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THE IMPROVEMENT OF THE COMPOSITION OF SWEET DOUGH PRODUCTS THROUGH THE USE OF COCONUT FLOUR

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Abstract: *The purpose of the research was to study the usability of coconut flour in Easter cake recipes to improve consumer properties and increase the nutritional value. It has been established that the replacement of 10% of wheat raw materials with coconut flour and a decrease in the amount of margarine by 28% in Easter cake recipes allows us to obtain products with good consumer properties, an increased content of mineral elements – selenium (by 58.3%), iron (by 13.3%), magnesium (by 9.1%), copper (by 5.5%) and coarse fibers (by 6.6%), and a reduced amount of gluten and trans fatty acid isomers.*

Key words: *Easter cake, wheat flour, coconut flour, nutritional value.*

1. Introduction

Coconut flour has become popular due to its unique composition and properties. So, coconut flour is rich in dietary fiber (over 40%) [5]; contains the necessary mineral elements (per 100 g): potassium – 356 mg, phosphorus – 113 mg, magnesium – 32 mg, calcium – 14 mg, iron – 2.4 mg, copper – 0.4 mg, zinc – 1.1 mg, selenium – 10.1 mg [17]; vitamins B (B1 – 0.06 mg, B2 – 0.1 mg, B5 – 0.8 mg), C – 1.5 mg, E – 0.44 mg, PP – 0.6 mg [8], [11].

We have a tradition originating from the remote past – to bake sweet, fragrant, delicious Easter cakes for Easter. Today, they are baked both at home and in production shops of catering and industrial enterprises. Like any sweet dough product, a traditional Easter cake is characterized by a high content of fats and carbohydrates, and a low content of dietary fiber, vitamins and other micronutrients [3], [6]. To this end, the purpose of this research was to study the usability of coconut flour in the formulation of a sweet dough product by the example of an Easter cake to improve

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consumer properties and to increase the nutritional value of the finished product.

2. Materials and Methods

The research materials included:

- High-grade baking wheat flour produced by MuZa Flour Milling Plant JSC (Russia, Kurgan region);
- Rotal Forest coconut flour supplied from Sri Lanka by TransCarob-Rus LLC (Russia, Moscow);
- Model samples of sweet dough and finished products, namely “Pokrovsky” Easter cake, whose quality complied with the requirements of TU 9116-013-18256266-06 “Sweet Dough Bakery Products. Easter Cakes”. The control model samples were baked according to the classical recipe (Table 1), the experimental model samples - with the replacement of the high-grade baking wheat flour with an identical amount of coconut flour: experiment 1 (5%), experiment 2 (10%), experiment 3 (15%), with a reduced content of margarine: experiment 1 (by 14%), experiment 2 (by 28%), experiment 3 (by 42%).

We used an accelerated dough making method; the products were baked molded with the net weight of 0.3 kg.

The organoleptic characteristics of the flour, sweet dough and Easter cakes were determined during a visual inspection, when cutting, chewing and smelling. The moisture content was determined by drying the sample in an oven at 130°C for 40 minutes to a constant weight, with a further calculation of the indicator. The amount of gluten in the flour was determined by its manual washing from the dough, the quality of gluten was determined by measuring its elastic properties using a gluten deformation meter. The mass fraction of fat in the raw materials and finished products was determined by using the extraction method with a preliminary hydrolysis of the sample. The acidity in the semi-finished and baked products was determined by titration with sodium hydroxide in the presence of phenolphthalein. The mass fraction of protein was determined by nitrogen, using a Kjeldahl flask, followed by con-version to protein. The mass fraction of ash in the flour was determined by ashing the samples at a temperature of no more than 500°C. The sugar content in the Easter cakes was determined by reducing oxide iron with copper oxide, followed by permanganate titration of iron oxide. The content of dietary fiber was determined by hydrolysis and removal of protein and starchy substances with enzymes. The content of magnesium, calcium, iron, copper, zinc in the flour and Easter cakes was determined by the atomic absorption method, phosphorus – by the molybdenum-vanadium method, and selenium by the fluorimetric method [14].

The norms of the daily requirement of an adult in physiologically active substances are taken from the medical recommendations [15].

All the measurements were made in triplicate. A statistical analysis was performed using the software suite: Microsoft Excel XP, Statistica 8.0. The statistical error of the data did not exceed 5% (with a 95% confidence level).

Recipe of "Pokrovsky" Easter cake Table 1

Ingredients	Amount of the raw materials used [kg]
High-grade baking wheat flour	93.0
"Brioche Mix" baking mix	7.0
Pressed bakery yeast	8.0
Edible salt	1.0
Granulated sugar	25.0
82% fat margarine	20.0
Dried grapes	25.0
Edible chicken eggs	10.0
Vanillin	0.03
Water	as per calculations

3. Results and Discussion

3.1. A Comparative Evaluation of Plant Raw Materials

It has been determined that the high-grade baking wheat flour is characterized by a white color with a creamy tint, has a slightly pronounced sweetish taste and an inherent smell, without extraneous flavors. The consistency of the flour is powdery and uniform. The coconut flour is a homogeneous powder consisting of white agglomerated particles, has a sweet taste and a characteristic coconut smell. We have established an acceptable compatibility of the raw materials by means of the sensory indicators. The results of studying the chemical composition of the coconut flour as compared to the high-grade wheat baking flour are shown in Table 2.

Table 2

Chemical composition and physical and chemical characteristics of the raw materials

Tested indicator	Test results	
	High-grade wheat flour	Coconut flour
Moisture content [%]	12.8 ± 0.2	8.8 ± 0.2
Mass fraction of fat [%]	1.0 ± 0.1	49.8 ± 2.5
Mass fraction of protein [%]	11.2 ± 0.2	18.9 ± 0.4
The amount of gluten [%]	28.3 ± 0.5	–
The quality of gluten [GDI units]	58.2 ± 0.9	–
Mass fraction of ash [%]	0.38 ± 0.02	1.03 ± 0.02
The content of dietary fiber [g/100 g], including:	3.52 ± 0.02	4.93 ± 0.03
• soluble	1.01 ± 0.02	1.22 ± 0.02
• insoluble	2.51 ± 0.03	3.71 ± 0.04
The content of phosphorus [mg/kg]	780.2 ± 41.2	940.3 ± 47.3
The content of zinc [mg/kg]	49.4 ± 2.9	18.7 ± 1.4
The content of copper [mg/kg]	1.80 ± 0.05	4.30 ± 0.09
The content of iron [mg/kg]	47.1 ± 3.8	103.1 ± 4.4
The content of calcium [mg/kg]	2102.1 ± 38.7	1830.2 ± 33.2
The content of magnesium [mg/kg]	372.4 ± 29.3	751.4 ± 56.6
The content of selenium [mg/kg]	0.21 ± 0.08	1.61 ± 0.06

We should note a relatively low humidity of the unconventional material to be taken into account when making recipes of experimental samples of Easter cakes in terms of calculating the water needed to knead the dough. Despite the relatively higher protein content (by 68.7%) in the coconut raw materials, it was impossible to wash gluten from it using the generally accepted method. The qualitative characteristics of gluten of the wheat flour corresponded to the category "good", which refers to quality group I.

It has been revealed that the coconut flour favorably differs in its nutritional value from wheat flour. Thus, in the amount of vegetable oil the coconut raw materials exceed the wheat flour by 50 times, in the fiber content – by 40%, in the level of selenium – by 8 times, iron – by 4.2 times, copper – by 2.4 times, magnesium – by 2 times, phosphorus – by 20.5%, but are inferior in the amount of zinc (by 2.6 times) and calcium (by 12.9%).

It is known that coconut oil contains lauric acid, which is included in breast milk, has antibacterial properties, reduces the probability of developing malignant tumors, stimulates the immune system, helps to reduce appetite, and reduces the level of “bad” cholesterol [4]. Dietary fibers remove various toxic elements from the organism, normalize cholesterol transformation, and restore the qualitative and quantitative composition of intestinal microflora [9]. Mineral substances, being components of all tissues and biological fluids of the human body, refer to the vital components of food, ensuring its normal development and functioning [2]. For example, selenium activates the immune system and thyroid functions, is a powerful antioxidant, participates in the generation of red blood cells, enhances the action of iodine in the human body, prevents and suspends the development of malignant tumors [10]. Iron is necessary for biological oxidation processes that provide the organism with energy. In case of a lack of iron in the human body, the hemoglobin level decreases, the brain activity is impaired, and muscle weakness is developed [1]. Copper is involved in hematopoiesis processes, synthesizes collagen and elastin, and regulates the endocrine system. Magnesium activates carbohydrate and energy metabolism enzymes, participates in the bone formation, and normalizes the excitability of the nervous system and the activity of heart muscles [16].

Thus, we have established the efficiency of replacing the high-grade wheat baking flour with the coconut raw materials to increase the amount of individual essential nutrients in the finished products. To this end, we used the following experimental dosages of the unconventional material: experiment 1 (5%), experiment 2 (10%), experiment 3 (15%). However, taking into account the high lipid content in the coconut flour, in order to stabilize the energy value of the sweet dough products, we have decided to reduce the content of margarine in the test samples of the Easter cake: experiment 1 (by 14%), experiment 2 (by 28%), experiment 3 (by 42%).

It is well known that trans-fatty acid isomers [12], which negatively affect human health, are an integral part of margarines. The consumption of an excessively large number of these components leads to the organism dysfunction at the cellular level [7]. In this connection, the replacement of margarine with coconut oil is a justified condition for

improving the toxicological safety of the developed products.

3.2. The Quality of the Model Samples of the Semi-Finished Product

In the course of the organoleptic studies of the model samples of the semi-finished product, we have revealed the influence of the coconut flour on the aromatic characteristics of the sweet dough. So, with an increase in the dosage of the unconventional raw materials, the coconut aroma is somewhat enhanced while preserving a typical pleasant taste. Yellowish shades disappeared in the color palette of test samples 2 and 3, but the color of the dough remained creamy; in addition, there was no gloss on the surface of the semi-finished product in experiment 3, the dough became denser (Figure 1).

It was interesting to study the influence of the used technological solutions on the physical and chemical indicators of the sweet dough. It has been revealed (Table 3) that with an increase in the dosage of coconut flour in the semi-finished products, there is an upward tendency of their moisture content (by 1.6-5.5%) resulting from an increase in the content of dietary fiber, which has good water-absorbing properties. The moisture content in experiment 3 slightly exceeded the established norm (no more than 32.5%).

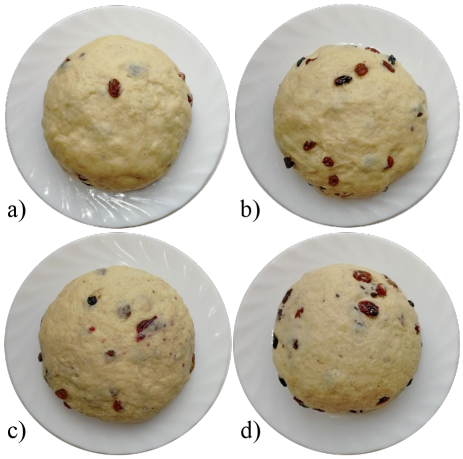

Fig. 1. *The appearance of the model samples of the sweet dough: a. control sample; b. experiment 1; c. experiment 2; d. experiment 3*

Table 3

Physical and chemical indicators of the model samples of sweet dough

Tested indicator	Test results			
	Control	Experiment 1	Experiment 2	Experiment 3
Moisture content [%]	31.0 ± 0.5	31.5 ± 0.3	32.1 ± 0.4	32.7 ± 0.3
Acidity [degrees]	2.73 ± 0.03	2.76 ± 0.04	2.82 ± 0.02	2.92 ± 0.05

The acidity in the experimental dough samples also had an upward tendency (by 1-7%), which is presumably due to an increase in the content of free fatty acids present in coconut oil, but did not exceed the regulated requirements (not more than 3.0 degrees).

3.3. The Quality and Nutritional Value of the Model Samples of the Finished Product

The test samples were baked at a temperature of 180-190°C, underwent steam humidification for 5 seconds at a

pressure of 0.3-0.7 atm. The appearance of the baked products is shown in Figure 2.

It has been determined that when the coconut flour was used in the studied dosages, the products acquired a pleasant coconut flavor and aroma. Experimental samples 1 and 2 do not differ from the control samples by their organoleptic characteristics, they retain their shape well; have a light brown convex surface; a soft, elastic, well-baked light yellow crumb; and a uniformly developed porosity. Experimental samples 3 are characterized by a squat shape, a flat and rough surface, and a very dense inelastic crumb [13].

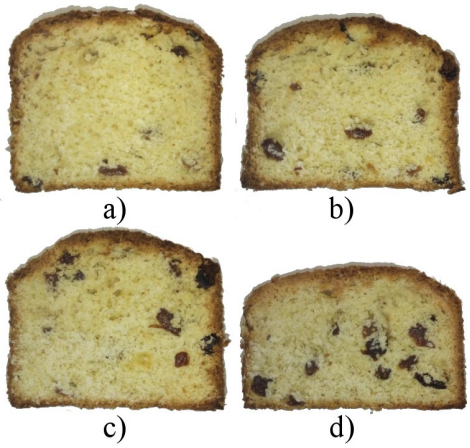

Fig. 2. *The appearance of the model samples of Easter cakes: a. control sample; b. experiment 1; c. experiment 2; d. experiment 3*

According to the results of a comprehensive quality assessment, experiment 2 has been recognized as the optimum variant for modifying the cake recipe, since it retains acceptable consumer characteristics at the maximum introduction of the unconventional raw materials and reduction of margarine dosage. To this end, further studies were aimed at a comparative assessment of the chemical composition (Table 4) and nutritional value of the control sample and experiment 2 (Table 5).

We have revealed a slight increase in the humidity of the experimental model (by 3.9%); the other physical and chemical parameters of the studied samples were within the inherent quantitative range.

It has been revealed that the Easter cake sample contains more of the following essential nutrients: mineral elements – selenium (by 58.3%), iron (by 13.3%), magnesium (by 9.1%), copper (by 5.5%), coarse fibers (by 6.6%). However, it is inferior in the content of zinc by 6.7%. The consumption of 100 g of the Easter cake with the modified recipe composition manages to satisfy a human daily need for food substances (%): mineral elements – iron (by 29.7), selenium (27.1), zinc (19.4), copper (15, 3), calcium (11.3), phosphorus (8.5), magnesium (6.3), plant fibers (14.2).

Physical and chemical indicators of the model samples of Easter cakes Table 4

Tested indicator	Norm as per 9116-013-18256266-06	Test results	
		control	experiment 2
Moisture content [%]	no more than 32.0	30.5 ± 0.3	31.7 ± 0.3
Mass fraction of fat in terms of dry matter [%]	11.5 ± 0.5	10.3 ± 0.4	10.4 ± 0.3
Mass fraction of sugar in terms of dry matter [%]	15.0 ± 1.0	14.3 ± 0.2	14.4 ± 0.2
Acidity [degrees]	no more than 2.5	2.27 ± 0.02	2.36 ± 0.03

Table 5

The content of essential nutrients in the model samples of Easter cakes

Tested parameter	Test results [mg/kg]	
	Control	Experiment 2
The content of dietary fiber [g/100 g] including:	2.71 ± 0.02	2.84 ± 0.02
• insoluble	1.81 ± 0.02	1.93 ± 0.03
• soluble	0.90 ± 0.01	0.91 ± 0.01
The content of phosphorus	677.2 ± 71.2	686.2 ± 74.5
The content of zinc	25.0 ± 1.2	23.3 ± 1.1
The content of copper	1.4 ± 0.1	1.5 ± 0.1
The content of iron	26.2 ± 0.7	29.7 ± 0.9
The content of calcium	1146.1 ± 9.6	1130.3 ± 9.8
The content of magnesium	233.2 ± 10.9	254.4 ± 14.2
The content of selenium	0.12 ± 0.02	0.19 ± 0.03

4. Conclusions

We have established the usability of coconut flour in the recipe of Easter cakes by replacing 10% of the high-grade wheat flour with a similar amount of unconventional plant raw materials while reducing the content of margarine by 28%.

The use of this technological solution allows us to obtain products with good consumer characteristics, an increased content of individual mineral elements and dietary fiber, and a reduced amount of gluten and trans-fatty acid isomers.

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