On the Sensory and Physicochemical Attributes of Functional Cookies

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ABSTRACT

The baking industry is quickly growing, and its products are becoming increasingly popular among customers around the world. Cookies are one of the most popular bakery items consumed by practically all sectors of society due to their extended shelf-life and inexpensive cost. They are also one of the most popular snack meals due to their range of taste, texture, and digestibility. Cookies offer several advantages over other ready-to-eat snacks, including a wider consumer base, a longer shelf life, and a preferred eating quality. Multigrain and flaxseed are important natural and valuable ingredients in the development of functional foods because they contain various antioxidants and bioactive compounds. As a result, the goal of this study was to look into the nutritional content, sensory quality, and shelf life of functional cookies. By combining the multigrain and flaxseed flour in the ratios of 10:10, 20:20, and 30:30, three variations and one standard cookie were created. The usual approach was followed for the physical, chemical, sensory, and shelf-life analysis of the formed cookies. The V1 cookies had the maximum moisture content, while the V3 cookies had the least, as per the nutritional research (7.24%). Calcium, phosphorus, potassium, magnesium, zinc, and iron were the most abundant minerals in V3, with 300.50mg, 782.80mg, 460.82mg, 42.65mg, 3.26mg, and 3.19mg, respectively. V3 cookies had high levels of SFA and PUFA, with 5.13 per cent and 7.12 per cent, respectively. Based on the findings, it was determined that 10:10 ratio multigrain and flaxseed cookies could be stored for a minimum of 15-20 days in the above-mentioned circumstances without substantial changes in quality features.

KEY WORDS: COOKIES, MULTIGRAIN POWDER, PHYSICO-CHEMICAL, SENSORY ATTRIBUTES.

INTRODUCTION

Cookies are the most well-known bakery food in the world. These are a portion of essential snack food for both children and adults (Hussain et al. 2000). New technologies and ingredients are being introduced worldwide to fulfil nutritional needs. To boost the nutritional content of cookies, they are now made with composite flour or fortified with other rich sources of nutrients such as whey protein concentrate, wheat germ, oyster mushroom, cassava, and water chestnut flours (Bala and Riar, 2015; Okafor et al. 2002; Wani et al. 2015). Cookies, unlike bread, allow for greater use of wheat flour alternatives due to their features that do not require gluten development and a high degree of dough extensibility and elasticity (Juki et al. 2018; Tyagi et al. 2020). Oats (*Avena sativa* L.) are high-protein, high-fibre, and high-mineral food. The number of oats utilised for human consumption has steadily increased because oats' health benefits are mostly due to their total dietary fibre and Beta-glucan content (Ahmad et al. 2014). Green gramme is a high-protein, low-carbohydrate meal. It has a protein content of 25%, roughly three times that of cereals. It meets the protein requirements of the country's vegetarian population. Grain use, or a mixture of one or two grains, legumes, and oilseeds, is a current baking trend that provides various health benefits in addition to better taste, aroma, appearance, and variety. Many writers have previously employed high-protein, high-fibre components to improve the nutritional quality of biscuits. When cereals, pulses, and oil seeds are combined, the resulting product will have more high-quality protein and dietary fibre (Ravi et al. 2018). Blended flour is a mixture of flour derived from roots and tubers, cereals, legumes, and other sources, with or without wheat flour.

The aim of making composite flour is typically to produce a product that is superior to the individual components. Better may refer to improved properties or performances, as well as enhanced economies in some cases. The addition of legume flours increases the nutritional value of cereal flours that are low in lysine but high in sulfur-containing amino acids and the nutritional value of root and tuber flours that are low in protein is sufficiently increased by the addition of cereal flours (FAO 2017). Few kinds of research on the

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use of multigrain to improve the nutritional quality of bread and other conventional products have recently been published. Cereals, pulses, oilseeds, and millets are some of the grains used in multigrain premixes. Cereals like barley and oats are high in soluble and insoluble dietary fibres, especially beta-glucan, which has been shown to lower cholesterol levels (Izydorczyk and Dexte, 2016). Rather than designing new goods to enhance functional characteristics, the current situation necessitates researching the possibility of integrating novel ingredients into widely consumed foods (Aleem et al. 2018). This study was conducted to make cookies of acceptable quality from oats, chickpea, green gramme, barley, and flaxseed blends since there is rising interest in the synthesis of multigrain flours from locally available grains that may be utilised as wheat substitutes in baked goods. As a result, the purpose of this research was to produce multigrain flour-based functional cookies and assess their physicochemical attributes and sensory qualities.

MATERIAL AND METHODS

The following raw ingredients were obtained from the local market in Muscat, Oman: oat (*Avena sativa*), chickpea (*Cicer arietinum*), whole green gram (*Vigna radiata*), flaxseed (*Linum usitatissimum*), and barley (*Hordeum vulgare*). Other food components, such as whole wheat flour, oil, salt, vegetable oil, baking powder, and so on, were purchased from a local grocery in Muscat, Oman. Except for flaxseed, the items were washed and ground in a mill before being placed in an airtight container for later use. Flaxseed was processed using the Roasting procedure, which can improve the flavour by caramelising and Millard browning the food's surface. In a roasting pan, spread the seeds out evenly. Roast the seeds for 5 to 10 minutes in a preheated 375°F (190°C) oven, or place the flaxseeds in a small non-stick pan. Dry roast them for 3 minutes over medium heat, stirring periodically. On a large platter, cool them fully. For future usage, store it in an airtight container. The ingredients for each multigrain combination used to make cookies are listed in the table below. Multigrain flour was created by combining 10:10, 20:20, and 30:30 per cent ratios of oat, chickpea, whole green gram, barley, and flaxseed. The respective control was made entirely with wheat flour (control). Wheat cookies were used as a control. To make cookies, functional flour and flaxseed flour were blended with wheat flour at varying levels of 10, 20, and 30%. Flour (100g), shortening (40g), sugar (40g), skim milk powder (10g), salt (1.0g), sodium bicarbonate (1.0g), and water (12–22ml) were used to make the cookies.

Shortening and sugar were combined to make a cream, which was then added to a flour, sodium bicarbonate, and skim milk powder combination and well combined to produce the dough. The dough was kneaded and sheeted to a consistent thickness of 0.25cm, then cut into 5-cm diameter circular shapes. The baking time was 15 minutes at 170°C. Cooled cookie samples were kept in sealed containers. All four functional cookie recipes were tested for physiochemical, mineral, and sensory qualities. The cookies were allowed to cool for around 30 minutes after baking. With a vernier calliper, the full height of six cookies was measured, and the result was divided by six to calculate the thickness of one cookie. The technique was repeated two more times to obtain duplicate readings. In centimetres, the average thickness and standard deviation were calculated. The diameter of the cookie was measured using a vernier calliper scale. After that, the cookie was turned 90 degrees and the diameter was re-measured in centimetres. Three replicates of measurements were used to compute the average and standard deviation.

The spread ratio was determined by dividing the diameter of the cookie by its thickness. It expresses the degree of quality. The average and standard deviation of three replicates were provided. The chemical composition of the cookie samples was determined using the NIN calculator, which included moisture content, ash, protein, fat, fibre, carbohydrate, and calorie content, as well as vitamin derivatives. After the cookie samples were digested using the wet ashing method, mineral content was measured using an atomic absorption spectrophotometer for Ca, Mg, and Fe and a Corning 400 flame photometer for K and Na (Abulude et al. 2007). Twenty semi-trained panellists were used to conduct sensory analysis. The taste, fragrance, crispiness, colour, and general acceptability of the items were assessed. The evaluations ranged from 9 (very) to 1 on a 9-point hedonic scale (dislike extremely).

All of the panellists were habitual cookie eaters. Between assessments, the mouth was rinsed with room temperature water. Cookies made entirely of wheat flour served as the control. The data was compiled and analysed using statistical methods. The data are represented using descriptive statistics such as mean, standard error means, standard deviation, one-way ANOVA, and Duncan's multiple comparison tests. p-values of less than 0.05 were considered statistically significant. To look for variations in baseline characteristics, the t-test was done. Paired comparison tests are computed using the statistical programme IBM SPPS Statistics (Version 19 2010). Duncan's multiple range tests were used to measure the significance of differences between samples.

RESULTS AND DISCUSSION

The physical features of cookies, such as thickness (mm), diameter (mm), and spread ratio, are shown in Table –2. The thickness of V3 was the thickest (31.40mm), followed by V2 and V1. The V2 cookie had the biggest diameter in contrast to the control, followed by the V1 and V3 biscuits. The spared ratio of V3 cookies was larger than that of control and other V1 and V2 cookies.

This research backs up the findings of Imran et al. (2002), who discovered that adding different sugars to wheat flour reduced cookie width. Singh et al. (2008) found similar effects when wheat flour was replaced with 20–80 per cent sweet potato flour. The increase in cookie thickness with increasing mango mesocarp flour replacement might be explained by the swelling and binding of the cookie components owing to water absorption. Chinma and Gernah (2007) discovered a similar outcome when wheat was replaced with cassava, soybean, and mango flour.

Previously, Jan et al. (2015) discovered that buckwheat integrated wheat flour cookies and barley flour included wheat flour cookies had reduced spread ratios (Sharma and Gujral 2014; Jan et al. 2015; Tyagi et al. 2020).

Table 1. Ingredients required to make functional cookies

Ingredients	Control	V1	V2	V3
Whole wheat flour	100	80	60	40
Multigrain flour mixture	-	10	20	30
Flaxseed		10	20	30
Shortening (vegetable ghee, Dalda, India) (g)	40	40	40	40
Sugar (g)	40	40	40	40
Skim milk powder (g)	10	10	10	10
Salt (g)	1.0	1.0	1.0	1.0
Sodium bicarbonate (g)	1.0	1.0	1.0	1.0
Water (ml)	12-22	12-22	12-22	12-22

Nutrient analysis of functional cookies: According to the results of the nutritional analysis of cookies (table-3), the V1 cookies had the highest moisture content, while the V3 cookies had the lowest (7.24 per cent). Low moisture levels may improve the product's quality and extend its shelf life. With increasing supplementation levels, the moisture content of cookies fell considerably ($p<0.05$). An increase in moisture and ash content of lined cookies was reported by (Wade 1988; Leelavathi and Rao, 1993; Rao et al. 1995; Pasha et al. 2002; Butt et al. 2004). [AG1] The highest protein, fat, crude fibre, ash content, and energy were observed in V3 cookies with the nutrient value of 24.65g, 7.13g, 5.73g, 2.95g, and 578.21kcal respectively. The highest carbohydrate was found in V1 cookies with a value of 37.35g. Studies have shown that barley flour has a high content of dietary fibre and a high proportion of soluble fibre especially b-glucan. The health effects of b-glucans are suggested to lower plasma cholesterol, improve lipid metabolism, reduce glycemic index, and boost the immune system. Insoluble fibre is known for a reduction in the risk of colon cancer (Potty 1996; Butt et al. 2004; Tyagi et al. 2020). Among the three variations of cookies, the V3 cookie's mineral content was high when compared to V1 and V2 cookies.

Table 2. The physical properties of functional cookies

Parameters	Standard *	V1*	V2*	V3*
Thickness (mm)	23.83 ± 1.20^{a}	27.13 ± 1.10^{ab}	29.40 ± 1.52^{ac}	31.40 ± 1.45^{a}
Diameter (mm)	4.80 ± 0.50^{ab}	4.40 ± 0.65^{ac}	4.50 ± 0.55^{c}	3.60 ± 0.60^{b}
Spread ratio	49.28 ± 2.21^{c}	61.66 ± 2.50^{a}	65.33 ± 2.32^{ab}	87.22 ± 2.20^{ab}

Data are mean values of triplicate determination ± standard deviation; Means in the same column not followed by the same superscript are significantly different ($p < 0.05$)

The highest calcium, phosphorus, potassium, magnesium, zinc, and iron content observed in V3 micro mineral content was 300.50mg, 782.80mg, 460.82mg, 42.65mg, 3.26mg, and 3.19mg respectively. Yildiz and Bilgicli (2012) reported an increase in the calcium content of bread Lavas with the blending of whole buckwheat flour Tyagi et al. 2020).

The calcium content of functional biscuits decreased significantly (p0.05) after 90 days of storage, from 56.90 mg/100g to 56.59 mg/100g. Calcium content may have decreased as a result of interactions with other components such as protein and carbs. Rubin et al. (1997) studied the effect of micronutrient addition to cereal grain products and found similar results. V3 cookies included 35.20mcg of vitamin A, 1.08mg of thiamine, 0.47mg of riboflavin, 5.26mg of niacin, 1.70mg of vitamin C, 38.84mcg of folic acid, and 19.28mcg of folate free components, according to vitamin analysis. The bulk of B group vitamins are contained in the bran and germ layer of cereals. According to Batifouliera et al. (2005), and significant extraction results in B group vitamin loss. According to Misfa et al. (2020), the iron content of wheat atta enhanced with elemental iron used for chapatti manufacture is decreasing. While conducting a nutritional study of sorghum and chickpea incorporated value-added products. Sikandra and Boora (2019) discovered similar results (Sikandra and Boora 2019; Tyagi et al. 2020; Misfa et al. 2020).

Based on organoleptic assessments, V1 functional cookies earned the highest overall acceptability score of 8.70, followed by V2 cookies and V3 cookies (table-6). V1 cookies scored 8.30, 8.10, 7.60, 7.70, and 7.30 for appearance, colour, flavour, texture, and taste, respectively. According to Shazia et al. (2019), increasing the amount of flaxseed flour in the cookies decreased the sensory characteristics significantly. Color is a fundamental physical property of foods and agricultural products that determines external quality evaluation in both the food business and food engineering research (Bouaziz et al. 2020).

Table 3. Nutrient analysis of functional cookies

Parameters	Standard *	V1*	V2*	V3*
Moisture	9.85±1.52[a]	8.30±1.55[ac]	7.56±1.48[ab]	7.24±1.56[c]
Protein (g)	15.94±2.01[ab]	21.36±1.35[ab]	29.19±2.34[c]	37.03±3.21[ac]
Fat (g)	41.71±2.10[c]	46.57±3.15[b]	51.78±2.36[ac]	56.98±3.18[ab]
Crude fiber (g)	3.25±1.35[ac]	4.55±1.40[ac]	5.05±1.43[a]	5.73±1.38[ab]
Ash (g)	2.14±0.88[b]	2.47±0.70[ab]	2.75±0.90[ac]	2.95±0.86[ac]
Carbohydrate (g)	70.45±3.15[a]	37.35±3.40[c]	29.62±3.81[bc]	23.71±3.62[c]
Energy (kcal)	895.90±27.47[ab]	989.30±36.14[ab]	1150.90±45.15[b]	1312.50±33.64[ab]
Sodium (mg)	9.30±1.60a	12.64±1.42[ab]	17.82±1.73[c]	23.04±1.80[b]
Calcium (mg)	189.80±2.34[a]	220.30±1.35[b]	260.40±3.41[ac]	300.50±3.65[b]
Phosphorus (mg)	455.40±23.34[ac]	517.20±22.30[a]	650.00±23.14[ab]	782.80±18.41[ac]
Potassium (mg)	412.47±16.92[a]	453.61±10.68[c]	455.35±22.10[c]	460.82±21.25[a]
Magnesium (mg)	31.21±0.16[c]	35.40±0.14[ab]	37.37±0.15[a]	42.65± 0.18[ab]
Zinc (mg)	4.38±0.10[ab]	2.74±0.11[b]	2.95±0.10[b]	3.26±0.13[b]
Iron (mg)	2.10±0.13[b]	2.55±0.12[a]	3.04±0.11[ac]	3.19±0.12[c]
Vitamin A (mcg)	7.25±1.60[ab]	15.60±1.42[b]	25.40±1.73[ac]	35.20±1.80[a]
Thiamine (mg)	0.54±0.34[ac]	0.65±0.05[ab]	0.87±0.41[b]	1.08±0.25[b]
Riboflavin (mg)	0.33±0.14[a]	0.36±0.00[ac]	0.41±0.10[c]	0.47±0.02[c]
Niacin (mg)	4.40±0.20[c]	4.11±0.01[b]	4.69±0.23[a]	5.26±0.31[ac]
Vitamin C (mg)	0.50±0.10[ab]	0.90±0.01[ac]	1.30±0.04[a]	1.70± 0.18[b]
Folic Acid (mcg)	35.80±0.10[b]	32.04±0.11[ab]	35.44±0.10[b]	38.84±0.13[a]
Folic Free (mcg)	12.10±0.13[ac]	12.88±0.12[c]	16.08±0.11[ac]	19.28±0.12[bc]

*Data are mean values of triplicate determination ± standard deviation; Means in the same column not followed by the same superscript are significantly different ($p < 0.05$)

Table 4. Mean organoleptic scores of functional cookies.

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Standard	8.15±0.56[ab]	8.50±1.08[be]	7.60±0.78[a]	8.20±0.78[b]	7.50±1.08[e]	8.10±0.56[ab]
V1	8.30±0.67[fg]	8.10±0.73[de]	7.60±1.07[bc]	7.70±0.82[c]	7.30±0.67[ab]	8.70±0.67[fg]
V2	7.00±1.15[bc]	7.50±1.08[bc]	6.90±1.10[ab]	7.20±0.78[abc]	7.20±1.03[ab]	8.40±0.51[b]
V3	6.00±1.15[a]	6.20±1.22[a]	6.40±1.17[a]	6.70±1.41[ab]	7.10±1.28[ab]	8.00±0.81[b]

Values are the means ± standard errors of means (SEM) of four (3) determinants. Means with the same superscript are not significantly different using Duncan's Multiple Range Test ($P < 0.05$).

CONCLUSION

Based on the findings of this functional cookies research, it was concluded that the addition of multigrain flour to wheat flour for the fabrication of cookies was feasible. When compared to other treatment combinations, the V1 cookies (10:10 ratio) exhibited the best overall quality during storage. Despite having a larger nutritional content, V1 outperformed the other variants in terms of sensory and storage stability. Biscuits, noodles, extruded snacks, and other goods can be made using these ingredient combinations, and they can also be sold. Other susceptible groups can be fed customized ingredient combinations that are high in nutrients and easy to digest carbs and amino acids. Whole grains are high in protein, fibre, B vitamins, antioxidants, and trace minerals (iron, zinc, copper, and magnesium). A diet heavy in whole grains has been related to heart disease, type 2 diabetes, obesity, and numerous forms of cancer.

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