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**О ВОЗМОЖНОСТИ МОДИФИКАЦИИ РЕЦЕПТУРЫ ХЛЕБА «ФИТНЕС» ГРЕЧНЕВЫЙ ПУТЕМ ПРИМЕНЕНИЯ МУКИ ИЗ ОРЕХА ГРЕЦКОГО**

**ABOUT THE POSSIBILITY OF MODIFYING THE RECIPE OF "FITNESS" BUCKWHEAT BREAD BY USING WALNUT FLOUR**

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***Аннотация.** Мука из грецкого ореха в настоящее время рассматривается специалистами пищевых технологий как источник полноценного белка, липидов, углеводов, минеральных веществ, витаминов и др. Исследовано качество и химический состав муки пшеничной, муки из ореха грецкого и смеси хлебопекарной гречневой. Выявлено превосходство муки из ореха грецкого над пшеничным сырьем по количеству ряда нутриентов. Определена приоритетная роль пшеничной муки в образовании пористости и формировании удельного объема хлеба. Проведена модификация рецептуры хлеба «Фитнес» гречневый.*

**Ключевые слова:** мука пшеничная, мука из ореха грецкого, смесь хлебопекарная, хлеб «Фитнес».

***Abstracts.** Walnut flour is currently considered by food technology experts as a source of high-grade protein, lipids, carbohydrates, minerals, vitamins, etc. The quality and chemical composition of wheat flour, walnut flour and buckwheat mixture have been studied. The superiority of walnut flour over wheat raw material in the number of nutrients was revealed. The priority role of wheat flour in the formation of porosity and the formation of the specific volume of bread is determined. Buckwheat fitness recipe was modified.*

**Key words:** wheat flour, walnut flour, baking mix, "Fitness" bread.

Walnut flour is considered by food technology specialists as a source of complete protein, lipids (mono-, di-, tri-glycerides, free fatty acids, phosphatides), carbohydrates (sugars, starch, fiber), minerals, vitamins, antioxidants (ascorbic acid, tocopherol, carotene), phenolic compounds (tannins, flavonols, catechins), organic acids, etc. [1-4]. In this regard, technologies are known for the use of walnut flour in the production of acidophilic fermented milk product with improved organoleptic and functional properties; experience in using walnut kernel concentrate in wafer fillings with a high content of essential amino acids, polysaccharides, polyunsaturated fatty acids; developed a recipe for lingering biscuits containing walnut flour, rich in protein, iron, magnesium, potassium, copper, phosphorus [4-7]. The technologies for obtaining flour confectionery and bakery products (wheat, rye and rye-wheat) with the addition of walnut flour are described [8]. Foods containing walnut shell powder have a low glycemic index [9].

The purpose of this study is to study the possibility of using walnut flour in the "Fitness" buckwheat bread technology in order to expand the range and increase the food density of bakery products.

The objects of research were samples of raw materials and model bread samples:

- baking wheat flour of the first grade (GOST 26574-2017) produced by IP A.A. Mikhailyuta (Russia, Omsk region, Kormilovsky district, Pobeditel village);
- Walnut flour (STO 33974444-011-2016) produced by ООО "Specialist" (Russia, Altai Territory, Biysk);
- bakery mix "Fitness Mix" buckwheat (TU 9295-040-18256266-2014) produced by LLC "IREKS" (Russia, Moscow region, Lyubertsy). Ingredients: buckwheat flour, wheat bran, dextrose, bakery wheat flour of the highest grade, malt wheat flour, malt barley extract, emulsifier E472e, wheat gluten, roasted wheat malt flour, stabilizers E341iii, E170, acidity regulator E263, antioxidant microbial origin.
- control samples of "Fitness" buckwheat bread (TU 9110-006-18256266-2005 with additions dated 04.16.2008) were produced according to a regulated recipe (table 1);
- prototypes No. 1 - with the replacement of 15% wheat bakery flour of the first grade for an identical amount of walnut flour. The dosage of unconventional raw materials was established empirically in a series of preliminary studies.
- prototypes No. 2 - with the replacement of 15% of the first grade wheat bakery flour with walnut flour and the replacement of 2% of the "Fitness Mix" bakery mixture with buckwheat for the same amount of wheat gluten;
- prototypes No. 3 - with the replacement of 15% of wheat bakery flour of the first grade for walnut flour and replacement of 4% of the bakery mix "Fitness Mix" with buckwheat for wheat gluten;
- prototypes No. 4 - with the replacement of 15% of the first grade wheat bakery flour with walnut flour and the replacement of 6% of the "Fitness Mix" bakery mixture with buckwheat for wheat gluten.

An accelerated dough preparation method was used; the products were baked with a molded mass of 0.5 kg net.

Table 1

Recipe for "Fitness" buckwheat bread

Raw material composition and technological parameters	Raw material consumption and dough preparation parameters, kg
Wheat flour of the first grade	80,00
Bakery mix "Fitness mix" buckwheat	20,00
Pressed bakery yeast	3,00
Table salt	2,00
Drinking water	by calculation
Dough fermentation time, min	15-20
Initial dough temperature, °C	26-28

The organoleptic evaluation of raw materials was carried out in accordance with GOST 27558-87, finished products - in accordance with GOST 5667-65. The quantity and quality of gluten was determined according to GOST 27839-2013, mass fractions of substances: moisture - according to GOST 9404-88, protein - according to GOST 10846-81, fat and ash - according to MU 4237-86. The content of dietary fiber was determined by the classical method [10], the content of calcium and magnesium - according to R 4.1.1672-03, iron, copper, zinc - according to GOST 30178-96, phosphorus - according to GOST 30615-99, selenium - according to M 04-33 -2004. The microstructure was determined using a scanning electron microscope [11]. The specific volume of bread was determined according to GOST 27669-88, acidity - according to GOST 5670-96, porosity - according to GOST 5669-96. The content of thiamine was determined according to GOST 29138-91, riboflavin - according to GOST 29139-91.

The study of organoleptic characteristics and compatibility of the raw materials used will prevent the formation of undesirable changes in the consumer properties of the finished bread. It was found that wheat flour has no visible deviations in the sensor quality indicators (Figure 1) from the standards regulated by the requirements of GOST 26574-2017. For the rest of the raw materials, specific characteristics were determined, due to both the botanical characteristics of the culture and the ingredient composition. So, walnut flour is a homogeneous finely ground powder, gray with a cream shade, a characteristic odor, a characteristic sweetish taste with a slight astringent aftertaste. Mixture "Fitness Mix" buckwheat is a free-flowing powder with the inclusion of small bran particles, which are especially noticeable when chewing. The color is light brown with a reddish tinge, uniform throughout the mass, the smell is characteristic, without extraneous tones, the taste is characteristic of buckwheat, sweeter, without extraneous tastes. An acceptable sensory compatibility of the studied raw material was revealed, which makes it possible to use it as part of a complex food system.

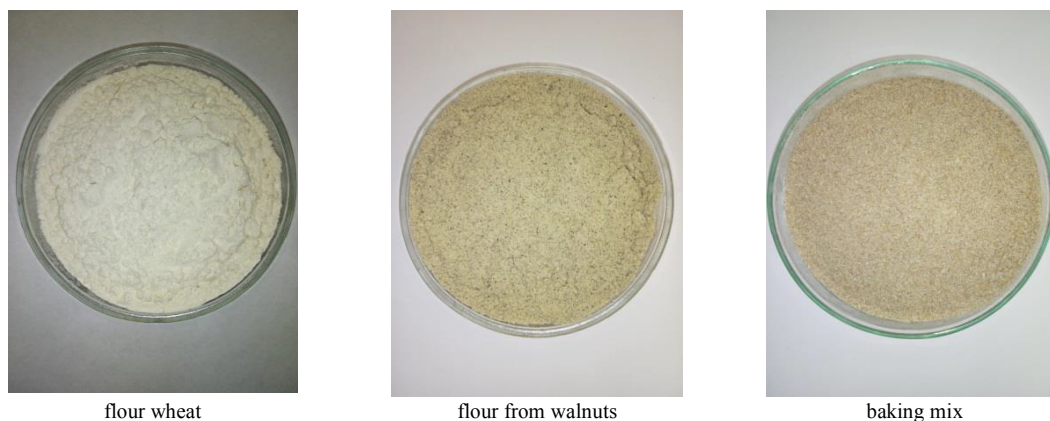


Fig. 1. Appearance of raw materials

The study of physical and chemical indicators and chemical composition of raw materials contributes to understanding the formation of crumb structure, rise and nutritional value of bread. It was determined that the basic physical and chemical quality indicators of the studied samples of raw materials are characteristic of the quantitative ranges of each of them. The moisture content of the baking mixture is somewhat different from that of the studied flour samples (Table 2), which must be taken into account when calculating the amount of water required for the preparation of the dough. Despite the content of glutelin in the composition of the walnut [8], and in the composition of the bakery buckwheat mixture - wheat flour of the highest grade and wheat gluten, it was not possible to determine the quality and quantity of gluten proteins in these samples of raw materials using the traditional method. Thus, in this case, only wheat flour objectively participates in the formation of porosity and specific volume of bread. This assumption was also confirmed when studying the microstructure of raw materials using scanning electron microscopy, where gluten proteins were found in large quantities in wheat flour and in the form of single inclusions in buckwheat mixture (Figure 2).

No significant difference in the amounts of the protein fraction of the tested samples of raw materials, which could globally reduce the protein deficiency in the new modification of bakery products, was not revealed. However, it is generally known that the amino acid composition of the walnut protein balance significantly prevails over the usefulness of wheat protein [4].

Table 2

Physical and chemical indicators and nutritional value of raw materials

Defined indicator	Results		
	flour wheat	flour from walnuts	baking mix
Moisture content, %	11,3 ± 0,3	10,7 ± 0,3	7,3 ± 0,2
Protein mass fraction, %	10,2 ± 0,4	14,7 ± 0,5	11,5 ± 0,4
The amount of gluten, %	32,3 ± 0,9	-	-
Gluten quality, units IDK	68 ± 1,1	-	-
Mass fraction of fat in terms of dry matter, %	1,10 ± 0,02	23,5 ± 0,5	3,03 ± 0,03
Dietary fiber content, g / 100 g, including:	3,71 ± 0,03	8,63 ± 0,04	4,92 ± 0,03
- soluble,	0,90 ± 0,02	2,81 ± 0,03	1,12 ± 0,02
- insoluble	2,81 ± 0,03	5,82 ± 0,05	3,80 ± 0,05
Ash content in terms of dry matter, %	0,57 ± 0,02	4,17 ± 0,07	2,62 ± 0,06
Mineral elements, mg / kg, including:			
P	1040,2 ± 53,4	6110,4 ± 79,6	4210,3 ± 49,2
Ca	237,1 ± 19,2	3007,2 ± 64,7	3100,0 ± 55,2
Cu	2,0 ± 0,3	15,9 ± 1,8	4,5 ± 0,7
Fe	53,1 ± 4,2	113,2 ± 6,1	46,4 ± 2,4
Mg	300,1 ± 21,7	3328,3 ± 58,9	1887,3 ± 33,1
Zn	19,8 ± 2,2	40,5 ± 3,3	24,9 ± 2,3
Se	0,26 ± 0,10	1,6 ± 0,6	1,1 ± 0,4

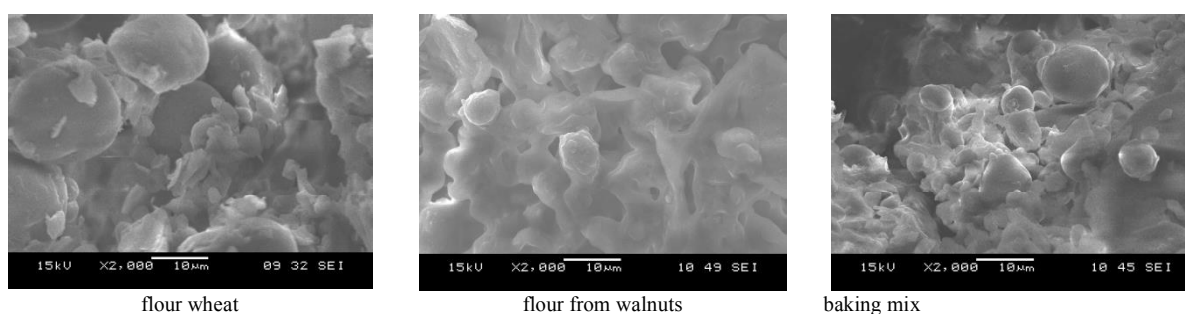


Fig. 2. Microstructure of raw materials (increase in 2000 times)

In further studies, the emphasis is placed on a comparative assessment of the nutritional value of first grade wheat bakery flour and walnut flour in order to establish the effectiveness of replacing traditional raw materials with original plant material.

A relatively high oil content of raw materials from walnuts has been established. Thus, the content of lipids in unconventional material exceeds their content in wheat flour by 21 times. It is known that essential polyunsaturated fatty acids of the following families predominate in nut oil:  $\omega$ -3,  $\omega$ -6,  $\omega$ -9 [12]. High content in oil  $\delta$ - and  $\gamma$ -tocopherols (natural antioxidants) protects its lipid complex from oxidation [1, 2]. It should be noted the superiority of nut flour both in terms of the total dietary fiber content and the amount of insoluble fiber. An increase in the content of dietary fiber in bread due to the substitution of raw materials can change the rheological properties of the dough and the finished product.

The high ash content of unconventional raw materials is reflected in its mineral composition. Thus, in comparison with wheat raw materials, walnut flour contains more of the following mineral elements: calcium (12.7 times), magnesium (11.1 times), copper (7.9 times), selenium (6, 1 time), phosphorus (5.8 times), iron and zinc (2 times). This circumstance will increase the nutritional density of modified bread and reduce the deficiency of certain minerals in the diet of Russians. It is also obvious that the use of a complex of food additives in the formulation of a buckwheat mixture, namely, orthophosphate, carbonate and calcium acetate, in total to the content of phosphorus and calcium in buckwheat flour, contributed to an increase in the content of these macronutrients in it by 4 and 13.1 times, respectively. The relatively high level of selenium in the baking mixture is apparently associated with the inclusion of wheat bran in its composition, since it is known that it is more selenium contained in wheat bran than in wheat grain, wheat or buckwheat flour [13].

The next step was testing the quality of model samples of "Fitness" buckwheat bread, obtained from the studied raw materials. It was revealed (Figure 3) that the control and experimental (experiment No. 1 with replacing 15% of wheat flour with raw materials from walnuts) samples have differences visible with the naked eye only in the color of the crumb (the control has light brown, uniform throughout the mass, experiment - there is a slight dark brown tint) and the height of the loaves (in the control - the height of the bread in the cross section is  $13.0 \pm 0.2$  cm, in the experiment -  $10.2 \pm 0.3$  cm, which gives the experimental samples some squat) ... The taste and smell of both samples of bread contains tones typical of buckwheat culture, without foreign tastes and smells.



Fig. 3. Appearance of model bread samples

The use of measuring research methods made it possible to study in more detail the difference in the quality of the tested bread samples. It was determined that replacing wheat flour with raw materials from walnuts in the recommended dosage reduced the specific volume (by 11.1%) and porosity (by 10.9%) of bread, but increased the acidity (by 19.4%) of products in excess of the regulated norm (table 3).

Table 3

Physicochemical indicators of model bread samples

Defined indicator	Norm according to TU 9110-006-18256266-2005	Test results	
		control	experiment No. 1
Specific volume, cm <sup>3</sup> / g	not regulated	3,79 ± 0,03	3,37 ± 0,02
Porosity, %		73,5 ± 0,9	65,5 ± 1,1
Acidity, deg.	no more than 4.0	3,6 ± 0,3	4,3 ± 0,2

To date, there is a positive experience of using dry wheat gluten in the composition of a bakery mixture in the production of bread from wheat flour of the first grade with the additional inclusion of gluten-free raw materials to increase the porosity and specific volume of finished products to standard levels [14]. In the production of "Fitness" bread in accordance with the requirements of TU 9110-006-18256266-2005, a quantitative variation of the buckwheat mixture in the range of up to 20% is possible without setting the lower limit. Considering the above, we considered several options for modifying the recipe of experimental samples No. 1 by replacing 2, 4 and 6% of the bakery mix "Fitness Mix" with buckwheat for wheat gluten (GOST 31934-2012, brand "A", manufactured by LLC "First Diet", Russia, Moscow) with the following results (table 4):

Table 4

Physicochemical indicators of model bread samples after modification

Defined indicator	Test results		
	experiment No. 2	experiment No. 3	experiment No. 4
Specific volume, cm <sup>3</sup> / g	3,53 ± 0,02	3,82 ± 0,03	3,71 ± 0,02
Porosity, %	69,2 ± 0,8	73,4 ± 0,9	72,2 ± 0,7
Acidity, deg.	4,0 ± 0,2	3,7 ± 0,3	3,4 ± 0,2

It was found that modified bread samples with the replacement of 4% buckwheat mixture for an identical amount of wheat gluten according to the studied parameters were as close as possible to the control sample against the background of the formation of a new taste feature, namely, a pleasant nutty flavor, and a lighter crumb tone. In this regard, control and experiment No. 3 were used in further tests.

It was determined that the moisture content of control and modified samples of bread corresponds to the established norm - no more than 46.0% (table 5). The bread of the modified recipe composition is characterized by a high content of: vegetable fat (3.9 times), rich in polyunsaturated fatty acids; protein (by 46.1%); soluble (by 47.5%) and coarse (by 23.6%) fiber that stimulates the work of the gastrointestinal tract; mineral elements (table 5). The new products showed a relatively high content of magnesium (2.1 times), calcium (1.8 times), selenium (1.7 times), phosphorus (1.6 times), copper (1.4 times), iron (by 25.1%), zinc (by 22.5%).

Table 5

Physical and chemical indicators and nutritional value of bread

Defined indicator	Test results	
	control	experiment No. 3
Moisture content, %	42,6 ± 1,2	44,3 ± 1,3
Protein mass fraction, %	6,5 ± 0,4	9,5 ± 0,5
Mass fraction of fat in terms of dry matter, %	1,1 ± 0,2	4,3 ± 0,4
Dietary fiber content, g / 100 g, including:	2,45 ± 0,04	3,17 ± 0,05
- soluble,	0,59 ± 0,02	0,87 ± 0,03
- insoluble	1,86 ± 0,04	2,30 ± 0,05

Ash content in terms of dry matter,%	0,62 ± 0,05	1,15 ± 0,06
Content of mineral elements, mg / kg, including:		
P	1110,1 ± 44,7	1825,8 ± 51,3
Ca	502,2 ± 15,3	920,9 ± 21,8
Cu	1,5 ± 0,3	2,1 ± 0,5
Fe	32,3 ± 2,4	40,4 ± 3,3
Mg	384,4 ± 13,6	825,8 ± 19,8
Zn	12,9 ± 1,9	15,8 ± 1,7
Se	0,267 ± 0,010	0,465 ± 0,025
Vitamins content, mg / 100 g, including:		
B1 (thiamine)	0,078 ± 0,023	0,120 ± 0,040
B2 (riboflavin)	0,14 ± 0,03	0,23 ± 0,06

The vitamin value of the experimental samples of "Fitness" buckwheat bread also increased, in particular, due to an increase in the content of thiamine and riboflavin by 1.5-1.6 times. The elimination of vitamin and mineral deficiencies in the diet of the working-age population is the most important factor in maintaining their health and performance [15]. The role of each of these micronutrients in the metabolism of the human body is undeniable.

The efficiency has been proven and the practical possibility of modifying the formulation of "Fitness" buckwheat bread has been established by replacing 15% of first grade wheat flour with walnut flour and replacing 4% of the "Fitness Mix" bakery mixture with a similar amount of dry wheat gluten. The bread of the modified recipe composition has good consumer properties, is distinguished by a high content of vegetable fat, protein, dietary fiber, rich in mineral and vitamin composition.

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