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Phytoadaptogen Effect Based on *Glycyrrhiza glabra* on Adolescent Body Adaptation Capabilities Living Under Conditions of Environment Chemical Pollution

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ABSTRACT

According to various sources, 15–20% of the world territories, are the zones of ecological disaster, about 50% of the population live in environmentally unfriendly regions. Licorice medicinal plant with the scientific name of *Glycyrrhize globra* is one of the medicinal plants used in cosmetics, food, health and pharmaceutical industries. The main aim of the study is to present the data on the correction of deviations concerning the adaptation system activity of 13-14-year-old adolescent bodies, exposed to chemical pollution of the environment by means of a phytoadaptogen based on licorice. According to the obtained data, they established the reduction of chemical, environmental pollution factor negative effect on the adolescent's body: normalization of rhythm, blood pressure, heart rate, maximum oxygen consumption, and the adaptive potential of the circulatory system.The results of the study demonstrate that the use of *Glycyrrhiza glabra* root extract as an adaptogen can help the normalization of blood pressure, heart rate, and variation range among 14-year old adolescents living in conditions of environmental chemical pollution. Besides, it can be concluded that *Glycyrrhiza glabra* root extract is an positive natural adaptogen since it decreases the detrimental impact of chemical pollution factors on the adolescent body, and consequently results in relative normalization of blood pressure.

KEY WORDS: ADOLESCENTS, ADAPTATION OPPORTUNITIES, CHEMICAL POLLUTION OF THE ENVIRONMENT, PHYTOADAPTOGENS, PHOTO CORRECTION, LICORICE.

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INTRODUCTION

In recent decades, a large amount of scientific information has appeared about the influence of an unfriendly environment on the physical development and functional state of a child's body (Agadzhanyan et al., 1993; Baevsky et al., 1987; Veltishchev and Fokeeva, 1996; Guminsky et al., 1990; Resenkova, 2003; Tolstikov et al., 1991; Ghorbanlou et al., 2020). The most acute issue is the

need for effective measures aimed at body resistance increase in adverse environmental conditions. For many centuries, various medicinal substances have been used by medicine for the treatment and rehabilitation of humans. In recent years, some low-toxic biologically active herbal remedies are purposefully used in sports practice to accelerate recovery, actively replenish spent plastic and energy resources, and selectively control the most important functional systems of the body during heavy physical exercise (Brehman, 1969; Yermolova and Zimova, 2001; Kerimov and Kasumov, 1998; Resenkova, 2003; Sidorova et al., 2020).

Table 1. Child physical performance assessment in terms of MOC/kg (A.A. Guminsky et al., 1990)

Age, years	MOC, ml/min•kg		Evaluation
	Girls	Boys	
13	41,0 43,0 45,0	37,5 39,5 41,5	low satisfactory high
14	43,6 45,5 47,5	35,5 37,5 39,5	low satisfactory high

Adaptogens are important among them. Adaptogens are the substances that have a general tonic effect on the body and increase its resistance during heavy physical exertion, under hypoxic conditions, and during drastic bioclimatic changes (Butova, 1999). Plant adaptogens can stimulate the nervous system and metabolic processes in the body moderately, which has a beneficial effect on the adaptation to physical exertion. Currently, herbal preparations based on *Glycyrrhiza glabra* root are in the field of study by modern scientists (Brehman, 1969; Yermolova and Zimova, 2001; Resenkova, 2003; Streltsov, 2002). A number of authors indicate the presence of anti-toxic (Cekic et al., 2012; Milashechkina, 2005) and immunomodulating (Ishida and Sympos, 1983; Halberg, 1969; Singamaneni et al., 2020) properties of licorice root.

Therefore, the goal of our study is to evaluate the effect of the drug on the basis of *Glycyrrhiza glabra* on the leading adaptation systems of the adolescent body living in conditions of chemical, environmental pollution. *Belyaev* (1969), Rezenkova (2002), Milashechkina (2003) studied the effect of *Glycyrrhiza glabra* extract on the processes of the organism adaptation. The authors found that the *Glycyrrhiza glabra* root has the obvious adaptogenic effect, which is reflected in the harmonization of the hormonal balance and, thus, the stimulation of adaptive responses to environmental factors.

Table 2. Evaluation of organism functional capabilities according to the values of the circulatory system adaptive potential

AP (in the cond. score)	Assessment of adaptation degree	Functionality level	Recommendations and activities
<1.60	Satisfactory	Optimal	Therapeutic
1.60-2.09	Incomplete or partial	Sufficient	Therapeutic
2.10-2.59	Unstable	There is a risk of decline	Improving and preventive
2.60-3.09	Stress adaptation mechanisms	Reduction	Preventive and curative
>3.10	Unsatisfactory, overstrain of adaptation mechanisms	A sharp decline	Medicinal

The confirmation is the increase of physical performance, the resistance to hypoxia and better results in the development of physical qualities - general physical endurance. Also, the *Glycyrrhiza glabra* extract implements its adaptogenic properties by optimizing the functional state of the central nervous system, helping to balance excitatory and inhibitory processes and to improve its quantitative and qualitative characteristics (Sadek et al., 2020) These data gave rise to the use of *Glycyrrhiza glabra* root extract as a stress-limiting agent among a group of 14-year-old teenagers, in which most of the indicators revealed the most significant negative changes.

MATERIAL AND METHODS

The influence of chemical, environmental factors on the body of adolescents was studied in natural experiment conditions. The participants of the study were 13-14-year-old adolescents, who were divided into the following groups: 1) control group (n=82; 42 boys and 40 girls) which are living in the area without anthropogenic pressure; 2) test group (n =102; 61 boys and 41 girls) which are living in the conditions of environmental chemical pollution; 3) correctional group (n=37), with the use of licorice root extract - it consisted of 17 boys and 20 girls living in the conditions of environmental chemical pollution.

A phytoadaptogen, based on *Glycyrrhiza glabra* extract, was given in the morning from 7.30 to 8.30 at the dose of 0.05 mg/kilogram of body weight (Resenkova, 2003). Also, to determine the adaptive capacity of the adolescent body, we used the indicators characterizing the state of regulatory mechanisms. The state of the respiratory system was determined by relative and absolute lung capacity

(LC), chest excursion and maximal oxygen consumption (MOC) test, the state of the circulatory system and its regulatory mechanisms by cardiointervalography indices: HRV (heart rate variability), arterial pressure (AP), the adaptive capacity of the circulatory system and an individual minute duration.

The stress test recognized by the World Health Organization as an objective and informative indicator of the functional status of the cardiorespiratory system and the functionality of a person - the maximum oxygen consumption (MOC). According to the researchers, the indirect method for the determination of MOC was proposed by A.A. Guminsky (Dzhandarova et al., 2014). The evaluation of the test results was carried out according to the data presented in Table 1. The adaptive potential of the circulatory system was determined by R.M. Baevsky's method (Belyaev, 2002), adapted for the use on the child organism by P.A. Fileshy (Resenkova, 2003), the assessment was made in accordance with the data given in Table 2.

Table 3. The state of the cardiorespiratory system among 14-year-old adolescents living in a chemically contaminated area after photo correction

Indicators	Control	Test	P1	Correctional group	P2	P3
		Girls				
VCL, l	2,38±0,05	2,27±0,08	>0,05	2,32±0,12	>0,05	>0,05
SP, mm.m.col.	99,29±1,70	109,70±1,70	<0,01	109,29±4,90	<0,05	>0,05
DP, mm.m.col.	59,29±0,29	63,77±1,52	<0,05	67,57±3,16	<0,01	<0,01
HR,b/min	81,77±3,01	92,2±3,63	<0,05	85,81±4,36	>0,05	>0,05
		Boys				
VCL, l	3,34±0,05	2,29±0,15	<0,001	2,32±0,16	<0,001	<0,001
SP, mm.m.col.	99,17±1,52	121,26±2,59	<0,001	107,33±1,75	<0,001	<0,01
DP, mm.m.col.	57,92±0,52	76,6±1,34	<0,001	66,33±5,50	>0,05	>0,05
HR,b/min	81,45±3,52	86,78±2,00	>0,05	88,00±1,39	>0,05	>0,05

Note: P1 - the reliability of differences in average values between the experimental and control groups; P2 - the reliability of differences in average values between the experimental and correction groups; P3 - the reliability of differences in average values between the control and correction groups.

Table 4. Heart rate variability among 14-year-old adolescents living in a chemically contaminated area, after photo correction

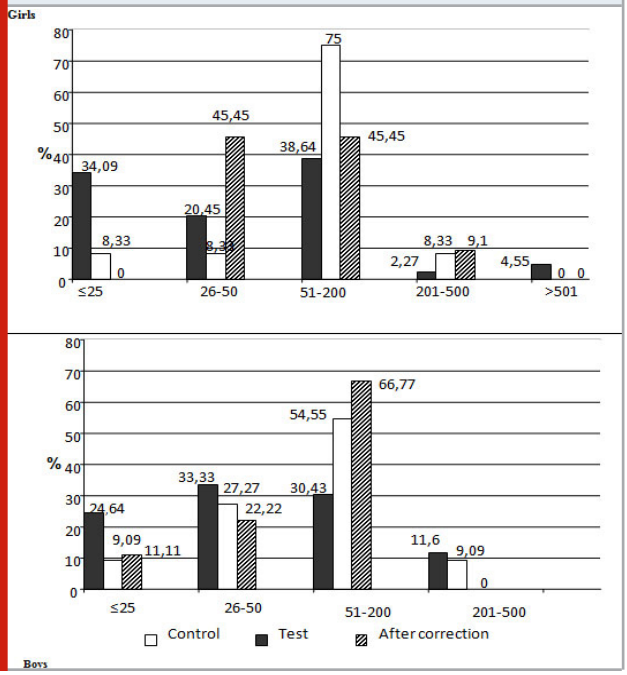
Indicators	Control group	Test group	P1	Correction group	P2	P3
		Girls				
M, ms	743±27,90	673,45±17,34	<0,05	715,45±46,79	>0,05	>0,05
MSD, ms	58,33±5,89	76,82±4,66	<0,05	66,45±9,50	>0,05	>0,05
ΔX, ms	331,33±30,23	649,70±61,54	<0,001	372,00±47,77	<0,001	>0,05
Mo, ms	716,67±33,22	647,73±18,84	>0,05	704,55±58,74	>0,05	>0,05
Amo, %	36,83±3,40	36,25±2,19	>0,05	34,00±2,84	>0,05	>0,05
		Boys				
M, ms	747±33,19	707,67±20,46	>0,05	683,56±10,64	>0,05	>0,05
MSD, ms	64,82±12,56	68,99±3,40	>0,05	66,44±10,53	>0,05	>0,05
ΔX, ms	362,91±51,36	563,90±31,65	<0,01	421,00±64,56	<0,01	>0,05
Mo, ms	731,81±42,80	673,91±19,05	>0,05	683,33±17,54	>0,05	>0,05
AMo, %	35,36±4,19	36,10±1,62	>0,05	35,44±2,92	>0,05	>0,05

Note: P1 is the reliability of differences in average values between the experimental and control groups; P2 is the reliability of differences in average values between the experimental and correction groups; P3 is the reliability of differences in average values between the control and correction groups.

The vital capacity of the lungs (VCL), expressed in litres, was measured using a spirograph. The subject drew the maximum inhale and then gradually exhaled the air through the mouthpiece into the spirograph. Cardio intervals were recorded and analyzed using the Varicard automated computer instrument. Statistical characteristics

of the dynamic range of cardio intervals included: expectation (M), heart rate (HR) and standard deviation (σ), expectation (M). The numerical characteristics of variational pulsograms along with indicators of statistical estimates were mode (Mo), variational span (Δx) and mode amplitude (AMo). Individual minute (IM) was determined by F. Halberg's method. According to the author method, the value of IM is a fairly informative test. The magnitude of myocardial infarction is a relatively stable indicator among healthy people. Mathematical-statistical processing of the survey results was carried out using Microsoft Excel software. The level of different significance for the studied parameters was determined using Student's criterion. The results were considered statistically significant at $p \leq 0.05$.

Figure 1: IN in st. units among 14-year-old girls and boys, living in a chemically polluted area, after photo correction with *Glycyrrhiza glabra* root extract



RESULTS AND DISCUSSION

According to the data we obtained (Table 3), when you use a phytoadaptogen based on *Glycyrrhiza glabra* VCL tends to increase among boys and girls, and SP has decreased significantly among boys (P<0,05), girls show the tendency of its decrease. This can be explained by the fact that the boys had more pronounced changes in blood pressure indicators as compared with girls, so they were also more sensitive to the effects of phytoadaptogen. The intake of *Glycyrrhiza glabra* root extract contributed to the normalization of the cardiovascular system functional capabilities (Table 4). The indicators of the expectation and heart rate variation decreased significantly among girls and boys, approaching the control group, as compared with the original (P>0.05).

Analyzing the indicators of IN before and after *Glycyrrhiza glabra* extract application (Fig. 1), they revealed the increase of adolescent number with a state of vegetative balance, both among boys (66.77%) and among girls (45.45%), which indicates the "smoothing" of chemical pollution negative impact after the use of phytoadaptogen based on *Glycyrrhiza glabra* root. Moreover, 20.3% of adolescents from the correctional group, had the value of IN even lower than in the control group, which, together with the change of expectation and variation scope indicators, indicates a high sensitivity of the vegetative nervous system to this phytoadaptogen. They revealed the positive effect of *Glycyrrhiza glabra* extract on the level of adolescent body adaptive abilities (Table 5). Thus, the relative magnitude of MOC/kg improved by 1.26 times among girls, and by 1.32 times among boys and approached that in the control group. The same can be said about the indicators of the circulatory system adaptive potential and the duration of an individual minute (Table 5). After correction, the average values of AP decreased and varied within the limits of a sufficient level of organism functional capacity of the organism (AP=1.61-2.09) both among girls and boys, averaging 1.93 ± 0.26. There has been an increase in individual minute duration.

Table 5. Adaptive abilities of 14-year old schoolchild body, living in a chemically contaminated area, after photo correction

Indicators	Control group	Test group	P1	Correction group	P2	P3
		Girls				
MOC/kg, ml./min./kg.	45,84±0,40	36,17±0,62	<0,001	45,45±1,29	<0,001	>0,05
AP, st.un.	1,75±0,03	2,27±0,08	<0,001	2,05±0,09	>0,05	<0,05
IM, s	45,56±0,02	56,91±0,99	<0,001	49,55±3,52	<0,05	>0,05
		Boys				
MOC/kg, ml./min./kg.	47,79±0,42	45,17±0,51	<0,001	46,83±1,09	>0,05	>0,1
AP, st.un.	1,76 ±0,03	2,22±0,05	<0,001	1,99±0,07	<0,001	<0,05
IM, s	54,68±0,11	45,90±0,53	<0,001	49,50±2,62	<0,05	>0,05

Note: P1 is the reliability of differences in average values between the experimental and control groups; P2 is the reliability of differences in average values between the experimental and correction groups; P3 is the reliability of differences in average values between the control and correction groups.

In this study, the data on the correction of deviations concerning the adaptation system activity of 13-14-year-old adolescent bodies, exposed to chemical pollution of the environment by means of a phytoadaptogen based on *Glycyrrhiza glabra* was investigated. The outcomes revealed that the application of *Glycyrrhiza glabra* root extract as an adaptogen contributed to the normalization of blood pressure, heart rate, and variation range among 14-year old adolescents living in conditions of environmental chemical pollution, (Sadek et al., 2020). Moreover, more pronounced changes towards the normalization of the functional state of the cardiorespiratory system were found among boys, which is probably explained by their more pronounced changes before correction. Among the adolescents of the correctional group, the level of adaptive capacity has increased, as was indicated by AP and MOC indicators. The indicators of IM approached those of the control group, which indicates the stabilization of rhythmostasis (Sidorova et al., 2020).

CONCLUSION

The study found that *Glycyrrhiza glabra* root extract is an effective natural adaptogen because it reduces the negative effect of chemical pollution factors on the adolescent body: it leads to a relative normalization of blood pressure, heart rate indicators, individual minute and maximum oxygen consumption. This provides a scientific basis for the development and the use of herbal remedies based on licorice as adaptogens, in order to level the negative effects of environmental chemical pollution.

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