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VASYLENKO OLHA
Sumy National Agrarian University
https://orcid.org/0000-0003-1643-0702
email: vasylenko.sumy@gmail.com
HOLOVKO TATYANA
State Biotechnological University
https://orcid.org/0000-0002-4235-5497
email: 0677096521@btu.kharkov.ua

RESEARCH QUALITY INDICATORS OF «MONACO» BISCUITS FOR A HEALTHY DIET

To create «Monako» biscuits for a healthy diet with partial replacement of gluten flour with beetroot powder, A2 dried milk, obtained from the milk of Holstein cows, was used. The recipe also includes beetroot powder (10% and 20%), which is a source of biologically active substances, and quail eggs. To reduce the gluten content (allergen) in the flour, part of the wheat flour is replaced with beetroot powder. Quail eggs are used instead of chicken eggs to increase the dietary value of the product. A2 dried milk is used instead of regular cow's milk. The new recipe reduces the amount of gluten and allergens, removes β-casein A1 and chicken eggs from the biscuit recipe, and also allows [1] for increasing the content of biologically active substances (betaine), fiber, and ash. The best recipe was determined by studying the physicochemical composition and organoleptic properties of the healthy diet biscuit with A2 dried milk, quail eggs, and beetroot powder. The results showed that replacing regular cow's milk with A2 dried milk, replacing chicken eggs with quail eggs, and adding 20% beetroot powder to the biscuit recipe (sample 2) significantly improved nutritional value, reduced fat content by 5%, and increased protein content by 35%. The biological value of Sample 2 compared to the Control significantly increased, which is confirmed by an increase in the content of dietary fiber by 284% and ash by 153%. Adding 20% beetroot powder gave the biscuits a pleasant red color and improved the organoleptic color indicator, which confirms the effectiveness of its use as a food coloring. Organoleptic indicators improved, which positively affected the main textural [2] indicator of chewability, which increased by 11.4%. «Monako» biscuits for a healthy diet with partial replacement of gluten flour with beetroot powder with A2 dried milk, quail eggs, and dried beetroot, due to high rates of nutritional and biological value and the presence of biologically active substances (betaine) in their composition, are suitable for everyday and dietary nutrition.

Keywords: A2 dry milk, quail eggs, dried beets, confectionery, healthy diet, quality characteristics.JEL Classification: L59.

ВАСИЛЕНКО ОЛЬГА
Сумський національний аграрного університет
ГОЛОВКО ТЕТЯНА
Державний біотехнологічний університет

ДОСЛІДЖЕННЯ ПОКАЗНИКІВ ЯКОСТІ БІСКВІТІВ «МОНАКО» ДЛЯ ЗДОРОВОЇ ДІЄТИ

Для створення бісквітів «Монако» для здорової дієти з частковою заміною борошна на порошок буряку із використанням сухого молока А2, отримане з молока голштинських корів. В рецептуру включено порошок буряка (10% та 20%), який є джерелом біологічно активних речовин, та перепелині яйця. Для зниження вмісту жиру та цукру, а також глютену (алергену) у борошні, частину пшеничного борошна замінено на буряковий порошок. Перепелині яйця використано замість курячих для підвищення дієтичної цінності продукту. Замість звичайного коров'ячого молока використано сухе молоко А2. Нова рецептура зменшує кількість глютену та алергенів, прибирає з рецептури бісквітів β-казеїн А1 та курячі яйця, а також дозволяє підвищити вміст біологічно активних речовин (беталаїн), клітковини та золи. Визначено найкращу рецептуру шляхом дослідження фізико-хімічного складу та органолептичних властивостей бісквіту для здорової дієти з сухим молоком А2, перепелиними яйцями та порошком буряка. Отримані результати дозволили встановити, що заміна звичайного коров'ячого молока сухим молоком А2, заміна курячих яєць перепелиними та додавання 20% бурякового порошку до рецептури бісквіту (зразок 2) значно покращило харчову цінність, зменшився вміст жиру на 5 %, а вміст білка збільшився на 35 %. Біологічна цінність Зразка 2 у порівнянні з Контролем значно збільшилась, що підтверджується збільшенням вмісту харчових волокон на 284 % та золи на 153 %. Додавання 20% бурякового порошку надало бісквітам приємний червоний колір та покращило органолептичний показник кольору, що підтверджує ефективність його використання у якості харчового барвника. Органолептичні показники покращились, що позитивно вплинуло на основний текстурний показник розжовуваності, що збільшилась на 11,4 %. Бісквіти «Монако» для здорової дієти з частковою заміною глютену борошна на порошок буряку з сухим молоком А2, перепелиними яйцями та сухим буряком, завдяки високим показникам харчової та біологічної цінності та наявності у своєму складі біологічно активних речовин (беталаїн), підходять для повсякденного та дієтичного харчування.

Ключові слова: сухе молоко А2, перепелині яйця, буряк сушений, кондитерські вироби, здорова дієта, якісні характеристики.

Introduction

This research investigates the development of «Monako» biscuits *for a healthy diet* incorporating A2 milk, quail eggs, and beetroot powder. While existing literature addresses aspects of these ingredients individually, a comprehensive study exploring their synergistic effects in biscuit formulation for a healthy diet, specifically addressing gluten reduction, is lacking. This study aims to fill this gap.

Milk proteins play an important role in both the dairy industry and the food industry in general, due to their high nutritional and functional properties, which make them indispensable components of various food products. Studies on the sensory and technological impact of β-casein variants in dairy products such as yogurt and confectionery are limited. However, available data indicate that the production of dairy products from A2

milk is a promising direction, since such products have minor differences compared to products obtained from traditional milk [1]. The production of confectionery products based on A2 milk is an innovative solution in the technology of biscuits with natural fillers, aimed at optimizing recipes [2]. Milk contains two main groups of proteins: caseins and whey proteins. Casein is present in the form of colloidal aggregates and precipitates at pH 4.6 and a temperature of 20 °C. Whey proteins, also called soluble proteins, remain soluble under these conditions, which is the main difference between these two groups of proteins. Caseins consist of four genetic variants (αs1-, αs2-, β- and k-casein) and are characterized by microheterogeneity due to genetic variation [3]. A2 milk is cow's milk that does not contain the A1 β-casein. A1 and A2 are genetic variants of the beta-casein protein that differ by one amino acid. Recent studies support the effectiveness of A2 milk in improving gastrointestinal function in both adults and children [4].

Quail eggs have high nutritional, therapeutic and functional potential and are widely used in the food industry both fresh and canned, using innovative drying methods such as liquid egg drying and foam-mat drying, with the aim of increasing their consumption worldwide [5]. The effect of adding quail egg yolk on the quality of sponge cake dough was studied. The physicochemical properties of the dough and the finished product, including its texture, volume and color, were analyzed [6]. A comparative study of the physicochemical and functional properties of chicken and quail eggs was conducted. The authors analyze the content of dry matter, proteins, fats, and also evaluate their emulsifying and foaming properties [7]. The study of the effect of lecithin from quail eggs on the rheological properties of wheat flour dough was conducted. Viscosity, elasticity and other dough parameters affecting the quality of bakery products were analyzed [8]. The issues of including quail eggs in the diet of pregnant women and for people leading a healthy lifestyle, given their nutritional value and potential beneficial properties, are considered [9].

Downsizing agricultural production for personal consumption, income generation, and as a hobby is a growing trend among Ukrainian and American farmers. Raising laying hens or quail is an economically viable activity for small farms with limited resources, such as energy-efficient farms in Ukraine [10].

Beetroot is widely used in the food industry as a source of betalain, as evidenced by studies of the efficient extraction of betalain from beetroot powder [11, 12]. Betalain is an important food additive used in the food industry as a natural colorant. Red beetroot is the most common source of betalain, and research into its drying and encapsulation methods is ongoing to improve its quality characteristics and shelf life [13].

Dried beetroot can be used as a food coloring and a source of dietary fiber and minerals in the production of sausage products enriched with protein isolate [14].

Flour confectionery products are one of the most promising objects of development of functional food technology, as they are widely used in the nutrition of the population both in Ukraine and around the world [15].

The incorporation of dietary fiber has demonstrated the potential to reduce both fat and sugar content within biscuit formulations. However, it is crucial to acknowledge that excessive fiber addition can detrimentally affect the organoleptic properties of the final product, leading to undesirable textural attributes such as hardness and diminished palatability. Consequently, optimization of dietary fiber levels is recommended to achieve a harmonious balance between nutritional enhancement and consumer acceptability [16].

Extensive research has elucidated the diverse health benefits associated with dietary fiber consumption. These benefits encompass improvements in digestive function, including the mitigation of constipation and other gastrointestinal discomforts, and positive modulation of cholesterol and glucose levels. Dietary fibers exert a positive influence on human health through various mechanisms. For instance, they can contribute to gluten reduction within the overall recipe. Furthermore, their role in lowering blood cholesterol and promoting healthy blood sugar regulation is particularly relevant for individuals managing diabetes or seeking cardiovascular health. Therefore, it is strongly recommended that dietary fiber be incorporated at appropriate levels in food products designed for a healthy diet [17].

Increasing consumer awareness and competence in choosing food products, in particular confectionery, is a priority task for improving the nutrition of the population. Interest in confectionery has recently increased [18]. The main factors contributing to the increase in demand for confectionery and bakery products are urbanization, low cost, long shelf life, pleasant taste and ease of transportation [19].

Healthy diet is the key to good health and the prevention of many diseases. It involves a balanced consumption of a variety of foods that provide the body with the necessary nutrients. In the context of this study, the development of a biscuit recipe for healthy eating is a topical task. Replacing traditional ingredients with healthier ones, such as A2 dried milk, beet powder and quail eggs, allows you to create a product with an increased content of biologically active substances, fiber and ash. Such biscuits can be a great addition to the diet of people who want to lead a healthy lifestyle and take care of their health [20].

The aim of the research is to develop a new recipe for biscuits for a healthy diet, by partially replacing components with dietary products, such as A2 cow's milk powder and quail eggs, as well as partially replacing wheat flour with beetroot powder and studying their organoleptic, physical-chemical indicators and texture profile.

Results and discussion

The new food products included in the recipe are affordable for low-income populations, while A2 milk powder, quail eggs, and beetroot powder have high nutritional and biological value.

To confirm the effectiveness of changing the cookie recipe, a chemical analysis of the ingredients was conducted and the quality characteristics of the healthy diet cookies were investigated.

Raw materials for the study. Cow's milk A1 and A2 from Holstein cows, chicken and quail eggs, fresh beetroot (Beta vulgaris L.), low-protein wheat flour, sugar, baking powder, oil and other materials used in the study were purchased at a local farmers' market in Sumy, Ukraine. Analytical reagent grade chemicals and solvents were used in the study.

Preparation of beetroot powder. Fresh beetroot (Beta vulgaris L.) was purchased from the local market and cleaned of foreign matter and inedible parts. The beetroot was then sliced into thin slices (2 mm) using a slicer. The sliced beetroot was blanched at 80 °C followed by drying at 55 °C for 4 hours in a chamber dryer. The drying process was carried out at a microwave power of 1000 W. The drying process was completed when the final moisture content of the beetroot slices was less than 7.0% wet weight. The dried beetroot was ground to a powdery consistency and packed in airtight glass containers for further use.

Biscuit manufacturing technology. To prepare the biscuits, sifted wheat flour and beetroot powder were first mixed. Beetroot powder was added to the biscuits together with flour after beating the sugar-egg mixture in the specified concentrations with a corresponding reduction in the wheat flour content and replacing chicken eggs with quail eggs. The resulting mixture was thoroughly mixed with other ingredients (baking powder, oil, A2 milk powder and vanilla essence). The dough was poured into a pre-oiled mold and baked at 170-180 °C for 25-30 minutes.

Chemical composition of ingredients and cookies. The chemical composition of the main ingredients (A2 milk powder, chicken and quail eggs, beetroot powder, wheat flour) and finished cookie samples was examined according to AOAC International standard methods (2006).

The determination of moisture, sugars and mineral content was carried out according to the relevant AOAC methods. The fat content was determined by the Soxhlet method, the protein content by the Kjeldahl method, and the total dietary fiber content by the enzymatic-gravimetric method. The energy value of the cookies (kcal/100 g) was calculated taking into account the content of proteins, fats and carbohydrates.

Organoleptic evaluation. The sensory characteristics of the cookies (color, consistency, aroma, taste, and overall acceptability) were evaluated using the Score Card method with the involvement of ten experts. The obtained data were processed by the one-way analysis of variance method and presented as mean values.

Texture analysis. ATA.XT Plus Texture Analyzer with a cylindrical probe (P50) and a compression ratio of 25% was used to study the textural properties of the cookies. During a typical TPA test, such parameters as hardness, elasticity, cohesiveness and chewiness were determined. The results were presented as the average of three repeated measurements.

Statistical data processing. The obtained experimental data were processed using one-way analysis of variance. The results were expressed as mean values (n=3) taking into account the standard error ($\alpha<0.05$).

Recipe and physicochemical composition of «Monako» biscuits for a healthy diet

The physicochemical composition of the main components of biscuits, namely A2 milk powder, chicken and quail eggs, beetroot powder, wheat flour is shown in Fig. 1. The fat content in beetroot powder is 2.5 times lower than in wheat flour. Partial replacement of wheat flour with beetroot powder will reduce the energy value of food products. Beetroot powder contains 60% more protein, 2.4 times more ash and dietary fiber than wheat flour. Thus, beetroot powder should be rationally introduced into the recipe of flour confectionery products in order to partially replace wheat flour with a reduced protein content and give them the status of low-gluten. As can be seen from the data obtained, beetroot powder will significantly increase the biological value of biscuits.

Fig. 1. Physico-chemical composition of the components of the «Monako» biscuits *for a healthy diet* recipe and their analogues n=3, α<0.05

Recipe for biscuits with reduced gluten content enriched with A2 milk powder, quail eggs and beetroot powder. Biscuits with reduced gluten content were prepared by partially replacing wheat flour with different proportions of beetroot powder. In the recipe, cow's milk powder was completely replaced by A2 milk powder, and chicken eggs were completely replaced by quail eggs. Using wheat flour and beetroot powder, two different biscuit samples were prepared. The ratio of wheat flour to beetroot powder in the recipe was 90:10 (Sample 1) and 80:20 (Sample 2). All ingredients used to prepare the biscuits are listed in Table 1. To prepare the biscuits, first, sifted wheat flour and beetroot powder were mixed in different proportions (10 and 20% *w/w*), and cow's milk powder was completely replaced by A2 milk powder, and chicken eggs were completely replaced by quail eggs.

Table 1

«Monako» biscuits *for a healthy diet* with beetroot recipe

Recipe ingredient, g	CONTROL	Sample 1	Sample 2
Wheat flour with reduced protein content	300	270	240
Beetroot powder	0	30	60
Sugar	150	150	150
Oil	170	170	170
Milk powder A2	75	75	75
Quail eggs	300	300	300
Baking powder	5	5	5
Total	1000	1000	1000

The addition of A2 milk powder, quail eggs and beetroot powder to the biscuit recipe led to significant changes in the physicochemical composition of low-gluten biscuits with beetroot. Replacing regular cow's milk with A2 milk creates the prerequisites for using biscuits in dietary nutrition of the population, since β-casein A2 does not have a negative effect on human digestion.

Physico-chemical composition of «Monako» biscuits for a healthy diet with beetroot. The data from Table 2 indicate that the highest percentage of carbohydrates registered in the Control sample is 38.3%, which is 3.5% higher than in Sample 1 and 7% higher than in Sample 2. The protein content in Sample 1 increased by 18% and in Sample 2 by 35%, which is associated with the replacement of chicken egg products with quail eggs, which contain more protein, and beetroot powder in the recipe of biscuits with a reduced gluten content. There was a tendency to reduce the fat content in the experimental biscuit Samples 1 and 2 by 2.5% and 5%, respectively. The dietary fiber content increased from 140% for Sample 1 and 280% for Sample 2. For Sample 2, the dietary fiber content increased by an average of 3 times compared to the Control. In terms of the total content of micro- and macroelements, the indicators of the experimental samples increased from 75% - Sample 1 to 150% - Sample 2. A significant increase in biological value and the presence of biologically active substances (betalain) in the composition of biscuits allows us to attribute it to preventive and dietary nutrition of the population. No significant changes were noted in the moisture index for the Control and Experimental samples. The fluctuation of moisture content was within 1.5%, which did not significantly affect the quality and organoleptic indicators of biscuits with a reduced fat content. A significant increase in biological value and a decrease in fat content are observed, despite the increase in the content of carbohydrates, which mainly consist of dietary fiber and natural sugars (Fig. 1).

Table 2

Physico-chemical composition of «Monako» *biscuits for a healthy diet* with beetroot n=3, α<0.05

Physico-chemical composition,%	CONTROL	Sample 1	Sample 2
Humidity	29.2	28.5	27.7
White	8.0	9.4	10.8
Fat	23.0	22.4	21.8
Carbohydrates:	38.3	37.0	35.7
dietary fiber	3.3	8.0	12.7
Ash	1.6	2.8	4.0
Energy value, kcal/100 g	391.9	387.1	382.3

Study of organoleptic parameters of «Monako» biscuits for a healthy diet. Organoleptic evaluation of low-gluten biscuits with beetroot. The organoleptic indicators for the consumer based on color, taste, texture, flavor and general appearance of the samples are shown in Fig. 2. The values in Fig. 2 are given as averages, after tasting by ten experts. It was also noted that Sample 2 of the biscuit, made with the addition of 20% beetroot powder, had high indicators of taste, texture and appearance among other proportions of beetroot powder and compared to the control. Sample 2 had a natural red color. It was investigated that Sample 1 of the biscuit, made with the addition of 10% beetroot powder, had reduced indicators of texture, taste and color. Sample 2 had an

unsaturated red color and had lower chewability indicators. Adding 20% beetroot powder to the recipe, instead of wheat flour, allows it to be fully used as a food coloring.

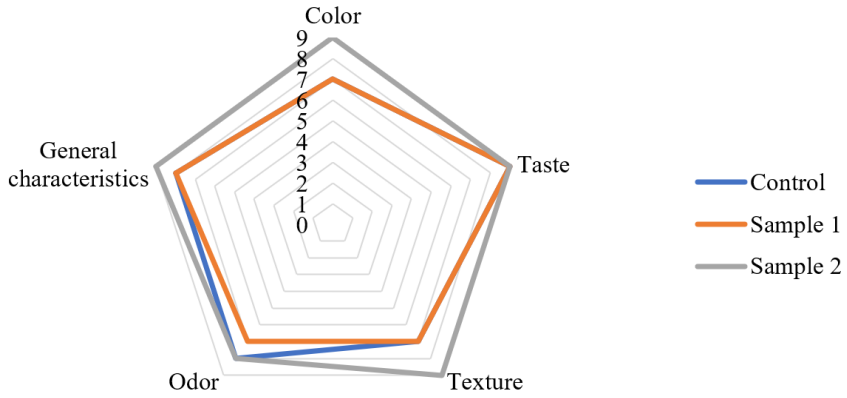

Fig. 2. Organoleptic evaluation of «Monako» biscuits *for a healthy diet* with beetroot

Analysis of the texture profile of «Monako» biscuits for a healthy diet. Texture profile analysis was performed to determine the chewiness of the biscuit enriched with beetroot powder, which is shown in Fig. 3. Studies have shown that a small amount of beetroot powder in the recipe and quail eggs affect its texture, and as a result, the chewiness of Sample 1 increased by 5% and Sample 2 by 11.4% compared to the Control. The elasticity and cohesiveness of Samples 1 and 2 increased slightly (Fig. 3).

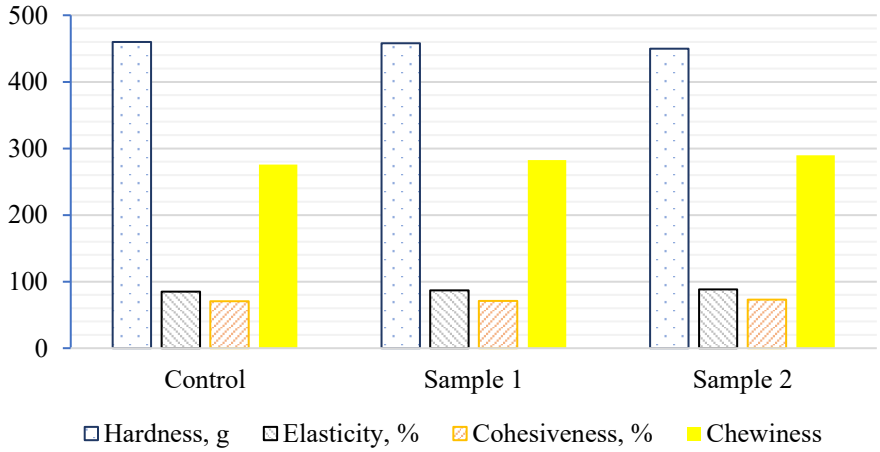

Fig. 3. Texture profile analysis «Monako» biscuits *for a healthy diet* n=3

Fig. 3 shows the dynamics of changes in hardness and other texture indicators. For Sample 2, it was the smallest, by 2% compared to the Control sample. At the same time, elasticity and cohesiveness increase, which is associated with a lower moisture content in the biscuit dough for Samples 1 and 2. Regular changes in texture require more in-depth research.

Conclusions

The physicochemical composition of skimmed milk A2, chicken and quail eggs, beet powder, and wheat flour, as the main ingredients of «Monako» biscuits *for a healthy diet*, was studied. The fat content in beet powder is 2.5 times lower than in wheat flour. Partial replacement of wheat flour with beet powder will reduce the energy value of food products. Beet powder contains 60% more protein, 2.4 times more ash and dietary fiber than wheat flour. Beet powder is a rich source of dietary fiber and minerals and can be used in the production of bakery and confectionery products. The content of protein, fat, ash, and fiber in different percentages of beet powder increased with increasing beet powder.

Two sample recipes for «Monako» biscuits *for a healthy diet* using beet powder were developed. The effect of introducing skimmed milk A2, chicken and quail eggs, beet powder on the physicochemical composition of gluten-reduced biscuits in terms of moisture, protein, fat, carbohydrates, dietary fiber, ash, and energy value was investigated. According to the studied indicators, Sample 2 with the addition of 20% beet powder was chosen as the best. Sample 2 had an almost 20% lower carbohydrate content, 35% higher protein content, and 5% lower fat content than the Control sample. For sample 2, the dietary fiber content increased compared to the Control by an average of 3 times. In terms of the total content of micro- and macroelements, the indicators of Sample 2 increased by 1.5 times compared to the Control.

The organoleptic properties of each recipe composition of «Monako» biscuits *for a healthy diet* determined during the experiment were evaluated. It was noted that Sample 2 of the biscuit, made with the addition of 20% beet powder, had better taste and texture characteristics and a pleasant, rich red color.

The texture of «Monako» biscuits *for a healthy diet* was studied in terms of hardness, elasticity, cohesiveness (stickiness), and chewiness. Studies have shown that a small amount of beet powder in the recipe affects its texture, and as a result, the chewiness of Sample 1 decreased by 5% and Sample 2 by 11.4% compared to the Control. The elasticity and cohesiveness of samples 1 and 2 slightly increased.

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