular velocity before and after the impact. In this case will be equal to . The results of high-speed shooting do not support this assumption; therefore, this theory cannot be used as the basis for the rotor's justification (Goranskikh, 1952).

Later, the issues of studying the dynamics of the rotor with hinged elements, applied to rotary machines, were considered by V.A. Konstantinov and L.I. Komarov. V.A. Konstantinov, investigating the relative motion of the cutting element, composed the equation of motion without considering the shear force. L.I. Komarov, analyzing the dynamics of the rotor, made a differential equation for the motion of the cutting element. But the external force applied to the cutting element during the shear was also not included in this equation. Therefore, the theory of research of the above authors is not much different from the previously considered ones and is not sufficient for a complete analysis of the movement of centrifugal forces (Konstantinov, 1964; Komarov, 1965).

Table 5. Geometrical characteristics of knives

Knife number	Knife weight	Knife length	The distance from the point of suspension to the center of mass of the knife	The moment of inertia of the knife relative to the point of suspension
	m, kg	l, m	pc, m	JB, kgm ²
1	1.02	0.375	0.064	0.01
2	0.663	0.310	0.072	0.007
3	0.826	0.220	0.073	0.009
4	1.468	0.175	0.12	0.02

Professor M.B. Uglanov most fully investigated the dynamics of the rotor with hinged elements (Uglanov, 1989). He compiled a differential equation of the relative motion of the cutting element, taking into account the shear force.

Thus, the obtained analytical dependencies of the process of an unsupported cut of potato haulm and the main parameters of the knives will allow for rational dynamic analysis and synthesis of the main working bodies of BD-4M haulm shredder, which will significantly increase its efficiency.

CONCLUSION

1. Based on the analysis of rotor machine designs, we have proposed a new version of the rotor with articulated knives and a variable cutting diameter. This design provides a copy of potato beds and makes possible the maximum removal of haulm and plant residues.

2. A mathematical model has been developed that establishes some connection between the parameters of the hinged knives and the cut-off weight of the haulm, which made it possible to determine the deviation of the hinged knives from the radial position. On the basis of the developed theory, the angles of deviation from the radial position for each type of knives are determined.

3. Based on the mathematical model linking the dynamics of the working bodies with an effective cut of the haulm stem, we have justified the patterns of motion of the rotor - hinged element system considering rational parameters of the rotor and cutting elements taking into account the stable operation of the system and the high-quality execution of the technological process.

4. Based on the study of the beds profile and taking into account the "coverage" of the knives on the surface of the beds, with the help of the graph-analytical method we have determined:

- variable length of 4 knives, which is equal to:
- L1= 375 mm- these knives cut the haulm in the rows;
- L2 = 310 mm
- L3 = 220 mm
- L4 = 175 mm - these knives cut the haulm at the top of the bed;
- justified knives masses equal to 0.663, 0.826, 1.02

and 1.468 kg.

-
- 5. Theoretically determined the angles of deviation of the knives, depending on the mass of the cut haulm stems, the deviation of the knives from the radial position of not more than 6° ensures the stable operation of the rotor.
- 6. Using differential equations, we substantiated the regularities of changes in the oscillation period of the knife from the angular velocity of the rotor of the machine and the parameters of the knife.
- 7. As a result of a laboratory study of the dynamic slice of potato haulm, the following parameters were established: the average shearing force of a single stem $P = 25.80 \dots 79.26$ N at a certain humidity of 84.5 % and the required linear speed of the cutting element for making an unsupported cut $V_{sh} = 36 \dots 38$ m / s.

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Polymorphism of Structure of Flowers and the Development of the Male Reproductive Sphere of Plants of Buckwheat Species of the Cymosum Group

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ABSTRACT

The large-seed group, or Cymosum group, includes 4 types of buckwheat: cultivated *Fagopyrum esculentum* Moench and *Fagopyrum tataricum* (L.) Gaertn., As well as wild-growing *Fagopyrum cymosum* Meissn. and *Fagopyrum homotropicum* Ohnishi. Despite the active use of these species in scientific research and human activities, many aspects of their morphology and reproductive biology remain unexplored at the moment. The aim of this study was to study the polymorphism of the flower structure and the development of the male reproductive sphere in large buckwheat species of the Cymosum group. As a result of studies, it was revealed that flowers with the formula P5A8G(3) typical for the genus *Fagopyrum* are found in the studied species with a frequency of 96-61%. Quite common options for the structure of the flower are also P5A7G(3), P6A8G(3), P6A3G(3), P5A9G(3), P5A8G(2) u P6A9G(3). By the number of variants of the structure of the flower, *F. esculentum* stood out, the least variable flower in *F. homotropicum*. The most variable part of the flower in all studied buckwheat species is androecium. A study of the embryological features of the species of the Cymosum group buckwheat showed that, in general, the processes of microsporogenesis and microgametogenesis are similar in species *Fagopyrum*. The studied species differed in the number of maternal microspore cells. *F. esculentum* significantly exceeded the other types of buckwheat in this indicator. The most frequent deviation in the development of the male reproductive sphere is the suspension of the development of sporogenous tissue cells and their subsequent degeneration. In all species of the studied buckwheat species, pollen fertility was found to be reduced, which is explained by disturbances during embryological processes during the formation of pollen. In *F. esculentum* and *F. cymosum*, pollen fertility decreased in response to drought. In *F. homotropicum*, pollen fertility was at a high level regardless of weather conditions.

KEY WORDS: Buckwheat, *Fagopyrum*, Cymosum Group, Flower, Embryological Processes, Pollen Productivity, Pollen Fertility.

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INTRODUCTION

The composition of the buckwheat genus in the past few decades has undergone significant revision (Ohnishi, 2016). If the number of existing buckwheat species is in the process of discussion, then the proposed division of the genus into large-seeded and small-seeded groups (Ohnishi & Matsuoka, 1996) does not cause objections. The large-seed group, or Cymosum group, includes 4 types of buckwheat. Two species (buckwheat *Fagopyrum esculentum* Moench and Tatar buckwheat *Fagopyrum tataricum* (L.) Gaertn.) Cultural, perennial *Fagopyrum cymosum* Meissn. and annual *Fagopyrum homotropicum* Ohnishi are wild growing. Currently, active interspecific crosses are being carried out within the large-seed group in order to improve existing crops, transfer to them valuable

traits and properties, as well as create new cultivated plants (Campbell, 2003; Suvorova, 2016). So, *Fagopyrum giganteum* Krotov - artificial amphidiploid from crossing *F. tataricum* and *F. cymosum* - is considered a promising cereal culture (Fesenko, 2010).

Despite the active use of these species in scientific research and human activities, many aspects of their morphology and reproductive biology remain unexplored at the moment. So, from the point of view of embryology only *F. esculentum* was studied in detail (Solntseva, 1983). In addition, for the Polygonaceae family, researchers have repeatedly noted high flower polymorphism (Sitnikov, 1991). Similar taxa, along with mutants defective in individual genes that control programs of floral development, are model objects for studying the genetic basis of flower morphogenesis (Chub & Yurtseva, 2007). The aim of this study was to study the polymorphism of the flower structure and the development

of the male reproductive sphere in large buckwheat species of the *Cymosum* group.

METHODS

The research material was varieties Chatyr Tau and Medova *F. esculentum*; samples K-17, K-108 *F. tataricum*; K-4231 *F. cymosum*; From 2026, C 9139 *F. homotropicum* and K-109 *F. giganteum*. Buckwheat samples were obtained from the N.I. Vavilov All-Russian Institute of Plant Genetic Resources and from the Federal Scientific Center of Legumes and Groat Crops. Also studied were buckwheat varieties of seed selection of the Tatar Scientific and Research Institute of Agriculture, Specialized Division Federal Research Center Kazan Scientific Center of RAS. The collection of material was carried out from 2012 to 2018 in the competitive variety testing of buckwheat and in the collection nursery of the Tatar Scientific and Research Institute of Agriculture.

Table 1. Variability of flower structure in *Fagopyrum* species.

Species	Specimen	Number of floral structure variants by the number of flower organs	Abnormal flower rate	The most frequent types of flower structure (occurrence rate, %)
<i>F. esculentum</i>	Chatyr Tau	36-42	9,9-12,5	P5A6G(3) (1,1) P5A7G(3) (3,4) P6A9G(3) (1,0)
	Honey	36	11,1	P5A6G(3) (1,2) P5A7G(3) (3,3) P5A9G(3) (1,9)
<i>F. tataricum</i>	K-17	13	38,0	P5A7G(3) (15,0) P6A7G(3) (3,0) P6A8G(3) (13,0) P6A9G(3) (2,7)
	K-108	10	39,4	P5A7G(3) (28,8) P6A8G(3) (6,4)
<i>F. cymosum</i>	K-4231	12	16,7	P5A9G(3) (10,7) P5A7G(3) (1,5) P5A8G(2) (1,0) P6A8G(3) (1,0)
<i>F. homotropicum</i>	C 2026	5	3,7-6,7	P5A7G(3) (2,3) P5A8G(0) (1,9)
	C 9139	5	9,9	P5A7G(3) (1,3) P6A8G(3) (5,0)
<i>F. giganteum</i>	K-109	19	23,0	P4A7G(3) (3,0) P4A8G(3) (4,4) P5A7G(2) (1,0) P5A8G(2) (1,4)

The flower morphology of species with large flowers was studied in the field; for small-color samples, flowers randomly selected were fixed in 70% ethanol and examined in the laboratory using a magnifier or a stereo microscope. 300 flowers were studied for each variety or sample. For evasive flower types, diagrams were drawn. When studying the embryological characteristics of inflorescences, the inflorescences were fixed in Chamberlain's fixative, and subsequently, permanent preparations were made from them using the standard technique using a sled microtome (Pausheva, 1988; Barykina, 2004). The thickness of the sections was 14 μm. Pollen fertility was determined by the iodine method (Pausheva, 1988). Selyaninov's hydrothermal coefficient was calculated for the 14-day period preceding the date of pollen fertility determination (Agricultural Encyclopedic Dictionary, 1989). The pollen productivity of the flower was estimated by calculation by the average value of the number of maternal microspore cells in the anther nest (Kadyrova & Mukhametshina, 2015). All obtained data were processed statistically (A package of programs for statistical and biometric-genetic analysis in crop production and selection AGROS, 1999).

RESULTS AND DISCUSSION

A typical buckwheat flower is characterized by the following structure: asymmetric, bisexual, five-circular with a simple perianth, consisting of two leaves of the outer, two leaves of the inner circle and one intermediate leaf. Hadroceum is represented by eight stamens located in two circles (5 stamens in the outer and 3 in the inner circle), the larva is lysicarpous of three carpels with an upper ovary. Between the bases of the stamens are 8 nectaries. Flowers with

a similar structure are found in buckwheat species of the Cymosum group with a frequency of 96.3-60.6%. The remaining flowers are represented by various other structural options. Atypical variants of the flower's structure have a reduced or increased relative to the usual number of organs (tepals, stamens, or carpels that make up the gynoecium). Among the studied species, the absolute record holder in terms of the number of flower structure variants was *F. esculentum*, the least variable flower in *F. homotropicum* (table 1). Within each variant of the flower's structure by the number of organs, different variants of the relative arrangement of organs are possible, in other words, several flower diagrams can correspond to the same flower formula (in figure 1, the formula $P_5A_8G_{(3)}$, for example, correspond to two mirror-symmetric diagrams).

Thus, a high polymorphism of the flower structure is found in both cultivated and wild-growing species of buckwheat. Although, it should be noted that the highest variability indicators (the number of flower structure options, the percentage of anomalous flowers) are observed in cultivated species. Perhaps, in the process of breeding work in these species, the mechanisms of stabilizing selection are loosened, and the variability of the structure of the flower increases.

In buckwheat of Tatar, abnormal flowers are noted with a maximum frequency among the studied species. For the most part, these were flowers with underdeveloped anthers of the outer circle of androecium. Earlier, we explained this phenomenon by the nonparticipation of these stamens in the pollination process and, accordingly, by poor control

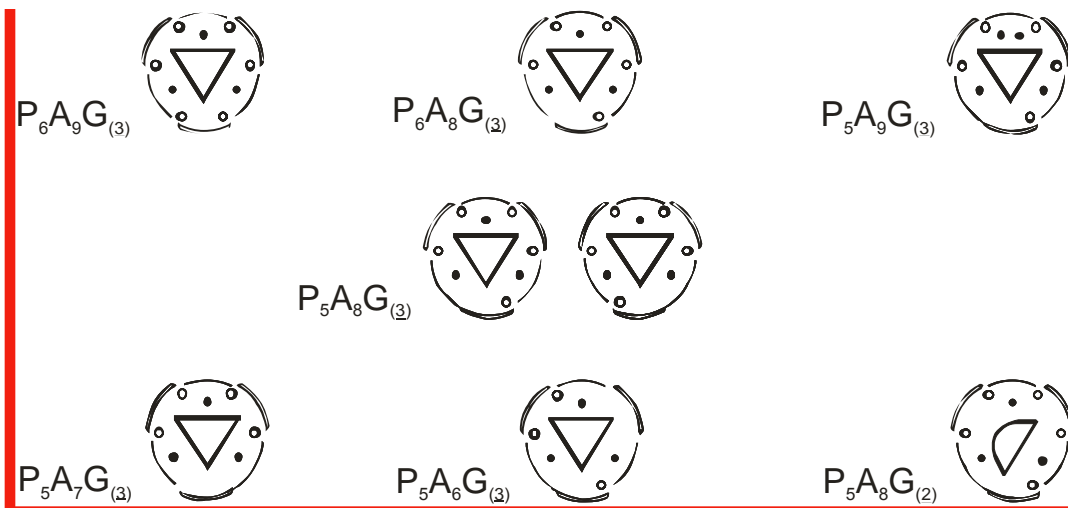


Fig. 1: The most common variants of the flower structure among the species of buckwheat Cymosum group.

over their development by stabilizing selection (Kadyrova, 2015).

In *F. giganteum*, flower structure variants were found with a high frequency, in which one or less often two external tepals (i.e., those organs of the flower that are laid first) were not located on the receptacle, but on the peduncle.

Table 1 shows that the most common flower structure variants among the Cymosum group species are, in addition to P5A8G(3), and also variants P5A7G(3), P6A8G(3), P6A3G(3), P5A9G(3), P5A8G(2) и P6A9G(3) (picture 1).

If we talk about the systems of flower organs that affect changes in the structure, then it is clearly visible (table 2) that the most variable part of the flower in the studied

buckwheat species is androecium (the frequency of such variants in different species ranges from 52 to 84%). Much less often, but with approximately equal frequency, abnormal flowers are found in which there is an altered number of carpels in the gynoecium or an altered number of tepals and stamens simultaneously. Very rarely observed are variants with an altered number of stamens and carpels, even less frequently than variants with an increased or decreased number of all considered organs. These data clearly fit into the theory of bipolar flower marking proposed for the Polygonaceae family (Chub & Yurtseva, 2007).

A study of the embryological features of the species of the Cymosum group buckwheat showed that, in general, the processes of microsporogenesis and microgametogenesis occur in species *Fagopyrum* similarly, similar to how they are described for *F. esculentum* (Solntseva, 1983;

Table 2. The frequency of occurrence of deviations in the structure of the flower, affecting one or another of its parts

Species	Rate of floral structure deviations affecting %its certain organs,						
	P	A	G	PA	AG	PG	PAG
<i>F. esculentum</i>	9	58	6	14	6	1	6
<i>F. tataricum</i>	0	84	0	15	0	0	1
<i>F. cymosum</i>	6	75	6	8	4	0	1
<i>F. homotropicum</i>	3	58	39	0	0	0	0
<i>F. giganteum</i>	14	52	7	16	9	0	2

Here: P – perianth, A – androecium, G – gynoecium.

Table 3. The number of microspore mother cells, potential pollen productivity of the flower and pollen fertility of *Fagopyrum* species.

Species	Specimen	The number of microspore mother cells in the anther nest	Potential pollen productivity of the flower	Hydrothermal coefficient	Pollen fertility, %
<i>F. esculentum</i>	Chatyr Tau	10,9 ± 0,55	1396,5	0,16 (severe drought)	67,1 ± 1,9
				1,82 (excessive moisture)	85,8 ± 1,3
<i>F. tataricum</i>	K-17 K-118	6,1 ± 0,18	778,2	2,77 (excessive moisture)	81,5 ± 1,7
				1,82 (excessive moisture)	56,1 ± 2,0
<i>F. cymosum</i>	K-4231	5,5 ± 0,12	704,0	0,06 (severe drought)	87,5±1,8
				1,14 (optimum hydration)	96,8±0,6
<i>F. homotropicum</i>	C 2026	5,2 ± 0,15	665,6	1,14 (optimum hydration)	93,4±1,0
				0,26 (drought)	93,6±1,2
<i>F. giganteum</i>	K-109	5,9 ± 0,15	750,1	1,82 (excessive moisture)	55,2 ± 1,7

Kadyrova & Mukhametshina, 2015; A package of programs for statistical and biometric-genetic analysis in crop production and selection AGROS, 1999; Kadyrova, 2015; Maryakhina ET AL., 1961; Pausheva, 1988; Poddubnaya-Arnoldi, 1948; Stevens, 1912). Anthers tetrasporangiate. The wall of microsporangia is formed according to a monocotyledonous type. In the formed wall there are 4 layers: the epidermis, endothecia, the only middle layer and the cellular tapetum; only the epidermis and endothecia remain in the mature wall. The simultaneous type of formation of microspore tetrads. The form of tetrads is tetrahedral. 3-cell mature pollen grain. However, the studied species differed in the number of sporogenous tissue cells and, accordingly, the microspore maternal cells (Table 3). Among the buckwheat species, *F. esculentum* stands out for this characteristic, significantly exceeding the indicators of all remaining Cymosum group species, in which the number of maternal microspore cells was approximately equal. This indicates a greater tendency of *F. esculentum* to xenogamy in comparison with other types of buckwheat (Cruden, 1977). Based on the calculated number of mother cells of microspores in the anther's nest, the potential pollen productivity of the flowers was calculated (Table 3).

In addition to the normal course of development, all types of buckwheat showed abnormalities during the development of microspores and pollen grains. For individual species, this question was considered by us in previous works (Kadyrova & Mukhametshina, 2015; Kadyrova et al., 2018). In general, it should be noted that for all species of the Cymosum group, the most frequent developmental deviation is the suspension of the development of sporogenous tissue cells (or maternal microspore cells) and their subsequent degeneration. Quite often, this violation was accompanied by the destruction of the inner layers of the wall of the anther. Also, in all studied species, violations in the passage of the meiosis process were observed in the form of observed micronuclei, rarely chromatin bridges, or irregular tetrads. In *F. esculentum*, cytotoxicity was noted in cell division preceding the formation of maternal microspore cells.

Such developmental disruptions lead to a decrease in the amount of pollen formed or to its sterilization. There are ideas that in diploid forms *F. esculentum* pollen fertility should be close to 100%, in tetraploid forms pollen fertility is reduced due to a violation in chromosome divergence in meiosis (Tkachev, 1990). According to our data, pollen fertility in neither diploid nor tetraploid samples was close to 100%. In *F. esculentum*, the discussed parameter strongly

decreased under drought conditions, but it was also reduced under conditions of excessive moisture. In *F. tataricum* in a diploid sample (K-17), pollen fertility was significantly higher than that of its tetraploid analogue (K-118). In allopolyploid *F. cymosum*, pollen fertility also changed depending on the prevailing weather conditions, which cannot be said for *F. homotropicum*, in the latter species, pollen fertility was at a high level in contrasting weather conditions. In *F. giganteum*, pollen fertility was assessed only once, but even under conditions of excessive moisture it turned out to be inexplicably low.

SUMMARY

1) Flowers with the formula $P5A8G(3)$ typical for the buckwheat genus are found in buckwheat species of the Cymosum group with a frequency of 96.3-60.6%. Quite common options for the structure of the flower are also $P5A7G(3)$, $P6A8G(3)$, $P6A3G(3)$, $P5A9G(3)$, $P5A8G(2)$ и $P6A9G(3)$. Among the studied species, the absolute record holder in terms of the number of flower structure variants was *F. esculentum*, the least variable flower in *F. homotropicum* (table 1). In buckwheat of Tatar, anomalous flowers most often had underdeveloped anthers of the stamens of the outer circle of androecium. The most variable part of the flower in all studied buckwheat species is androecium. Much less often, but with approximately equal frequency, abnormal flowers are found in which there is an altered number of carpels in the gynoecium or an altered number of tepals and stamens simultaneously.

A study of the embryological features of the species of the Cymosum group buckwheat showed that, in general, the processes of microsporogenesis and microgametogenesis are similar in species *Fagopyrum*. The studied species differed in the number of maternal microspore cells. *F. esculentum* significantly exceeded the other types of buckwheat in this indicator. The most frequent deviation in the development of the male reproductive sphere is the suspension of the development of sporogenous tissue cells and their subsequent degeneration.

In all species of the studied buckwheat species, pollen fertility was found to be reduced, which is explained by disturbances during embryological processes during the formation of pollen. In *F. esculentum* and *F. cymosum*, pollen fertility decreased in response to drought. In *F. tataricum* in a diploid sample (K-17), pollen fertility was significantly higher than that of its tetraploid analogue (K-118). In *F. homotropicum*, pollen fertility was at a high level regardless of weather conditions.

CONCLUSION

The revealed polymorphism in the flower structure in the species of large-seeded buckwheat *Cymosum* group is partly associated with the variability of the volume of the floral meristem, and partly with disturbances during embryological processes. Frequently encountered abnormal flowers with underdeveloped stamens are an external manifestation of the suspension of sporogenous tissue development, regularly accompanied by the destruction of the anther wall. Probably, *F. homotropicum* with a low-variable flower and highly fertile pollen is one of the proofs of this provision.

The fact that the revealed polymorphism of the flower structure is repeated in all studied species and species forms of buckwheat, both cultural and wild, suggests that this phenomenon is characteristic of the whole genus *Fagopyrum* as a whole.

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Diversity of Verhniy Kaban Lake Species by 18s Rrna of Hydrobionts on Next-Generation Sequencing Method

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ABSTRACT

The paper presents the results of the species diversity study of the freshwater lake Verhniy Kaban (Kazan, Russia) using the 18S rRNA gene based on the next-generation sequencing method. The lake Verhniy Kaban, Sredniy Kaban and Nizhniy Kaban are included in the system of urban lakes Kaban. According to environmentalists the lake Verhniy Kaban Lake belongs to slightly polluted lakes. The sequenced sequences of the 18S rRNA gene fragment of aquatic organisms in the freshwater lake Verhniy Kaban within fastq format are entered into the international database on the NCBI website with the numbers SRR7510986, SRR7465374, SRR7516513. A total of 53057 (2016) and 44910 (2017) high-quality reads were obtained; 78.8% (2016) and 45.7% (2017) of the hydrobionts was classified to the kingdom, while 76.9% (2016) and 42.1% (2017) was classified to the phylum level, 44.9% (2016) and 37.2% (2017) was classified to the class level, 35.7% (2016) and 30.1% (2017) was classified to the order level, 29.4% (2017) was classified to the family level, 29% (2017) was classified to the genus level, and 24% (2017) was classified to the species level. The analysis of the metagenomic data of the Verhniy Kaban Lake shows that indicator hydrobionts identified by the 18S rRNA gene are grouped between *o*-saprobity and *b*-mesosaprobity. The Verhniy Kaban Lake can be characterized by the quality of water as the transition from a polluted to a clean state.

KEY WORDS: Saprobity, Gene 18s Rrna, Next-Generation Sequencing, Freshwater Lake, Ecology.

INTRODUCTION

The lake Verhniy Kaban is one of the Kaban lakes located within the city of Kazan. It is a closed body of water that does not have a hydrological connection with the other Kaban lakes. The water level in the Verhniy Kaban Lake is approximately 2 m higher than in the Nizhniy Kaban and

Sredniy Kaban lakes. The Verhniy Kaban Lake is located outside the industrial zone. It is used for recreational purposes and is experiencing communal impact from nearby villages. A comprehensive assessment of the Verhniy Kaban Lake ecological state also includes the study of the reservoir biodiversity by traditional methods.

Currently, the rapid development of metagenomics allows research on the biodiversity of water bodies using marker genes. Metagenomics can provide valuable information on the functional ecology of environmental communities (Raes et al. 2011). Earlier, we used metagenomic DNA sequencing to analyze species diversity by marker genes CO1 of animal organisms and *rbcL* plants to assess the ecological state of the freshwater lake Verhniy Kaban by bioindication (Kharchenko et al., 2018; Husainov & Frolova, 2018).

In contrast to the marker genes CO1 and *rbcL*, the 18S rRNA gene is present in all eukaryotes. This is one of the most conservative genes that is used to determine the systematic position of фт щкпфтшыь and the time of

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discrepancy with similar species based on the analysis of similarities and differences in rRNA sequences (WWW.Molecular-Plant-Biotechnology.info). For eukaryotes, it is most convenient to analyze 18S rRNA from three types of rRNA.

This article presents the results of the species diversity study of the Lake Verhniy Kaban (Kazan, Russia) using the 18S rRNA gene of aquatic organisms based on a new generation sequencing method. The Verhniy Kaban Lake is the part of three urban Kaban lakes. According to environmentalists, it belongs to slightly polluted lakes.

METHODS

The sampling from the Lake Verhniy Kaban (Kazan, Russia) was carried out in 2016-2017 according to the standard of hydrobiological methods (Bulion. 1981). DNA was isolated from the precipitate obtained by centrifuging 50 ml of the sample at the speed of 10,000 g for 15 minutes using the FAST DNA Kit (MP biomedical) according to the manufacturer's protocol. The amplification of the extracted DNA was carried out by Phusion High-Fidelity DNA polymerase (Thermo Fisher) using the primers (Table 1).

The second PCR cycle was performed to index samples (Nextera XT indices). The purification of PCR products was performed using Agencourt AMPure XP beads (Beckman Coulter). The resulting DNA libraries were sequenced on an Illumina MiSeq instrument (MiSeq Reagent kit v3). Metagenomic data were entered into the international SRA database on the NCBI website with the numbers SRR7510986, SRR7465374, SRR7516513 (<http://www.ncbi.nlm.nih.gov>). After filtering the reads by quality, service sequence trimming and chimeric sequence removal, the obtained nucleotide sequences of the 18S rRNA hydrobiont gene were aligned with the BLAST program to determine the taxonomic composition. The software Krona

Table 1: Primers for PCR of 18S rRNA gene	
Primers	Sequences
SR1_Illumina	5'-tcgtcggcagcgtcagatgtgataag agacagattaccgcgctgct-3'
SR1r_Illumina	5'-gtctcgtggctcggagatgtgataagag acagtacctggtgatqctgccagt-3'



Fig. 1: Verhniy Kaban Lake (Kazan city, Russia)

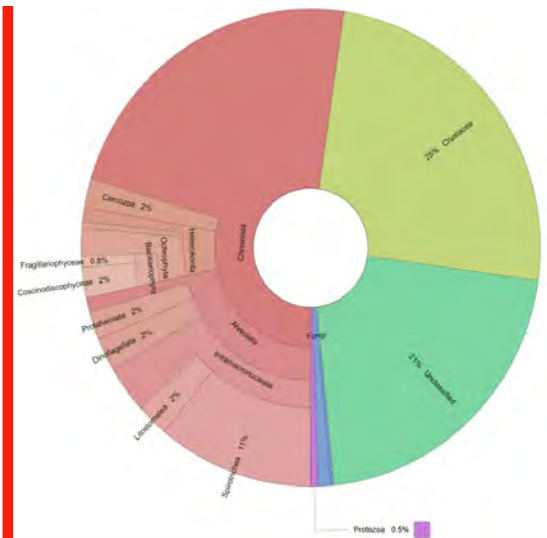


Fig. 2: The percentage of 18S rRNA hydrobionts by reads of Verhniy Kaban Lake (2016)

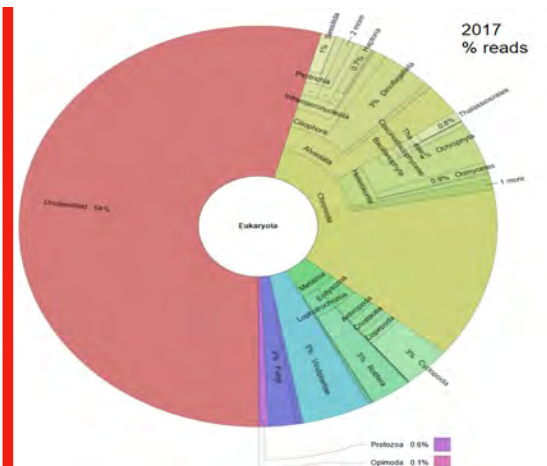


Fig. 3: The percentage of 18S rRNA hydrobionts by reads of Verhniy Kaban Lake (2017)

chart (<http://github.com/marbl/Krona/wiki>) and GraphPad (<https://www.graphpad.com>) were used to develop the diagrams.

RESULTS AND DISCUSSION

In 2016-2017 the next-generation sequencing method was used to identify hydrobionts by the 18S rRNA gene from the Lake Verhniy Kaban. It is a lake about of 1 km in long and 0.3 km in wide and has the geographic coordinates - 55°43'28.9"N and 49°09'14.2"E (Fig.1). The Verhniy Kaban Lake is located in a large industrial city, and experience anthropogenic stress. According to environmentalists, the Verhniy Kaban Lake belongs to slightly polluted lakes.

Krona chart of the hydrobionts represented by 18S rRNA gene amplicon-based species diversity

The percentage distribution of the Lake Verhniy Kaban hydrobionts by reads for 2016 (Unclassified 21%) is shown on Fig. 2. The percentage distribution of the Lake Verhniy Kaban hydrobionts by reads for 2017 (Unclassified 54%) is shown on Fig. 3.

Each circle represents the kingdom, phylum, class, order, family, genus, and species from the inside to the outside of the circle, respectively, indicated by percent diversity.

The percentage of 18S rRNA hydrobionts of Verhniy Kaban Lake by kingdom. The percentage of species diversity of 18S rRNA hydrobionts of Verhniy Kaban Lake by kingdom (2016-2017) shown on Figure 4. As can be seen from Fig. 4, the most numerous by species diversity are Chromista (84.44% / 52.98%), Viridiplantae - 21.41% (2017) and Fungi (4.44% / 11.7%) at the kingdom level.

The percentage of 18S rRNA hydrobionts by reads of Verhniy Kaban Lake by kingdom (2016-2017) shown on Figure 5. As can be seen from Figure 5 the most numerous hydrobionts by reads are the following ones: Chromista (52.31%/31.52%) and Metazoa – (24.89%/6.43%).

The percentage of species diversity and reads of 18S rRNA hydrobionts of Verhniy Kaban Lake by phylum (2016-2017) shown on Figure 6a-b. As can be seen from Fig.6a the following species are the most numerous by species diversity at phylum level in 2016-2017: Ciliophora (17.4%/12.4%), Ochrophyta (15.2%/15.2%) and Unclassified (21.74%/4.2%); 2016 – Cercozoa (8.7%) and Cryptophyta (8,7%); 2017 – Chlorophyta (17.2%). As can be seen from Fig. 6b the following species are

the most numerous by species diversity at phylum level in 2016-2017: Arthropoda (24.9%/3.4%), Cryptophyta (21.6%/8.6%), Ciliophora (16.5%/4.7%) and Unclassified (23.1%/57.9%).

The percentage of 18S rRNA hydrobionts of Verhniy Kaban Lake by species

The species diversity of hydrobionts in 2017 makes 24% of the total number of organisms by reads. Ten hydrobionts are included on a top by reads - *Cryptomonas curvata* (7.61%), *Keratella cochlearis* (2.68%), *Leiocephalum pseudosanguineum* (1.87%), *Cyclops insignis* (1.75%), *Cyclops kolensis* (1.02%), *Phacotus lenticularis* (0.58%), *Acanthocyclops viridis* (0.55%), *Stephanodiscus parvus* (0.45%), *Thalassiosira pseudonana* (0.34%) and *Pythium intermedium* (0.33%). Figure 7 shows the species of hydrobionts with the reads over 0.05%.

283 hydrobionts of Verhniy Kaban Lake were identified by 18S rRNA gene. Among them there are 24 hydrobionts with saprobities in Sladечek’s list (Sladечek, 1973).

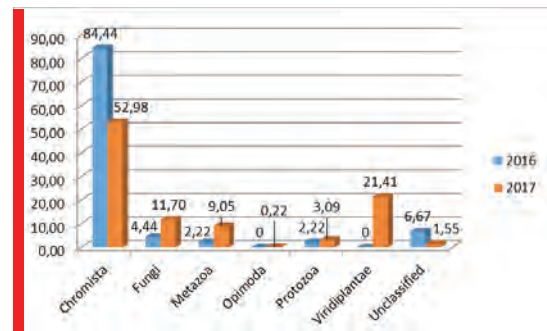


Fig. 4: The percentage of species diversity of 18S rRNA hydrobionts of Verhniy Kaban Lake by kingdom (2016-2017)

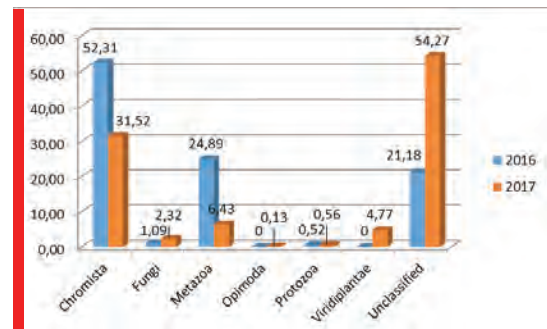


Fig. 5: The percentage of reads of 18S rRNA hydrobionts of Verhniy Kaban Lake by kingdom (2016-2017)
The percentage of 18S rRNA hydrobionts of Verhniy Kaban Lake by phylum

Table 2 shows the saprobic hydrobionts of the Lake Verhny Kaban.

1 Algae, freshwater species. They are not known to produce any toxins (Choi et al., 2013). Cryptomonas are photolithotrophs that contribute to oxygenic carbon fixation making them greatly critical to the carbon levels of fresh water reservoirs (Hoef-Emden & Melkonian, 2003).

2 Phacotus is a genus of green algae. Habitats of Phacotus are rich in lime and vary from oligo- to hypertrophic. High abundances were observed at temperatures between 15.8 and 24.7 °C and at pH values from 8.3 to 9.6 (Schlegel et al., 1988).

3,24 Freshwater species of Ciliata. Vorticella habitats may include moist soil, mud and plant roots. They are known to feed on bacteria and can also form extracellular associations with mosquitoes, nematodes, prawns and tadpoles (Patil et al., 2016).

4,6 Synura is a genus of colony-forming algae. Each cell

is covered by silica scales (Leadbeater, 1990).

5 Dinobryon is a type of microscopic algae. Dinobryon are mixotrophs, capable of obtaining energy and carbon through photosynthesis and phagotrophy of bacteria. D. divergens blooms in lakes and ponds. Such blooms may produce volatile organic compounds that produce odors and affect water quality (Caron et al., 1993; Rashash et al., 1995).

7 Freshwater invertebrate animals. It lives along the plant-covered banks of stagnant and slow-flowing bodies of water, where it feeds on small fragments of plant material, animals or carrion. Cyclops has the capacity to survive unsuitable conditions by forming a cloak of slime (Cuvelier & Walter).

8,11,21 The freshwater species of unicellular diatom algae. An important factor for the development of diatoms is temperature, the degree of illumination, and the quality of light (<https://en.wikipedia.org/wiki/Diatom>).

9 Tintinnidium fluviatile – unicellular organisms, eukaryotes. A review of the ecology of the fresh-water Tintinnina

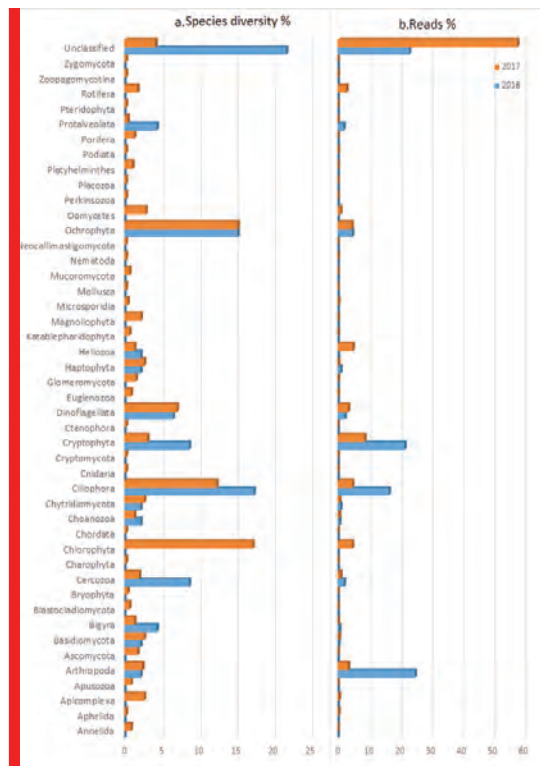


Fig. 6a,b: The percentage of 18S rRNA hydrobionts of species diversity and reads of Verhny Kaban Lake by phylum (2016-2017)

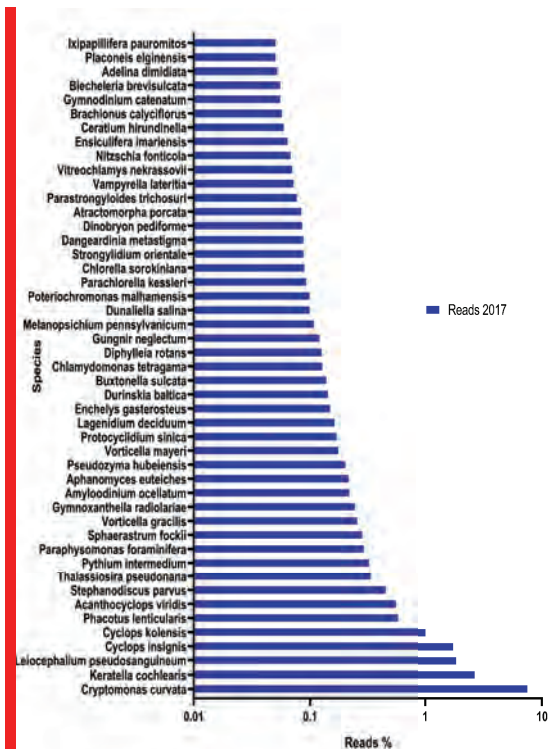


Fig. 7: The species of hydrobionts and reads of Verhny Kaban Lake (2017)

indicated that water temperature seems to be the most essential ecologic factor (FOISSNER & WILBERT, 1979).

10 *Botryococcus braunii* is a green planktonic microalga. The species is notable for its ability to produce high amounts of hydrocarbons, that are typically around 30–40% of their dry weight (Metzger & Largeau, 2005; Wolf et al., 1985).

12,13,14,16,18 The Rotifera, commonly called wheel animals, are a phylum of microscopic and near-microscopic pseudocoelomate animals. Rotifers are an important part of the freshwater zooplankton, being a major foodsource and

with many species also contributing to the decomposition of soil organic matter (<https://en.wikipedia.org/wiki/Rotifer>; Streble & Krauter, 2006).

15 *Ceratium hirundinella* is a species of freshwater unicellular algae. *C.hirundinella* are mixotrophs. It is common in lakes of temperate latitudes and has a significant seasonal presence in phytoplankton. The density of stocks is highest in August-September, at that time it can be nearly monospecific. The species is close to the surface of water (Heaney & Talling, 1980).

17 *Sida* is a genus of Cladocera, found among aquatic vegetation in the littoral of lakes. Most of the time it

Table 2: Hydrobionts with saprobities in Sladechek's list of Verhnyy Kaban Lake

Species	Saprobity	Reads %
Cryptomonas curvata ¹ , Phacotus lenticularis ² , Vorticella mayeri ³ , Synura petersenii ⁴ , Dinobryon divergens ⁵	b	8.370
Synura spinosa ⁶	b-o	2.681
Cyclops insignis ⁷ , Nitzschia fonticola ⁸ , Tintinnidium fluviatile ⁹ , Botryococcus braunii ¹⁰ , Asterionella formosa ¹¹ , Dicranophorus forcipatus ¹² , Lacinularia flosculosa ¹³	o	0.065
Keratella cochlearis ¹⁴ , Ceratium hirundinella ¹⁵ , Trichocerca elongata ¹⁶ , Sida crystallina ¹⁷	o	0.065
Brachionus calyciflorus ¹⁸ , Coleps hirtus ¹⁹	b-a	0.060
Chlamydomonas reinhardtii ²⁰	a	0.013
Cyclotella meneghiniana ²¹ , Urostyla grandis ²²	a-b	0.013
Chlorella vulgaris ²³ , Vorticella aequilata ²⁴	p-a	0.007

o – oligosaprobity (clean), o-b, b-o – between oligosaprobity and b-mesosaprobity, b-mesosaprobity (polluted), a-b – between a- and b-mesosaprobity, a-mesosaprobity (very polluted), p-saprobity (dirty)

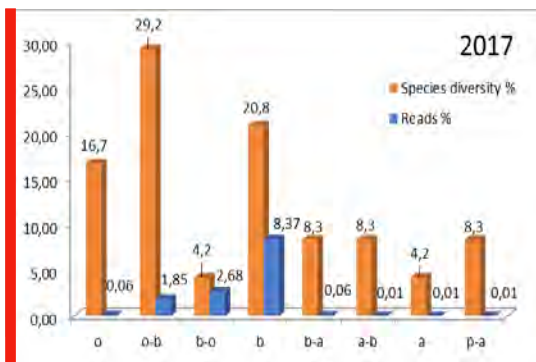


Fig. 8: The percentage of reads and species diversity in the Lake Verhnyy Kaban by hydrobiont saprobity (2017)

spends attached to the surface of plants. It feeds mainly on unicellular algae and small particles of detritus (Korovchinsky, 2004).

19 The *C.hirtus* does not possess algal symbionts and feeds directly on other microbes (<http://www.ciliates.at/en/2016/01/29/coleps-hirtus-hirtus>). Coleps feeds on bacteria, algae, flagellates, living and dead ciliates, animal and plant tissues (Buonanno et al., 2014).

20 *Chlamydomonas reinhardtii* is a single-cell green algae. *C. reinhardtii* is a well-studied biological model organism, partly due to its ease of culturing and the ability

to manipulate its genetics. When illuminated, *C. reinhardtii* can grow photoautotrophically, but it can also grow in the dark if supplied with organic carbon (<http://www.algaebase.org>).

22 Ciliates are unicellular, nonphotosynthetic organisms which show a number of light-induced responses. Orientation with respect to the direction of light, phototaxis, has been demonstrated in some species of ciliates (Kuhlmann, 1998).

23 Green eukaryotic microalgae, which has been present on earth since the Precambrian period (Safi et al., 2014). Figure 8 shows the percentage of reads and species diversity of saprobic aquatic organisms in the Lake Verhniy Kaban for 2017.

As can be seen from Fig. 8, most indicator organisms are grouped between o-saprobity and b-mesosaprobity. The water quality of the Verhniy Kaban Lake is characterized as transitional from polluted to clean state.

CONCLUSION

Based on the results of the study using the next-generation sequencing method they identified the hydrobionts by the 18S rRNA gene for the Lake Verhniy Kaban in 2016-2017.

A total of 53057 (2016) and 44910 (2017) high-quality reads were obtained; 78.8% (2016) and 45.7% (2017) of the hydrobionts was classified to the kingdom, while 76.9% (2016) and 42.1% (2017) was classified to the phylum level, 44.9% (2016) and 37.2% (2017) was classified to the class level, 35.7% (2016) and 30.1% (2017) was classified to the order level, 29.4% (2017) was classified to the family level, 29% (2017) was classified to the genus level, and 24% (2017) was classified to the species level.

They identified 283 species of aquatic organisms, among which Sladchek saprobity was determined for 24 species. Indicator hydrobionts - *Cryptomonas curvata*, b (7.6%), *Keratella cochlearis*, b-o (3%), *Cyclops insignis*, o-b (2%) are of the greatest importance by reads; o-b-mesosaprobity (29.2%), b-mesosaprobity (20.8%), o-saprobity (16.7%) are of the greatest importance by the number of saprobic species. Thus, most indicator organisms are grouped between o-saprobity and b-mesosaprobity. The quality of the water of Verhniy Kaban Lake is between a clean and polluted.

SUMMARY

The use of the next-generation sequencing method allows the identification of a large number of aquatic organisms. The method can be used for bioindication to assess the ecological status of water bodies. The results obtained are of great practical interest in the field of water body monitoring.

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The Change of Sympatho-Adrenal System Activity Among Boys In School Year Dynamics

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ABSTRACT

They studied the reactions of the long-term adaptation of the sympatho-adrenal system among teenage schoolchildren to a long-term training load. They revealed that the activity of the sympatho-adrenal system changes in different directions among the adolescents of different age groups during the school year. During the period of intense puberty, the orientation of the adaptive dynamics of catecholamines and DOPA excretion deviates from the age trend among 13-14 year-old boys. There is the decrease of the symptom-adrenal system reserve capacity, expressed in dopamine and DOPA excretion decrease due to fatigue of schoolchildren at the end of the school year.

KEY WORDS: Sympathoadrenal System, Catechol Amines, Adrenaline, Noradrenaline, Dopamine, Dioxiphenylalanine, Teenage Boys.

INTRODUCTION

Due to the ongoing reform of secondary education, a modern school introduces intensively a variety of the latest technologies for student teaching, education and development from junior to middle level. The requirements for the quality and intensity of educational activities are increasing, requiring significant adaptive efforts from the body of children and adolescents (Antropova, 2009; Bezrukikh, 2014). There is a fairly large number of studies

devoted to the analysis of adaptive reactions of the cardiovascular, respiratory, endocrine systems to physical activity, to the action of extreme and ordinary environmental factors, including educational activities (Krylova, 2014; Luchitskaya, 2009; Sitdikov, 2008; Suvorova, 2012; Krylova, 2015). The features of adaptive reactions of such a regulatory system of the body as sympatho-adrenal are studied to a lesser extent, which limits adaptive reactions both at rest and under the influence of disturbing factors (Dudnikova & Nesterova, 2011; Krylova, 2019; Sitdikov, 2008; Alevtina, 2016).

In this regard, our attention was drawn to the problem of studying the dynamics of the sympatho-adrenal system activity in the learning process during adaptation to educational activities, including the long-running multi-stage educational process with all the variety of dynamic, static and mental stresses experienced by schoolchildren during the school year.

Objective: to identify a change in the functional state of the sympatho-adrenal system of boys depending on their age and the period of the school year.

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OBJECT AND RESEARCH METHODS

We examined 145 healthy teenage boys at the age of 11-16 (high school students). The survey was conducted three times during the school year (October, February, April).

The activity of the sympathoadrenal system (SAS) was determined by age and gender groups and the excretion of catecholamines (adrenaline, norepinephrine, dopamine) and dioxiphenylalanine (DOPA) in urine by the fluorimetric method (according to E.Sh. Matlina) (Luchitskaya, 2009). The stages of puberty (SP) were evaluated by D. Tanner's method.

The results of the study were processed by the method of parametric and correlation analysis of the intrasystem relationships of SAS indicators.

STUDY RESULTS AND DISCUSSION

The analysis of catechol amines (CA) and DOPA excretion among 11-16-year-old boys in a state of relative dormancy revealed the increase of almost all of the studied

parameters in most age groups from the beginning to the end of the school year (Table 1).

Thus, the observation of adrenaline (A) excretion dynamics among 11-year-old boys (1 SP) showed that a statistically significant increase occurs already in February, when excretion is 7.10 ± 0.37 ng/min, versus 4.75 ± 0.20 ng/min in October. This level is maintained in April. here the excretion makes 7.24 ± 0.38 ng/min, which is significantly higher (by 52.43%) than during the first period of the study.

The excretion of norepinephrine in this age group during the middle and end of the school year is also higher than at the beginning. The excretion level increases from 12.97 ± 1.16 ng/min to 17.85 ± 1.12 ng/min and 16.61 ± 0.96 ng/min, respectively. This increase is statistically significant. The increase makes 35.67% on the average.

Dopamine excretion among 11 year-old boys changes less significantly. There are no significant differences between

Table 1: Change of catecholamines and DOPA excretion among 11-16 year-old boys during the school year (M ± m; ng/min)

Indicator	Age	October	February	April
Adrenalin	11	4.75± 0.20	7.10± 0,37*	7.24± 0.38*
	12	7,11± 0.19	7.91± 0.37	10.22± 0.30*
	13	9.97± 0.25	11.89± 0.43*	12.04±0.57*
	14	8.35± 0.32	9.58± 0.32*	10.36± 0.51*
	15	5.95±0.27	6.27±0.62	5.59± 0.73
	16	5.55± 0.21	5.43± 0.47	5.19± 0.51
Norepinephrine	11	12.97±1.16	17.85± 1,12*	16,61±0.96*
	12	15.95± 1.32	18.04± 1.21	21.24± 1.13*
	13	21.00±1.37	18.29± 1.61	15.45± 1.01*
	14	25.98± 1.29	23.17±1.78	15.32± 1.14*
	15	20.94±1.30	21.23±1.42	21.07± 1.11
	16	20.17± 1.15	20.33± 1.41	19.20± 1.01
Dopamine	11	108.95± 7.35	112.33± 9.68	114.95± 8.02
	12	116.00± 7.01	132.71±11.00	141.48± 7.19*
	13	151,84± 7.22	145.11±14.21	122.21±8.38*
	14	168.33±7.35	150,60±10.81	140.94± 7.63*
	15	219.31±9.14	222.67±10.32	223.16±11.36
	16	223.75±9.17	222.53±10.61	220.56± 9.48
DOPA	11	31.96± 1.36	36.59± 1,65*	37.84± 1.83*
	12	38.010± 2.15	42,29±2,81	46.83± 2.16*
	13	41.97± 2.33	40.13±3.41	30.99± 2.31*
	14	47.98±2,55	43.73± 3.32	35.29±1.73*
	15	65.99± 2.37	68.61± 2.61	67.58± 1.93
	16	65.88± 2,33	65.41± 2.18	66.17±2.26

Age (years)	Study period	A+NA+DA/DOPA	A+NA/DOPA	NA/DA	NA/A
11	October	3.90	0.20	0.11	2.70
	February	3.75	0.22	0.16	2.51
	April	3.67	0.21	0.14	2.29
12	October	3.59	0.19	0.13	2.40
	February	3.73	0.20	0.14	2.28
	April	3.69	0.21	0.15	2.08
13	October	4.25	0.19	0.14	2.22
	February	4.34	0.20	0.12	1.54
	April	4.83	0.19	0.12	1.28
14	October	4.17	0.22	0.17	3.30
	February	4.19	0.21	0.15	2.42
	April	4.72	0.18	0.11	1.48
15	October	3.80	0.11	0.10	3.37
	February	3.65	0.12	0.10	3.38
	April	3.67	0.12	0.09	3.35
16	October	3.72	0.11	0.09	3.34
	February	3.79	0.12	0.09	3.36
	April	3.71	0.11	0.09	3.36

the indicators, although there is the tendency to increase excretion.

DOPA excretion among the schoolchildren at the age of 11 in February and April is higher than in October and makes 36.59 ± 1.65 ng/min and 37.84 ± 1.83 ng/min, respectively, against 31.96 ± 1.36 ng/min in the background.

Thus, a similar trend is observed in the dynamics of the absolute indicators of catechol amines and DOPA excretion among 11-year-old boys, - the increase of excretion from the beginning to the end of the school year. It is noteworthy that the observed dynamics does not contradict the age-specific direction of changes in the excretion of catecholamines and DOPA, which consists in its increase among 11 - 12 year-old boys. The changes are more pronounced in terms of adrenaline and norepinephrine.

Analyzing the ratio of CA and DOPA excretion, we studied the change in the following coefficients: A+NA+DA/DOPA, A+NA/DA, NA/DA, NA/A (Table 2). According to generally accepted notions, these coefficients indirectly reflect the processes of CA development dynamics: A+NA+DA/DOPA coefficient reflects the accumulation of DOPA, A+NA/DA coefficients, NA/DA - the transition of DA to NA. The

coefficient NA/A allows you to judge the state of CAC links. The increase in NA/A ratio indicates the increase of the mediator link activity, the decrease indicates the priority of the hormonal CAC link.

The analysis of CA and DOPA ratio showed that by the end of the school year, 11 year-old boys have the tendency to a certain decrease in A + NA + DA / D coefficient, which reflects the accumulation of dopamine and the increase of A + NA/DA and NA/DA coefficients characterizing the transition of dopamine to norepinephrine (Table 2).

Therefore, they can assume a slight increase in the reserve capacity of SAS among 11-year-old students by the end of the school year as compared to its beginning. A similar dynamics takes place among 12-year-old boys (2 SP).

Among 13 and 14 year-old boys (3-4 SP), the absolute values of catecholamines and DOPA excretion vary in different directions during the school year: the excretion of norepinephrine, dopamine and DOPA decreases, and the excretion of adrenaline increases. These differences are most pronounced at the end of the school year. It should be noted that the dynamics of norepinephrine, dopamine and DOPA excretion in these groups does not coincide with the

age trend, which consists in the excretion increase of these catecholamines among 12 - 14 year-old boys. All this allows us to evaluate the observed changes as unfavorable.

The excretion of catecholamines and DOPA among older students (15-16 years old, 5 PS), during the school year is quite stable and does not depend on the study period.

The analysis of catecholamines and DOPA ratios shows that their most pronounced change depending on the study period is observed at 3-4 PS. So, the coefficient A+NA+DA/D is almost doubled by the end of the school year. On the contrary, the coefficients A+NA/DA and NA/DA are markedly reduced.

The nature of coefficient change suggests the decrease of SAS reserve capacity for these schoolchildren, which, in our opinion, is also confirmed by a significant decrease of norepinephrine, dopamine, and especially DOPA excretion from October to April, which contradicts the age dynamics and indicates the deficiency of predecessors and the stressful functioning of SAS. The balance of the final products is also disturbed, as evidenced by a significant change in the NA/A ratio towards greater activity of the hormonal link. Probably, during the period of intense functioning of the SAS, the role of its hormonal link increases, as a more mature link of the system.

To study the dynamics of the interconnections of SAS indicators, the correlation analysis method was used in our studies, which characterizes the degree of relationship tightness between the analyzed parameters and helps to isolate the role of individual SAS links in adaptive reactions to a long-term training load. To this end, we analyzed the change in the correlation coefficient between CA and DOPA. It is known that the correlation coefficient (r) ranges from - 1 to + 1. The stronger the relationship between the features, the greater the coefficient value.

In our studies, we analyzed the change of relationship strength in CAC indicators (A, NA, DA, DOPA) during the school year. According to our data, the relationships between CAC indicators are very dynamic. 11-12 and 15-16 year-old boys demonstrate strong bonds A-DA ($r = + 0.80$), A-NA ($r = + 0.83$), NA-DA ($r = + 0.75$), and NA-DOPA ($r = + 0.71$) and DA-DOPA ($r = + 0.72$), which reflect the sequence of catechol amine biosynthesis, which do not change significantly during all three observation periods. 13-14 year-old boys, preserve only A-DA ($r = 0.68$) and A-NA ($r = 0.70$) bonds, which are significantly weakened

by April: A-DA ($r = 0.45$) and A-NA ($r = 0.53$). Obviously, the weakening of the bond strength of catecholamines and DOPA indicates a relative decrease in the reserve capacity of CAC among 13-14 year-old boys (3-4 ATP) during the process of long-term adaptation to educational activities. Thus, the functional state of CAS among 13-14 year-old boys (3-4 ATP) worsens by the end of the school year relative to the background.

In our studies 15-16 year-old (5 ATP) pupils did not reveal significant changes in the absolute values of catecholamines and DOPA excretion. Excretion is quite stable during all periods of the study, the differences are only within the measurement error. Constancy is also observed in the ratios of catecholamine excretion, which practically did not change during the school year. All this testifies to the maturity of SAS among high school students, the sufficient reserve capabilities of SAS, the balanced functioning of the system at the final stage of puberty, and the stability of the system to the influence of external influences.

SYMMARY

Thus, in the studied age range, it is possible to distinguish the age periods of adolescent boys characterized by the intense functioning of SAS during the school year. This should include the age of 13-14 years (3-4 ATP) - the period of intensive development of SAS links, accompanied by the decrease of its reserve capabilities and which turned out to be the most sensitive to environmental influences. This leads to the deviations in the dynamics of a number of SAS parameters from age-related tendency of their development, during the period of fatigue among schoolchildren, which is observed at the end of the school year.

CONCLUSION

1. The excretion of adrenaline, norepinephrine and DOPA increases among 11 year-old boys by the middle of the school year, not accompanied by dopamine excretion increase. The growth of catechol amines does not take place by the end of the school year.
2. In 12-year-old boys, an increase in the excretion of catechol amines and DOPA was detected only by the end of the school year.
3. Among 13-14 year-old boys, the excretion of adrenaline increases by the middle and the end of the school year, while the excretion of norepinephrine, dopamine and DOPA decreases.

4. 15-16 year-old boys have a stable level of catechol amines and DOPA excretion throughout the school year.

INTRODUCTION CONFLICT OF INTEREST

The author confirms that the presented data do not contain a conflict of interest.

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Isolated Heart of Rats with Limited Motor Activity

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ABSTRACT

Currently, hypokinesia, due to the restriction of motor activity, occupies the first position among the factors that have a huge impact on the structure and functions of many body systems. There is a lot of data on the negative effects of hypokinesia on the body after technical progress, space flight or prolonged bed rest. First of all, these are disorders of the musculoskeletal system, cardiovascular, muscular, and respiratory systems. As a result of hypokinesia, the hereditary apparatus of the cell and many body systems undergo morphofunctional changes. It has been established that a long-term restriction of motor activity leads to a gradual thinning of muscle fibers, and a decrease in minerals is also observed in the bones associated with a violation of calcium intake in the body [1,2]. The authors note that the restriction of motor activity has a negative effect on myocardial contractility, namely, changes in the systole of the heart cycle occur (the period of tension increases, the period of exile decreases). In turn, these phenomena lead to oxygen starvation of body tissues, which is confirmed by the presence of signs of dystrophy in the liver cells [3]. In this regard, studies researching the effect of limitation of motor activity on the body and organ systems are relevant. The aim of this study was to study the effect of hypokinesia on the Langendorff-isolated heart of 7-week-old rats. An ex vivo study of isolated heart parameters was performed at the Langendorff facility (AD instruments, Australia). During the experiment, a decrease in the pressure developed by the left ventricle, an increase in the heart rate and a decrease in the coronary duct, systolic and end-diastolic pressure of the left ventricle of the isolated heart of hypokinesized rats were observed, in contrast to the control group of animals that were under conditions of unlimited motor activity.

KEY WORDS: Isolated heart, Hypokinesia, Pressure Developed by the Left ventricle, Heart rate, Coronary Duct.

INTRODUCTION

Restriction of motor activity leads to impaired coordination of organs and organ systems, however, a prolonged or severe restriction of motor activity causes severe changes

that can lead to pathological damage to organs and tissues (Birge, 1976; Chinkin, 2012). As a result of hypokinesia, energy metabolism is disrupted: the rate of synthesis and decomposition of substances decreases, the structure of cellular components is disrupted, atrophy occurs due to the lack of sufficient loads. Also, according to published data, during hypokinesia, a decrease in body weight is observed, but an increase in heart mass is observed (Gimaraes, 2001).

It is known that weakening of the skeletal muscle leads to atrophy, which is characterized by a decrease in volume and thinning of muscle tissue; also leads to thickening of the connective tissue and the conversion of red muscle fibers into white. The effect of these changes in muscle tissue on the increase in the activity of free radicals was shown. There is little data on the influence of these processes in the cardiovascular system, but it should be noted that damage to the heart by free radicals is induced by various stress factors (Grigoriev, 2004).

As a result of hypokinesia, immobilization stress is generated in rats, as a result of which the hypothalamic-pituitary-adrenal and sympathoadrenal system is activated,

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which in turn significantly increases the level of adrenaline and norepinephrine in the plasma. Increased secretion of catecholamines can increase ventricular contraction, but when abruptly terminated, it can reduce myocardial contractility. In contrast, high levels of catecholamines can damage heart tissue and reduce left ventricular function due to Ca overload and free radical formation; can also cause myocardial ischemia, lead to an increase in ventricular afterload and heart rate (Kvetnansky, 1995).

Norepinephrine and epinephrine act directly on the heart through adrenergic receptors, increase heart rate and myocardial oxygen demand. They also indirectly affect the heart by increasing systemic blood pressure and lowering coronary blood flow by contracting vascular smooth muscle cells and platelet aggregation. These complex interactions complicate the differences in the direct action of catecholamines on the heart from their indirect effects as a result of stress and caused by heart diseases in humans (Lychkova, 2013; Maltseva, 2008).

Nitric oxide (NO) is known to be of primary importance in hypokinesia. The authors showed the importance for the central and autonomic nervous system, cardiovascular system and blood supply to the brain and heart, where deviations of the NO level can entail the risk of stroke and heart attack (Maltseva, 2009).

Hypokinesia disrupts the contractility of the muscle fibers of the working myocardium, this is facilitated by a decrease in the number of myofibrils, mitochondria and a decrease in trophic functions of these cellular structures (Grigoriev, 2004).

With limited motor activity, compared with control rats under standard vivarium conditions, a decrease in stroke and minute blood volume is observed. According to published data, hypokinesia in adult rats showed a decrease in stroke volume by 25% and a slight decrease in minute volume (Oganov, 1998).

Given all these facts, the aim of this work was to study the effect of limitation of motor activity for 30 days on the work of the parameters of the isolated heart of rats of 7 weeks of age.

METHODS

Motion restriction experiments were performed on Wistar white laboratory rats that underwent hypokinesia at 3 weeks of age. The animals were divided into 2 groups: 1 group (control), was in conditions of unlimited motor activity, 2 - an experimental group, which was subjected to hypokinesia.

During hypokinesia, animals were placed in cell cages, hypokinesia was carried out for 30 days. We used a method that creates the conditions for the formation of hypokinesia developed by R.A. Abzalov. The first two days, the animals were subjected to hypokinesia for 1 hour, for 2 and 3 days for two hours, and also every 2 days, the time of limitation of motor activity increased by 2 hours.

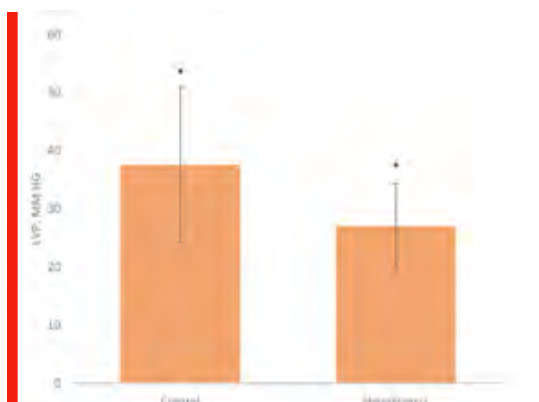


Fig. 1: Average indicators of pressure developing in the left ventricle of rats kept under standard conditions, and rats kept under conditions of hypokinesia. Note: LVP - pressure developed in the left ventricle, "" $p < 0.05$**

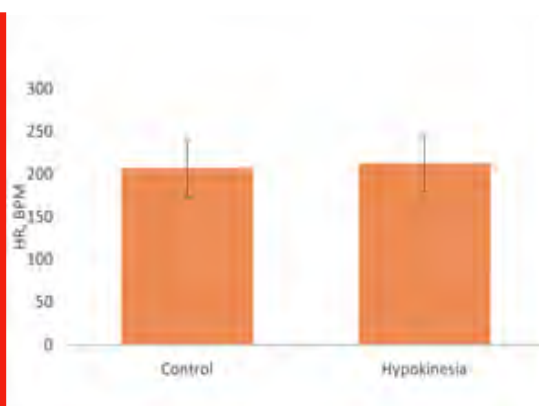


Fig. 2: Average heart rate of rats grown under standard conditions, and rats grown under conditions of limitation of motor activity. Note: HR is the heart rate.

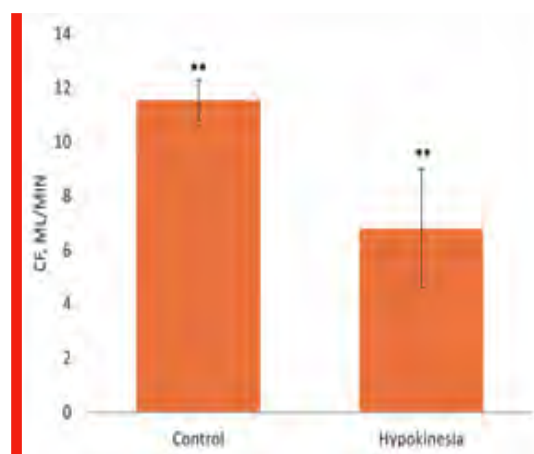


Fig. 3: Average heart rate of rats grown under standard conditions, and rats grown under conditions of limitation of motor activity. Note: CF - coronary duct, "" $p < 0.01$**

Rats were anesthetized with urethane (800 mg / kg animal weight), then the heart was taken out and placed in a cold Krebs-Henselyte working solution (pH = 7.4).

The heart was fixed on the cannula of the Langendorff apparatus and perfused with the working solution. Perfusion was carried out retrograde through the aorta at a constant pressure of 60-65 mm Hg.art., the solution was saturated with oxygen and maintained at a temperature of 37 ° C, which is optimal for warm-blooded animals. Intraventricular pressure was recorded using a latex balloon, which was inserted into the cavity of the left ventricle.

Ex vivo experiments were carried out on an isolated heart at the power Lab 8/35 (ADInstruments) facility, data recording was carried out on the LabChart Pro program. Statistical processing was carried out in Excel, the reliability was determined using t-Student criterion. The data were considered statistically significant at $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$.

RESULT

We analyzed such indicators of the work of an isolated heart as the pressure developed by the left ventricle, heart rate, coronary duct, systolic and end-diastolic pressure of the left ventricle of control and hypokinesized rats of 7 weeks old for 30 days.

The value of cardiac muscle contraction force in control rats under conditions of unlimited motor activity was 37.6 ± 13.43 mm Hg.

The contractility of the heart muscle in 7-week-old rats kept under conditions of limitation of motor activity was 27.04 ± 7.3 mm Hg.

We observed a significant difference in the indicators of pressure developed by the left ventricle in rats of the experimental and control groups. In rats hypokinesized

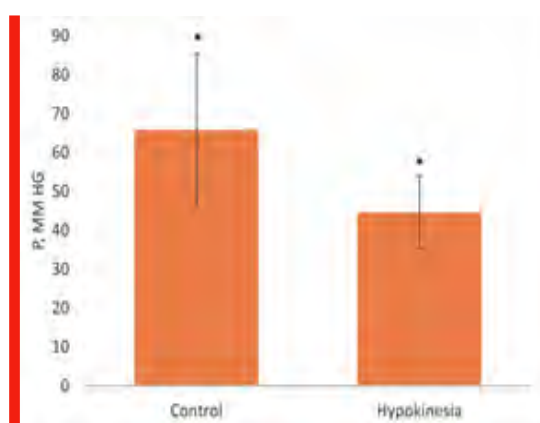


Fig. 4: Average values of systolic pressure of the left ventricle of the isolated heart of rats grown under standard conditions, and rats grown under conditions of limitation of motor activity.
Note: P - systolic pressure of the left ventricle, "*" $p < 0.05$.

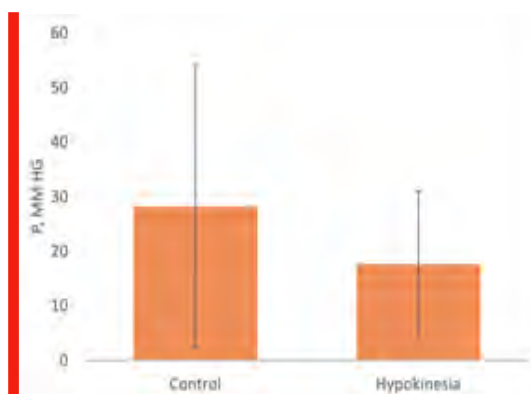


Fig. 5: Average values of systolic pressure of the left ventricle of the isolated heart of rats grown under standard conditions, and rats grown under conditions of limitation of motor activity.
Note: P - end-diastolic pressure of the left ventricle.

within 30 days, this indicator decreased by 28.08% compared with control animals ($P \leq 0.05$) (Fig. 1).

The heart rate in 7-week-old rats kept under standard conditions was 207.9 ± 34.4 beats / min.

The value of heart rate in pups of 7 weeks of age with hypokinesia was 212.61 ± 33.12 beats / min.

That is, in the dynamics of heart rate there were no significant differences between the two experimental groups. In hypokinesized rats, in contrast to rats that were under unlimited conditions of motor activity, heart rate increased by 2.3% (Fig. 2).

The coronary duct in rats grown under hypokinesia was significantly less in contrast to rats grown under standard conditions, the difference was 41.21% ($P \leq 0.01$) (Fig. 3).

The mean systolic pressure of the left ventricle in the rats of the control group was 65.81 ± 19.6 mm Hg, the end-diastolic pressure of the left ventricle was 28.21 ± 25.9 mm Hg. After restriction of motor activity for 30 days, the value of systolic pressure of the left ventricle in hypokinesized rats was 44.61 ± 9.33 mm Hg, and the value of the end-diastolic pressure was 17.6 ± 13.4 mm Hg.

That is, after the restriction of motor activity, a significant decrease in systolic pressure of the left ventricle of an isolated heart was observed by 32.21% ($P \leq 0.05$) (Fig. 4) and an unreliable decrease in end-diastolic pressure of the left ventricle by 37.61% compared with such values in rats under conditions of unlimited motor activity (Fig. 5).

CONCLUSION

Based on the results of the study, it can be concluded that hypokinesia lasting 30 days reduces the pressure developed by the left ventricle of the isolated heart of 7-week-old rats. The restriction of motor activity for 30 days reduces the coronary duct, causes a tendency to increase the cardiac activity of the isolated heart of animals of 7

weeks of age. As a result of hypokinesia, a decrease in systolic and end-diastolic pressure of the left ventricle of the isolated heart of rats of 7 weeks of age is observed.

Literature data confirm that the restriction of motor activity in warm-blooded animals activates stress factors, which are characterized by an increase in the level of production of catecholamines and glucocorticoids.

It was shown that a prolonged restriction of motor activity leads to the destruction or decrease in the activity of cellular components. Under the influence of hypokinesia in the heart, a decrease in the content of RNA is observed, which leads to a violation of protein biosynthesis in the heart muscle. As a result of hypokinesia, the metabolism in the cells changes, namely, the structure of DNA, proteins and membrane organoids is damaged by the active forms of oxygen. The resulting activation of peroxidation leads to a violation of the nucleus, mitochondria and the structure of cell membranes (Grigoriev, 2004; Palmer, 1992).

Hypokinesia leads to defective functioning of mitochondria, resulting in impaired energy functions, tissue respiration, weakening of the biochemical processes of respiration, as a result of which the heart muscle experiences oxygen starvation. As a result of hypokinesia, heart cells are deficient in nutrients and energy (Palmer, 1992).

The literature data indicate that, with limited motor activity, the efficiency of the cardiovascular system decreases, which is characterized by an increase in tension of the heart function, manifesting itself in an increase in heart rate, which reaches its peak by 100-110 days of hypokinesia (Gimaraes, 2001). In our results after hypokinesia, we also observe a tendency to increase heart rate. Perhaps, due to the fact that the restriction of motor activity was carried out for 30 days, we observed minor changes in heart rate.

Myocardium responds to an increase in heart rate under normal conditions by an increase in the force of contractions, and in pathological conditions, an increase in the rhythm frequency leads to a decrease in the force of contraction. It is believed that in small rodents, the circulation of calcium in the body maintains a high rhythm of heart rate. Therefore, due to the lack of motor activity in experimental animals, these signs appear that characterize heart failure (Tkachenko, 2011).

According to our data, with a limitation of motor activity, a decrease in the contractile function of the heart is observed. A decrease in the number of cardiomyocytes and the number of myofibrils under the influence of hypokinesia, which also increases the predisposition to the programmed cell death process, can lead to a deterioration in contractility and myocardial extensibility (Grigoriev, 2004).

Our data are consistent with the results of other studies in which it was shown in vivo that the pressure developed by the left ventricle in rats with limited motor activity decreased by 3 times compared with control animals (Oganov, 1998).

As the experimental results showed, the restriction of

motor activity caused a decrease in the coronary duct in the isolated heart of rats. The vasoconstrictor effect may be associated with the activation of α_2 -adrenergic receptors of vascular smooth muscle cells, through which vasoconstriction is performed (Wang, 2010). It is known that with hypokinesia nitric oxide is of paramount importance, and adrenergic receptors, interacting with the NO system, support the regulation of heart function in normal and pathological conditions (Maltseva, 2009; Zefirov, 2014). Based on this, it seems promising to study the dynamics of the NO system and adrenergic mechanisms of heart regulation while limiting the motor activity of mammals.

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Assessment of the Ecological Status of Belye Lake (Tatarstan, Russia) and the Development of a Landscaping Project

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ABSTRACT

They performed long-term studies of the Lake Belye, located in the protection zone of the Volga-Kama State Natural Biosphere Reserve. The purpose of the research is to assess the ecological state of the lake and the coastal zone and to develop a landscaping project. Hydrochemical studies revealed supersaturation of the surface layers of water with oxygen and deficiency at the bottom, the increase of nutrient content, a high content of organic substances, and increased pH values of the water. All of the abovementioned indicates an intensively ongoing process of eutrophication. The basis of the community was represented by rotifers. The summer abundance of zooplankton over the years varied from 406.2 thousand un./m³ to 4120.9 thousand un./m³, biomass from 1.6 g/m³ to 12.0 g/m³. By the value of the saprobity index, the reservoir belonged to the β -mesosaprobic zone in most cases. The values of biotic indices, high quantitative indicators of zooplankton characterize the Lake Belye as eutrophic. The analysis of the ecological state of the lake and its coastal territory showed that the main problems are the intake of suspended solids, the compounds of nutrients and pollutants with tributary water, as well as an intensive recreational load, leading to land litter, trampling of vegetation, and lake pollution. In accordance with the environmental problems and ecological restrictions of the territories, they developed the recommendations to reduce the anthropogenic load and project proposals, including the creation and arrangement of a recreation area. Prior to the commencement of improvement, it is recommended to carry out restoration measures, such as aeration of the reservoir, mechanical collection and mowing of plants, cleaning of coastal territory and the lake itself, installation of information signs.

KEY WORDS: Zooplankton, Lake, Bioindication, Nature Reserve, Landscaping, Eutrophication.

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INTRODUCTION

With the growth of urbanization, natural areas become increasingly attractive as holiday destinations, especially during summer period. People come to the forest or to ponds in order to relax from the bustle and routine of the city, enjoy the clean air, take sun and air baths. Water bodies have a special aesthetic and recreational value and are attractive for tourists. At the same time, reservoirs are often used by local residents for household needs. Of course, when you develop the projects for natural object landscaping, it is important to take into account different, sometimes opposite interests.

The object of research is the Lake Belye, located in the village of Belo-Bezvodnoye, Zelenodolsk district of the Republic of Tatarstan (Russia). The area of the lake is 7.06 hectares, the maximum depth is 4 m, the average depth is

2 m. The lake is flowing. The influx of the lake flows through the territories used for agricultural production. With the waters of the tributaries, suspended solids and compounds of nutrients are introduced into the lake. A large number of them enter the lake during the flood period and lead to the lake siltation. The lake is used both by local residents for household purposes, and by tourists as the place of recreation and fishing.

The lake Beloye is located in the protection zone of the Volga-Kama State Natural Biosphere Reserve (VKS NBR), and it is a natural monument. The lake is subject to eutrophication. It is necessary to take measures aimed at its environmental status improvement. The aim of the research was to assess the ecological state of the Lake Beloye and develop the proposals for its improvement.

METHODS

A set of methods was used to assess the ecological state of the lake and the coastal zone. The physicochemical parameters of the lake water were studied by the VKS NBR employees from 1998 to 2017. Water samples were taken once in the middle of the growing season (in June-July) separately from the surface and bottom layers of water. The analyzes were performed in a specialized analytical laboratory using generally accepted methods.

Zooplankton samples were taken from station 1 in June 2016-2018. Using the Jedi network (mesh size 100 μm), the entire column of water (3 m) was filtered 3 times from the bottom to the surface. The office processing of zooplankton samples included the determination of species composition, abundance, and biomass, and was performed according to generally accepted hydrobiological methods (Adamczuk et al., 2015). To determine the level of water body pollution with organic substances, the Pantle and Bucca saprobity index was calculated in the Sladchek modification (S) (Derevenskaya & Urazaeva, 2017). Community structure was assessed by the Shannon species diversity index and Simpson dominance (Derevenskaya et al., 2017; Ejsmont-Karabin & Karabin, 2013).

The condition of the coastal territories and the reservoir was evaluated according to the methods by V. Smetanin and Vlasov V.A. using the scales which allow to characterize various aspects of the territory and the water body use in point terms. The technique includes two blocks of scales. The first block allows you to give the score for the following indicators: the water body genesis, the degree of eutrophication, the assessment of the natural complex of the territory from the point of view of its cultural and historical

significance. Block No. 2 includes the assessment of a water body state by the degree of technogenic transformation; the degree of natural complex anthropogenic digression and the ability to perform environmental functions; the state of the landscape and architectural environment of the natural complex of the territory, taking into account the urban planning situation and planning situation; recreational significance and potential of the territory natural complex; the degrees of engineering and meliorative arrangement of the territory natural complex (Guidelines for the collection and processing of materials during hydrobiological studies in freshwater bodies, 1982; Ma et al., 2015).

The following programs were used during the project development: Sketch Up, Brighter 3d, Adobe Photoshop, Paint, Inkscape, Google Earth, and Revit. They used Yandex Maps and the public cadastral map of the Russian Federation to analyze the condition of the territories.

RESULTS AND DISCUSSION

The Lake Beloye is characterized by a low level of transparency. It usually did not exceed 0.6 m during sampling. The temperature regime of the lake corresponds to the regime of shallow water bodies. The upper layers warm up to 20-27,4 $^{\circ}\text{C}$ during summer, the water temperature drops to 11-19 $^{\circ}\text{C}$ in the bottom layers (3,5-4 m).

The gas composition is characterized by a high oxygen content in the surface layers (up to 15.08 mg/dm^3). With depth increase, the oxygen content decreases. For many years, there was the deficit of oxygen in the bottom layer. According to the magnitude of the environment active reaction, the lake water belongs to slightly alkaline (up to 8.5), which is the consequence of the intensive development of phytoplankton and indicates a high trophicity of the reservoir.

The water of the Lake Beloye belongs to the hydrocarbonate-calcium type, moderately hard (3-6 mEq/dm^3). The lake has a rather high content of organic substances, often exceeding the permissible values of chemical oxygen consumption ($> 30 \text{ mgO}/\text{dm}^3$) and biological oxygen consumption ($> 2 \text{ mgO}/\text{dm}^3$). During some years, they noted that the permissible content of ammonium ions and nitrite ions was exceeded (at the depth of 3.5-4 m).

During almost all years, the lake exceeded permissible concentrations of total iron ($> 0.1 \text{ mg}/\text{dm}^3$), often copper and manganese ($> 0.001 \text{ mg}/\text{dm}^3$ and $> 0.1 \text{ mg}/\text{dm}^3$, respectively). In some years, they noted an increased

phenol content. According to integral indicators the quality of surface water ranges from extremely clean to slightly polluted.

Zooplankton communities are good indicators of the reservoir ecological state and can be used as the bioindicators to assess the status of reservoirs and identify eutrophication processes (Mingazova, 2014; Opochocka & Paształeniec, 2016; Shannon & Weaver, 1949; Sladeček, 1973; Smetanin, 2003). 24 species of zooplankton were identified as the part of the lake Belye zooplankton during the research period, of which 12 (50%) were rotifers, 8 - cladoceran and 4 copepods. The following species were dominated by numbers over different years: *Asplanchna priodonta* Gosse, 1850, *Bosmina* (*Bosmina*) *longirostris* (O.F. Muller, 1785), *Filinia longiseta* (Ehrenberg, 1834), *Keratella quadrata* (Muller, 1786), *K. cochlearis* (Gosse, 1851), *Thermocyclops oithonoides* (Sars, 1863), *Polyarthra major* Burckhard, 1900, *Trichocera cylindrica* (Imhof, 1891), *Brachionis calyciflorus* Pallas, 1776. *A. priodonta*, *Th. oithonoides*, *B. (B.) longirostris*, *T. cylindrica*, *P. major* were dominated by biomass. The composition of dominant species characterizes the reservoir as eutrophic.

Over the years the number of zooplankton varied from 406.2 thousand un./m³ to 4120.9 thousand un./m³, the biomass varied from 1.6 g/m³ to 12.0 g/m³. Rotifers predominate in the community structure. The saprobity index was 1.7, which characterizes the reservoir as moderately polluted. The values of the Shannon index ranged from 1.7 to 3.1 in different periods, the Simpson index - from 0.6 to 0.8. In general, according to zooplankton indices, the lake can be attributed to the eutrophic type with moderately polluted water.

The environmental assessment of the coastal territory of the water body was carried out according to the methods by V. Smetanin and Vlasov V.A. (Guidelines for the collection and processing of materials during hydrobiological studies in freshwater bodies, 1982; Ma et al., 2015). According to the results of the assessment, the Lake Belye has a satisfactory ecological condition. Ecological and urban planning assessment of the coastal territories of the Lake Belye included the determination of the territory economic use ratio. The coastal areas of the lake are free from development by 85.72%.

Environmental restrictions include natural and planning restrictions. Adverse engineering and geological conditions should be considered as natural restrictions. Such as karst, suffusion, landslides, seismicity, territory at risk

of flooding, etc. Planning restrictions are provisioned by environmental standards. These are sanitary protection zones, water protection zones of surface water bodies, the sanitary protection zones of drinking water supply sources, specially protected natural territories and security zones around them. The Lake Belye is included in the protection zone of the VKSNBR. The security zone is created in order to ensure the conservation regime and minimize the negative impact of economic activity on the natural complexes of the reserve. The territory of the protection zone is not withdrawn from land users, but the activities that negatively affect the natural complexes of the protection zone and reserve territory are prohibited. A 50-meter water protection zone is provided for the Lake Belye. A special regime for economic and other activities is established for this zone in order to prevent pollution, clogging, silting and depletion of their waters, as well as to preserve the habitat of aquatic biological resources and other objects of the animal and plant world.

In order to reduce the anthropogenic load on the lake, it is recommended to collect household garbage in the coastal territory and install garbage container regularly. It is necessary to establish information signs that there is a water protection zone of 50 m for this lake. The parking of vehicles is prohibited within the boundaries of the water protection zone. According to the Water Code of the Russian Federation, a fine is set for the prohibition violation. It is necessary to ensure compliance with the regime of the water protection zone (Vlasov & Smetanin, 2008).

Since the lake is subject to eutrophication, it is recommended to carry out restoration measures. One of these activities is aeration of the reservoir. Aeration is necessary to restore the oxygen regime of the reservoir. There is the deficiency of oxygen in the lake during winter, which leads to fish kills. Installation of aerators will solve this problem. Also, if the bottom layers are enriched with oxygen, the phosphorus release rate may be decreased (this substance, as a rule, is the "culprit" of eutrophication) (Water Code of the Russian Federation, 2006).

You may install a water mill or a fountain for the Lake Belye. This method of aeration is effective when applied to shallow lakes. In addition, the fountain also has such advantage as aesthetic appeal. They recommend to perform the mechanical collection and the mowing of higher aquatic plants. The use of heavy equipment (for example, dredgers) is not recommended, since this lake is a natural monument. It is also highly desirable to reduce the supply of biogenic elements from the catchment area, which will

reduce the load on the lake.

These restoration measures are developed according to the ecosystem approach, the concept of lake restoration, the concept of a living river (Whittaker, 1965). According to these theoretical views, when you improve lakes, the integrity of the lake ecosystem should not be violated; it is necessary to preserve biotopes and ecosystem components, the elements of biocenoses as much as possible. Therefore, all measures during the improvement of small lakes should be small in volume and sparing, using small-sized equipment or should be carried out manually, without violating the self-cleaning processes. When we developed rehabilitation measures, we took into account the nature of anthropogenic impact, their scale, and the specificity of pollutants.

Design proposals. The lake is attractive for tourists. However, unorganized tourism often damages the natural environment. Therefore, it is necessary to regulate the recreational load, as well as to take measures to reduce the effects of this load on the ecosystem.

We propose the creation of a square on the left bank of the lake. It will include several functional zones: a sports zone, the zone for children, passive rest zone. Wooden benches and wooden pergolas above them will be installed in the square. Pergolas will protect vacationers from rain and sun, and they also perform an aesthetic function. You can plant climbing plants near pergolas. The park provides lighting. The square was created taking into account the water protection zone, which makes 50 m.

In the passive recreation area, they plan to plant trees and shrubs. They plan to create several landscape groups in the square. In the landscape group, you can plant such trees as thuja western Brabant, common juniper, red barberry, and Tsisten plum. They also plan to create several tapeworms from a decorative apple tree. Shrubs and trees bloom beautifully, and have bright greenery.

When they selected plants, climatic conditions, daylight hours, and average ambient temperature were taken into account. The plants selected for landscaping should be attractive in appearance, have a controlled growth rate, be resistant to frost, diseases and pests, and should be without pungent odor. The aesthetic appeal of trees and shrubs was also taken into account. Before starting improvement, it is recommended to remove old dried trees that reduce the aesthetics of the coastal area.

It is planned to create a road-path network in the park. The path will run along the passive rest area. We designed the track of optimal width, it is comfortable for one person to walk on it. The track does not contain sharp turns, and convenient for use.

When they designed the square, they took into account that it should attract people, should be convenient and accessible to all categories of the population, and be safe. The indicator of a public space success is its attendance.

We tried to make this landscaping project environmentally friendly. Activities are recommended taking into account the need to preserve the natural coastline and the lake shape. During the preparation of the dendrological plan they used the plants that are inherent in this area. The plants should be unpretentious in care and combine well with each other. When we chose outdoor furniture, we were guided by the following criteria: the furniture should be functional, convenient to use, easy to care for and beautiful. Furniture should also be made from environmentally friendly materials. It is advisable to use predominantly natural materials.

CONCLUSION

The Lake Belye demonstrates the supersaturation of the surface layers of water with oxygen and deficiency at the bottom, a slightly alkaline environment, and a high content of organic substances and biogenic element compounds. All of the abovementioned indicates an intensively ongoing process of eutrophication.

24 species were identified as the part of zooplankton. The dominant complex is represented by 6-8 species, and includes the following species: *Asplanchna priodonta*, *Bosmina longirostris*, *Filinia longisetata*, *Keratella quadrata*, *Thermocyclops oithonoides*, *Polyarthra major*, *Trichocera cylindrica*, *Brachionis californicus*. By the value of biotic indices, the reservoir can be characterized as eutrophic, and moderately polluted.

According to the method by V. Smetanin (2003) and Vlasov V.A. (2008) the environmental assessment of the coastal territory characterizes the ecological state of the lake as satisfactory. Most of the coastal zone is free from development.

In accordance with environmental problems and environmental restrictions of the territories, we have developed recommendations to reduce the anthropogenic load and project proposals. It is proposed to place a park

on one of the shores of the Lake Beloye, which includes an active recreation area, passive recreation area, a sports area and a playground. Trees and shrubs will be planted in the park. During the square design, all environmental restrictions were taken into account.

Prior to the improvement stage, it is recommended to carry out restoration measures, such as aeration of the reservoir, mechanical collection and mowing of plants, cleaning of coastal territory and the lake itself from garbage, and installation of information signs. The proposed activities minimize the coastal zone and the lake change, but allow to increase its recreational capacity.

SUMMARY

Lake ecosystems are one of the significant components of the natural environment. Eutrophication of water bodies leads to the decrease of the species diversity of plants and animals due to anthropogenic impact on them, to the change of community structure, and also reduces their aesthetic qualities.

Aquatic ecosystems are a favorite recreational site. The recreational burden on aquatic ecosystems is a type of anthropogenic impact and, if the recreational capacity is exceeded, it may lead to water quality decrease. The recreational potential of water bodies can be enhanced through the improvement of coastal areas. When they implement the measures for reservoir improvement, the following conditions must be met: preservation of natural complexes and unique natural ecosystems that are characteristic of a given zone; maintaining the natural connection of the natural landscape constituent components; an appropriate distribution of the cultural landscape fragments in space and time; creation and maintenance of a favorable habitat of various types. A set of measures was proposed to improve the ecosystem of the lake and the coastal territory as the result of the work carried out. We tried to make this landscaping project "environmentally friendly". The activities are proposed taking into account the need to preserve the natural coastline and the lake shape. During the preparation of the dendrological plan, the plants are used that are inherent in the area, as well as unpretentious during care and are well combined with each other.

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Age-Related Features Influence of Alpha (1) - Adrenoceptor Stimulation on Isolated Rat Heart

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ABSTRACT

The study was conducted on white outbred rats of 20-, 6-, 3- and 1-week-old. To stimulate alpha 1 adrenergic receptors, the pharmacological preparation methoxamine hydrochloride was used at a concentration of 10-8 M. Stimulation of alpha 1 adrenergic receptors with methoxamine led to bradycardia of an isolated heart in rats of 20, 6 and 3 weeks old age and did not change the chronotropy of the heart of newborn rats. In this case, the opposite dynamics of the coronary flow of an isolated heart was observed in adult and newborn rats. In response to the introduction of methoxamine coronary flow of the hearts of 20-week rats decreased, and 1-week-old rats were significantly increased. The study showed that the negative effect of stimulation of alpha1-AP on chronotropy of rat heart has age-related features: bradycardia of an isolated heart is observed in rats starting from the 3rd week of postnatal ontogenesis. The absence of a chronotropic reaction in newborn rat pups may be due to the lack of formed adrenergic innervation of the heart at a given age, which affects the density and maturity of the studied receptors. Moreover, an increase in the rate of coronary perfusion in newborn rat pups, in response to stimulation of alpha1-adrenoreceptors, indicates a decrease in the tone of the coronary vessels of an isolated heart. This phenomenon may have a compensatory character, due to which an increase in coronary blood circulation of the heart in rats at this stage of postnatal development can be caused.

KEY WORDS: Rat, Isolated Heart, Chronotropy, Coronary Flow, Alpha1-Adrenoreceptors.

INTRODUCTION

Adaptation of the heart during changes in environmental conditions is accompanied by processes of restructuring

of regulatory mechanisms, with peripheral units of adrenergic regulation undergoing significant changes, one of which is membrane receptors. Adrenergic receptors (ARs) mediating the effects of the sympathetic nerve mediator norepinephrine, the hormone adrenaline and other biologically active substances are divided into nine subtypes: $\alpha 1A$ -, $\alpha 1B$ -, $\alpha 1D$ -, $\alpha 2A$ $\alpha 2B$ -, $\alpha 2C$ -, $\beta 1$ -, $\beta 2$ - and $\beta 3$ -ARs (Brodde et al., 2006).

In the heart reactions to catecholamines, the β -adrenergic component predominates with its inherent speed and versatility of effects, while the effects of alpha1-adrenoreceptors ($\alpha 1$ -AR) are limited to an inotropic reaction to adrenaline, and the reaction to norepinephrine is very weak. Therefore, when studying the adaptation of the heart, the interest in changes in the mechanisms of β -adrenergic regulation was predominant, the $\alpha 1$ -adrenergic component of regulation remained out of the field of view of researchers (Chinkin, 1987).

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All three subtypes of α 1-AR are present in rat and mouse cardiomyocytes and their number significantly increases during 1-2 weeks of postnatal development (Chinkin, 2014; Docherty, 2010). In the heart of humans and rodents, α 1A- and α 1B-AR predominate. α 1D- and α 1A- adrenergic receptors in the vascular system play a major role in controlling blood pressure. Since norepinephrine is highly effective against α 1D-AR, these receptors mediate the fastest response, especially with low frequency stimulation, and α 1A-AR are more important at high frequencies of stimulation. In addition to smooth muscle contraction, α 1-AR can induce endothelium-dependent relaxation of blood vessels, and activation of α 1D-adrenoreceptor can have a trophic effect on endothelial cells (Filippi et al., 2001). The blockade of α 1-AR by prazosin improves behavioral symptoms in patients with Alzheimer's disease, and can reduce alcohol dependence (Kenna et al., 2016; Khabibrakhmanov et al., 2018). Other actions of α 1-AR include narrowing of the bronchi and narrowing of the sphincters of the gastrointestinal tract, and in the genitourinary system these receptors are involved in the reduction of the VAS deferens and bladder neck (Luther et al., 2001).

α 1-adrenoreceptors are associated with many secondary messengers, mainly through Gq/11 proteins, which activate phospholipase C with the formation of inositol triphosphate and diacylglycerol. The latter stimulates protein kinase C, and inositol triphosphate releases accumulated calcium from the endoplasmic reticulum (Metz et al., 1996).

In the heart of rats of different ages, stimulation of α 1-AR with phenylephrine causes a short-term decrease in heart rate, bradycardia is especially pronounced in 20 and 6 week old rats. This effect is not removed with the blockade of Ca²⁺-L-type channels. However, in 3- and 1-week-old rat pups, the negative chronotropic phenylephrine reaction was abolished by blocking I_f currents (Minneman, 1988; Nigmatullina et al., 1999). In *in vivo* experiments, prazosin reduced heart rate in 3 and 10 week old rats by 17 and 10%, respectively (Nozdrachev et al., 2016). In rats after beta-adrenoreceptor blockade, the effect of adrenaline on stroke volume of blood tends to decrease. These changes may be associated with compensatory activation of alpha1-adrenergic receptors, which enhances the weak effects of adrenaline and inhibits strong effects (Wang et al., 2009). The blockade of α 1-AR by prazosin leads to a reduction in the heart rate of rats older than 3 weeks of age, and does not affect the heart rate of newborn rats. The authors note that the physiological functions of α 1-AR can significantly differ with the development of cardiac

regulation mechanisms (Zefirov et al., 2016). Stimulation of α 1-adrenoreceptors with methoxamine causes short-term *in vivo* rat heart bradycardia (Zefirov et al., 2011). However, selective stimulation of α 1A-AR agonist A-61603 leads to a decrease in heart rate *in vivo*, but does not have a chronotropic effect on the isolated heart of rats (Ziyatdinova et al., 2013).

The physiological effects of the activation of α 1-AR on chronotropy and coronary circulation of the heart of mammals have been little studied. The age aspect of this problem is also practically unexplored. In this regard, the aim of this study was to study the effect of stimulation of alpha1-adrenoreceptors on chronotropy and coronary flow of an isolated heart of rats of different ages.

METHODS

White outbred rats of 1-, 3-, 6-, 20-week-old were used in the work. For anesthesia of animals, a 25% solution of urethane in a dose of 800 mg / kg of rat mass was used.

The study was carried out according to the method described in previous studies (Zefirov et al., 2011; Ziyatdinova et al., 2013). We studied the effect of stimulation of α 1-adrenoreceptors on the frequency of contractions (heart rate) and coronary flow (CP) of an isolated heart. To activate α 1-AR, a non-selective agonist, methoxamine hydrochloride (Sigma), was used at a concentration of 10⁻⁸ mol. Statistical analysis of the significance of differences was performed using Student's t-test.

RESULTS AND DISCUSSION

Alpha stimulation effects α 1-adrenoreceptors on the frequency of contraction of the isolated heart of rats of different ages.

Methoxamine at a concentration of 10⁻⁸ M led to a decrease in the frequency of contractions of the isolated heart of 20-week-old rats from 169.3 ± 29.7 beats / min to 126.4 ± 21.9 beats / min (p < 0.05), bradycardia was 25% (Fig. 1).

The chronotropic reaction of the isolated heart of 6-week-old rats in response to the action of methoxamine was also negative, heart rate within 12 minutes decreased from 269.5 ± 12 beats / min to 214.7 ± 22 beats / min (p < 0.05), the effect was 20%.

The heart rate of 3-week-old rats after methoxamine infusion at a concentration of 10⁻⁸ M (n = 6) decreased from 198.2 ± 15 beats / min to 160.8 ± 17 beats

/ min ($p < 0.01$). The maximum chronotropic effect upon stimulation of alpha1-adrenoreceptors was 19% and was recorded at 12 minutes after introduction of the agonist.

The isolated heart of 1-week-old rat pups did not produce a chronotropic reaction in response to the action of methoxamine at a concentration of 10^{-8} M ($n = 6$). Over 12 minutes, heart rate ranged from 148.2 ± 8.2 beats / min to 151 ± 11.2 beats / min (Fig. 1).

Alpha stimulation effects1-adrenoreceptors on the frequency of contraction of the isolated heart of rats of different ages.

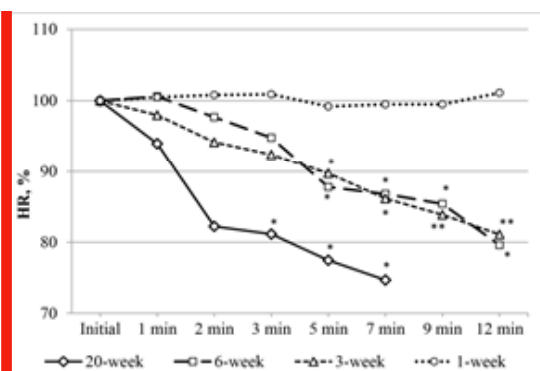


Fig. 1: The effect of methoxamine on the frequency of contraction of the isolated heart of rats of different ages. The ordinate axis is the heart rate (HR, in%), the abscissa axis is time (minute). Note: the validity of the changes compared to the original values.

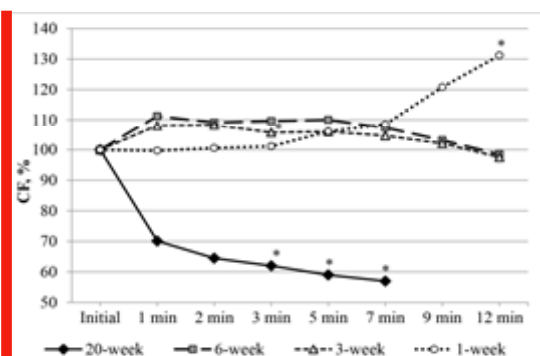


Fig. 2: The effect of methoxamine on the frequency of contraction of the isolated heart of rats of different ages. The ordinate axis is the coronary flow (CF, in%), the abscissa axis is time (minute). Note: the validity of the changes compared to the original values.

The coronary flow of an isolated heart of rats of 20 weeks of age after methoxamine infusion (10^{-8} mol) decreased from 6.3 ± 0.97 ml / min to 3.57 ± 0.3 ml / min ($p < 0.05$), the change was 43% (Fig. 2).

After methoxamine infusion, the coronary flow of the isolated heart of 6-week-old rats tended to increase. The coronary flow rate within 1 minute after introduction of the agonist changed from 5.3 ± 0.3 ml / min to 5.9 ± 0.5 ml / min, however, the change in the index was restored by the end of the experiment.

The coronary heart flow of 3-week-old rat pups in response to the action of methoxamine changed from 2.5 ± 0.09 ml / min to 2.6 ± 0.12 ml / min ($p < 0.05$) (Fig. 2), then inverse dynamics of the indicator was observed. At 12 minutes of the study, the coronary flow rate was 2.4 ± 0.17 ml / min.

Stimulation of alpha1-AP of the isolated heart of 1-week-old rat pups caused a relatively slow coronary flow response. By the 3rd minute, the indicator values changed from 0.88 ± 0.08 ml / min to 0.89 ± 0.075 ml / min. 3 minutes after the addition of methoxamine, there was a tendency to increase the rate of coronary flow. By the 7th minute, the coronary flow changed to 0.95 ± 0.06 ml / min. At the 12th minute of methoxamine action, the maximum increase in the coronary flow rate was observed to 1.15 ± 0.1 ml / min ($p < 0.05$), the growth rate was 31% (Fig. 2).

SUMMARY

Stimulation of alpha1-adrenoreceptors with methoxamine at a concentration of 10^{-8} mol causes bradycardia of an isolated heart in rats starting from the 3rd week of postnatal ontogenesis. Methoxamine at a concentration of 10^{-8} mol does not affect the heart rate of the isolated heart of newborn rats. Stimulation of alpha1-adrenoreceptors causes a decrease in the coronary flow of the heart in adult rats, and its increase in 1, 3-week-old rats.

CONCLUSION

Thus, non-selective stimulation of α_1 -AR of the isolated heart of rats of different ages exerted multidirectional effects on the indices studied by us. Stimulation of alpha1-adrenergic receptors with methoxamine led to bradycardia of an isolated heart in rats of 20, 6, and 3 weeks of age and practically did not change the chronotropy of the heart of 1-week-old rats. In this case, the opposite dynamics of the coronary flow of an isolated heart was observed in adult and newborn rats. In response to the introduction of methoxamine coronary flow of the hearts of 20-week rats decreased, and 1-week-old rats were significantly

increased. In 3-week-old rat pups, only a slight increase in coronary flow was observed, and in 6-week-old animals, this indicator had only a tendency to increase. In addition, differences in the temporal dynamics of the coronary flow after introduction of methoxamine were observed. The coronary flow in rats of 20, 6, and 3 weeks of age changed immediately after the introduction of the agonist, in 1-week-old rat pups, a change in this indicator began only after the 3rd minute of methoxamine addition.

This study showed that the negative effect of stimulation of alpha1-AP on rat heart chronotropy is age-related. These data are consistent with our previous results (Minneman, 1988; Ziyatdinova et al., 2013). The absence of a chronotropic reaction in newborn rat pups may be due to the lack of formed adrenergic innervation of the heart at a given age, which affects the density and maturity of the studied receptors. Moreover, an increase in the rate of coronary perfusion in newborn rat pups, in response to stimulation of alpha1-adrenoreceptors, indicates a decrease in the tone of the coronary vessels of an isolated heart. This phenomenon may have a compensatory character, due to which an increase in coronary blood circulation of the heart in rats at this stage of postnatal development can be caused.

Our results confirm the idea of other researchers that in ontogenesis appears alpha1-mediated inhibition of the activity of the heart of mammals. The features and mechanisms of these phenomena may be the subject of further research.

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Ecological Mapping of the Territory on the Basis of Integrated Monitoring

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ABSTRACT

Process and pollution level by radionuclides of lands adjacent to the territory of Semipalatinsk Nuclear Test Site (SNTS) are considered in the article. Data of space monitoring of the territory and experience use of integrated technology was analyzed. This technology is the result of the integration of the geographic information system (GIS) and space monitoring. Complex monitoring results (geodetic and radio ecological) in SNTS territory aimed at creation of common information space and prevention of the secondary emission of radioactive substances are given. Primary analysis of geodetic monitoring results using «Balapan» «Telkem» where surface subsidence measured up 5-6 mm were analyzed. Based on complex monitoring dynamic maps of the temperature and ecological characteristics of the test site territory were obtained. Attained results are used for additional assessment of pollution consequences of SNTS and recommendation development on the use of lands in the context of radiation safety.

KEY WORDS: Underground Nuclear Explosion, Geographic Information Systems, Space Monitoring, Geodetic Monitoring, Radio Ecological Monitoring, Analysis of the Results, Temperature Anomaly, Deformation of Daylight Surface, Radioactive Contamination Maps.

INTRODUCTION

At the present stage of the development of society, the geo-ecological problems in terms of urgency of their solution are on par

with social and economic problems; therefore their study cannot be carried out without a holistic study of the whole complex of socio-ecological-economic factors that form the living environment of human society in a certain territory (Grummo, Zelenkovich, Zhilinskiy, Iluchik & Voznyachuk, 2012). At the same time, a clearly defined spatial aspect of geo-ecological problems determines the crucial role of cartographic materials, especially complex geo-ecological maps, which are research tools that allow all the main characteristics available to evaluate the geo-ecological state of the territory.

Geo-ecological mapping will allow not only to conduct a regular survey of the territory based on the analysis of the obtained data, but also to identify changes in the state of geo-ecological systems in a timely manner, to simulate their condition and justify measures to restore disturbed areas, as well as to correct the decisions taken on the special engineering protection of production facilities and the environment in areas of possible critical situations

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(Nikiforova, 2010). At the same time, the lack of a general concept of cartographic support for the development of territories and methodological developments in cartography for territorial entities, in particular for developing countries, makes solving the problem of cartographic support as one of the most important tasks (Selestin, 2010).

The deterioration of the environment state and ensuring environmental safety require the creation of a visual image of a new environmental reality. This task is most consistent with the cartographic form, which adequately reflects the ecological situation. Environmental maps have a special role in the implementation of environmental control, monitoring, environmental protection measures, and economic management (Leshanin & Brehova, 2016).

The cartographic mapping of the anthropogenic human influence on the environment is a difficult task for many reasons:

- versatility and high dynamic changes;
- insufficient knowledge of the response of the natural environment, both to individual types of impact, and to their combinations;
- weak elaboration of classifications and systematics of anthropogenically and technologically changed environments;
- frequent absence of obvious signs and limits of manifestation of certain environmental change.

The complexity of integrated environmental mapping is due all, a multiplicity of characteristics that need to be considered. In this regard, integrated environmental mapping is not comparable with any particular thematic area (geological, soil, socio-economic and other mapping), but with thematic mapping as a whole (Hohlova, Osadchaya & Ovcharuk, 2013).

The complexity of environmental mapping involves the simultaneous display:

- geographical environment (landscapes) in which the interaction takes

place and development of ecological relations between natural and socio-economic systems;

- anthropogenic and technogenic impacts and environmental response on them;
- assessments of the effects of exposure (i.e. the ecological status of the natural environment).

In this case, the object of mapping can be both current and retrospective or predicted state of the environment.

Practically, the task of integrated environmental mapping is solved by creating a set of interrelated maps of environmental content or by drawing up individual integrated maps, the content of which includes all of the listed elements (albeit in minimal amounts). When compiling a set, the predominant part of the maps describes the state of the individual components of the environment (Makarov, Novakovskiy & Chumachenko, 2002).

Mapping is almost always based on the results of comprehensive studies (often carried out specifically) and allows a deep and comprehensive characterization of the ecological situation in the territory. At the same time, conclusions from a comprehensive description, including comparative assessments and usually causing the greatest public and practical interest, should be presented on a separate synthesis map. Therefore, the features of integrated environmental mapping are most fully revealed in the creation of integrated environmental maps (Leshanin & Brehova, 2016).

There are 7 positions that should be taken into account when designing and reflected in the mapping of environmental topics:

- Natural resource potential of the mapped territory, types and the intensity of its modern use;
- the overall level of the ecological status of natural complexes and the associated morbidity of the population;
- placement on the territory of objects of economic and other activities that affect the natural environment;
- assessment of damage to the natural environment and the health of the population caused by various types of economic activity;
- factors limiting the further development of specific types of economic activities determined by existing standards on indicators of the quality of the natural environment and public health;
- environmental and economic priorities that determine further socio-economic development of the region;
- a system of recommendations aimed at stabilizing and improving the environmental situation in the locations of objects of economic and other activities.

Currently, there are 3 types of integrated environmental maps:

- inventory;



Fig. 1: SNTS location

- inventory assessment;
- comprehensive assessment.

Elements of the natural environment are shown on the inventory maps (natural areas, landscape areas, landscapes) and the nature of their use (agriculture and forestry, etc.), as well as sources and (not always) the amount of anthropogenic impact on them - human settlements, transport communications, industrial and agricultural enterprises (Lopandya & Nemtinov, 2007; Lurye, 2008).

The main meaning of maps of this type in showing the subjects of evaluation, elements objects, which are sources of environmental hazards and environmental violations. The map shows the location of hazardous objects and other objects that are of interest from the point of view of the formation of environmental situations. The availability of such information will allow assessing the overall situation, to present the possible development of events. Maps of this type do not yet give an opportunity to assess the situation (Telegina & Yannikov, 2013).

On integrated assessment maps, the main element of the content is the assessment of the environmental situation, which characterizes the state of both individual components and the natural environment as a whole. The ecological situation is understood as a combination of various, including positive and negative, from the point of view of living and state of human health, conditions and factors that create a certain ecological situation in the territory, varying degrees of well-being or distress (Hohlava, Osadchaya & Ovcharuk, 2013; Veselova & Shmarova, 2010).

Based on the foregoing, at the moment there are four directions integrated environmental mapping:

The first direction is the creation of maps showing the division of territory into landscapes, an assessment of the degree of auspiciousness of living conditions of the population and disturbed landscapes. The main object of study is the natural territorial complex (NTC), the rank and size of which is determined by the scale of the study. Separately on the map mark the centers and centers of environmental pollution, the volume and nature of harmful emissions. Such a direction of ecological mapping can be called landscape-ecological.

The second direction of integrated environmental mapping has received the name of the administrative and environmental. The object of environmental assessment in this case is administrative territorial units or their combination. Administrative environmental mapping is widely used in assessing the spatial differences in the environmental situation at the federal and regional levels. The advantage of this approach is the reliance on sufficiently extensive environmental information and statistical data. Disadvantages are revealed by a simple comparison of the sizes of territorial

operational units (mapping objects) of the same rank (Baimbetov, 1999).

For the third direction of ecological mapping, almost complete refusal to draw up integrated maps and display the most complete information about the territory (natural landscape differentiation, anthropogenic load, negative changes in habitat, etc.) on one final map. With such approach, it is not necessary to talk about the main object of mapping, since the objects of topographic base, natural landscape areas, and areas of pollution of the territory are simultaneously displayed on one map. This direction can be called information and environmental mapping.

Fourth, problem-ecological direction is associated with the development of maps environmental situations created since the late 80s of XX century for the territories of the former USSR, Russia and its individual regions, CIS countries and the world.

The basis of these maps is the division of the territory into natural and natural anthropogenic habitats (geo-systems), which are assessed according to the nature and extent of changes in the ecologically significant natural properties of landscapes that are important to humans and their economic activities.

The specific content of the ecological map is the display of areas environmental situations of varying degrees of severity with a set of environmental problems of different significance or a single problem. When economic impact on nature occurs, as a rule, a number of negative environmental changes in the components of nature (pollution, degradation, violation, etc.), which interact with each other, form an ecological situation.

Thus, the mapping of environmental situations provides for a number of strictly sequential actions and the creation of a multi-layered system of maps, providing a focused characterization of the state of nature, population and economy (Sturman, 2000; Aleksandr Minkov, 2012).

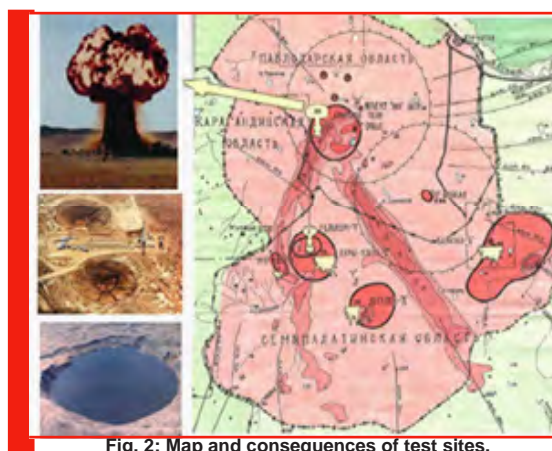
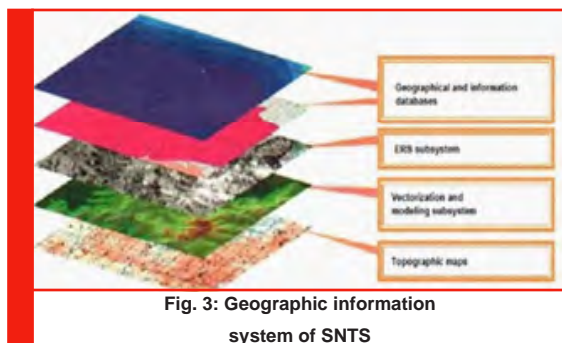


Fig. 2: Map and consequences of test sites.



Ecological systems of Kazakhstan are characterized by low resistance to human intervention. About 75% of its territory (territory of the Aral sea and SNTS , the coast of the Caspian Sea, desert and semi desert pastures of Central and Southern Kazakhstan, etc.) are subject to an increased risk of environmental disruption. SNTS was one of the main test sites used for nuclear weapons tests for 40 years (Fig.1) (Proceedings from International Scientific Conference: Semipalatinsk nuclear test site. Radiation heritage, and development prospects. 2012; Sultangazin, 2002).

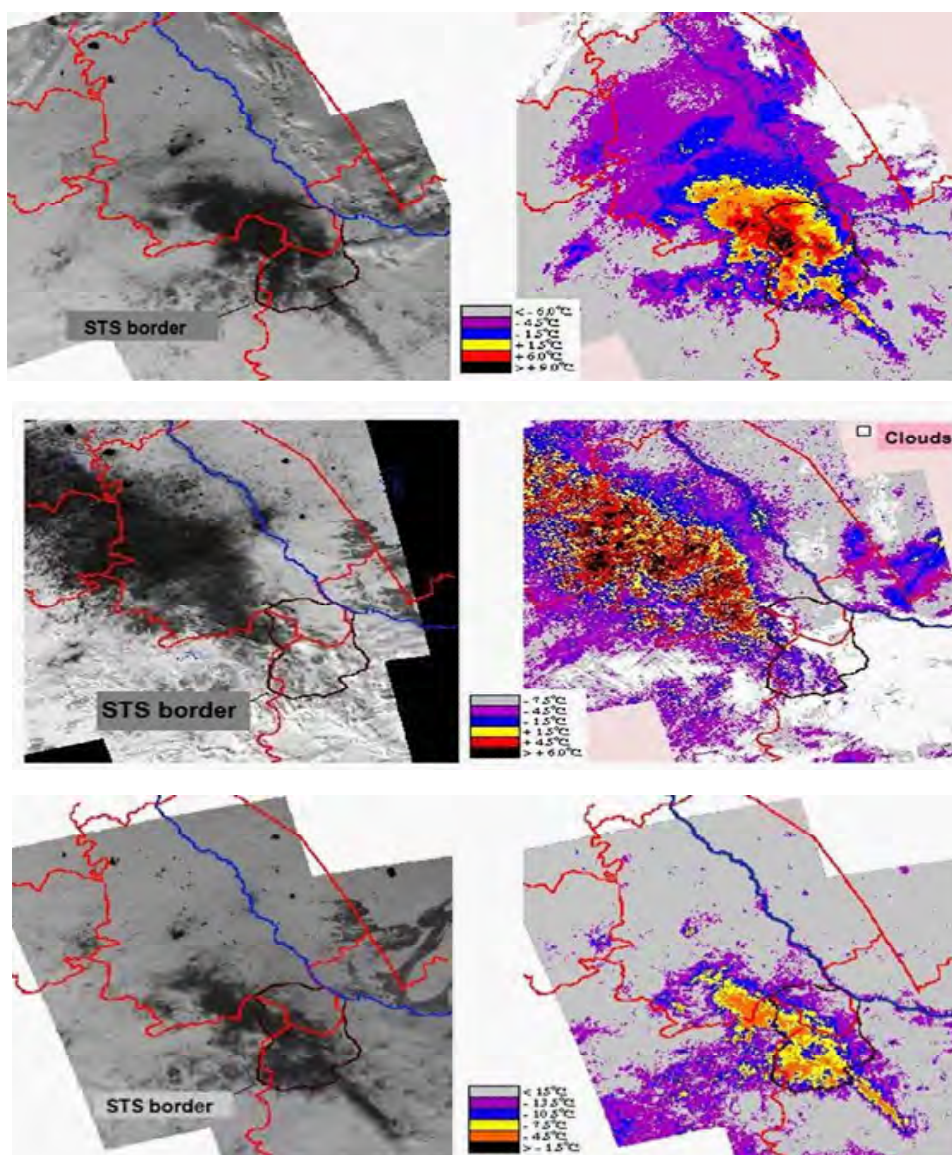


Fig. 4: State of the snow cover and infrared (IR) range temperature field of SNTS area according to the data of the US satellite NOAA in different years: a) 17.02.1997; b) 12.03.1999; c) 03.07.2000

By the decree of the President of the Republic of Kazakhstan N.A. Nazrbayev test site was closed on August 29, 1991 leaving the contaminated zones on the testing territory and in nearby regions. This circumstance caused intensive researches of the nature and pollution level of test site territory with aim of determination of the consequences of nuclear explosions and monitoring of radiation-hazardous objects.

For the timely indication of further changes, assessment of the tempos and areas' degradation of the natural environment, prevention of negative processes and situation control, operational control of the state of these regions is necessary.

In view of large area of Kazakhstan, hardness of many areas and limited funding in modern conditions such control can be effectively organized only based on multi-method research (satellite monitoring and ground investigations).

The government, as a body of general competence, develops the state environmental policy, establishing its main directions, state environmental programs aimed at ensuring environmental protection and environmental management. In the event of a negative environmental situation on the territory of Kazakhstan, the Government declares this region a zone of emergency environmental situation, and after eliminating the consequences, decides on the removal of this status.

The state takes certain steps in the field of environmental protection. To this end, it has given local representative and executive bodies sufficiently broad powers. They in the respective territories approve and implement environmental programs, manage natural resources, prohibit or allow the construction of enterprises and facilities, and so on. And this is fully justified, since it is the local authorities that know

the entire ecological situation and have detailed information.

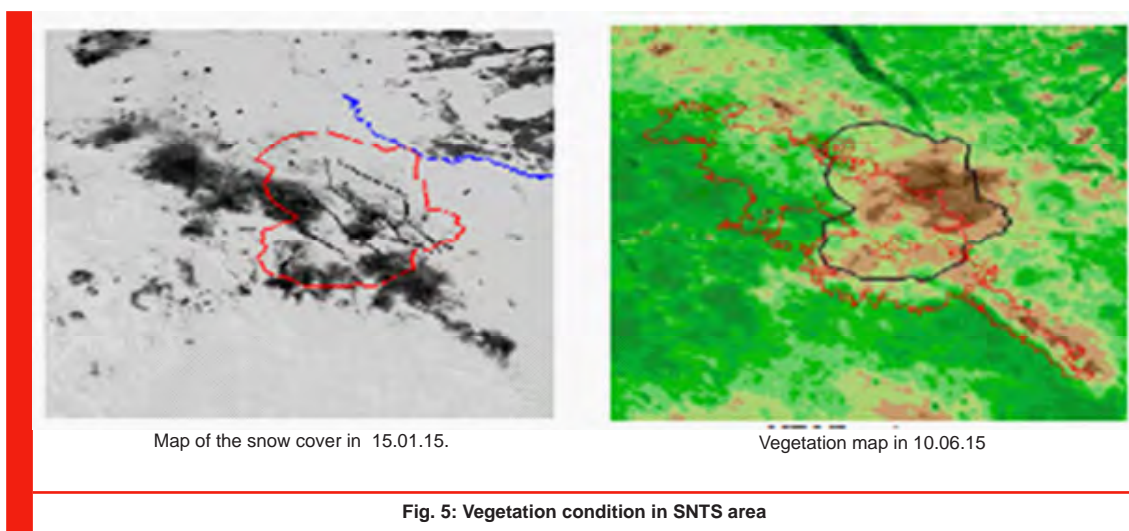
The local authorities in various ways and methods help public associations, whose role in the field of environmental protection is invaluable. Public associations, in turn, control the activities of state bodies, if necessary; apply to judicial bodies, whose activities represent a promising area of control activities in the field of environmental protection.

However, to date there have been no significant changes in the direction of improving the environmental situation. Therefore, in modern conditions, there is a growing need for a new legal mechanism that should ensure environmental safety, protect the rights and legitimate interests of citizens from industrial pollution, accidents or disasters.

Ecological zoning is one of the modern and effective legal measures to ensure environmental management and protection of the environment. It is not carried out by the Government, or local authorities, or public associations, although the latter are not prohibited from participating and helping in the process of environmental zoning.

Ecological zoning of the territory of the country is necessary for the practical activities of government bodies in solving environmental problems. The criteria for assessing the environmental situation lose their meaning if they are used in relation to the undifferentiated space of the country (Kuderin, 2014).

The process of environmental zoning in the Republic of Kazakhstan is a function of special state bodies in the field of environmental protection, which is one of the constituent parts of the general system of state policy in the field of state security and national



priorities in ecology.

It is necessary to set before the state the task of conducting ecological zoning and improvement of legislation in this area. To solve it you need:

- definition of the concept of "ecological district" and "ecological zoning";
- determining the role and effectiveness of environmental zoning in the implementation of environmental policy and ensuring the environmental safety of Kazakhstan;
- scientific support, which is one of the important elements of increasing the efficiency of the state for the sustainable environmental development of the country;
- creating an effective regulatory framework. The results of scientific research could be used in the development of new and with the addition of existing laws and regulations;
- definition of legal principles, their relationship with other environmental principles;
- identification of the most effective legal methods, methods and means of regulating environmental zoning;
- creation of an appropriate system of government bodies;
- analyze international treaties and conventions on environmental zoning;
- financial support for the formation of environmental areas.

Summarizing the above, we can say that at the present time there is a need to carry out environmental zoning of Kazakhstan. But this task was not assigned to local authorities and public associations. At the same time, the practice of recent years has shown the inexpediency and ineffectiveness of the implementation of certain functions by local state administration, which requires revising and reassigning some of them to the central level of state administration (Agleshov, 2004).

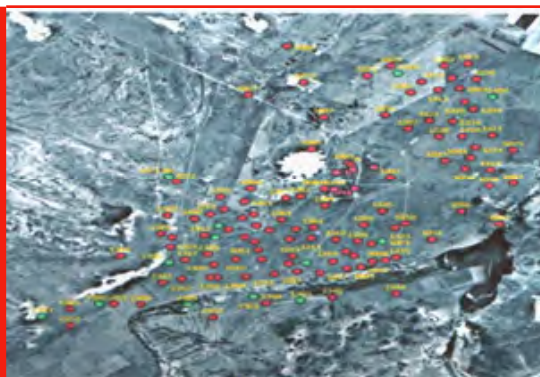


Fig. 6: Scheme of closed tunnel on the test site

MATERIAL AND METHODS

SNTS is located at the intersection of three regions of Kazakhstan: Pavlodar, Karaganda and East Kazakhstan and covers 18 thousand square kilometers. During the operation of the SNTS (1949-1989), 456 nuclear tests were conducted on its territory, including 86 - air test sites, 340 - underground and 30 - contact tests. Here, the first in the USSR nuclear (1949) and the world's first hydrogen (1953) bombs were tested.

As the result of the nuclear explosion in 1965, more than 10 million tons of ground was thrown to a kilometer height and funnel with a diameter of 430 meters and depth of 100 meters was formed, this funnel called «Atomic lake». As the result of the tests, radioactive decay residues – radionuclides covered SNTS territory (Fig.2) (Bekbassarov & Nurpeisova, 2017).

A lot of scientific researchers had been devoted to the research of the territory of the former SNTS. However, these researches were not put on common information basis, which would allow moving from scientific researches to solving practical problems.

In this case, creation of GIS is the most effective way, which allows to not only preserve the available data and provide easy access to it, but also to carry out simulation, the results of which can be combined with geographical and space images of the region under study. All the components of GIS and SNTS presented in Fig. 3 are interrelated (Nurpeisova & Kirgizbaeva, 2011).

Geographic information system of SNTS include:

- Geographic and information data base;
- Subsystem of remote sensing;
- Subsystem of modeling;
- Subsystem of visualizing results.

The main tool that combines subsystems into integrated GIS is the ArcInfo package. It is one of the most powerful tools for creating geographic information systems.

Cartographic data «poured» into the subsystem of remote sensing, i.e. participate in the process of geo-referencing space images. In turn, space images are source of information for geographic information database. Geographical data and remote sensing data are inputs to the subsystem «Modeling».

During the space images processing, number of interesting results including the detection of temperature anomalies in SNTS area were obtained, which had large resonance both inside the country and abroad.

Methods for reconstructing the surface temperature from Earth remote sensing (ERS) data are based on the separation of the

part corresponding to the radiation surface (taking into account the absorption and radiation of the atmosphere) (Sultangazin & Zakarin, 2000; McClain, Pichel & Walton, 1985; Sultagazin, Zakarin, Spivak, Arkhipkin, Muratova & Terekhov, 1998). After this, surface temperature using the known dependence (model) on the brightness of radiation is determined.

These modules were approved fully for homogeneous surfaces, in particular surfaces of the sea and oceans, for which there are reliable methods of temperature recovery.

Task of the temperature recovery of the land surface is more complex, as additional difficulties are emerged associated with surface relief. This complicates the use of simple models to determine the relationship between brightness and physical temperature. It is possible to recovery temperature of the earth's surface truly only for homogeneous areas: steppe, desert, snow cover, etc. Territory of Kazakhstan is satisfied this condition. Such cases, temperature recovery algorithms usually are used developed for the temperature recovery of surface of seas. In this field, algorithm developed by McClain (McClain, Pichel & Walton, 1985) was found an extensive application according to which the temperature of the underlying surface of the land is determined by the formula:

$$T = -283.934 + 4.081 * T4 - 3.046 * T5. (1)$$

To process the obtained temperature fields in the GIS environment, they must be resulted in the cartographic form and combined with topographic base of the studied territory. The corresponding technology was tested in dynamics mapping of the temperature characteristics of the underlying surface in SNTS area.

From 1998 to 2008 SNTS territory was studied by various earth satellites rockets (ERS), but in those years ERS were not available. At present, during the processing of space images, including the detection of temperature anomalies in SNTS area, number of interesting results had been obtained. Snowless areas during winter period (Fig. 4) and areas without vegetation in the summer were identified

According to IR range data several focuses on the constructed thermal field are allocated, where temperature more than 10 ° C exceeded the general background of the surrounding snow cover (Fig. 4, a). In the middle of March 1999, a snowless spot was appeared and it covered a vast territory of the test site (Fig. 4, b). On the temperature maps within the spot, the areas of high temperature (to 8-9 ° C) are clearly distinguished (Nurpeisova, 2012a). The mapping results of the temperature fields from data surveys of 2000 year confirmed the presence of temperature anomalies in this region (Fig. 4, c).

It is also necessary to note the similarity of the configuration of the snowless zones in winter with the areas without vegetation in summer (Fig. 5).

The analysis of remote sensing data indicates the presence of a stable connection in the location of snowless areas and summer drought focuses in SNTS area, they are confined to test sites. The foregoing facts could have been caused by an accidental combination of weather conditions or local terrain features (relief, hydrothermal regime, etc.) that contribute to the denudation of the snow cover and, as a result, more intensive heating of bare areas of the earth by the sun's rays.

On the other hand, temperature increase could be consequence of the activation of tectonic processes caused by numerous nuclear explosions. The fact is that several deep faults pass through the territory of the test site. It is well known that, as the result of underground explosions cardinal changes are occurred in the state of geological environment and hydro geological conditions (Nurpeisova, 2012a).

Although the explosive hills are closed, the natural environment of SNTS territory is covered by waste of radioactive decay - radionuclides. The energy of underground explosions in the form of seismic vibrations is caused destruction in the thickness of the enclosing rocks. The radius of the impact zone can reach several kilometers. The force of seismic action in underground nuclear explosions depends on the power of the charge and geological conditions (tectonic faults, fracture of rocks, etc.) of the test site.

The Nevada polygon is dominated by porous tufts that can significantly absorb the seismic energy of blast waves. At the same distance from the explosion of the same power at the Nevada test site, the intensity of

Despite more than 20 years have passed since the last tests in SNTS were carried out, the region is still an ecologically dangerous zone. Fig. 6 shows the plan of closed wells only at «Balapan» test site.

seismic vibrations is 3-4 times lower than in Semipalatinsk.

The sites of the Semipalatinsk test site are robust rocks of granite origin. Granites have low absorption properties of elastic seismic vibrations. Therefore, underground explosions are accompanied by significant tremors (Nurpeisova, 2013b).

Totally 343 underground explosions were conducted, each of them lead to earth movement. Rock destructions during nuclear

underground explosions as formation of new open fissures and ancient tectonic structure are taken place, which caused depression of earth surface.

Fig.7 shows structure section of one of the fields of the underground tunnel, where the nuclear object is located in the last box.

Researches of hydro - geologists have shown that nuclear tests have a destructive effect on groundwater. In fissure waters content of uranium, strontium, and cesium is ten times higher than the maximum permissible concentration.

At present, the coal deposit Karazhyra is being developed, salt is extracted from Zhaksytuz lake, geological survey is carrying out, cattle is pastured, hay is prepared on the territory of the test site.

Such activities, firstly, contributes to the transfer of radioactive contamination inside the test site and beyond it; secondly, it is connected with the additional risk of workers, for the population of the region as a whole and for consumers of products.

Exploitation of the mineral deposit, carried out without notice the radioactive situation, hydro geological maps of radioactive contamination can lead to loss of the deposit - for hundreds and even thousands of years, the territory, soils and minerals

themselves may be contaminated.

Therefore, it is vitally important to conduct comprehensive researches in SNTS territory. The object of the research is the natural environment: soil and vegetation cover, water and air mediums, fauna. Radio-ecological monitoring is also integrated within GIS; where it is possible to integrate terrestrial geodetic methods with space ones. It increases the reliability and accuracy of measurements and monitoring. GIS-based space monitoring is the most comprehensive monitoring, since it performs all monitoring functions: observation, analysis, forecasting and control.

RESULTS AND DISCUSSION

The results of radio ecological researches conducted in SNTS territory from 2011 to 2017 have revealed areas of significant radioactive contamination with nuclear materials (Fig. 8). Main part of the radionuclides formed during the explosions fell directly the test sites («Experimental field», «Balapan», «Degelen», «Sary-Uzen»). Underground nuclear explosions (UNE) in the Balapan area were conducted in 105 « combat » wells. At many sites, underground nuclear tests led to deformation of the day surface in epicentral zones. It proves that afterward previously conducted underground nuclear explosions, over focus cavities different geodynamic processes are occurred after several decades.

To identify technogenic objects on the territory of «Balapan» space images were studied, which allowed identifying a number of objects, including large epicenters. Then field visits were conducted to inventory technogenic objects and assess the degree of technogenic disruption of the natural landscape.

Since 2005 on the territory of the test sites of «Balapan» and «Sary-Uzen», complex monitoring of the so-called «combat» wells had begun. As a result, the nature of the change in the daytime surface uplift and subsidence was established, which may indicate various processes that occur over focal cavities of UNE. This can lead to dangerous phenomena both in and out of objects, and at a distance from them.

Seven wells at «Balapan» site (wells № 1414, 1207, 1066, 1203, 1226, 1235 and Glubokaya) and two wells at the Sary-Uzen site (№ 101 and №104) were selected to control these phenomena, changes in the daylight surface were revealed on these wells by results of geodetic monitoring (Ustavich & Yakovenko, 2013).

To determine the location of points in the geographical coordinate system global positioning device Garmin Rino 520 was used, which allows determining the position of points with an accuracy of ± 5 m. A survey network was preliminarily calculated. The coordinates of the survey network points were recorded in the GPS receiver and were determined on-site in the navigation mode (GPS receiver

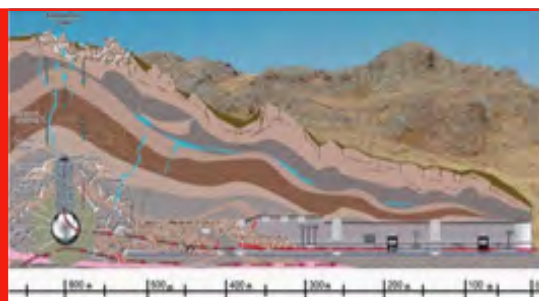


Fig. 7: Location of the nuclear object in the test site

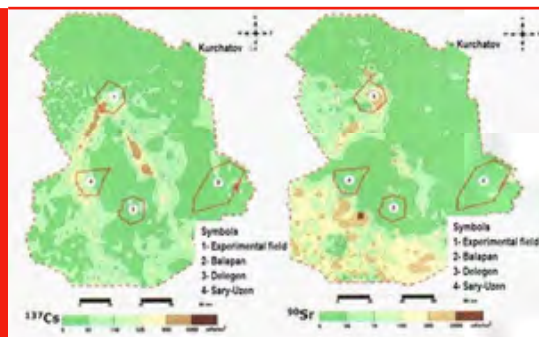


Fig. 8: Site pollution map

Garmin rino 520. Manual).

Observation of daylight surface changes was conducted by II class geometric leveling instrument. For this purpose, the project of the observational network was developed (Fig. 3). This scheme was used for all sites.

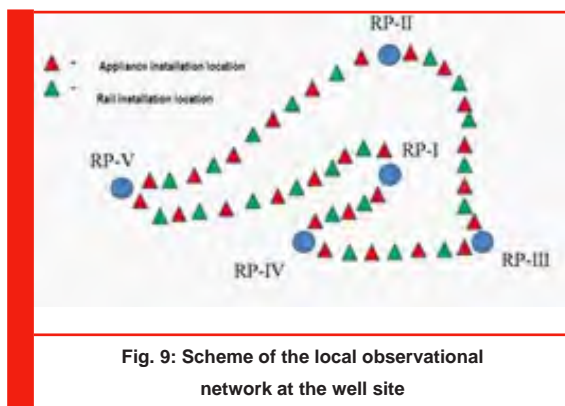
Geodetic monitoring on the site is carried out by II class leveling instrument on the local observational network, which consists of 5 ground-level benchmarks. The total length course of II class leveling is 695 m., maximum distance between the rapiers did not exceed 242 m., minimum distance was 61 m.

On the leveling line, wooden markers were mounted for installing leveling instrument over them (painted green) and installing racks (painted in red). In Fig. 9 shows the scheme of the local observational network at well site № 104.

Leveling instrument distance to rods was measured by digital leveling and did not exceed 30 m, the inequality of distances from leveling instrument to rods at the station did not exceed 1 m, and accumulation of inequalities in the section did not exceed 2 m. The height of the sighting beam did not exceed 0.5 m.

During II class leveling the digital leveling instrument SOKKIA SDL 30 (Japan) was used, leveling process was carried out using bar-code rods with RAB code. Leveling process was carried out in closed loop in the forward and backward directions along the stakes. Measurements were carried out in the spring and autumn periods of the year, according to the requirements (Nurpeisova, Umirbekova & Bekbassarov, 2018c).

According to the data from 2011 to 2016 we can say about the preserved trend of positive change in the altitude position on the monument I, during this period, upwell occurred to +21.9 mm., rest of the benchmarks showed minimal changes in the altitude position: at the benchmark II +2.2 mm., benchmark III +0.6 mm., benchmark IV - 0.0 mm.



Comparing the data of 2016 and 2011, we can speak of daylight surface swelling the in SNTS epicenter, at the benchmark I (bottom of the funnel) its value was +23.9 mm., at the benchmark II - slight sagging of -3.2 mm, at the benchmark III altitude did not change , and at the benchmark IV minimum change in altitude position - 0.8 mm.

Thus, we can speak about heterogeneity and inconstancy of dynamical changes in altitude position of observable monument, which may be caused by insufficient data. It is necessary to continue observations on the local monitoring network to obtain more data and to establish the causes of the ongoing processes (Yakovenko & Ustavich, 2015).

Two underground nuclear tests were conducted in the south-eastern part of the Semipalatinsk test site with subsoil release: single explosion «Telkem-1» (21.10.1968) and group (of three linearly disposed charges) – «Telkem-2» (12.11.1968). The funnel formed by the group explosion filled with water (Fig. 10, a and b). Atomic lake was formed as a result of an excavation thermonuclear explosion with a capacity of 140 kilotons. After the explosion, a funnel with a diameter of 400 m. and depth of more than 100 m appeared. Radiation contamination of the earth around this lake amounted to about 3-4 km. There is the nuclear SNTS legacy.

During performing ground-based field observations it is necessary to take into account the radioactive contamination at the site, which arose due to UNE. To do this, performers must have access to geodetic work in the zone of increased radiation pollution in accordance with the requirements of regulatory documents, and also the methodology for performing measurements should ensure minimum time for staying of performers in a radiation-contaminated site.

To determine the radiation situation and to inventor radiation-hazardous objects at the technical site -1, gamma survey was performed using Radiagem 2000 dosimeter radiometer (Operating Instructions for the Radiagem 2000 Radiometer.)

Based on the survey results, map of EDR pattern was constructed at this technical site -1 Balapan (Fig. 11, a).

The funnel of radiation-hazardous object (RHO) of site-1 has small dimensions, no visible ridges of funnel (pile), there is an outlet to the groundwater surface in the center of the funnel.

Contamination area with EDR level is 0.24 mSv/h more, where the population staying must

be limited. For more visual representation of EDR pattern a three-dimensional map-scheme of pattern of pollution is constructed on

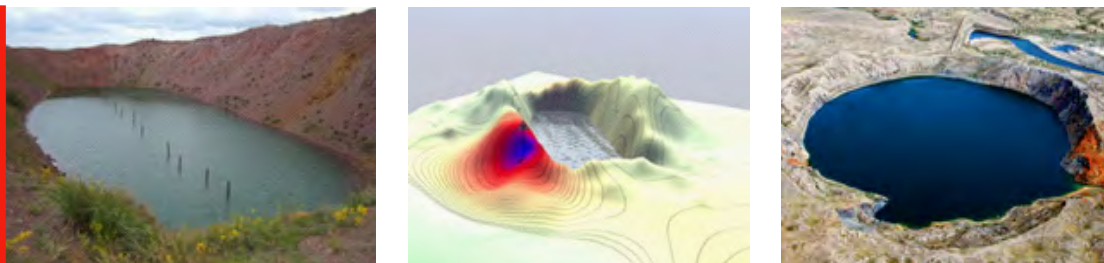


Fig. 10. a) Telkem-2 and b): its three-dimensional model with a radioactive contamination site; c) Atomic Lake.

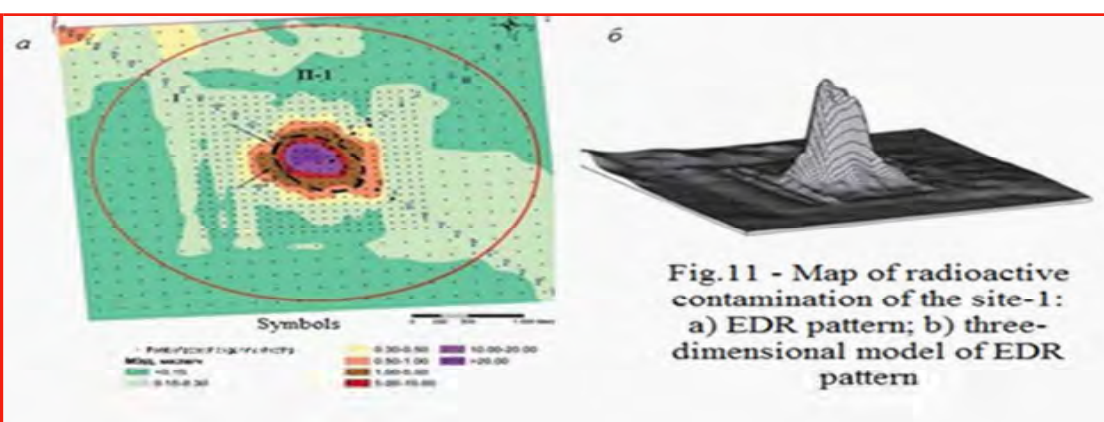


Fig. 11 - Map of radioactive contamination of the site-1: a) EDR pattern; b) three-dimensional model of EDR pattern

Fig. 11: Map of radioactive contamination of the site -1: a)EDR pattern, b) three dimensional model of EDR pattern

the site (Fig. 11, b).

As result of the analysis of conducted studies materials, information on the current state of ecosystem components of «Balapan» site was received. It is established that radioactive contamination with technogenic radionuclides of soil and bottom sediments of the territory is confined to funnels of the «Atomic lake» and «Telkem». The total area of pollution is limited to 10-12 km from funnel crest.

It is determined that the main pollutant of water resources is technogenic radionuclide ^3H , maximum value of which in 2015 was recorded in the flood period at distance of 5 km from «Atomic Lake» amounted to 200 000 Bq/kg. It is necessary to continue monitoring observations; it will allow obtaining more complete picture of the seasonal variations of tritium distribution.

Tritium presence was found in all samples of plants selected on the banks of «Shagan» river and around the funnel of «Atomic Lake». Values of radiation parameters outside the funnel of «Atomic Lake»

are within background values for this area. There is no doubt that the earth interior contains large number of radioactive products, including long-lived ones which were tested in galleries and wells. Such places, which are not subject to development, have to be guarded for a long time, excluding people's access there.

Based on the available data on the radiation situation in the area, the plan of stepped inspection of SNTS until 2021 was developed by the government with aim to solve cardinaly the problems of the former SNTS to the 30th anniversary of the Independence of the Republic of Kazakhstan (Resolution of the Republic of Kazakhstan on the integrated solution of the problems of the Semipalatinsk zone of ecological disaster to 2020 in accordance with the developed plan for the stepped inspection of SNTS until 2021. (2017,September29).

CONCLUSION

Based on the above facts, it can be confidently asserted that the SNTS area is located in the zone of stable climatic anomaly characterized by an earlier snow cover, increased surface temperature in the winter-spring period and reduced volume of

green biomass in the summer. These facts provide sufficient grounds for the conclusion that nuclear explosions are involved in the temperature anomalies in area and emergence of drought focus in this region.

To solve problems aimed at preventing the secondary distribution of radioactive substances, the most acceptable approach is carrying out the complex monitoring (space, geodetic and radio-ecological) of SNTS territory. Main task of integrated monitoring - creation of common information space that can be formed on the basis of modern geo-information technologies.

Application of geographic information systems for the analysis of radio-ecological processes in radioactively contaminated areas at nuclear testing sites will effectively process large amounts of information needed to solve problems associated with the rehabilitation of contaminated areas.

Obtained results allow justifying the recommendations on improving the operation of local networks and creation on their basis of a regional network at whole SNTS. This will allow us to further study the geodynamic processes and build maps of the temporal movements of the earth's crust for the entire SNTS territory. Additional work is required to assess the consequences of radionuclide contamination of SNTS with further development of recommendations on the use of lands in terms of radiation safety

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Basic Operation Principles of Associate Co-Processor Module for Specialized Computer Systems Based on Programmable Logical Integral Schemes

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ABSTRACT

Nowadays, the main field of computer application is the work with large volumes (arrays) of data, where the operations of all sorts of searches and sorting are the most complex ones. Existing computing systems use the address memory architecture. With such an organization, it is necessary to read each memory module address and compare it with the search argument in order to search for data in memory. Thus a lot of computer time is needed to search for the necessary information in memory. This circumstance affects the speed of the computer system as a whole. The paper considers the possibility of an associative coprocessor module implementation for specialized computer systems using a modern element base. The purpose of the article is to develop and to study the module of an associative coprocessor based on FPGA for specialized computing, for example, multiprocessor systems that perform associative functions and data storage functions. The object of this article development and research is an associative coprocessor based on FPGA. To achieve the goals set in the work, the Xilinx Web Pack CAD system was used with the ability to create and simulate the work of the device using a schematic editor and VHDL language, which greatly facilitates the synthesis of projects for the use on a modern element base - FPGA. The result of the research is VHDL codes of the associative coprocessor module and its individual blocks have been developed and debugged. The device functionality and performance was verified by CAD system testing used during the work, and time charts were obtained. The results of the study are the received VHDL codes of the associative coprocessor module, from which the firmware file was synthesized for FPGA configuring.

KEY WORDS: Memory Addressing, Associative Memory, Module, Bus Interface, Computer System, Coprocessor, Hardware Implementation, Memory Cell, Multiple Coincidence Analyzer, Record Cycle, Read Cycle.

INTRODUCTION

Perhaps the most basic area of computing systems (CS) and clusters application today is the work with large amounts of data. The most laborious operations here are all sorts of data searches and sorting. The existing CS use the address memory architecture. This circumstance affects the speed of a CS as a whole. It is much faster to get access to the data by association (content). The essence of addressing principle by content is described in (Kohonen 1982; Ognev & Borisov 2000).

Problem Statement

This article is of a research nature as a whole. Literature sources were analyzed in the course of the subject area study to find poorly worked issues (Kohonen 1982; Tsilker & Orlov 2011; Martyshkin & Yasarevskaya 2015; Martyshkin

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2016; Martyshkin 2016; Salnikov et al. 2016). A number of problem-oriented moments related to the possibility of the associative coprocessor module hardware implementation for fast data retrieval have not been reflected adequately in the publications on this topic, but they have been covered partially and shown in (Martyshkin 2016).

The purpose of the article is to develop and to study the functional organization of the associative coprocessor module based on FPGA for specialized computing, for example, multiprocessor systems. This issue is a topical

today due to global informatization and almost universal operation of huge amounts of data. In order to achieve this goal, the tasks of the device functional organization principles operation are solved. The developed coprocessor has the ability of address and associative access to the data stored in memory. An addressable access is required to work with a specific record and to use test libraries developed for address memory.

A described device consists of two parts: the main one that implements the functions of an associative coprocessor (ordinary (address) record to the associative memory device (AMD), the associative record in AMD, the normal reading from AMD, the associative reading from AMD, the search for matches), and partially the conjugation with CS, which performs the function of signal conversion coming from a central processor (CPU) into the signals with which a coprocessor will operate, i.e. this part of the device organizes the interface with the CPU.

The connection of the described device to the CS is possible in the following ways (Ognev & Borisov 2000): direct connection to the CPU bus, the coprocessor must be included in the system board; the connection to a serial interface (USB); with this connection method a coprocessor must be made in the form of a separate housing and be provided with a separate power supply; the connection to the computer expansion bus (PCI); in this case the coprocessor will be executed in the form of an expansion board.

With direct connection to a CPU bus, a device must be included in a motherboard, which will lead to coprocessor cost increase and its universality (the device will be designed to work with a certain class of CPU and a certain CS architecture). When the connection is performed using the USB interface, the coprocessor will look like a separate module, but it will work in sequence, which will result in performance decrease. A coprocessor connection to a PCI bus will allow to implement it as an expansion board. In this case, the work with the module will be carried out on a parallel interface, which will achieve maximum performance. Having analyzed all the above-mentioned methods of the device main part arrangement and the part of the interface with the CS, it was decided to perform the main part in the form of a parallel AMD, since this method has maximum performance. The connection to the system is realized via the PCI bus since it has a sufficiently high throughput.

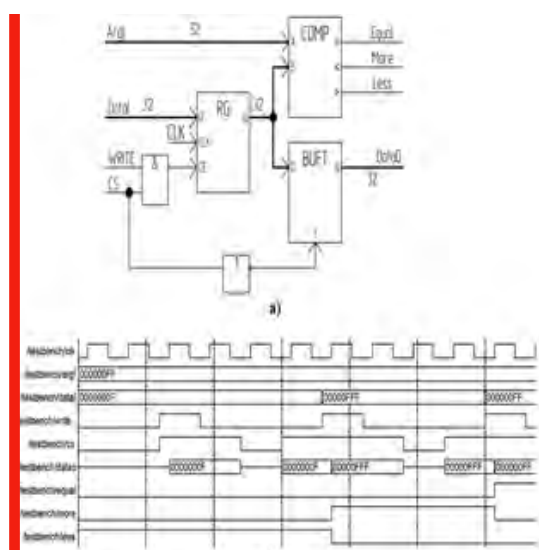


Fig. 1: Memory cell: functional diagram (a); operation time diagrams (b)

Table 1: Associative coprocessor commands

Command	Command description
0000	readRAM – address reading
0001	WriteRAM – address record
0010	WrArg – the search argument record to the argument register
0011	FixHit – responding cell fixation command
0100	rdAEqual – a cell address provision whose contents are equal to an argument
0101	rdAMore – a cell address provision whose contents are greater than an argument
0110	rdALess – a cell address provision whose contents are lesser than an argument
0111 - 1111	reserved

Associative Coprocessor Description At Functional Level

The basis of the associative coprocessor under consideration is a memory module, which is an array of memory cells. Thus, the development of a memory module is reduced to the design of a memory cell and their combining into an array. The memory element of a memory cell can be implemented in a parallel register, which is an array of D-triggers, providing maximum performance and minimum logic required to implement the storage of information. The main signals for the register are 32-bit D signal, through which the data is fed into a register, CE signal and 32-bit Q signal, from which the stored data is read out from a register. The comparison scheme can be implemented on the basis of a comparator. The main signals for it are 32-bit signals A and B, to which arguments are supplied for comparison, the signals =, <and>, from which the comparison results are read. A buffer element is included in a memory cell to disconnect the output data bus of a memory cell from a common output bus. The main signals of a buffer element are 32-bit signal D, the 32-bit signal Q and the signal T. If the signal T is equal to logical zero, then the data is fed to Q from D. Otherwise, Q is switched to the third state.

The functional diagram of a memory cell is shown on Fig. 1, a. The search argument is supplied to ArgI input. The data are entered to a memory cell through the DataI input. The data is read from a cell from the Data O input. WRITE and CS inputs serve to control a memory cell operation. A cell is

selected by CS signal, i.e. the buffer element BUFT sends the signals from the output of the register RG to the output bus DataO. The data from the DataI input is recorded to the RG register through a single signal WRITE. The outputs Equal, More and Less form the signals "EQUAL", "MORE" and "LESS" respectively.

The operational diagrams of a memory cell, confirming its operability, are shown on Fig. 1, b. Here the record of a number of values in a memory cell is shown: "F", "FFF" and "FF". The search argument is "F". As the figure shows, while the CS signal is equal to logical zero, the output bus (DataO) is in the third state, i.e. it is disabled. When a logical unit is fed to the CS input from the data bus (DataO) the data stored in a register can be read. An entry into a cell is done by sending a logical unit to WRITE input. The resulting time diagrams show that the results of the search are set on the outputs Equal, More and Less as soon as a new value is written to a memory cell.

In (Martyshev 2016), the functional organization of a coprocessor block is considered. Here we describe the algorithms in more detail according to which some component parts of the associative coprocessor block and the device as a whole operate. The commands are entered into a coprocessor via a separate internal bus - the command bus. Commands are decoded and fed to the component blocks of the device. Coprocessor commands are shown in Table 1.

Table 2: Allocation of PCI I/O space addresses

AD[31:10]AD[9:7]	AD[4:0]	Description	Reading	Record
BAR+	000	0000–11111	The reading from the memory of an associative coprocessor	The record to the memory cells of an associative coprocessor
	001	xxxxx	The reading of responding cell number	The record of a search argument in an argument register
	010	xxxxx	The reading from a memory cell whose contents are equal to an argument	The record to a memory cell whose contents are equal to an argument
	011	xxxxx	The reading from a memory cell whose contents are larger than an argument	The record to a memory cell whose contents are larger than an argument
	100	xxxxx	The reading from a memory cell whose contents are less than an argument	The record to a memory cell whose contents are less than an argument
	101	xxxxx	–	The fixation of responding cells in the memory of reaction fixation

The command decoder is implemented on the decoder basis, the four-digit input of which is connected to a command bus. The readRAM command performs the address read function, i.e. the address received by an address bus is decoded, the logical unit is fed to the CS input of the corresponding PC and the contents of this PC enter an output data bus. WriteRAM command performs the address write function. An address is decoded, logical units are fed to CS and WRITE input of the corresponding PC. The signals from the data input line are fed to the input of the PC register, i.e. memorization is carried out. Using WrArg command, the signals from the input data line are fed to an argument register input. Using FixHit command, Equal, More and Less signal are fixed in the memory of reaction fixation (MRF) and signals appear on the output bus of PC number that contain the information about PC number whose contents are equal to an argument, greater than an argument, and less than an argument. The command rdAEqual analyzes the contents of MRF and sends the address of the first PC to the address of the responding cell. First PC contents is equal to the argument.

After that, PC is reset to the MRF corresponding to a given address. The command rdAMore analyzes MRF contents and the address of the first PC comes to the address bus of a responding cell, the contents of which are greater than an argument. After that, PC is reset to MRF corresponding to a given address. The rdALess command analyzes the contents of MRF and sends the address of the first memory cell whose contents are less than an argument to the address of a responding cell. After that, PC is reset to MRF corresponding to a given address.

The configuration memory block is executed on the register, which is responsible for the address space selection of a PCI device. The allocation of PCI I/O space addresses is given in Table 2.

AMC can be implemented on the basis of the shift register (Figure 2, a) and the priority analyzer (Figure 2, b). The main elements of AMC based on a shift register are a looped shift register and an address counter. The result of

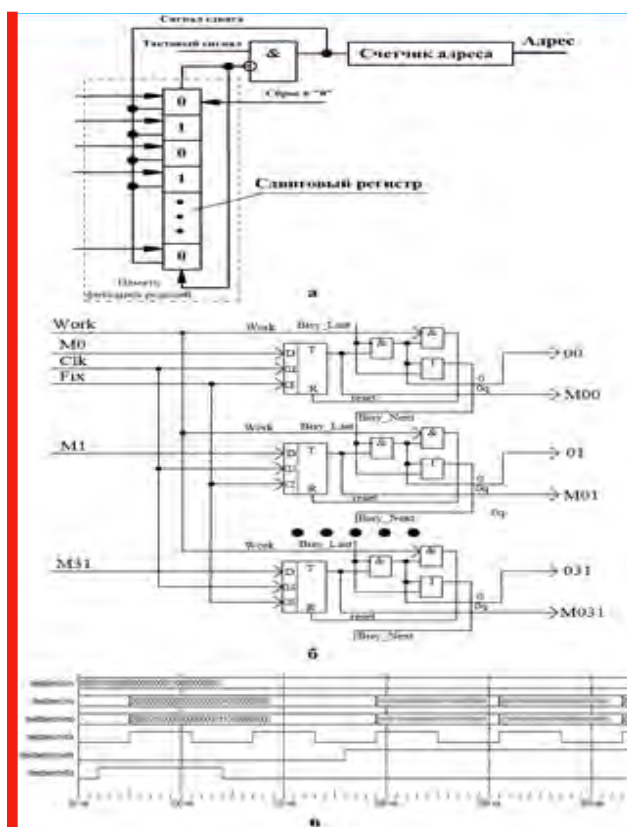


Fig. 2: The analyzer of multiple coincidence based on the shift register (a) and on the basis of the priority analyzer (b); time diagrams of reaction fixation memory operation and the analyzer of multiple coincidences (c)

all CP search is recorded in this looped shift register (MRF). Then a sequence of clock pulses is sent to a register and to a counter. The contents of the register are shifted toward the upper digits until the first one has a logical "1". At this point, the clock signal is blocked automatically. If only zeros were recorded in the initial state to the counter, then at the end of the count, its contents indicate the address of the first matched word directly. This code is entered in an address register, after which a word is read. Then the unit in the first digit of the register is reset and the clock pulses are resumed automatically. Again, the content of the register shifts up until the next unit is appeared in its first digit. After that, the next matched word is read, etc., until an entire queue is serviced.

AMC based on the priority analyzer consists of D-triggers performing MRF and combinational logic functions. This circuit operates on the edge of CLK signal. The priority analyzer is a logical circuit that allows you to select the line with the lowest number among own inputs set to "1". It is built according to the principle of discharge consecutive connection. Each single input of this circuit blocks the action of lines with large numbers, thus only the output corresponding to the first active line is set to the unit, the signal from which goes to the output automatically, and

the function of the signal "Reset" is the reset of the first "responding" trigger.

MRF and AMC are implemented on the basis of a priority analyzer scheme, since this circuit has a faster response time than a shift-based scheme. The time diagrams of the circuit operation are shown on Figure 2, b.

The order of work with the block considered in the article is the following one:

1. It is necessary to fill in the CP AMD;
2. To put down a search argument in an argument register;
3. To perform the fixation of coincidences;
4. To count the number of matches;
5. The work with responded cells, i.e. the reading or the record to these cells.

The considered block of the associative coprocessor is implemented on Xilinx FPGA. The project has been developed consisting of four main modules that implement the main parts of the device: the associative coprocessor, the MRF and AMC, the description of PCI interface and the conjugation of the associative coprocessor with it.

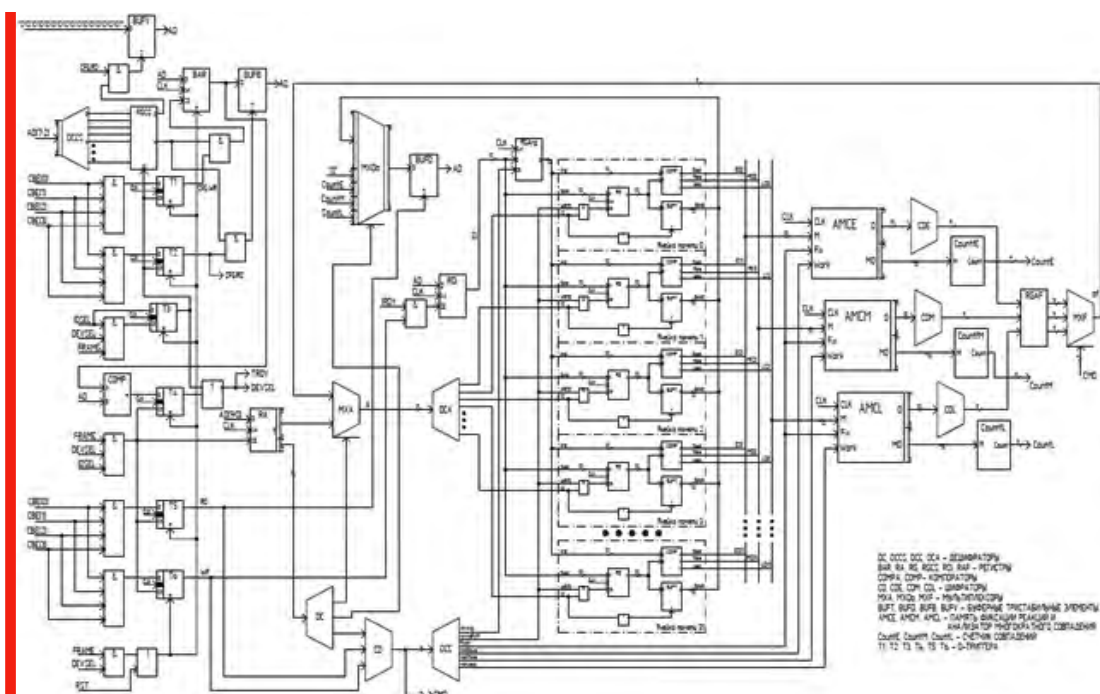


Fig. 3: Functional scheme of the associative coprocessor

Computational Experiment

The work of the associative coprocessor (Figure 3) begins with the power on or with a hardware reset (the signal RST# is equal to logical zero), during which the BAR register and all device triggers are reset.

After reset, the device does not respond to I/O space addressing. Its configuring is started using configuration/read cycles. IDSEL signal is set to a single value. T3 trigger captures the addressing to the configuration memory. The device sets DEVSEL and TRDY signals to

zero, thereby confirming the readiness to receive/transmit data. The signals of command bus (CBE) are decoded. If this is a configuration reading command, the trigger T2 is set to a single state. The address of the configuration memory register is read and decoded by DCCS decoder from AD lines [7: 2] in the address phase. The decoded binary sequence is fixed on RGCS register. In the case of configuration reading, a logical unit is supplied from the zero-address register to the permissive input T of the BUFV buffer element and DEVICE ID and VENDOR ID ("010101010101010101010101010101") are provided

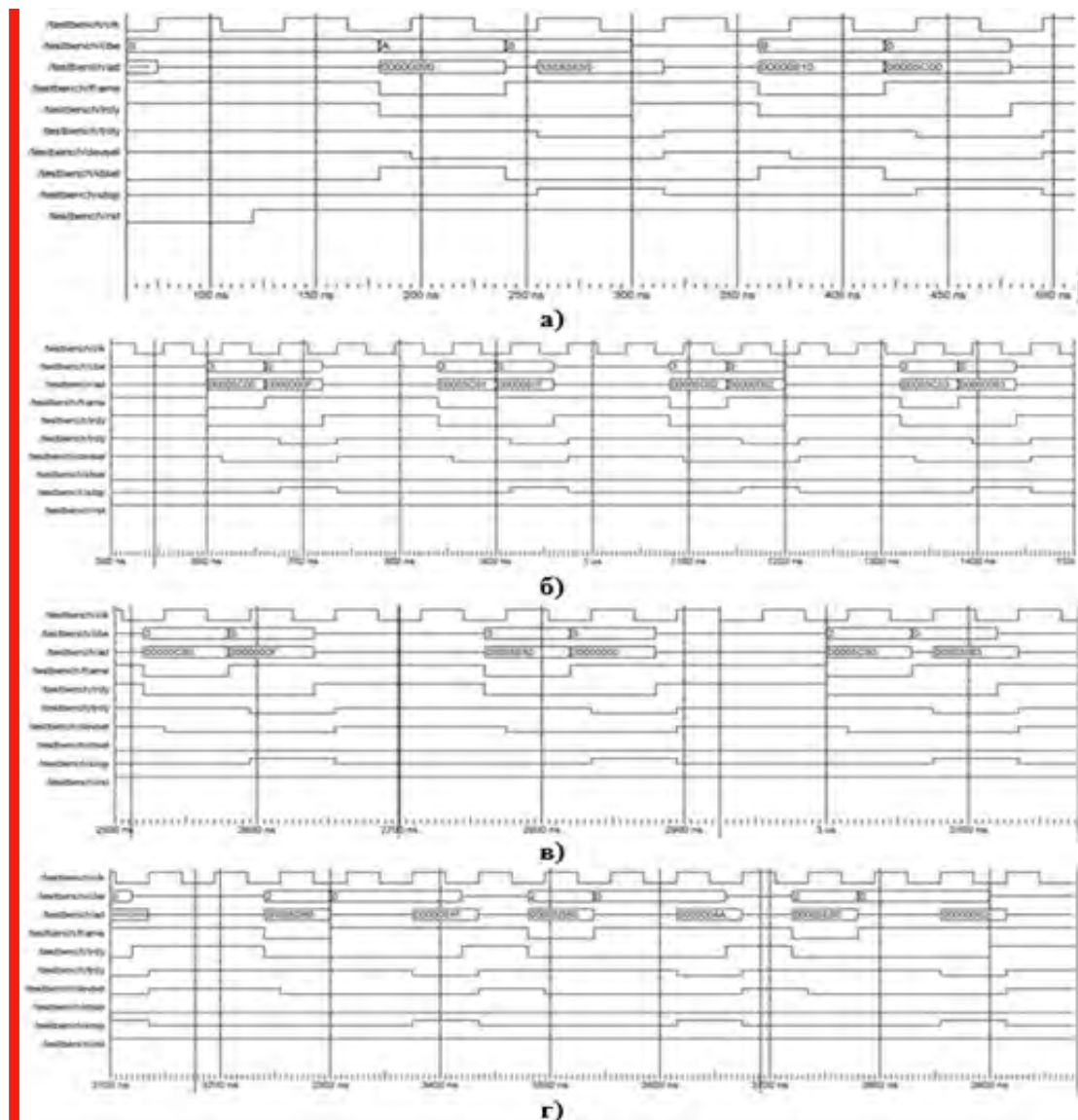
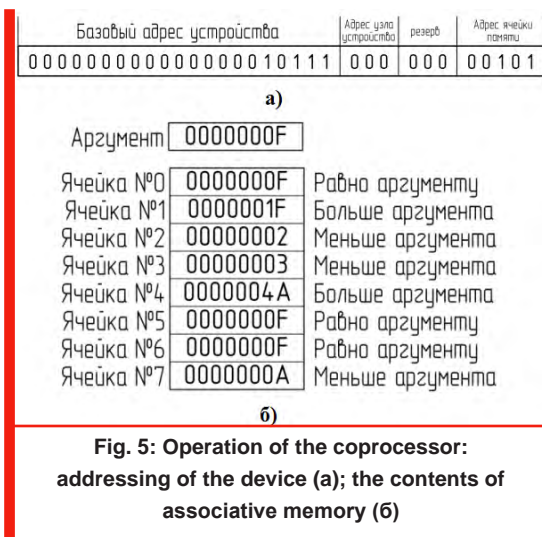


Fig. 4: Temporary diagrams of associative coprocessor operation: a - the device configuration; б - the record to memory cells; в - the record in a search argument, the fixation of matches and the reading of the number of matches; г - reading from memory cells whose contents are greater and less than an argument



to AD bus. In the case of configuration reading a logical unit is supplied from the register with 10h address to the permissive input T of the BUFB buffer element and the contents of the BAR register are fed to the AD bus. If the command received via CBE bus is a configuration record command, then T1 trigger is set to a single state. As in the case of configuration reading, the address of the configuration memory register is decoded by DCCS decoder. And by the address to the configuration memory register with the address 10h, a logical unit is sent to the permitting input CE of BAR register, the base address of I/O area is recorded from the AD bus to the BAR register. Once the configuration is complete, the device is ready for use.

The comparator COMP compares the signals on the AD bus with the value written in the BAR register constantly. If the signals on the AD bus and the value written in the BAR register are equal, a logical unit is fed to the input of T4 trigger, and if FRAME and IDSEL signals are zero and the DEVSEL signal makes one, T4 trigger locks the unit at its input. DEVSEL and TRDY signals are set to zero. I.e. the device is ready to receive or transmit data. During the address phase, AD signals are registered on RA register [9:0]. Based on 9, 8 and 7 bits of the Q output of the RA register, the DC decoder and the CD encoder generate a command (CMD bus), which is deciphered by DCC and entered to the coprocessor units. The bits 0 - 4 of Q register of RA address are sent to MXA multiplexer input, which, depending on an internal command, coming through CMD bus (normal read/record commands), connects these signals to the input of the DCA decoder, which in its turn

decrypts the address and generates a CS signal for the corresponding memory cell.

With address (normal) reading from the memory cells, the WriteRAM signal is zero. CS signal generated by DCA address decoder for a corresponding cell allows the signals from the RG register output to the output data bus (DataO). At other memory cells BUFT buffer elements disconnect the register output from the output data bus. Through MXDo multiplexer and BUFD buffer element, the data from the output data bus is sent to the AD bus. At an address (usual) record to a memory cell by the decoder of DCC command, WriteRAM signal is transferred to a single state. CS signal is generated by DCA address decoder for a corresponding cell, and the signals from AD bus are written to the register RG of the corresponding memory cell through the register RDi. Asynchronously, COMP comparators of all memory cells compare the contents of RG register to the argument and generate Equal, More, and Less signals for cases where the contents of cells are equal, greater or less, respectively. Using fixation command (FixHit command), these signals are fixed in the memory of reaction fixation.

The time diagrams of the associative coprocessor operation are shown on Fig. 3 a-d). Fig. 3, a, shows the diagrams of configuration cycles. The first cycle, which occupies 2 tacts, demonstrates the configuration reading from a configuration memory cell with the address 0h. CBE bus sends the configuration reading command "1010", it is A in hexadecimal calculation system. The address of the configuration memory cell ("0") is transmitted via 7-2 bits of AD bus. DEVSEL and TRDY signals are set to zero, confirming the device is ready for operation. Then the data phase begins in the next cycle, and the device issues DEVICE ID and VENDOR ID - "5555555h". During the second cycle, which is also composed of 2 tacts, a configuration entry is made to the configuration memory cell with the address 10h (the cell responsible for the base address of the I/O area). We put down 5C00h in it. In the future, until the next reset or the record of another value to the base address register of I/O area (BAR), the device will respond to I/O ports addressing with the addresses 5C00 - 5FFF. Since the bits 31 - 10 are used as the base address, the rest are used to address the device nodes.

In Fig. 4 6 demonstrates the diagrams of record cycles in AP cells. The loop consists of the address phase and the data phase. As you can see from the diagrams, you need two tacts for the record into the device. During the first tact

(address phase), the address of the device ("00000000000000001011xxxxxxxx") is transmitted by 31 - 10 bits of AD bus. The address of the device node ("000" - address reference to memory cells) is sent in the bits 9 - 7 of the AD bus, and the address of AP cell («0000», «00001», «00010», «00011», «00100», «00101», «00110», «00111») is sent via 4-0 bits of AD bus. Thus, in order to access the memory cell 5h on the AD bus, the address must be set to "000000000000000010110000000101" (Figure 4a). In the first tact, the record command to the input/output port ("0011") is also transmitted via CBE bus. In the second tact, the data is received via AD bus. The cell with the address 0h is recorded with "0000000F", the cell with the address 1h - "0000001F", the cell with the address 2h - "00000002", the cell with the address 3h - "00000003" (Figure 3b); the cell with the address 4h - "0000004A", the cell with the address 5h - "0000000F", the cell with the address 6h - "0000000F" and the cell with the address 7h - "0000000A".

Fig. 3 b shows the cycles of an argument record, the fixation of matches and the reading the number of matches. The loop of writing a search argument is no different from the record to a memory cell. It also requires two tacts. During the address phase, an address is sent consisting of the base address ("00000000000000001011xxxxxxxx") and the node address ("001"). The address of the memory cell is ignored. "0000000F" is put down in the argument register. Thus, we have 3 cells whose contents are equal to the argument, the content of 2 cells is more than the argument and the content of 3 cells is less than the argument (Figure 4, b).

The coincidence loop begins from the address 5E80h. This address was obtained as the result of the address base part combination (it makes "00000000000000001011xxxxxxxx" as in all other cases), the address of the device node "101" and the address of the memory cell that does not participate in the coincidence loop record. The fixation of matches occurs only at the command of writing to the input/output port ("0011"). The value passed during the data phase does not matter, since it is not taken into account anywhere. This value is transmitted because the PCI bus transaction must have at least one data phase. The cycle of reading the number of matches begins with the address of the identical cycle of the argument record. The difference is that the number reading cycle starts with the reading command from the I/O port, and the argument record cycle starts from the record command to the I/O port. During the data phase, the value of the number of elements is equal to the argument (AD [17:12]), greater than the argument (AD [11: 6]) and less than the argument

(AD [5: 0]). In our case, this value makes 3083h ("000011000010 000011"), i.e. the number of memory cells whose contents equals the argument makes 3. The number of memory cells whose content is larger than the argument makes 2. The number of memory cells whose content is less than the argument makes 3.

Fig. 3 r demonstrates the cycles of memory cell reading, the contents of which are larger and smaller than the argument. One cycle of reading requires three tacts. This is due to the fact that the tact is required to read the address of a responding cell. I.e. the address consisting of the base address and the node address is transmitted during the first tact (it is "011" for the reading of cells whose contents are larger than the argument, it is "100" for the cells whose contents are larger than the argument), DEVSEL signal is set to zero. In the second tact, the address of a responding cell is read. In the third tact, the data are read by set address, and TRDY signal is set to zero, indicating that the target device is ready to produce the data of data.

The hardware module under consideration is implemented on Xilinx FPGA. VHDL codes of the device are developed, the description of which consists of four modules, including the main blocks of the implemented device: an associative coprocessor, reaction fixation memory and a multiple coincidence analyzer, the description of PCI interface, and an associative coprocessor conjugation with it.

SUMMARY

Based on the description of the associative coprocessor at the functional level, VHDL device code was developed, followed by a firmware file to configure FPGA. The performance of the device and individual units was tested and the debugging of the developed VHDL codes was performed.

The data bus width, described in the coprocessor operation makes 32 bits (double machine word). The capacity of the AP array makes 32 double machine words. An associative coprocessor is implemented in hardware, which allows to perform complex search and comparison operations, thereby unloading CPU and increasing the overall performance of CS. This work was supported by the Russian Foundation for Basic Research (Grant No. 16-07-00012).

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Research of the Reconfigurable Cross-Platform Computing System for the Digital Signal Processing

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ABSTRACT

The article is devoted to studying the architecture of a cross-platform reconfigurable computer system for digital signal processing, including a subsystem for planning and assigning tasks. We performed the debugging and testing of the developed computer system. For the mathematical calculations, the article uses queuing theory, namely, the open-ended queuing networks as this tool is well designed and described. The functioning of the reconfigurable cross-platform system is described in the VHDL language. The summary includes some conclusions on the work performed.

KEY WORDS: Cross-Platform System, Reconfigurable System, Mathematical Model, Scheduler, Hardware Implementation, Digital Signal Processing.

INTRODUCTION

In connection with the availability and expansion of the microelectronic element base, it is possible to create multiprocessor and multi-core systems of various performance, for example, cross-platform reconfigurable computing systems (RCS) for digital signal processing (DSP) on the programmable logic integrated circuits (PLIC). The RCS has the ability to quickly rebuild its architecture for different classes of tasks.

We considered a number of issues, one of which is the research and development of the architecture of cross-platform RCS. At the initial stage, the architecture of the computer system (CS) "single command stream - multiple data stream" (SSMD) was chosen. In the CS structures with such an organization, one device manages the operation of a plurality of processor modules, so that each of them simultaneously performs one command at first, then the second one, etc.

There is debugging and testing of the developed aircraft, including the study of performance, time characteristics, search for the ways and possibilities to minimize and optimize the system in the work. In connection with the situation that has arisen in the world, it is more than ever necessary to replace the imported components. So, the search for a domestic element base is under way. It is possible to use the PLIC of "Voronezh Plant of Semiconductor Devices-Assembly" JSC "VZPP-S."

The cross-platform system developed and described in this article is designed on the ALTERA Cyclone IV PLIC. The research was carried out on the ZRtech debug board. It is possible to simulate the system in a mode close to real working conditions, which greatly facilitates the design

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and development of the project, with the help of a debug board. The subsystem of planning and dispatching tasks, which is an integral part of the high-performance system implemented on the debug board, is considered in detail in this article.

One of the main problems in high-performance computing is the scheduling and assignment of tasks by the central processing units (CPU). The traditionally used software implementation of dispatching functions contributes to increasing the time required for the synchronization of processes. There are two approaches to resolve this situation: hardware implementation of the process planning functions with a common and individual task queue for each CPU, the models of which were considered in (Tanenbaum & Bos 2015; Martyshkin & Yasarevskaya 2015; Martyshkin 2014; Martyshkin 2015) and in (Martyshkin 2016; Martyshkin et al. 2015; Martyshkin 2016), respectively.

Problem Statement

To solve the task specified, the article considers a scheduler with a common task queue (time-sharing strategy). The study is performed as a set of simulations on the queuing systems (Matalytsky et al. 2011; Lozhkovsky 2012; Abramov 2006; Kempa Wojciech 2010) and a hardware solution implemented using the VHDL hardware description language and creating a firmware file for the debugging board. The scheduler description developed by the VHDL is included in the project to develop a reconfigurable computer system (RCS) (Martens-Atyushev & Martyshkin 2015).

Mathematical modeling, based on the positions of queuing theory, makes it possible to obtain capacious statistics from the results of the probabilistic-temporal values of the model. The considered network model (see Fig. 1) for the study of the scheduling subsystem and the assignment of tasks with time separation consists of a serving multichannel processor node and a single-channel node, which, in fact,

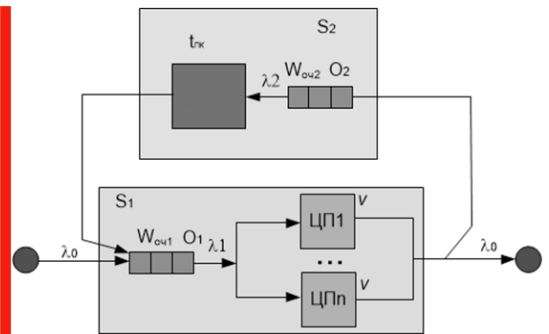


Fig. 1: The system model studied

is the scheduler itself. The maintenance requirement, which comes from the source S0 with an intensity of λ_0 , is assigned in any CPU. To obtain the results, an equiprobable task distribution, which allows avoiding overloading the system when certain CPUs are idle, is used in this work. Since the queue has a limited number of parts, if it is overflowed, some part of the applications will be suspended and expected to be serviced either in the order they are received in the system or in accordance with priority. Consequently, the intensity of the task flow of the queue Q1 will be equal to $\lambda_1 = \lambda_0 \lambda_2$. The queue formed before the scheduler does not exceed the number of waiting CPUs, that is, the n-1 task will wait in the queue Q2 until the previous task is on maintenance, then the intensity of Q2 will be $\lambda_1 = \lambda_0 - \lambda_2$.

The tasks from the source S0 in the RCS come with an intensity of λ_0 and become in the queue Q1, if there are empty parts in it. If there are none, then the task leaves the system untreated. In accordance with the FIFO discipline, the tasks exit the queue with an intensity of λ_1 and are assigned for processing in the n-th CPU. As soon as the maintenance time is over, a check is made to fully complete the task processing. If the result is positive, then the task leaves the system. The task processing in the n-th CPU takes a time quantum (k). After the CPU processing is completed, the processing time - the time of one quantum (tk) is subtracted from the internal variable of the task. Next, we check for completeness by comparing the internal variable of the task that is responsible for the rest of time necessary to complete the processing, with zero. When confirming that the task has been processed definitively, it leaves the RCS. If the check does not give a positive response, then the task waits for the scheduler to be released, while the n-th CPU is not released, this phenomenon creates a queue of suspended CPUs. When the scheduler is freed, the task will come to it for processing. After that, the task tries to return to the general queue, if there is free space in it, otherwise it leaves the

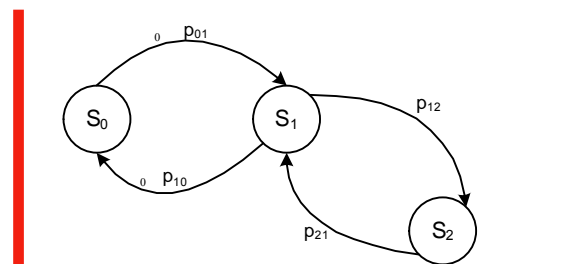


Fig. 2: System transmission graph with the general scheduler

system partially processed. The graph of the above RCS is shown in Figure 2.

On the basis of the graph proposed, the probabilities of the output (p_{10}) of the processed task and the transition (p_{12}) to the service to the scheduler are calculated. The probabilities p_{10} and p_{12} depend on the complexity of the task received for processing: the more time-consuming the task is, the longer it is for servicing in the CPU, the less important it is the probability of the output of the task processed from the RCS and the greater it is the probability of returning to the pre-service task in the CPU (Martens-Atyushev & Martyskhin 2015; Salnikov et al. 2016). When modeling the complex tasks in the system, the values of p_{10} and p_{12} were set at 0.07 and 0.93, respectively. When receiving tasks with an average time-consumption, the values were assumed to be 0.19 and 0.81. When modeling the arrival and maintenance of short tasks, p_{10} and p_{12} were assumed to be 0.45 and 0.55, respectively. All calculations were carried out in the program of analytical modeling and

calculation of the queuing networks (Certificate of state registration; Biktashev et al. 2013).

To obtain the results of a computational experiment conducted on analytical models, probabilistic and temporal characteristics were investigated, namely the CPU load, the time of the task stay in the system, the average queue length, etc. During the experiment, we took the parameters that corresponded to real computer systems: the CPU number ranged from 4 to 16; the intensity of task arrival changed as follows: for the tasks with a high response from 9.3 to 93 tasks/ms (the average processing time on the CPU is 0.009 ms), for the tasks with an average response from 0.333 to 3.33 tasks/ms (the average processing time on the CPU is 0.068 ms), for the tasks with low response from 0.07 to 0.7 tasks/ms (the average processing time on the CPU is 0.15 ms). The received intensity values provide an average CPU load at the level of 65% ($\rho_{CPU} = 0.65$); the total queue length in the system with the scheduler is equal to 128 tasks; the average time of the scheduler, taking into account the time of the cache reset and task context switching, is 0.002 ms (Mikhalev 2012).

Based on the results of the studies given in (Martyskhin & Yasarevskaya 2015; Martyskhin 2016; Martyskhin 2016), we will show the expression for determining the mean waiting time of the task in the RCS queues in more detail

$$W = \frac{w_1}{P_{10}} + \frac{w_2 \cdot P_{12}}{P_{10}} = \frac{w_1 + w_2 \cdot P_{12}}{P_{10}}, \tag{1}$$

where w_1 – queue time before the CPU; w_2 – CPU waiting time before scheduling; P_{10} – probability of the output of the task processed from the RCS; P_{12} – probability of the task transition for the maintenance to the scheduler.

The response time (latency) in the system with the scheduler and the general queue of tasks in the RCS is (Martyskhin & Yasarevskaya 2015; Aliev 2009)

$$U = \frac{(w_1 + k \cdot (t_k + \delta))}{P_{10}} + \frac{P_{12} \cdot (w_2 + k \cdot (\tau + \zeta))}{P_{10}} = \frac{w_1 + k \cdot (t_k + \delta) + P_{12} \cdot (w_2 + k \cdot (\tau + \zeta))}{P_{10}}, \tag{2}$$

where k – number of quanta per task; t_k – duration of one quantum; δ – time required to restart the cache; ζ – scheduler operation time, τ – time required to switch the task context.

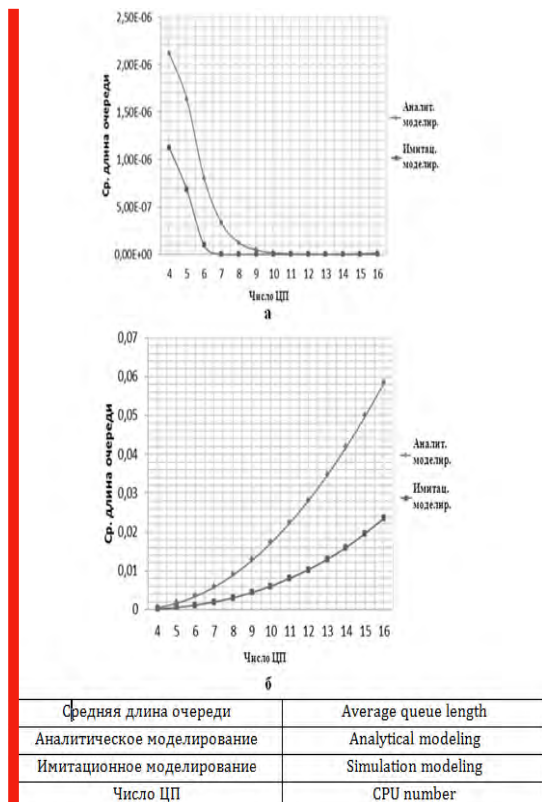


Fig. 3: Dependence of the average queue length before the CPU (a) and before the scheduler (b) on the CPU number in the system

During the experiment, based on the proposed analytical model, an imitation model was developed, according to which the values of the scheduler load, the mean queue length in the RCS were obtained, and it has been also investigated how the change in the task complexity affects the scheduler loading.

Figure 3 shows the dependencies of the average queue length before the CPU and before the scheduler on the CPU number. The graphs show how the queue tends to zero when the CPU number increases, but it increases before the scheduler on the contrary. It follows that the larger it is the CPU number in the system, the greater it is the probability of CPU idle.

We can draw the following conclusion from the figure obtained: the scheduler load with time division increases with the decreasing labor-intensiveness of tasks, i.e. with an increase in the RCS reactivity. The development

of microelectronic technologies made it possible to use new architectural solutions to improve the performance of computer systems (CS). In recent years, it has become increasingly common to see how different CSs are built without the use of traditional CPUs. Instead, they are used to increase the flexibility of the system using programmable logic integrated circuits (PLIC). This solution is also used for hardware support of the scheduler that is part of the RCS project, which is a device consisting of 4 reconfigurable CPUs implemented on the PLIC for the digital signal processing (DSP) (Fig. 5). The implementation of the entire system on the PLIC allows quickly rebuilding the device for different types of tasks. A more detailed description of the RCS was considered in (Martens-Atyushev & Martyskhin 2015).

When designing the multiprocessor operating systems, there appears the problem of reducing the time losses that arise, in particular, in the process planning

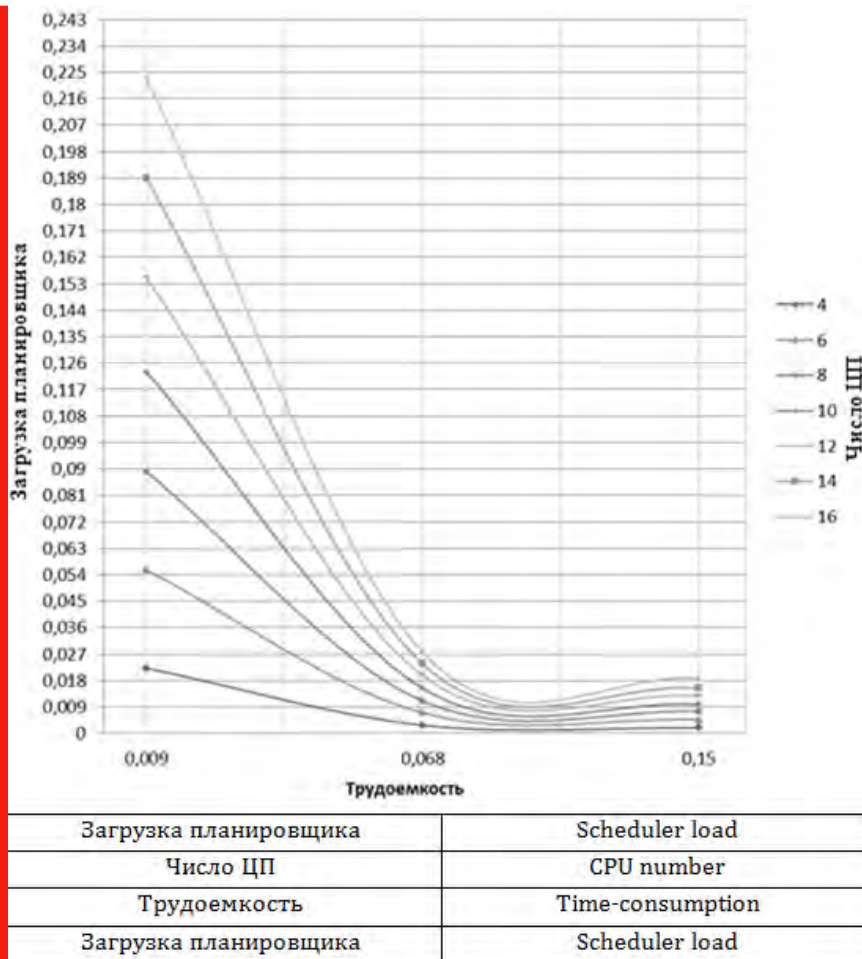


Fig. 4: The scheduler load dependency on the complexity of tasks in the RCS.

(Tanenbaum & Bos 2015). Part of the scheduler is the function of dispatching tasks (processes, threads) when they are assigned to the processor nodes. The implementation of this function is often associated with the need to synchronize the interacting processes. Usually, in the uniprocessor systems, the processes are synchronized programmatically in the kernel space of the operating system or in the user space and have no fundamental effect on the computing system performance. In the multiprocessor systems, the relative time required for the process synchronization is increased. With fairly high accuracy, we can assume that for the same program being run in the uniprocessor and multiprocessor modes, the time required for the process synchronization is the same (Tanenbaum & Bos 2015; Martyshkin & Yasarevskaya 2015). Relative same time costs differ sharply due to a decrease in the time for execution of the parallel flows. This is because the part of the program that is associated with the process synchronization is consistent and is a factor reducing the performance of the multiprocessor system. Therefore, in this development, the task manager was implemented in hardware, which largely eliminates the problem of time losses (Martyshkin 2016).

task identifiers into the system. It analyzes whether there is free space in the task queue, and if there is, puts the new task identifier into the FIFO. It also retrieves the task identifier from the queue (by the FIFO principle) for servicing in a free processor. The FIFO unit for task storage is designed to store the task identifiers. Upon request from the queue management unit, it places the new task identifier at the end of the list or extracts the task identifier from the list top to transfer it to the processor. Free processor control unit - each processor, which turns out to be free, forms the signal "Free" on a corresponding output. This unit receives such signals from all processors in the system, analyzes the number of free processors, and determines, according to the priority scheme, which of the free processors should be selected for the task processing. The synchronization unit is the main unit in the system, whose functions include analysis of the information about: whether there are some waiting tasks in the system and whether there are some free processors that can be assigned to process these tasks. This unit interacts with each processor in the system and is responsible for transferring the task identifier to the free processor selected for maintenance, in accordance with a specific priority scheme.

Fig. 6 shows the units:
The task queue management unit is designed to receive

The algorithm of the configured task manager is as follows:

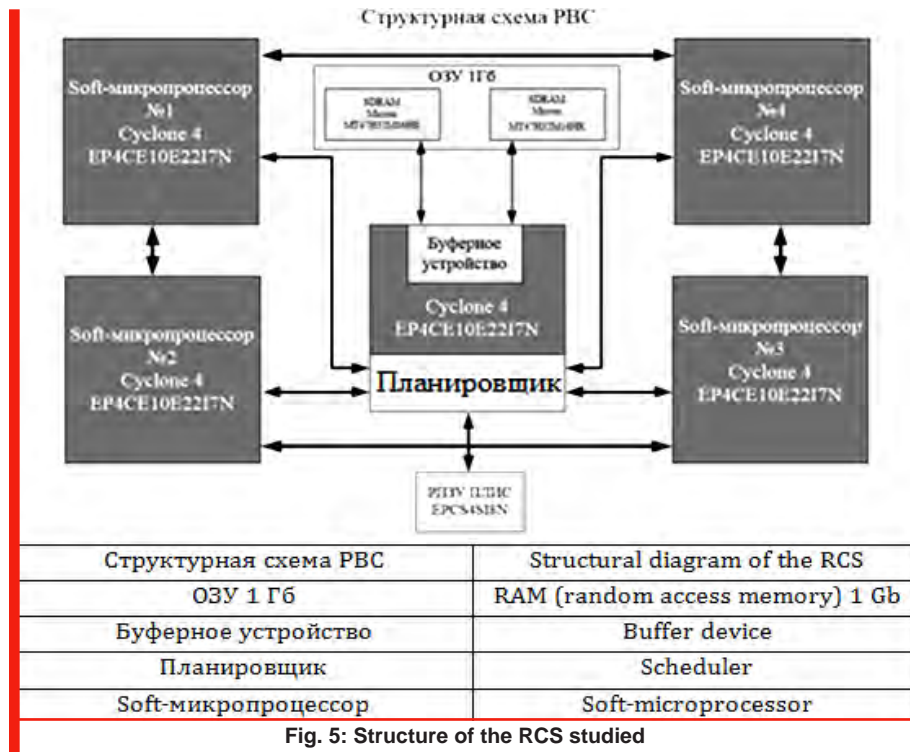


Fig. 5: Structure of the RCS studied

The newly arrived task is placed by the scheduler at the end of the queue, and the tasks, which are at the beginning of the queue, are the first to be executed. When one of the processors is freed from the current work, it refers to the dispatcher, which selects the ready task from the beginning of the queue and works with it until it is completed or until it is blocked, for example, due to the need for the input/output operation. The load sharing algorithm is the most simple and at the same time effective way of planning, because it has a number of advantages: The load is distributed evenly between the processors, ensuring that there are no processor idles in the presence of ready-to-perform tasks; simplicity of presentation and a high degree of comprehensibility of the scheduler functioning algorithm; when the processor is freed, it calls the function of assigning tasks (dispatcher) from the operating system. The dispatcher units are designed in the VHDL hardware description language. For the research, we also created the units of task generation and processor operation

simulation.

Fig. 7 shows the interaction of 2 multi-core processors and task manager. According to this scheme, a model, on which research is currently carried out, is implemented.

Let us consider in more detail the hardware implementation of the scheduler, which was designed using the VHDL language in the CAD Quartus II. The developed structure (Fig. 8) consists of the following units. The task generation module (block_task_manager) for modeling the constant transmission to the scheduler of task identifiers ready for execution. The module transmits the new task identifiers at regular intervals and reports this to the queue management unit, which facilitates simulating the task flow

The task queue management module (block_upr_ocher) - accepts the task identifiers in the system. It calculates whether there is a free cell in the queue. In the event

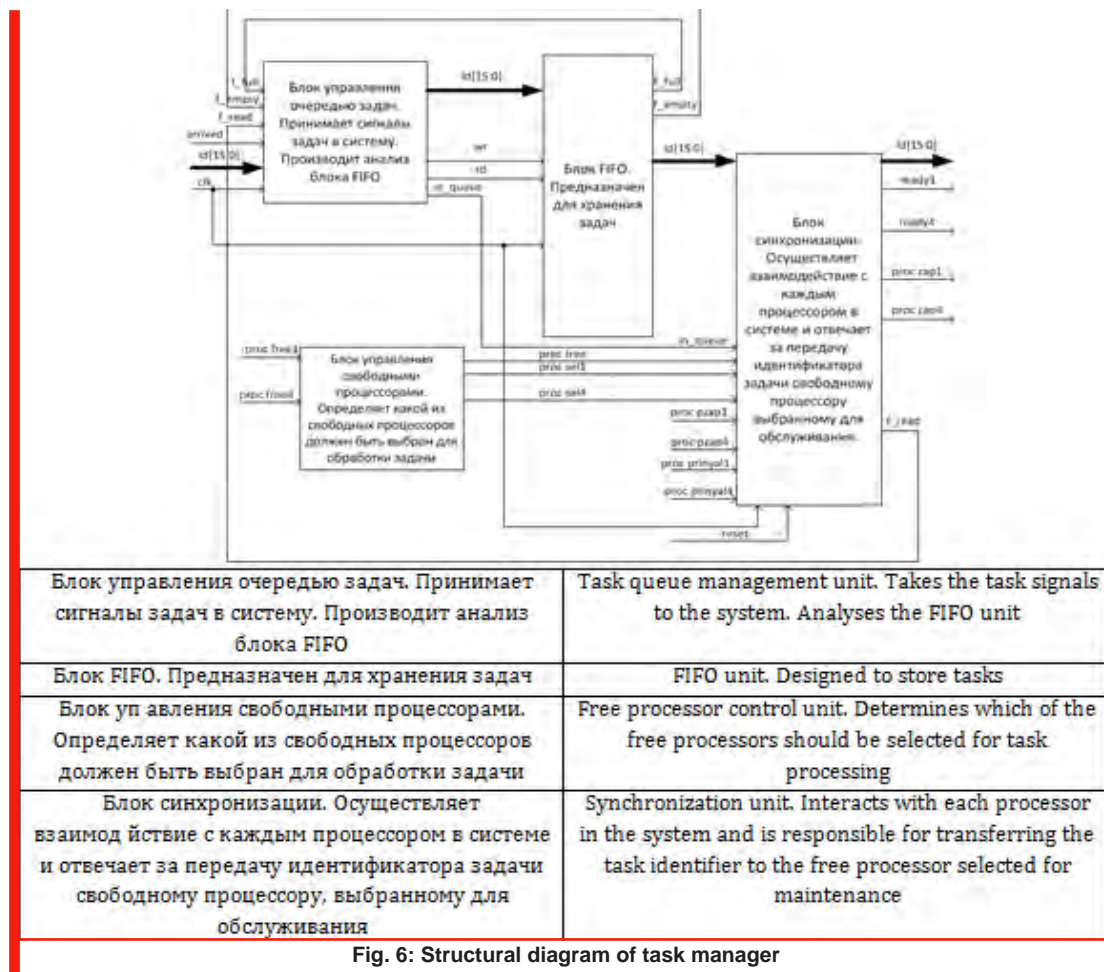
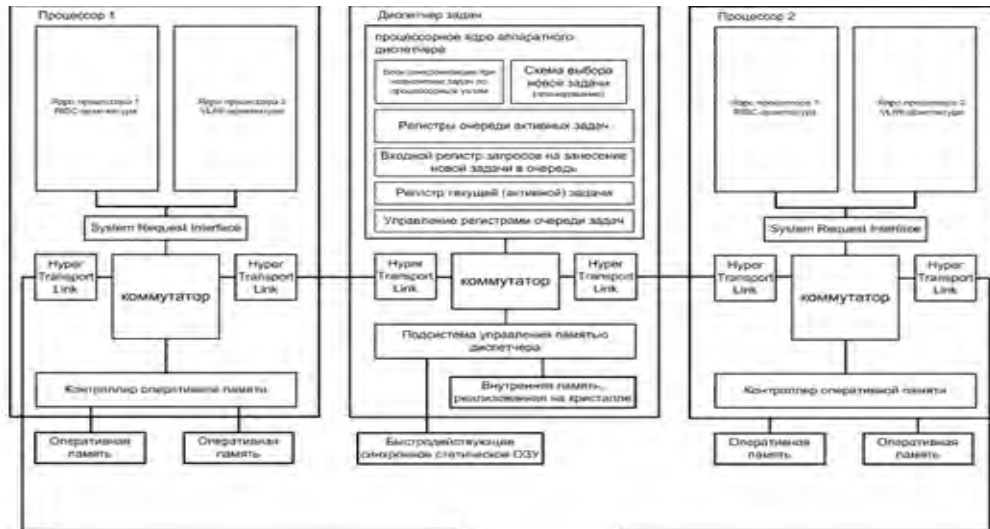


Fig. 6: Structural diagram of task manager



Процессор 1	Processor 1
Ядро процессора 1	Processor core 1
Ядро процессора 2	Processor core 2
архитектура	architecture
коммутатор	switch
Контроллер оперативной памяти	RAM controller
Оперативная память	RAM
Диспетчер задач	Task manager
Процессорное ядро аппаратного диспетчера	Processor core of the hardware dispatcher
блок синхронизации при назначении задач по процессорным узлам	Synchronization unit when assigning tasks to the processor nodes
Схема выбора новой задачи (планирование)	The scheme for a new task selection (planning)
Регистры очереди активных задач	Active task queue registers
Входной регистр запросов на занесение новой задачи в очередь	Input register of requests to put a new task into the queue
Регистр текущей (активной задачи)	The current (active task) register
Управление регистрами очереди задач	Managing the queue task registers
Подсистема управления памятью диспетчера	Memory management subsystem of the dispatcher
Внутренняя память, реализованная на кристалле	Internal memory implemented on a chip
Быстродействующее синхронное статическое ОЗУ	High-speed synchronous static RAM
Процессор 2	Processor 2
Чипсет	Chipset

Fig. 1: Structural diagram of the RCS

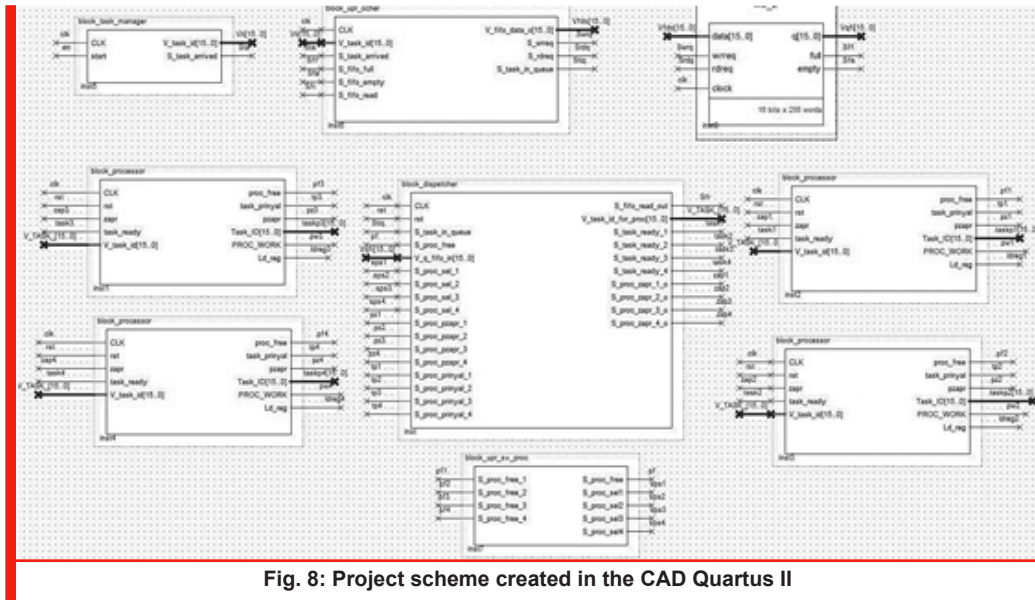


Fig. 8: Project scheme created in the CAD Quartus II

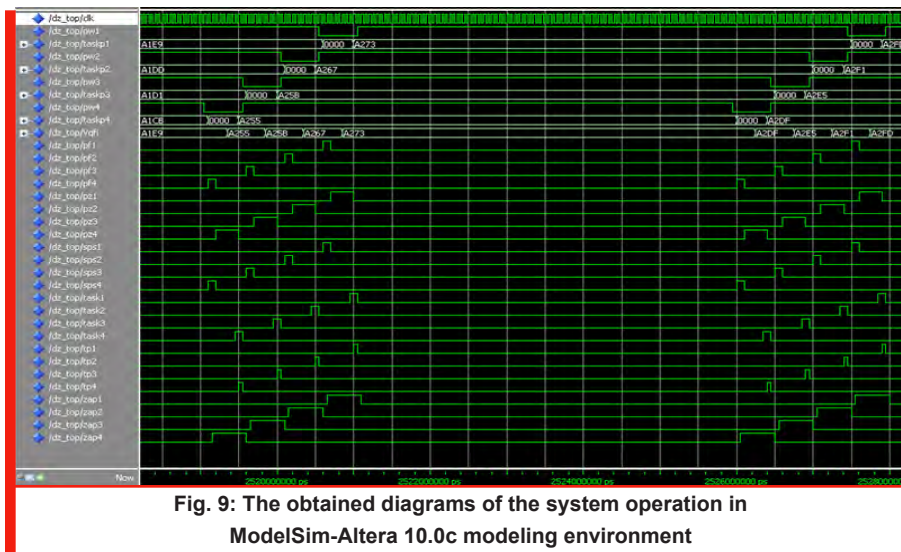


Fig. 9: The obtained diagrams of the system operation in ModelSim-Altera 10.0c modeling environment

that there is free space, it passes the identifier (ID) of the incoming task to the FIFO queue module. Another of its functions is to retrieve the task ID from the queue (by the FIFO principle) for processing in a free CPU. The FIFO task storage queue module (fifo_2) has the following operation principle: on the request signal from the queue management module, it puts the ID of the incoming task in the "tail" of the list or extracts the task ID from the "head" of the queue for further transfer to the CPU for processing.

The processor module (block_processor) mimics the CPU operation. It is designed to generate signals from the "processor-scheduler" interface. When the task ID is

received, the module is disconnected from the scheduler so that the CPU moves to its maintenance. This function is implemented in the form of a counter that counts the bars during the task processing. When the required number of bars is counted, the module informs the scheduler that it is free, and is ready for further work. The synchronization module (block_dispatcher) is the main module in the device. It is used to analyze whether there are waiting tasks in the system, and whether there are currently free CPUs that can be defined to process these tasks. This module interacts with each CPU in the RCS and is responsible for transferring the task ID to the free CPU selected for maintenance, in accordance with a specific priority scheme

used in the RCS.

Experiment Results

Modeling of the developed project in the VHDL language was carried out using Model Sim-Altera 10.0c. After compilation, the project simulation was started, where the simulation results were obtained in the form of time diagrams of the RCS functioning (Fig. 9). The diagram shows that the identifier of the incoming task under the number A255 was sent to the CPU for processing at number 4 (taskp4), after which the CPU signaled that it had accepted the task for processing (tp4). CPU number 4 was busy, so the next task identifier A25B was accepted for processing in the third CPU. Like the fourth CPU, the third one sets a signal (tp3) that it has started to process the task. Based on the modeling results, it is evident that the fourth CPU is the first to serve the current task, then the third CPU is assigned, and so on. This is due to the priority scheme for the task performance in the system, i.e. from the fourth CPU to the first one.

CONCLUSIONS

We considered the mathematical model of cross-platform RCS in the article. We offered the expressions to determine its probabilistic-temporal characteristics. We developed the VHDL description of the task planning and assigning subsystem, which allows considering the RCS operation in real time, Martyshkin, (2016). During the study we revealed that the scheduler used could manage to receive and assign the entire flow of tasks entering the system. It is not overloaded over the entire modeling time period and is capable of handling a more intensive incoming task flow. As a result of the experiments conducted we revealed that the number of CPUs in the cross-platform RCS depends on the task parameters and the architectural parameters of the task scheduler. The results obtained in the course of research testify to the adequacy of the model developed to the real system.

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Sociological Analysis of Reproductive Strategies

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ABSTRACT

Reproductive behavior is a multifaceted concept that embodies an interdisciplinary approach and affects many aspects of public life. In this work, reproductive behavior is defined as an institutionalized scenario that is implemented at different levels of society. A comprehensive review of the phenomenon will help to understand the processes at various levels. Macro level - in the field of state policy, meso level - in the field of individual structures and organizations, micro level - in the field of practices. Nowadays, there is no holistic view of the institutionalization mechanisms for reproductive behavior. As a rule, this process is viewed through the prism of demographic analysis and gender studies. The issues of pregnancy planning, child birth, the spread of assisted reproductive technologies, and the dynamics of reproductive culture are not developed sufficiently. Thus, the need for a comprehensive study of reproductive behavior institutionalization processes and ongoing reproductive practices was formed and became meaningful. The demographic situation of the Russian Federation is marked by low birth rates, population decline, and a low total birth rate. Fertility is largely determined by the demographic structure and reproductive behavior. The article highlights the effectiveness of existing reproductive strategies (government support measures for families and the families with children) through the secondary analysis of data from leading centers for the study of public opinion. The main focus is on maternity capital, and a generic certificate.

KEY WORDS: Reproductive Behavior, Family Policy, Demographic Situation, Birth Rate, Maternity Capital, Birth Certificate.

INTRODUCTION

Nowadays, the issues of family, family policy, and demographic situation have become relevant. Fertility growth is one of the important areas of social policy. The birth rate on a certain territory, during a certain period of

time, measured by the indicators adopted in demography, depends on two factors: demographic structure and reproductive behavior. In this regard, the trends in the socio-demographic development of the Russian population and reproductive behavior are socially significant.

The birth rate continues to fall in Russia. The latest recent indicators of the Federal State Statistics Service are presented by the year 2016, and 2017. The deterioration of the situation has been observed precisely in recent years: the natural population growth has significantly decreased (from -2286 to -135818). The indicator of the total fertility rate (the number of children per woman) is also important, which makes 1.621 in 2017 (it was higher during previous years). And the indicator of 2.1 at least is needed for simple long-term reproduction of the population.

The analysis of the statistical data of the demographic forecast until 2035 demonstrates a continued decline of the birth rate, negative indicators of natural population growth (an approximate exit to zero values is noted by

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2026), the average indicator of the total birth rate continues to remain at 1.6-1.7.

Experts attribute the drop in the number of newborns to the demographic pit and the current economic situation in the country. From 1987 to 1993, the number of births decreased by almost half, and now women and men of that time have entered the childbearing age. So, if 1.9 million children were born in 1990, in 1993 this indicator made only 1.3 million. In 1997, the indicator dropped to 1.2 million children and remained at that level until 2001.

In this regard, it is important to pay attention to the work of the reproductive system in modern Russian society. Reproductive behavior is formed under the influence of a complex of factors: social, political, economic, sociocultural, psychological, and ethical. The study of reproductive behavior allows you to determine the influence of personal motives of people, their living conditions on fertility processes, as well as ongoing family policies.

The state of the current demographic situation is associated with economic, political determinants, the role of the social component is also high. Reproductive behavior is being transformed: the institution of family and marriage undergoes some changes - the natural development of the family, the transition to a new type of family-marriage relations, and the reorientation of values takes place.

Reproductive behavior also has wide practical application - mechanisms are being developed at the state level to influence the birth rate, which may subsequently lead to the situation stabilization and the country demographic prosperity.

Maternal capital (MC) as one of the main and most significant measures of child family support nowadays still raises many questions, various discussions are performed about the real impact on the birth rate of Russians. The program began its implementation in 2007. The implementation of this measure was not doubted by anyone - the orientation to a two-child family has been mentioned more than once in various state program documents and the Messages from the President of the Russian Federation.

MC has been operating for more than 10 years in Russia; after a while, conclusions can be drawn. However, the assessment of MC effectiveness is evaluated differently by the population and experts. The text presents the latest available data from mass polls.

In 2007, based on a mass survey of the POF on March 17-18 (the population survey was held in 100 settlements of 44 regions, territories and republics of Russia. Interview was performed among 1,500 respondents at the place of their residence on March 17-18, 2007. The statistical error does not exceed 3.6%) half of the respondents positively assessed the introduction of MC as the measure of fertility promotion, the third admitted that they were skeptical about this. The survey participants found that main problems associated with the certificate are the following: "it is still a certificate, not cash", "a small amount" (MC was estimated at 250,000 rubles during that period), "money will depreciate", "they don't give out money right away: who needs them after three years", "distrust of the state, fear of being deceived", "insufficient measure, it is necessary to redo the whole family policy".

In 2013, already 87% rated MC positively, and only 4% negatively. Does MC help increase fertility? In 2006 there were 49% of consonants, in 2007 - 50%, 2013 - 75%, 2016 - 78%. That is, the percentage is growing, a positive attitude remains among the majority of Russians to the existing measure of family support. At that, the proportion of those who disagree with this judgment decreases every year.

Let us turn to the opinion of experts and their studies regarding the family (maternal) certificate. Some scholars believe that MC and other additional measures of child family support have affected fertility, but not so radically. Natalia Zvereva, the professor at the Department of Population, Faculty of Economics, Moscow State University, gives the results of the program in her study "The social guarantees of family support and new measures to stimulate large families: how population estimates them (based on the results of the sample survey of Rosstat)". As a rule, there is only one conclusion - economic measures are not enough to stimulate fertility.

According to the survey, 58% of women and 56% of men believe that their decision on the birth of a child did not depend on state support measures. That is, more than half of the respondents with children born after 2007 deny the influence of state programs. The share of those whom MC and other social guarantees prompted the decision to have a baby made 16% among women and 17% of men. And only 6% claim that the measures taken in the country contributed to the birth of their children.

In this study, the respondents were also asked to evaluate the effectiveness of social guarantees by 5-point scale. In general, government support measures for families had low

ratings. At the same time, the report shows the results of the scores from women, since the estimates of men were much lower. So, the MC got the “best” mark of 3.91 points. It is worth noting that the highest ratings were given by those who do not have children yet (we take into account the fact that the birth of the second and subsequent children is a long-term prospect for them).

A child care leave of less than one and a half years and the corresponding social benefits were rated by 3 points, the measure of compensation for preschool education payment received the same rating. Benefits and housing loans had low scores. Moreover, 2–3-child respondents rated the housing program lower than childless, because of the established age limit for participation in it.

In addition to existing measure evaluation, respondents were asked to evaluate the conditions that could influence the decision to give birth to a child. The availability of kindergartens and the quality of the services they provide is the priority and make 4.85 points, followed by the quality of work of clinics for children, the availability of their own housing, a decent level of wages, and the strengthening of reproductive health (all factors were encouraged by more than 4 points).

Russian families wait for additional social guarantees, emphasized Natalia Zvereva, summing up the study. “People say: “We need new measures. We will give birth more often; we will give birth earlier; but these are not the measures that you are offering us now.” The speaker summed up that it is necessary to think over one more block of family bonuses, first of all, concerning the “housing problem” and kindergartens.

Elena Gorina, the Senior Researcher at the Center for the Analysis of Income and Living Standards of the Higher School of Economics, studied the information of the Russian Pension Fund on the issuance of certificates for MC and the use of its funds from the beginning of the program until 2013, and also attracted microdata from Rosstat sample surveys in her report “Disposal of Maternity Capital: General Challenges and Regional Differences”.

They issued 4,822,000 certificates from the beginning of the program and until 2013. A sample observation of population incomes and the participation in social programs conducted by Rosstat in 2012 provides the data on the results of MC coverage. The author of the study found that approximately a third of women who met the criteria for MC issuance did not apply for the participation in the

program. Moreover, of these, slightly less than half are just poor families from the village.

The expert emphasizes that MC has a number of problems besides passive participation in the program: the gradual depreciation of funds, insufficient options and the accumulation of deferred spending obligations of the federal budget. As a rule, most of the families spend MC money on the improvement of their living conditions - the problem that needs to be addressed in the present in contrast to non-urgent tasks that can be postponed for a while: retirement benefits for the mother and education for the child (children).

Moreover, capitalization in the housing market can be difficult. There are several reasons for this. Firstly, it is “most convenient” to implement MC during primary housing purchase, but not all program participants can do it. The purchase of secondary real estate, in which, as a rule, individuals and alternative transactions are involved, causes difficulties due to the long wait for the transfer of funds from the PFR. Secondly, it is worth bearing in mind the difference in housing prices in different regions of the country.

In connection with the theses of his research, the author believes that the problems can be solved by expansion of MC use possibilities, and the attraction of additional budget costs. But, it is emphasized that one should not expect any changes in the action of MC so far. “There will be a trend in which the vast majority of certificates will be directed to housing condition IMPROVEMENT,” the expert predicts.

With the introduction of maternal capital, the birth rate in Russia increased, but the contribution of this allowance to reproduction was small so far - the “increase” was about fifteen children per hundred women of reproductive age. The Associate Professors of the HSE International Institute of Economics and Finance Fabian Slonimchik and Anna Yurko found out this in their study “The Assessment of Maternity Capital Policy Impact in Russia”, published in the HSE Journal “Demographic Review” (No. 3, 2015). But the proportion of women who decided to have two or more children increased. In addition, the “calendar” of births has changed: under the influence of fertility promotion policy, women began to decide quickly on the next child, whose birth they put off. The authors of the study analyzed the effectiveness of government measures by constructing a dynamic structural model of fertility and employment based on panel data.

Thus, the main conclusion is that the lower efficiency of the MC program is demonstrated in comparison with the estimates obtained using simple descriptive analysis methods.²

According to the amendments to the federal law "On Additional Measures of State Support to Child Families", the program will be valid until December 31, 2021. At that, they plan further indexing and expanding of certificate use possibilities.

Let us turn to the next measure of state support for families, another component (besides MC) of the Priority National Project "Health" - the birth certificate.

"More than a third (37%) of respondents believe that the introduction of birth certificates helps to increase the birth rate in the country (13% say that to a large extent, 24% - to an insignificant extent), the third (33%) believes that this measure does not contribute.³ That is, there is approximately the same distribution of those who agree and disagree with the positive effect of the birth certificate on fertility.

Basically, people believe that the system of the birth certificate is aimed at medical service quality improvement, ensuring successful outcomes of childbirth, many people think that it is aimed at life and work of the medical staff improvement: "primarily for doctors." Thus, the current circumstances compel experts to conclude that "the family should become the unit of state policy. Only the focus on family in social policy can lead to a steady increase of the birth rate and support the trend of economic growth." The Russians wait for additional measures. They believe that purely economic measures are not enough. Not always (very rarely, low correlation) the inhabitants of our country decide on the birth of a child, based on the introduced state measures.

The thing which is closer to a person at the moment (depending on the situation he is in) is fundamental, necessary and caring for him. In this regard, depending on different cohorts, social, marital status, the level of education, priority areas are set differently. For some, the most important thing is to become pregnant, to give birth successfully (birth certificate), to others it is important to arrange and have housing (affordable housing, the issue of land plots), the third want money (child benefits, maternity capital), then kindergartens (the availability of preschool benefits, compensation for payments in kindergartens), tax

preferences, less often Russians think about reproductive health.

The imperfection of Russian family policy leads inevitably to the deterioration of the country demographic situation. You should not be frivolously reassured by a slight improvement in the birth rate during recent years. This is a temporary effect of the demographic structure factors and the implementation of delayed births in terms of relative economic stabilization.² Along with the birth rate increase, the population of active reproductive age is decreasing (20-24, 25-29 years), which accounts for the bulk of births.

State attempts to improve the situation are mainly based on non-modern approaches. As a rule, it all comes down to socio-economic stimulation of the birth rate. There is a huge gap between scientific proposals and the practical implementation of the problem solution.

Social and economic measures are sometimes insufficient and ineffective. Mass media, mass culture are the main sources of information, as a rule, promote anti-family values. There is the reorientation of many foundations of family life. In this regard, the focus on reproductive behavior is very relevant. To solve the problem, it is necessary to achieve stabilization of the simple reproduction among population, to transform the reproductive culture of society, and this is not a quick process.

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FOOTNOTES

Population data from Federal State Statistics Service. URL: