The use of non-traditional types of flour in the technology of sponge cake

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Abstract. Increasing the nutritional value of flour and flour confectionery products by adding additives with a high content of protein and amino acids, including non-traditional types of flour, is a promising direction in the food industry. Materials on the justification and development of semi-finished biscuit products with the addition of non-traditional types of flour are presented. It is known that these types of flour contain more proteins, vitamins, essential amino acids and minerals than wheat flour. That is why their addition will increase the nutritional value of products. Wheat flour, green buckwheat and lentil flour are used as the main raw materials. The biochemical composition of flour was studied. Based on the analysis of the composition, the expediency of using non-traditional types of flour is shown. The resulting products, thanks to the unique composition of the types of flour used, can expand the range of semi-finished products produced. According to the calculated data, the content of vitamins and minerals in the simulated semi-finished products increased. In the composition of semi-finished biscuit products, green buckwheat flour helped to reduce the caloric content, as well as increase the nutritional value and antioxidant activity. Lentil flour is rich in protein, it can be recommended in the formation of diets with a high protein content, used, for example, for diabetes. In the composition of semi-finished biscuit products, lentil flour contributed to an increase in nutritional value.

1 Introduction

The improvement of food production technologies inevitably leads to the expansion of their assortment, along with the possible use of non-traditional food raw materials.

According to statistics, the consumption of flour and flour confectionery products in our country has increased over the past year. Thus, it is possible to observe a violation proper nutrition principles. This phenomenon is caused by a decrease in the country's population purchasing power, as well as the state of production of food raw materials and foodstuffs. At the same time, the population awareness level regarding healthy rational nutrition remains low.

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Therefore, increasing the nutritional value of flour and flour confectionery products by introducing additives with a high content of protein and amino acids, including non-traditional types of flour is a promising direction in the food industry. It is known that these types of flour contain more proteins, vitamins, essential amino acids and minerals than wheat flour. Consequently, their addition will increase the nutritional value of the products.

Thus, due to this approach it is possible to create medical and preventive and also functional oriented flour and flour confectionery products.

According to traditional technology wheat flour is used to produce a biscuit semi-finished product. There are also various developments with the use of protein isolates [1-2], amaranth flour [3] and also with the addition of dietary fiber [4,5].

In this work the technology of biscuit dough based on unconventional raw materials was proposed and tested.

Lentil flour and green buckwheat flour were selected as potentially useful types of flour. The addition of lentil flour to wheat flour in an amount of 15-20% increases the protein content in the products by 3-4%.

Lentil flour contains many polyunsaturated fatty acids such as oleic and linolenic and contains up to 30% in protein [6–9].

Lentils have a low glycaemic index (25), and also contain a large amount of dietary fiber. Among the vitamins in lentils are vitamins A, E and B3. Lentils are also rich in minerals such as potassium, calcium, manganese, and selenium [10].

Green buckwheat flour is made from buckwheat grain that has not undergone hydrothermal treatment. The absence of hydrothermal treatment contributes to the preservation of useful nutrients. Green buckwheat contains many phenolic compounds (for example catechins) [11].

In addition, green buckwheat contains B vitamins, vitamin E and R. Therefore, the studied types of flour are richer than wheat in terms of nutritional and biological value [12,13].

The obtained biochemical profiles of the studied types of flour revealed 20 free amino acids out of which - valine, threonine, leucine, isoleucine, tryptophan, methionine and phenylalanine are irreplaceable.

Fatty acids are widely represented in biochemical profiles. The highest content in the presented samples is in unsaturated acids, namely linolenic (33-46%), oleic (16-36%) and saturated palmitic (14-24%). The most of fatty acids are found in green buckwheat flour and less in wheat flour (Fig. 1).

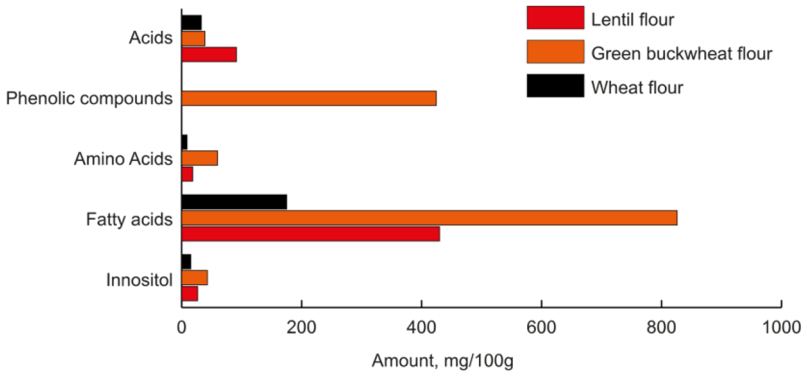

Fig. 1. Biochemical composition of various types of flour.

Phenolic compounds were detected only in green buckwheat flour and they are represented by catechins (Fig. 2). It should also be noted that a large content of inositol was

found in the flour from green buckwheat which contributes to the normalization of metabolism and improves the functioning of the digestive system.

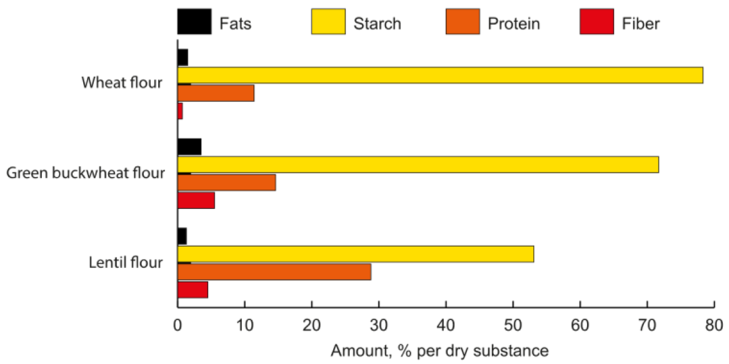

Fig. 2. Selected indicators of flour biochemical profiles.

As can be seen from the figures, the highest oil content was found in green buckwheat flour, which is 2.3 times more than in wheat flour. It also has the highest total fatty acid content.

Among the flour samples studied, the largest amount of protein is contained in lentil flour, which is 2.5 times more than wheat flour. The protein content of green buckwheat flour in turn is 1.3 times higher.

The maximum amount of fiber is found in green buckwheat flour and lentil flour. The total antioxidant activity of non-traditional types of flour was also studied together with the Kazan National Research Technological University [12]. Fig. 3.

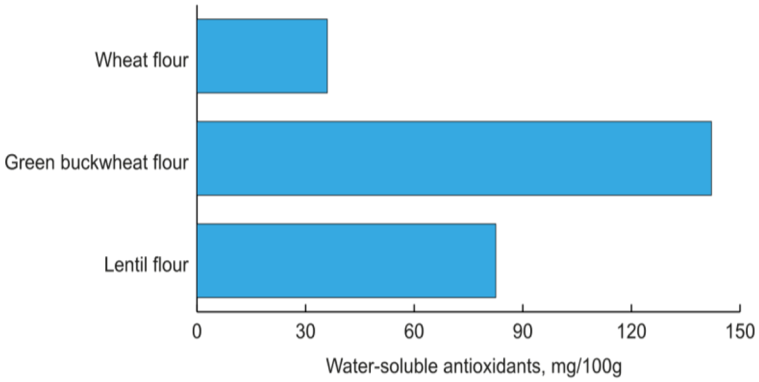

Fig. 3. General antioxidant activity of unconventional flours.

Green buckwheat flour has the greatest antioxidant activity. The content of water-soluble antioxidants in it is 3.9 times higher than in wheat flour. The content of antioxidants in lentil flour is 2.3 times higher.

The study of non-traditional food raw materials has shown the possibility of using it in the production of flour products for specialized nutrition, which inevitably leads to an expansion of the assortment.

The purpose of this study is to expand the range of biscuit semi-finished products using non-traditional types of flour and to research the influence of various types of flour – lentil

and green buckwheat on the organoleptic and physico-chemical quality indicators of the biscuit semi-finished product.

Study tasks are to develop a technology for the production of a biscuit semi-finished product using lentil flour and green buckwheat flour and to determine the quality indicators of the received products.

Objects of research are biscuit semi-finished product with lentil flour and green buckwheat flour.

As for the control sample, the classical technology of preparing the main biscuit was used in the work (Table 1).

Table 1. Biscuit semi-finished product recipe.

Raw materials	Mass fraction of dry substances, %	Raw materials consumption for 1 kg of semi-finished product, g	
		Under normal conditions	Dry substances
Wheat flour	85,5	319,5	273,2
Potato starch	80	35,5	28,4
Granulated sugar	99,85	350,0	349,5
Melange	27	650,0	175,5
Raw materials total	-	1355,0	826,6
Yield	-	1000	750
Humidity	25%	-	-

2 Materials and methods

The nutritional and energy value of biscuit semi-finished products, with losses taken into consideration, was obtained by calculation, humidity determined according to State Standard 5900-2014, porosity according to Governmental Standard 5669-96, density and swelling in water according to standard methods.

3 Results and discussion

Based on the control recipe of the biscuit semi-finished product (Table 1), products (biscuit semi-finished products) were developed with the replacement of wheat flour by dry substances with lentil flour and green buckwheat flour in quantities of 30, 50, 70 and 100%. The results of sensory evaluation of finished products with the replacement of part of the flour with non-traditional raw materials in the recipe of the biscuit semi-finished product are presented (Fig. 4).

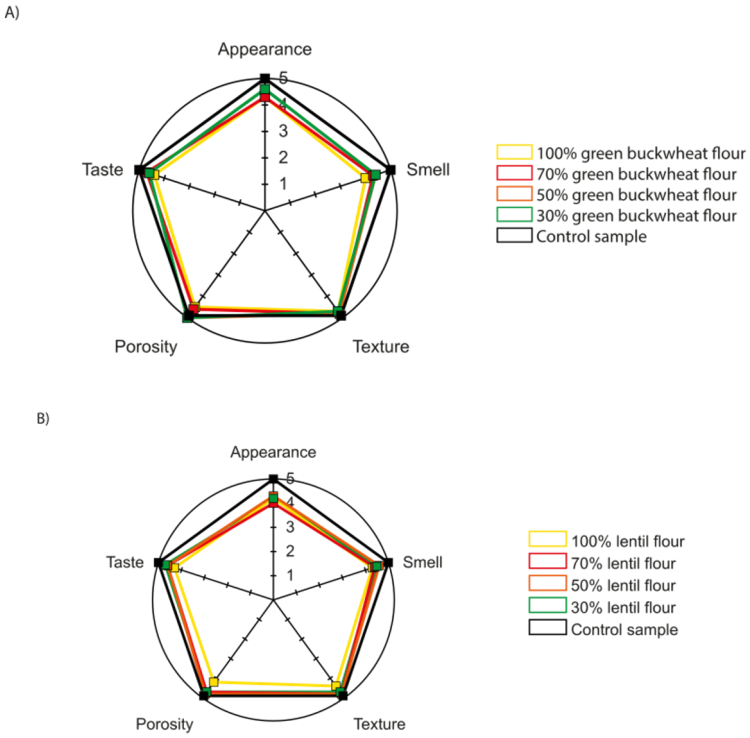

Fig. 4. Biscuit semi-finished product sensory evaluation results: A – wheat flour replaced with green buckwheat flour; B – wheat flour replaced with lentil flour

The sample containing 50% green flour had the best organoleptic characteristics compared to the control sample (Fig. 4A). As noted by experts, it had pleasant appearance, smell and texture. The specific buckwheat taste was absent, as opposed to samples with 70 and 100% green buckwheat flour added.

As for the lentil flour, samples with 50% content of lentil were outstanding (Fig. 4B). Experts noted that it had the most appealing smell, taste and texture. In addition, there was an increase in sweetness and dryness which corresponded with an increase in the amount of lentil flour in the samples.

Thus, based on the organoleptic evaluation for further research, it was decided to choose biscuit semi-finished products with 50% of wheat flour replaced.

It was found that with the introduction of non-traditional types of flour, the mass fraction of moisture increased (Table 2). This value is reflected in the technical and technological documentation for confectionery products.

Table 2. The main parameters of a biscuit semi-finished product

Samples	Humidity, %	Density, г/см3	Porosity, %	Swelling, %
Control	25.5	0.307	76.56	321.8
Buckwheat flour 50%	30.1	0.278	77.94	292.8
Lentil flour 50%	29.8	0.306	75.71	241.5

The table 2 shows that the replacement of 50% wheat flour led to a decrease in the density of the product and an increase in porosity. Thus, the resulting products are not inferior to the control sample according to these indicators.

The swelling index decreased when wheat flour was replaced. The decrease of the swelling index can be explained by the lower starch content in green buckwheat flour and lentil flour.

During the study, a comparative analysis of the nutritional and energy value of the obtained semi-finished products was compared with the control. The nutritional and energy value was determined by the calculation method (Fig. 5).

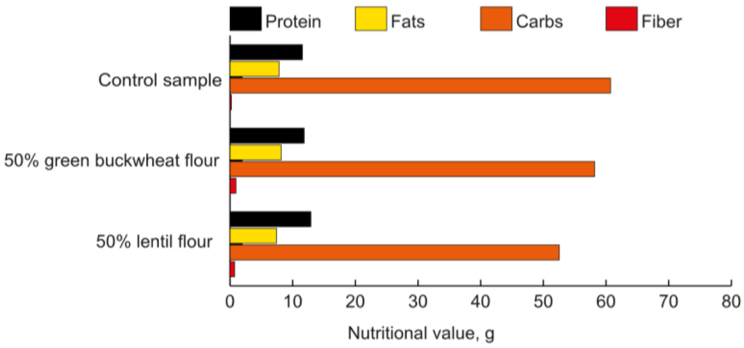

Fig. 5. Comparative analysis of food and energy value of semi-finished products

As can be seen from the figure, the replacement of wheat flour by 50% leads to an increase in the amount of protein in biscuit semi-finished products prepared with green buckwheat flour by 2.4%.

The amount of fat decreases with the replacement of wheat flour by 50% of lentil. The deviation is 5.4%, but the amount of fat in the semi-finished product with green buckwheat flour increases. The amount of carbohydrates in all samples decreases compared to the control, and the amount of fiber increases up to 4 times.

The energy value of all samples also decreased by 1.7 and 8.7% compared to the control for green buckwheat and lentil flour, respectively.

According to the calculated data, the content of vitamin A in the simulated semi-finished products has increased by 5 or more times which in comparison with the daily norm is insignificant. The Si content increased up to 10 times in all samples. In a sample with 50% of green buckwheat flour, the Mg content increased by 3 times, Mn by 1.7 times, and in a sample with 50% of wheat flour replaced with lentil flour, the amount of vitamin B9 increased by 1.7 times, Mg by 1.8 times, K by 1.6 times, Fe by 1.7 times, Si and Mo by 2 times.

4 Conclusion

The studied flour samples introduced into the developed products have a unique composition. Fiber-rich green buckwheat flour will be useful for supplementing diets, intended for people suffering from problems with intestinal peristalsis, diabetes and tendency to obesity, as well as in sports nutrition. As part of the biscuit semi-finished products, green buckwheat flour contributed to a decrease in caloric content, as well as to an increase in nutritional value and antioxidant activity. Lentil flour, rich in proteins, can be recommended when forming diets with a high protein content, used, for example, for diabetes. As part of the biscuit semi-finished products, lentil flour also contributed to an increase in nutritional value.

Thus, products manufactured with alternative flour types have a unique content and can expand the range of semi-finished products produced. Green buckwheat has a positive effect on the level of glycemia. Cereals contain slow carbohydrates with a glycemic index of 43.

This fact is important for those suffering from carbohydrate metabolism disorders (diabetes) and overweight [14]. Lentil flour, in turn, is rich in easily digestible proteins, which can be an important part of the diet of athletes, vegetarians and those who are fasting [15,16].

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