Use of chickpea flour in food production

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Abstract. Currently, the production of special varieties of bread and bakery products using non-traditional plant raw materials is relevant. The article presents the results of studies on the introduction of chickpea flour into the recipe of wheat bread. Chickpea is a crop that is adapted to vegetation in unfavorable soil and climatic conditions of the Volgograd region. Chickpeas are high in protein (up to 32%) and fat (8%), while the amount of carbohydrates is insignificant (up to 5%). In the laboratory, test baking of bread was carried out using the following options: wheat bread (control) and wheat-chickpea bread. Chickpea flour was added to wheat flour in the amount of 5, 10, 15 and 20%. Before baking, a study of wheat flour and mixtures of wheat flour with chickpea was carried out for the content and quality of crude gluten. The addition of chickpea flour has been found to reduce the amount of wet gluten, but not to decrease its quality group. After test baking, the volume of the bread was measured and the organoleptic characteristics were determined. It was found that the addition of chickpea flour leads to a decrease in the volume of the finished product. The bread with the addition of chickpea flour differed from the control variant in the color of the crust and crumb. The pulp was denser and finer. The taste and smell of chickpea were felt only in the variants with the addition of 15 and 20% chickpea flour. The addition of chickpea flour contributed to the enrichment of wheat bread with essential amino acids. With the consumption of 300 g of bread containing 80% wheat and 20% chickpea flour, the daily requirement of the human body for essential amino acids would be satisfied by 48.8%.

1. Introduction
On the Russian bakery market today, there is a general European trend aimed at improving the quality of products of a new level that satisfy consumer demand. In modern conditions, it is no longer enough for manufacturers to win the attention of consumers simply to offer high quality products at an affordable price.

Of particular interest are flour mixtures that make it possible to produce special types of bread and bakery products. The use of bakery mixtures gives the manufacturer a number of advantages: it expands the range of bakery products, increases the nutritional value and shelf life of products, and ensures production efficiency.

According to the latest scientific data, bread and baked goods are sources of protein, carbohydrates and energy, providing, respectively, 40%, 53% and 36.6% of their daily intake.

Bread products are a classic natural source of vitamins B, B, PP, E and folate acid. Their content in grain of wheat and rye is balanced in accordance with human needs, and 100 g of grain cover 20-30% of the daily requirement for each of these vitamins [1].
Compared to meat, fish, dairy products, bread is relatively inexpensive, which is why its consumption currently exceeds the standard. It is available to everyone, and no one can do without it. It is not for nothing that the people say: "Bread is the head of everything."

For a significant mass of the population of our country, bread is the main supplier of protein - the most valuable part of the diet.

Proteins provide plastic function in the body. Our body is built from them, blood, enzymes, hormones, antibodies are formed. The presence of protein determines the ecological well-being and resistance of the population to negative factors of the working environment, to infections, poisons, radiation, and also depends on the physical and mental development of a person. Unfortunately, bread proteins are defective, since they do not contain or contain in insignificant quantities vital and essential amino acids for the body: lysine, methionine, tryptophan. It is up to the mind and hands of a person to correct this natural deficiency, which can be done by introducing missing amino acids into the bread recipe, for example, whey, soy flour, individual amino acids, which are produced microbiologically [2].

Research into the possibility of enriching bread with useful components contained in soybean, corn, barley flour was begun in our country in the 30s - 40s of the last century. The work was interrupted during the Great Patriotic War, but they formed the basis for the creation of bread products in besieged Leningrad.

After the war, the work was continued, expanded and deepened. As a result, a range of products and technologies for the production of bread with increased biological value was created using 15-20% soybean and pea flour.

In recent years, in the Volgograd region, there has been an increase in the cultivated areas of chickpea, the plants of which are most adapted to vegetation in the unfavorable soil and climatic conditions of the Lower Volga region. Among leguminous crops, chickpeas are distinguished by a rather high content of protein (up to 32%) and fat (up to 8%), with an insignificant content of carbohydrates (up to 5%).

A number of authors conducted studies on the possibility of using chickpea flour as a wheat improver [3,4]. The addition of chickpea flour in an amount of 10-20%, in their opinion, promotes an increase in the protein content by 18.6%, a decrease in the starch content by almost 3 times and an improvement in organoleptic characteristics. At the same time, the volume of bread increases by 10%.

The main substances that determine the nutritional value of chickpea are proteins. Although chickpeas are inferior in protein content to major legumes, their amino acid composition is similar to proteins of animal origin.

It is well known that the quality of wheat bread is largely determined by the quantitative and qualitative characteristics of crude gluten.

Gluten dry matter contains 43.2% gliadin, 39.1% glutenin, 4.41% other proteins, i.e. albumin and globulin. Thus, the main mass - about 82% of the dry matter of gluten - is gliadin and glutenin. They form, as it were, the skeleton of that protein jelly, which is gluten.

In turn, chickpea protein is represented mainly by water-soluble and salt-soluble proteins, that is, albumin and globulin. Therefore, it is of some interest how the protein complex of chickpea flour will affect the protein complex of wheat flour, in particular, the quantity and quality of crude gluten [5,6,7].

The aim of the work was to study the effect of the protein complex of chickpea flour on the protein complex of wheat flour, in particular, on the quantity and quality of crude gluten.

2. Research methods and materials

Organoleptic evaluation. The appearance of the bread was determined by inspection. The state of the crumb of bread was determined by porosity, elasticity. We pay attention to the size of the pores. The cut product was squeezed by hand, then the speed and completeness of the restoration of the original shape was observed. The smell was determined by two or three deep breaths from a whole and freshly cut product. To determine the taste, slices with a thickness of 6-8 mm were cut, chewed for 3-5 seconds.

Determination of the amount of wet gluten. 25 g of flour was kneaded with 14 cm³ of water. The resulting dough was covered and left to rest for 20 minutes. Then washing was carried out. The dough
was held over a container of water and gently kneaded with your fingers while constantly adding water from the container in the palm of your hand. When the gluten started to form, washing was carried out in water between the palms. The water was changed 4 times, filtering through a sieve, maintaining the water temperature in the range of 18 ... 20 °C. The detached pieces of gluten were collected from the sieve and added to the total mass of gluten. The process was continued until the moment when the weight difference between the two washes did not exceed 5%. The washed gluten was squeezed out, dried by pressing between the palms, wiping them with a dry towel. The squeezed gluten was weighed, then washed again for two minutes, squeezed again and weighed with an accuracy of 0.01 g. If the difference between the two weighings did not exceed 0.10 g, the process was terminated.

Determination of the quality of crude gluten. From the finally washed, squeezed out and weighed gluten, a sample weighing 4.0 g was isolated. It was molded into a ball, placed in a container filled with water at a temperature of 18 ... 20 °C for laying, held for 15 min. Then the gluten ball was placed in the center of the table of the gluten strain meter and the measurement was carried out. The results of measuring the elastic properties of gluten were expressed in conventional units of the gluten strain meter device – units, gluten strain meter. Readings from the indicator panel of the device were taken with an accuracy of 0.1 units, gluten strain meter.

3. Results
In the laboratory, test baking of bread was carried out using the following options: wheat bread (control) and wheat-chickpea bread. Chickpea flour was added to wheat flour in the amount of 5, 10, 15 and 20%.

Before baking the bread, the quantity and quality of crude gluten in wheat flour and in wheat-chickpea mixtures were determined. The results are shown in table 1.

| Variants                        | Indicators for crude gluten | The difference compared with the control, % |
|--------------------------------|----------------------------|--------------------------------------------|
| Wheat flour (control)          | 28.8%                      | 71 units                                   |
| Wheat flour (95%) + chickpea flour (5%) | 27.2%                      | 71 units, -1.6%                           |
| Wheat flour (90%) + chickpea flour (10%) | 22.4%                      | 70 units, -6.4%                           |
| Wheat flour (85%) + chickpea flour (15%) | 20.0%                      | 71 units, -8.8%                           |
| Wheat flour (80%) + chickpea flour (20%) | 14.8%                      | 70 units, -14.0%                          |

The results obtained allow us to conclude that the addition of chickpea flour does not have any effect on the quality of crude gluten, its elastic-deformation properties. Both when washing gluten from wheat flour and from a mixture of wheat-chickpea flour, regardless of the amount of added chickpea flour, gluten was characterized by the I quality group.

Different results were obtained when determining the amount of wet gluten. Experiments have shown that an increase in the content of chickpea flour in the flour mixture led to a significant decrease in the content of crude gluten.

So, when adding chickpea flour in the amount of 5%, the content of crude gluten decreased by 1.6% compared to the control. With the addition of 10% chickpea flour, the content of crude gluten decreased by 6.4%, with the addition of 15% chickpea flour - by 8.8%, and with the content of 20% chickpea flour in the flour mixture, the content of crude gluten decreased by 14%.

When carrying out a test laboratory baking of bread, the unpaired method was used. The introduction of chickpea flour into the composition of wheat flour had a noticeable effect on the volume of baked bread and on the organoleptic indicators of its quality (table 2).
When baking wheat-chickpea bread, a decrease in its volume was noted depending on the amount of added chickpea flour. The use of 5% chickpea flour reduced the bread volume by 5 cm (1.8%) compared to wheat flour bread. With the content of 10% chickpea flour in the mixture, the volume of bread, in comparison with the control, decreased by 25 cm or by 4.2%. Bread baked from 85% wheat and 15% chickpea flour reached 555 cm$^3$ in volume, which was 45 cm (7.5%) less than the volume of the control bread sample. The smallest volume of bread was observed when it was baked from a mixture in the ratio of 80% wheat and 20% chickpea flour. In this case, the volume of bread was 500 cm$^3$, which is 100 cm$^3$ or 16.7% less than the volume of bread made from wheat flour.

The decrease in the volume of bread with the addition of chickpea flour is explained by the decrease in the content of crude gluten in the flour, which, as you know, is the “frame” of wheat bread.

**Table 2. Qualitative characteristics of wheat and wheat-chickpea bread.**

| Variants                              | Bread volume, cm$^3$ | Crust color                  | The porosity of the crumb | Crumb color           | Taste                        | Smell                          |
|---------------------------------------|---------------------|------------------------------|---------------------------|-----------------------|------------------------------|--------------------------------|
| Wheat bread (control)                 | 600                 | Light yellow with a golden hue | Small, evenly distributed pores | White                | Pleasant, without foreign tastes | Pleasant, no foreign smells   |
| Bread with the addition of 5% chickpea flour | 595                 | Light yellow                 | Small, evenly distributed pores | White with a yellowish tinge | Pleasant, without foreign tastes | Pleasant, no foreign smells   |
| Bread with the addition of 10% chickpea flour | 575                 | Yellow                       | Small, evenly distributed pores | Yellow               | Pleasant, without foreign tastes | Pleasant, no foreign smells   |
| Bread with the addition of 15% chickpea flour | 555                 | Yellow                       | Low porous                 | Yellow with a darkish tint | Pleasant, chickpea taste     | Pleasant, with a slight chickpea smell |
| Bread with the addition of 20% chickpea flour | 500                 | Dark yellow                  | Low porous                 | Dark yellow          | Nice, chickpea taste          | Pleasant, with a slight chickpea smell |

In the course of baking, a difference in the color of the surface of the bread crust was observed. The crust color of the wheat-chickpea bread was more intense. This, apparently, can be explained by the fact that the addition of chickpea flour increased the sugar content in bread. The darker color was caused by their caramelizeation during the baking process.

The color of the crumb changed noticeably. If in wheat bread it was white, then in wheat-chickpea it acquired a yellow color. The more chickpea flour contained in the bread, the darker the crumb was.

The addition of chickpea flour somewhat condensed the flesh of the baked bread. This was most pronounced when the mixture contained 20% chickpea flour.

It should be emphasized that chickpea flour did not cause particularly noticeable changes in the taste and smell of bread. Only when it was contained in an amount of 15 and 20% did a barely perceptible taste and smell characteristic of chickpea appear.
Calculations on the change in the amino acid composition of wheat bread with the introduction of various doses of chickpea flour have shown that the use of chickpea flour, even in a small amount, has a significant effect on the change in the amino acid composition of bread.

So, when 5% chickpea flour was added, the content of essential amino acids was 3.722 g, which is 0.452 g more than in wheat bread. And with the introduction of 20% chickpea flour, the content of essential amino acids has already reached 5.549 g, which is 2.279 g more than in the control sample.

The average citizen of our country eats up to 300 grams of bread a day. Taking this into account, the consumption of wheat bread allows the body to get about 9.81 g, or 28.8% of the amino acids of the daily value. With the consumption of wheat-chickpea bread containing 80% wheat and 20% chickpea flour, the daily requirement of the human body for essential amino acids would be satisfied by 48.8%, that is, almost half.

4. Conclusions

Based on the results of our research, we recommend adding 20% chickpea flour to the wheat bread recipe. This increases the content of essential amino acids to 5.549 g per 100 g of bread. Consumption of 300 g of wheat bread with the addition of 20% chickpea flour covers 48.8% of the daily requirement for essential amino acids.

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