Using a mixture of almond and chickpea flour in wheat bread production technology

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Abstract. In the modern food industry, various methods are used to enhance the quality of food products and optimize the technological process. One effective and relatively simple approach is the use of alternative raw materials that can improve the nutritional value of bread and bakery products. Almond and chickpea flour are examples of such alternative ingredients. This study investigated the impact of adding a mixture of almond and chickpea flour to the recipe on the organoleptic and physicochemical properties of wheat bread. The researchers determined the most effective ratios of almond and chickpea flour that could improve the physical and chemical characteristics of the bread without compromising its organoleptic quality. The results show that the optimal addition to the dough is a mixture of 10% almond flour and 15% chickpea flour, calculated from the total mass of flour. This combination enhanced the nutritional value of the wheat bread without adversely affecting its sensory attributes. The study provides a rationale for using a mixture of almond and chickpea flour as recipe-component solutions when baking wheat bread. The findings suggest that this approach can be a viable strategy to improve the overall quality of bread and bakery products.

1 Introduction

At the present stage of development of the food industry, the direction of expanding the range and production of food products from plant raw materials with improved characteristics is of particular relevance [1].

There is an increasing trend in society towards a more balanced and healthy diet, which is largely realized through the consumption of products from biologically active raw materials [2].

A key focus of Russian state policy on national food products could be to establish domestic production of high-demand food materials and boost the production of mass-consumed food items, particularly common types of enriched bakery products that are widely consumed across the population. These products could incorporate various non-traditional ingredients that serve as potent sources of antioxidants, such as vegetable and fruit purees,

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processed cereal products (like buckwheat flour and cereal germ), green tea extract, and other plant-based products [3-4].

By the team of authors O.O. Prokopenko, E.N. Efremova, E.A.Zenina, and D.V. Chapko, studies have been conducted on the use of flour from spelled grain in the production of bakery products [5].

S.G. Boev and co-authors in their studies declare the possibility of using plant raw materials - burdock root flour with the addition of psyllium and a gluten-free mixture in the production of fortified bread [6].

A.G. Belyaev in his works he suggests using fireweed powder as a fortifier [7].

The widespread consumption of bread highlights its remarkable capabilities and importance in enhancing nutritional quality and shielding the body from the negative impacts of environmental toxins. Additionally, bread is the most feasible product for fortification and enrichment with mineral additives due to its relatively low cost and widespread availability to the general population. Premium flour bread typically contains small amounts of vitamins B1, B2, and PP, while vitamins A, C, and D are largely absent. Incorporating raw materials rich in these nutrients into the recipe enables the compensation for these deficiencies [8-9].

The creation of mixtures from various raw materials will significantly expand the range of these products for their intended purpose, namely, to increase the segment of products for therapeutic, preventive and dietary purposes, and make them more accessible, especially for socially vulnerable segments of the population [10].

The advantage of enriching bakery products with natural plant raw materials is the complexity of its chemical composition and, as a result, the possibility of complex enrichment of the finished product with vitamins, proteins, polyunsaturated fatty acids, minerals and trace elements, dietary fiber and other equally important biologically active substances [11].

In the modern food industry, various methods are used to improve the quality of food products and improve the technological process. The most effective and relatively easy to implement turned out to be the use of raw materials that improve the nutritional value of bread and bakery products. One of these types of raw materials is almond and chickpea flour. An analysis of various literary sources proves the feasibility of using almond and chickpea flour as a wheat fortifier. The value of using almond and chickpea flour is due to its unique amino acid composition and the content of vitamins and balanced minerals.

Chickpea flour is rightfully considered a valuable dietary product that is available to all groups of people, regardless of income. For good nutrition, sufficient amounts of proteins, vitamins and minerals, improved health, normalized weight, as well as saving financial and time costs for cooking, it is recommended to use chickpea flour as often as possible.

Chickpeas (also known as chickpeas or chickpeas) are one of the oldest crops, cultivated in the Middle East and other tropical and subtropical countries since time immemorial.

It belongs to the legume family along with lentils and peas and is an excellent source of fiber, protein, complex carbohydrates, folate, manganese, potassium and copper, in addition to being virtually free of saturated fat, cholesterol and sodium.

It is known that the use of chickpea flour improves the quality of baked goods, for example, when it is added in an amount of 5–20% by weight of wheat, the rheological properties of the dough and its formation positively change, and when 10–20% of chickpea flour is added to wheat flour, the nutritional value and taste qualities of bakery products.

Chickpea flour contains 2 times more protein and 4 times more fat than premium wheat flour. Of the 4.3 g of fat contained in 100 g of chickpea flour, more than half (2.9 g) is unsaturated fatty acids. The starch content in chickpea flour is 1.6 times lower than in wheat flour, which makes products made from chickpea flour suitable for feeding people with diabetes.

An important component in human nutrition is dietary fiber, the content of which is almost 10 g per 100 g of chickpea flour, while it is almost completely absent in premium wheat flour.

Chickpea flour does not contain gluten, so products even with a partial replacement of wheat flour will complement the line of products with a reduced gluten content for dietary and therapeutic nutrition.

Almond flour is a product obtained by processing an almond nut, the fruit of a tree or shrub with the same name, by grinding and drying the nut pulp.

Almonds are not only tasty, but also very healthy. All nuts are very good sources of protein, which is very important especially for vegetarians. Almonds contain up to 60% fat, 30% protein. Nuts also contain vitamin B and minerals (iron, zinc and magnesium). Almonds are rich in iron, calcium and phosphorus more than other nuts. Compared to other nuts, almonds are very rich in vitamin E, which is a natural antioxidant and is believed to help prevent heart disease and some types of cancer. Almonds are also a good source of calcium. Nuts, however, are very high in calories and fat. It has also been noted that when eating nuts, brain activity is activated. In general, nuts are very good for the nervous system, and not only due to the microelements they contain

The flour obtained from the nut is hygroscopic; it is able to absorb and retain moisture well. Thanks to this, baked goods made from almond flour remain fresh longer and do not go stale.

Almond flour is distinct in its chemical composition, featuring a unique blend of saturated fatty acids, a full range of B vitamins, choline, beta-carotene, calcium, magnesium, phosphorus, iron, chlorine, sulfur, potassium, bioactive compounds, antioxidants, and phytoestrogens. This flour retains the valuable components of fresh nut kernels, maintaining their beneficial properties even after heat processing.

The significant advantage of almond flour is its near-total absence of gluten, making it an ideal choice for creating a variety of gluten-free foods and confectionery products suitable for individuals with gluten sensitivities.

2 Materials and methods

The department of commodity science, technology and examination of goods at South-West State University carried out the experimental studies. The experimental studies were conducted in the laboratories of the department in accordance with the assigned tasks. The researchers followed the established protocols and procedures to investigate various aspects of commodity science, technology, and goods examination.

The work used generally accepted and special methods for assessing the properties of the product. The control sample was based on the recipe for ordinary white bread, which is presented in Table 1.

Table 1. Recipe for regular white bread for a control sample.

Name of raw materials	Raw amount, g	
	Gross	Net
Premium wheat flour	400	400
Table salt	8	8
Sugar	25	25
Water	260	260
Yeast	6	6

According to this recipe, a percentage of premium wheat flour was replaced with almond and chickpea flour. The remaining ingredients remained unchanged. The developed recipes

for samples of white bread made from wheat flour, followed by its percentage replacement with almond and chickpea flour, are presented in Table 2.

Table 2. Recipes for bread samples.

Ingredients	Sample #1	Sample #2	Sample #3	Sample #4
Premium wheat flour, g	400	320	300	260
Almond flour, g	—	40	40	60
Chickpea flour, g	—	40	60	80
Sugar, g	25	25	25	25
Table salt, g	8	8	8	8
Drinking water, ml	260	260	260	260
Yeast, g	6	6	6	6

The properties of pre-prepared laboratory bread samples were evaluated using both sensory and physical-chemical methods. The moisture content and dry matter percentages were determined using the standard method outlined in GOST 21094. Titratable acidity was measured according to GOST 5670-96. The sensory characteristics of the finished bread samples were assessed according to GOST 5667-65. The porosity of the bread was determined using a Zhuravlev tester, which consists of a metal cylinder with a 3 cm internal diameter, a pointed edge on one side, a wooden sleeve, and a wooden or metal tray with a transverse wall featuring a 1.5 cm deep slot at a distance of 3.8 cm from the wall.

To investigate the feasibility of using a mixture of almond and chickpea flour in wheat bread, the following samples were prepared: sample No. 1 (control sample) without the addition of almond and chickpea flour; sample No. 2 with 10% almond and chickpea flour from the total flour amount; sample No. 3 with 10% almond and 15% chickpea flour from the total flour amount; and sample No. 4 with 15% almond and 20% chickpea flour from the total flour amount. These recipes were used to bake the bread samples (Fig. 1).

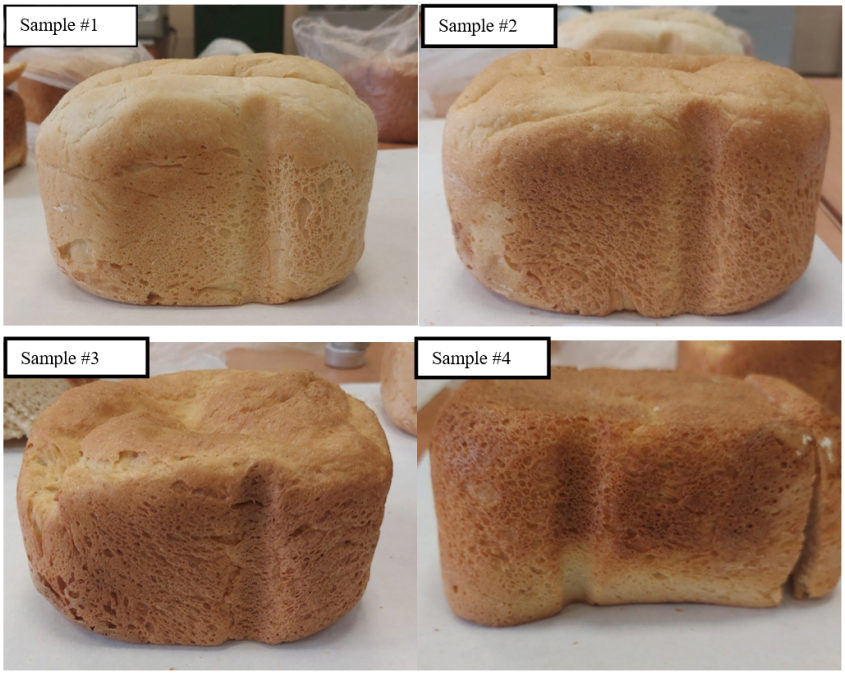

Fig. 1. Received bread samples.

3 Results and discussion

The organoleptic (sensory) qualities of experimental bread samples made from wheat flour were assessed on a five-point scale. The results of the sensory evaluation for bread made from premium wheat flour with the addition of a mixture of almond and chickpea flour are presented in Table 3.

Table 3. Organoleptic characteristics of bread.

Indicator	Expert rating scale			
	Sample #1	Sample #2	Sample #3	Sample #4
Appearance	5	5	5	3
Surface	4	4.5	5	3
Color	4	5	5	5
Bakedness	5	5	5	4
Promes	5	5	5	4
Porosity	5	5	5	3
Taste	4.5	4.5	5	4
Smell	5	4.5	5	4
Total	37.5	38.5	40	30

Bread sample No. 2 has the correct shape and surface, with no large cracks or tears. The color is golden, and the crumb is baked and elastic, with homogeneous and uniform porosity. There were no signs of tampering. In contrast, sample No. 3 has a similar appearance, with a golden color and a smooth surface without cuts or punctures. The crumb is also baked and elastic, with a pleasant taste and smell. These characteristics earned sample No. 3 the highest score based on organoleptic indicators. Sample No. 4, however, has a different appearance. The surface has cracks and tears, but the color remains golden. The crumb is baked and not wet to the touch, with small lumps observed. The smell and taste are pleasant and bready, but two tasters noted the presence of mealiness on the surface, which reduced their score. This sample received the lowest score based on organoleptic characteristics.

When evaluating physicochemical indicators, several factors are considered, including moisture content, acidity, porosity, and the total mass fraction of ash. High humidity can reduce the nutritional value of bread, impair its taste, and shorten its shelf life. The grade of flour used also affects these indicators, with higher grades typically resulting in lower moisture content. Acidity affects the taste of bread, and bread that is too sour or too sour tastes unpleasant. The porosity of bread is the volume of pores in 100 volume units of crumb and is a key factor in its nutritional value. Porous bread is easily digestible and well saturated with digestive juices in the gastrointestinal tract.

The porosity of the highest grades of wheat bread can reach 75% or higher, while rye bread made from wallpaper flour rarely exceeds 55%. Therefore, the porosity of bread is a feature that increases its nutritional value. Analysis of baked samples of white bread with improved consumer properties was carried out according to the following indicators: humidity, acidity, ashing, and porosity. All studies were conducted in accordance with GOST requirements, and the results are presented in Table 4.

Table 4. Results of the study of physical and chemical indicators and quality of white bread samples

Indicator	**Results**			
	Sample #1	**Sample #2**	**Sample #3**	**Sample #4**
Crumb moisture, %	32	32	32	36
Crumb acidity, %	4.4	4.96	6	6.72
Crumb porosity, %	65	65	67	60
Mass fraction of ash, %	5.7	6.6	7.4	7.6

Table 4 shows that obtained during the study of physicochemical quality indicators (humidity, acidity, ash content and porosity) of bread, all sample indicators differ slightly and vary within fairly narrow limits.

Sample No. 3 has physical and chemical quality indicators that comply with GOST standards.

4 Conclusion

The organoleptic assessment of the quality indicators of the studied samples of wheat white bread with the addition of a mixture of almond and chickpea flour revealed that sample No. 3 stood out as the best. This sample exhibited the correct shape, with a golden color that was visually appealing. The surface was smooth and free of large cracks and tears, cuts, or punctures, indicating proper baking and handling. Furthermore, the bread was baked to perfection, with a pleasant taste and aroma that was free from any foreign odors or tastes.

According to the results of a study of physical and chemical indicators, namely: crumb moisture, acidity, porosity and total mass fraction of ash. For sample No. 3, we note an increase in porosity to 67% and ash mass fraction to 7.4% compared to the control sample. Acidity and humidity correspond to standard values.

During storage, all bread samples showed changes in organoleptic quality indicators: signs of drying appeared after 24 hours from the moment of baking, as evidenced by slight hardening of the crusts and drying out of the crumb.

After 48 hours from the moment of baking, it could be noted that the crusts of the bread became hard, crumbled heavily when cut, the crumb began to lose elasticity, the taste and smell were not sufficiently pronounced.

After 96 hours, the samples were difficult to cut, indicating significant hardening of the bread. Bread molding processes were not identified.

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