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SPONGE CAKE ENRICHED WITH BEETROOT POWDER AND CHARD PUREE: NUTRITIONAL AND SENSORY QUALITIES

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Abstract. The work investigates the possibility of using beetroot powder and chard puree in the technology of sponge cake with reduced gluten content. Reducing the gluten content in the sponge cakes was achieved by using wheat flour with a reduced protein content (8.2%), beetroot powder and chard puree. Beetroot (*Beta vulgaris L.*) and chard (*Beta vulgaris var. cicla*) are sources of fiber, minerals, flavonoids, alkaloids, triterpenes, carotenoids, saponins and betalains, but semi-finished products from beetroot and chard have not yet been used in the technology of flour confectionery. Wheat flour in the experimental samples was partially replaced by beetroot powder in different proportions (5, 10, 15 and 20% *w*/*w*). Egg products, which are allergens, have been partially replaced by chard puree in different proportions (10, 15, 20 and 25% *w*/*w*). Sponge cake recipe has been determined, which, in terms of the content of nutrients that determine the biological and energy value, as well as sensory properties, is characterized by the most acceptable indicators for dietary flour confectionery products with a reduced gluten content. Chemical composition (content of moisture, protein, fats, carbohydrates, dietary fibers, ash) and energy value of sponge cakes enriched with beetroot powder and chard puree were studied. Adding 15% beetroot powder and 20% chard puree to the sponge cake (Sample 3) provides a 36.51% reduction in fat, a 538.46% increase in dietary fiber and a 712.5% increase in ash. Energy value of Sample 3 is 15.76% less compared to the Control sample. Study was conducted to assess the organoleptic properties of sponge cakes enriched with beetroot powder and chard puree, according to the results of which Samples 3, 4 and the Control sample are characterized by the best indicators. Textural analysis was carried out for indicators of hardness, springiness, cohesiveness and chewiness of sponge cakes. Obtained results made it possible to establish that the addition of 15% beet powder and 20% chard puree to the sponge cake recipe (Sample 3) significantly improved the structure indicators (chewiness increased by 2.9%), compared to the recipe of the Control sample. Results of the conducted research indicate the effectiveness of using beet semi-finished products as potential substitutes for wheat flour and other allergens in confectionery technology. Introduction of the proposed ingredients into the recipe of sponge cakes allows to increase the content of bioactive compounds and ensures a decrease in the content of gluten and egg products.

Key words: confectionery, vegetables, dried beetroot, chard puree, baking, dietary food, quality characteristics, bioactive compounds.

Introduction. Formulation of the problem

Flour confectionery products are one of the most promising objects for development of technologies for functional food products, as they are widely used in nutrition of the population, both in Ukraine and around the world. Interest in confectionery products has increased recently, the main factors contributing to increase in demand for the consumption of confectionery and bakery products are urbanization, low cost, long shelf life, good taste and easy transportation [1,2]. Usually, the population of the planet uses confectionery and bakery products, such as bread, biscuits and cookies [3].

Composition of existing confectionery is characterized by a high content of gluten and a low content of complete protein, vitamins, minerals and dietary fibers. It is necessary to pay great attention to the enrichment of food products, in particular, flour confectionery products with proteins, dietary fibers, vitamins and minerals. Low protein content in confectionery can be easily increased by adding protein isolate [4]. Content of other biologically active substances should be increased by adding semi-finished products from plant raw materials.

Introduction of gluten into the body causes a violation of the process of absorption of nutrients (macro- and microelements, vitamins), deterioration of the general condition of a person. As a result, the work of the gastrointestinal tract is disturbed [5]. Improving the production technologies of products with a reduced gluten content based on imported ingredients will expand the range of such domestically produced food products and make them available to a wide range of consumers. Problem of production of low-gluten and gluten-free products remains the object of increased attention from manufacturers and consumers.

Analysis of recent research and publications

Nutritional value of the vast majority of flour confectionery products, produced according to traditional recipes, does not meet the modern requirements of nutrition science. It has a high content of simple carbohydrates, fats and does not contain enough protein, vitamins, macro- and microelements. Therefore, the main task in the production of this group of products is to increase the nutritional and biological value, the use of raw materials available for production and the preservation of the main technological indicators known to the consumer. Such products are developed with the aim of correcting and improving the nutritional status of the population within the framework of the state policy in the field of healthy nutrition. Optimization of food products recipes is an effective method of their improvement [6].

There are criteria that affect quality when developing new types of food products: safety for the consumer, high nutritional value and attractive appearance. One of the reasons for the development and production of products in which the components of the traditional recipe are replaced by alternative ones, was the increase in cases of gluten allergy, as well as the demand for this group of products among the population leading a healthy lifestyle. Gluten-free diet is the only effective treatment for individuals suffering from gluten-intolerance disorders, and has growth trends and is shifting its focus to the emerging market for gluten-free products. Europe has the largest market share of gluten-free products (47.5%) [7]. Extensive research has been carried out for the possibility of replacing gluten-containing raw materials with other ingredients, as well as texturing additives that give the dough a unique viscoelasticity and, as a result, the quality of confectionery products [8]. Production of gluten-free confectionery products with appropriate cohesion and elasticity remains a difficult task. Gluten-free products usually have low nutritional value and not always complete sensory and nutritional properties [9]. To increase the organoleptic properties and nutritional value of gluten-free food products, it is advisable to use various food additives, such as protein isolate [10] and selenium-protein complexes [11].

Many types of gluten-free confectionery have been supplemented with a wide range of additives, such as hydrocolloids, acidifiers, emulsifiers, leavening agents, preservatives and aromas or flavors, as well as proteins and sugars up to 81 and 87%, respectively [12]. Although the above-mentioned ingredients optimize the quality of the products, they tend to further reduce the nutritional value [13]. Common flours that naturally contain gluten (for example, wheat, barley and rye) can be deglutinated using bioprocess technologies, for example, the addition of a selected starter is able to detoxify immunogenic peptides through the action of enzymes secreted by lactobacilli [14]. However, these compositions of gluten-free products lack dietary fibers and bioactive compounds, which are reasonably necessary for the normal functioning of the body. Sources of dietary fiber and ash in confectionery products include seeds, skins, bones, stems and cores of fruits and vegetables, which can add biological value to the product [9].

Commercial value of any confectionery product is determined by its texture, sensory and organoleptic properties, which are mainly influenced by the physicochemical properties of the ingredients [15]. The most common source of dietary fiber is vegetable raw materials, namely root crops, including beets of various types. Beetroot is a unique source of dietary fiber – soluble and insoluble, protein and micro- and macroelements. The high biological value of beetroot powder is due to the optimal combination of vitamins, minerals and well-digested carbohydrates (glucose, fructose, sucrose). Flour obtained from legumes, root crops, and grain products can be used as a source of vegetable protein, micro- and macroelements, and dietary fiber to enrich the nutrient content of confectionery products [16]. Deficiency of fibre, iron,

calcium, antioxidants and folic acid in confectionery, especially in high sugar products such as biscuits, can be compensated for by replacing some of the flour with beetroot powder to make it healthier and more nutritious. Beetroot is widely used in cooking due to its high content of nutrients [17]. The deficiency of complete protein and mineral substances in food products is reduced due to the use of hydrobiont pastes enriched with microelements in the recipe [18]. Beetroots and its leaves are rich in dietary fibers, minerals and vitamins [19,20]. Beetroot contains a large number of bioactive substances such as carotenoids [21], phenolic compounds, saponins, betaine [22], betalains, polyphenols and flavonoids [23], which are also present in beetroot powder and have antioxidant properties [24]. Beet betaine is a trimethyl derivative of the amino acid glycine that promotes muscular endurance, strength, and power [25].

The inclusion of dietary fibers in confectionery products, in particular biscuits, has many advantages, mainly reducing their caloric content, as well as increasing the consumption of dietary fibers [26]. Physical properties, chemical composition, microstructure and organoleptic analysis of new cupcake recipes based on mixtures of gluten-free flour from various legumes (chickpeas, coral and green lentils), vegetables (spinach, zucchini, beets, pumpkin and carrots) and cereals (rice and corn) are investigated. The results showed that composite flour has higher protein, fiber and ash content compared to wheat flour. Recipe compositions of cupcakes were characterized by increased nutritional value in terms of protein and mineral content compared to the control. However, muffins based on composite flour had a significantly lower volume due to the absence of gluten. Analyzes of textural parameters showed a significant increase in hardness with an increase in the percentage of composite flour, as wheat flour produced less viscous and springy cakes. These results suggest that the use of colored legumes and vegetables can be a good alternative for the development of gluten-free confectionery [27]. Recipes of gluten-free biscuits are optimized by the mixture design methodology by adding whey protein concentrate [28].

The effect of replacing part of wheat flour with pea flour and the properties of butter dough and muffins were studied. Since the protein composition of pea flour differs from that of wheat flour, the effect of its inclusion in the recipe on the formation of dough and properties of muffins was monitored at various stages of muffin production. The results highlight the physico-chemical mechanisms and a schematic representation of the phenomena occurring at different stages of mixing depending on the order of inclusion of the ingredients. Replacing 20% and 40% of wheat flour with pea flour provided the best indicators of the structure of the cakes [29].

Flour from chestnut, carrot and chickpea powder has high nutritional and functional properties and can be included in biscuit recipes. Innovative research was aimed at evaluating the effect of mixing these types of flour with wheat flour when preparing biscuits. The density, microstructure and viscosity of the dough, as well as the specific volume, consistency and chewiness of the biscuits were evaluated. Chickpea flour decreased dough density and increased viscosity compared to wheat flour, while chestnut flour and carrot powder decreased viscosity and did not affect density [30].

Considering the solvency of the population, it is advisable to use available ingredients with a relatively high biological value for the manufacture of sponge cakes. The use of beetroot powder and puree, which has a high content of vegetable proteins, dietary fibers, ash and pigments (betalain), is promising in sponge cake technology. Scientists have not conducted a similar study to evaluate the benefits of using beetroot powder and chard puree in confectionery products such as sponge cakes.

The purpose and tasks of the research.

The purpose of the research is the development of flour confectionery products with a reduced gluten content, enriched with beetroot powder and chard puree.

To achieve the goal, the following **tasks** were performed:

1. To investigate the chemical composition of wheat flour, beetroot powder, chicken eggs and chard puree, as the main ingredients of sponge cakes with reduced gluten content.
2. Develop recipes for sponge cakes with reduced gluten content with beetroot powder and chard puree.
3. To investigate the effect of the introduction of beetroot powder and chard puree on the chemical composition of sponge cakes with reduced gluten content in terms of moisture content, protein, fat, carbohydrates, dietary fiber, ash and energy value.
4. To evaluate the organoleptic properties of each recipe composition of sponge cakes with reduced gluten content with beetroot powder and chard puree determined during the experiment.
5. To investigate the texture of sponge cakes with reduced gluten content with beetroot powder and chard puree for hardness, springiness, cohesiveness and chewiness.

Research materials and methods

Raw material for research. Fresh beetroot (*Beta vulgaris L.*); fresh chard (*Beta vulgaris var. cicla*); wheat flour with a low protein content " Purple Orchid Low Gluten Wheat Flour", China; dietary chicken eggs, Ukraine; white sugar "Shchedra Torbynka", Ukraine; vanilla essence "Badia", USA; milk powder "Sto Pudiv", Ukraine; baking powder "Dr. Oetker", Romania and refined deodorized corn oil "Kama",

Ukraine. All reagents used in this experiment were of analytical grade.

Preparation of beetroot powder. Fresh beetroot (*Beta vulgaris L.*) were cleaned of foreign substances and inedible parts. Then the beetroot were cut into thin pieces (3 mm) using a slicer. Sliced beetroot were blanched at 80°C followed by drying at 55°C for 3–4 hours in a chamber dryer. The drying process was carried out using microwave power of 1000W. The drying process was stopped when the final moisture content of the beetroot slices was lower than 6.0%. The beetroot slices were crushed, passed through a 200 μm sieve, the beetroot powder was packed in a plastic bag and stored at 25°C for further use.

Preparation of chard puree. Fresh tops of chard (*Beta vulgaris var. cicla*) were blanched for 1 min. and crushed in a blender to a homogeneous puree consistency. Chard puree was evaporated in a chamber dryer to a pasty consistency to a moisture content of ≤60 %.

Sponge cake manufacturing technology. To prepare sponge cakes, sifted wheat flour and beetroot powder were first mixed. Beetroot powder was added to the sponge cake dough together with flour after whipping the sugar-egg mixture and chard puree in given concentrations with a corresponding reduction in the content of wheat flour and egg products. The resulting mixture was thoroughly mixed with other ingredients (baking powder, oil, milk powder and vanilla essence). The dough was poured into a previously oiled mold and baked at 160–180°C for 20–30 minutes.

Chemical composition of wheat flour, beetroot powder, chicken eggs and chard puree, and analysis of nutritional value of sponge cakes. An analysis of the chemical composition of wheat flour, beetroot powder, chicken eggs and chard puree and sponge cake samples with their addition was carried out, including the measurement of moisture, sugars and ash [31]. Fat content was analyzed using the Soxhlet extraction method [32], protein content using the Kjeldahl method [33], and total dietary fiber content using the enzymatic gravimetric method [31]. The energy value of sponge cakes in kcal per 100 g was determined by the calculation method [31]. Wheat protein content was determined by the calculation method [31].

Organoleptic characteristics. Ten experts evaluated sponge cakes using the Score Card method to evaluate sensory parameters of color, flavor, texture, taste and overall acceptability [34]. The obtained values from the participants were evaluated using a one-way analysis of variance and expressed as a mean value.

Structural analysis of sponge cakes. A typical TPA (Texture profile analysis) test was conducted using a TA.XTPlus Texture Analyzer equipped with a cylindrical probe (P50) with a compression ratio of 50%. The parameters of hardness, springiness, cohesiveness and chewiness were determined. The results are the average of six replicate cycles of textural analysis of sponge cakes.

Statistical analysis. The results of the studies were evaluated using one-way analysis of variance and expressed as the mean value with the number of experiments n=6 and standard error $\alpha<0.05$.

Results of the research and their discussion

In order to compare the main recipe components of sponge cakes, namely beetroot powder, wheat flour and chard puree, their chemical composition was analyzed, which is shown in Table 1. The data in Table 1 show that the fat content in beetroot powder is 2 times lower and in chard puree 5 times lower than in wheat flour. Partial replacement of wheat flour with beetroot powder will reduce the energy value of sponge cakes. Beetroot powder contains 1.4 times more protein, 3.4 times more ash and 2.7 times more dietary fiber than wheat flour. Beetroot powder contains much sugar, since the average amount of sugar in beets is 8.47–8.98% [35], and the concentration increases significantly during drying. Thus, it is rational to introduce beetroot powder into the recipe of flour confectionery in order to partially replace wheat flour. As can be seen from the obtained data, beetroot powder and chard puree will significantly increase the biological value of sponge cakes due to the high content of dietary fibers and ash.

Table 1 - Chemical composition of wheat flour, beetroot powder, chicken eggs and chard puree, n=6, $\alpha<0.05$

Name of nutrients	Nutrient content, %			
	Wheat flour with low protein content	Beetroot powder	Dietary chicken eggs	Chard pasta
Moisture content	9.5	6.5	73.6	60
Protein	8.2	12.2	12.6	10.5
Fat	2.5	1.1	12.0	0.5
Carbohyd-rates:	78.3	75	0.7	21.8
sugars	-	47.5	-	6.2
dietary fiber	10.5	27.5	-	11.5
Ash	1.5	5.2	1.1	7.2

Recipe for sponge cakes with reduced gluten content enriched with beetroot powder and chard puree. Sponge cakes with reduced gluten content were prepared by partially replacing wheat flour with different proportions of beetroot powder. In the recipe, egg products are partially replaced by chard puree in different ratios. Using different ratios of wheat flour, beetroot powder, and chard puree, four different samples of sponge cakes were made. The ratio in the recipe of wheat flour and beetroot powder is 95:5

(Sample 1), 90:10 (Sample 2), 85:15 (Sample 3) and 80:20 (Sample 4). The ratio of eggs to chard puree is 90:10 (Sample 1), 85:15 (Sample 2), 80:20 (Sample 3) and 75:25 (Sample 4). All the ingredients used to prepare the sponge cakes are listed in Table 2. To prepare the sponge cakes, sifted wheat flour and beetroot powder were first mixed in different proportions (5, 10, 15 and 20% *w*/*w*), and chicken eggs were partially replaced by chard puree in different proportions (10, 15, 20 and 25% *w*/*w*).

The effect of the introduction of beetroot powder and chard puree on the chemical composition of sponge cakes with reduced gluten content. Data from Fig. 1 indicate that the highest carbohydrate content determined in Sample 4 is 44.3 g/100g, which is 13.01% higher than in the Control sample. In Sample 3 with 15% beetroot powder and 20 % chard puree, the carbohydrate content exceeded the Control sample by 10.46%. The protein content of Samples 2, 3, 4 decreased by 1.47%, which is due to the partial replacement of egg products in the recipe of sponge cakes with reduced gluten content. There was a tendency to decrease the fat content in experimental sponge cake Samples 1, 2, 3, and 4 by 17.84%, 27.39%, 36.51%, and 45.64%, respectively. The fat content in sponge cakes with a reduced gluten content was most affected by the decrease in the number of dietary chicken eggs in the recipe (Table 2), since they contain a significant amount of fat, and there is almost no fat in the chard puree (Table 1). The dietary fiber content increased from 238.36% for Sample 1 and 676.92% for Sample 4. For Samples 3 and 4, the dietary fiber content increased by an average of 5 times compared to the Control sample. According to the total content of micro- and macroelements, the indicators of the experimental Samples increased from 337.5% – Sample 1 to 887.5% – Sample 4, compared to the Control sample. There were no significant changes in the moisture index for the Control sample and Experimental samples. The fluctuation of moisture content was within 1.1%, which did not significantly affect the quality and organoleptic indicators of sponge cakes with reduced gluten content. There is a significant increase in nutritional value and a decrease in fat content, despite an increase in the content of carbohydrates, which mostly consist of dietary fibers and natural sugars (Table 1).

The content of wheat protein, which contains gluten and mainly consists of glutenins and gliadins, in the Control sample was 2.05 g/100g. With the addition of beetroot powder and chard puree to the sponge cake recipe, the wheat protein content began to decrease. For Sample 3, the wheat protein content decreased by 13.7%, and for Sample 4 by 17.1%. The energy value of sponge cakes with reduced gluten content for the Control sample was 400.9 kcal/100g. Sample 3 showed a 15.76% decrease in energy value compared to the control.

Organoleptic evaluation of sponge cakes with reduced gluten content enriched with beetroot powder and chard puree. Organoleptic indicators for the consumer based on color, flavor, texture, taste and overall acceptability of the samples are shown in fig. 2. Values in fig. 2 are given as average, after tasting by ten experts. It was also noted that sponge cakes Sample 3 made with the addition of 15% beetroot powder and 20% chard puree had high taste, texture and color scores among other proportions of beetroot powder compared to the control. Sponge cake sample 4, made with the addition of 20% beetroot powder, was found to have reduced texture and flavor scores, which is due to the large amount of beetroot powder and chard puree in the recipe.

TPA of sponge cakes with reduced gluten content enriched with beetroot powder and chard puree. The analysis of the texture profile was carried out to determine the chewiness of the sponge cake enriched with beetroot powder and chard puree, shown in Fig.3.

Table 2 - Recipe for sponge cakes with reduced gluten content enriched with beetroot powder and chard puree

Recipe ingredient, g	Control sample	Sample 1	Sample 2	Sample 3	Sample 4
Wheat flour with low protein content	250.0	238.0	226.0	216.0	207.0
Beetroot powder	0.0	12.0	24.0	34.0	42.5
White sugar	180.0	180.0	180.0	180.0	180.0
Corn oil	190.0	190.0	190.0	190.0	190.0
Milk powder	12.5	12.5	12.5	12.5	12.5
Dietary chicken eggs	360.0	324.0	306.0	288.0	270.0
Chard puree	0.0	36.0	54.0	72.0	90.0
Baking powder	5.0	5.0	5.0	5.0	5.0
Vanilla essence	2.5	2.5	2.5	2.5	2.5
In total	1000	1000	1000	1000	1000

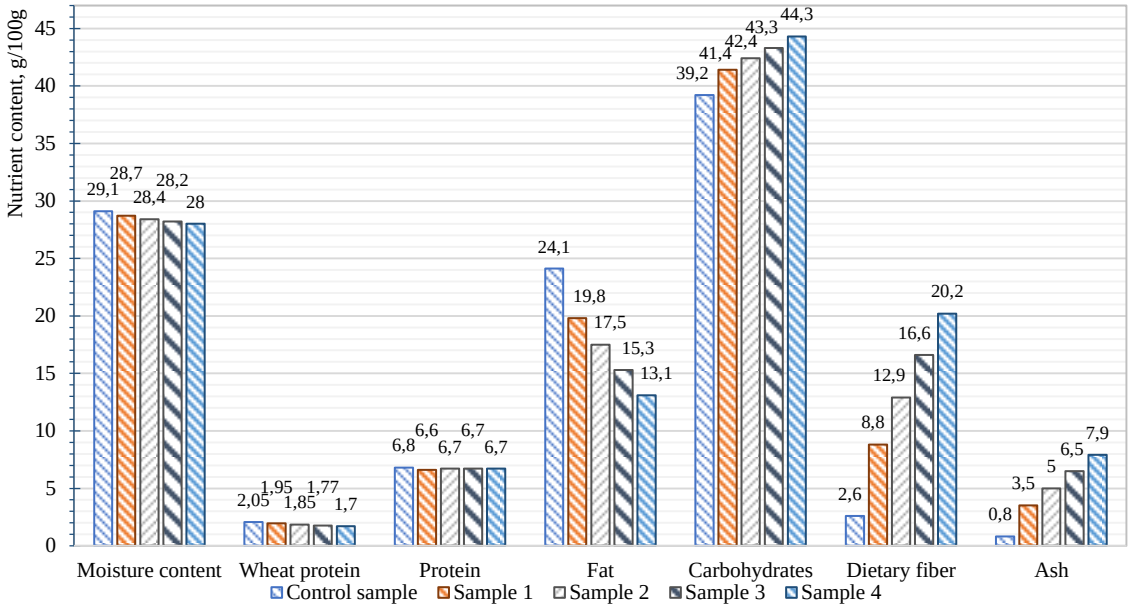

Fig. 1. Composition of nutrients in sponge cakes with reduced gluten content enriched with beetroot powder and chard puree n=6, α<0.05

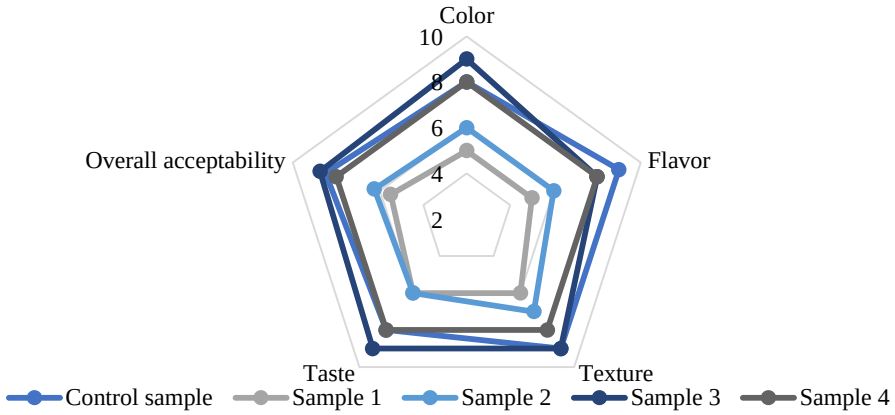

Fig. 2. Organoleptic evaluation of sponge cakes enriched with beetroot powder and chard puree

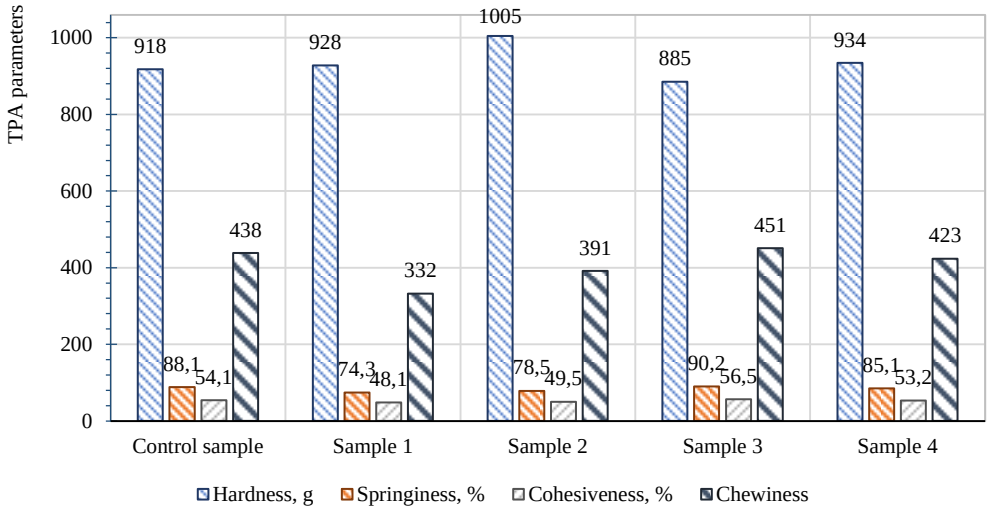

Fig. 3. Texture of sponge cakes enriched with beetroot powder and chard puree n=6, α<0.05

Studies have shown that a small amount of beetroot powder and chard puree in the recipe worsens its texture, so the chewiness of Sample 1 decreased by 31.9% and Sample 2 by 12% compared to the Control sample. The springiness and cohesiveness of samples 1 and 2 also decreased. Positive dynamics began to be observed in Sample 3, when the addition of a large amount of chard puree (20%) to the recipe of sponge cakes enriched with beetroot powder and chard puree contributed to a better recovery of beetroot powder in the production of sponge cakes (Table 2). Reducing the moisture content of sponge cakes enriched with beetroot powder and chard puree had a positive effect on springiness and cohesiveness, which improved chewiness, which increased by 2.9% for Sample 3 compared to the Control sample. The dynamics of changes in hardness and other texture indicators are well monitored. Thus, for Sample 2, it was the largest, by 9.48% of the Control sample. At the same time, the springiness and cohesiveness decrease, which is due to the lower moisture content of the sponge cake dough for Samples 1 and 2. More addition of chard puree increases the springiness and cohesiveness of the sponge cakes, thereby reducing the hardness, which for Sample 3 decreased by 3.73% compared to Control sample. Patterns of texture change require more in-depth research.

Conclusion

Chemical composition of wheat flour, beetroot powder, chicken eggs and chard puree as the main ingredients of sponge cakes with reduced gluten content was studied. It has been proven that the fat content in beetroot powder is 2 times lower and in chard puree 5 times lower than in wheat flour. Beetroot powder contains 1.4 times more protein, 3.4 times more ash and 2.7 times more dietary fiber than wheat flour. Thus, it is rational to introduce beetroot powder into the recipe of flour confectionery in order to partially replace wheat flour. Beetroot powder is a rich source of dietary fibers and minerals and can be used in the production of bakery and confectionery products. Content of protein, fat, ash and fiber in different percentages of beetroot powder increased with increasing beet powder. Four samples of the sponge cake recipe with reduced gluten content were developed using beetroot powder and chard puree. The effect of the introduction of beetroot powder and chard puree on the chemical composition of sponge cakes with reduced gluten content was studied in terms of moisture content, protein, fat, carbohydrates, dietary fiber, ash and energy value. Sample 3 with 15% beetroot powder and 20% chard puree was the best. Sponge cakes containing 15% beetroot powder had better color, taste and texture compared to other samples. This study showed that sponge cakes prepared with 15% (*w*/*w*) beetroot powder had comparatively better nutritional and sensory characteristics compared to the control. Therefore, we advise you to use sponge cake made from 15% beetroot powder in your daily diet for health benefits. The protein content of Sample 3 decreased by 1.47%, which is due to the partial replacement of egg products in the gluten-reduced sponge cake recipe. With the addition of beetroot powder and chard puree to the sponge cake recipe, the wheat protein content began to decrease. For Sample 3, the wheat protein content decreased by 13.7%. In Sample 3, there was a tendency to decrease the fat content by 36.51%. Dietary fiber content increased for Sample 3 compared to the Control sample by an average of five times. According to the total content of micro- and macroelements, the indicators of Sample 3 increased by 712.5% compared to the Control sample. The fluctuation of moisture content was within 1.1%, which did not significantly affect the quality and organoleptic indicators of sponge cakes with reduced gluten content. Sample 3 showed a 15.76% decrease in energy value compared to the control. Organoleptic properties of each recipe composition of sponge cakes with reduced gluten content with beetroot powder and chard puree determined during the experiment were evaluated. Sponge cake Sample 3, made with the addition of 15% beet powder and 20% chard puree, was noted to have high taste, texture and color scores among other proportions of beet powder compared to the control. The texture of gluten-reduced sponge cakes with beetroot powder and chard puree was studied for hardness, springiness, cohesiveness and chewiness. The dynamics of changes in hardness and other texture indicators were monitored. Thus, for Sample 2, it was the largest, by 9.48% more than the Control sample. At the same time, the springiness and cohesiveness decrease, which is related to the lower moisture content of the sponge cake dough for Samples 1 and 2. More addition of chard puree increases the springiness and cohesiveness of the sponge cakes, thereby reducing the hardness, which for Sample 3 decreased by 3.73% compared to the Control sample, which gave the best results among other samples. Further research should focus on the use of different beet varieties, color indicators, pigment content and qualitative analysis of beet mineral substances. Further research should be directed to the use of different beet varieties, the determination of color indicators, the qualitative analysis of beet pigments and minerals, and the use of beet semi-finished products in the recipe of other dietary food products to replace ingredients that cause intolerance and allergens.

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БІСКВІТ ЗБАГАЧЕНИЙ БУРЯКОВИМ ПОРОШКОМ ТА ПАСТОЮ МАНГОЛЬДА: ПОЖИВНІ ТА ОРГАНОЛЕПТИЧНІ ВЛАСТИВОСТІ

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Анотація. У роботі досліджено можливість використання бурякового порошку та пасти мангольду у технології бісквіту зі зниженим вмістом глютену. Зниження вмісту глютену у складі бісквітів досягали шляхом використання борошна пшеничного зі зниженим вмістом білка (8,2%), бурякового порошку та пасти мангольду. Буряк (*Beta vulgaris L.*) та мангольд (*Beta vulgaris var. cicla*) є джерелами клітковини, мінеральних речовин, флавоноїдів, алкалоїдів, тритерпенів, каротиноїдів, сапонінів та беталаїнів, однак напівфабрикати з буряку та мангольду досі не застосовували у технології борошняних кондитерських виробів. Борошно пшеничне у дослідних зразках частково замінено на порошок буряку у різних пропорціях (5, 10, 15 та 20% *мас./мас.*). Здійснено часткову заміну традиційних для бісквітів яєчних продуктів, що є алергенами, на пасту мангольду у різних пропорціях (10, 15, 20 та 25% *мас./мас.*). Визначено рецептуру бісквіту, яка за вмістом нутрієнтів, що визначають біологічну та енергетичну цінність, а також сенсорними властивостями, характеризується найбільш прийнятними показниками для борошняних кондитерських виробів дієтичного спрямування зі зниженим вмістом глютену. Проведено дослідження хімічного складу (вміст вологи, білка, жирів, вуглеводів, харчових волокон, золи) та енергетичної цінності бісквітів, збагачених порошком буряку та пастою мангольда. Додавання до бісквіту 15% бурякового порошку та 20% пасти мангольду (Зразок 3) забезпечує зменшення жиру на 36,51%, збільшення вмісту харчових волокон на 538,46% та золи на 712,5%. Значення енергетичної цінності Зразка 3 на 15,76% менше у порівнянні з Контрольним зразком. Здійснено дослідження щодо оцінки органолептичних властивостей бісквітів, збагачених порошком буряку та пастою мангольда, за результатами яких найліпшими показниками характеризуються Зразки 3, 4 та Контрольний зразок. Проведено текстурний аналіз бісквітів, а саме показники твердості, пружності, когезивності та розжовуваності. Отримані результати дозволили встановити, що додавання до бісквіту 15% бурякового порошку та 20% пасти мангольду до рецептури бісквіту (Зразок 3) значно покращило показники структури (розжовуваність збільшилась на 2,9%), порівняно з рецептурою Контрольного зразка. Результати проведених досліджень свідчать про ефективність використання напівфабрикатів з буряку, як потенційних замінників борошна пшеничного та інших алергенів у технології кондитерських виробів. Уведення в рецептуру бісквітів пропонованих інгредієнтів дозволяє підвищити вміст біологічно активних речовин та забезпечує зменшення вмісту глютену та яєчних продуктів.

Ключові слова: кондитерські вироби, овочі, буряк сушений, паста мангольду, випічка, дієтичне харчування, якісні характеристики, біологічно активні речовини.