Development of technological parameters of wheat grain germination

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Abstract. Green wheatgrass juice has an increased nutritional value. It is well suited for enriching bakery products. Juice of green wheat germs, yeast dough made from wheat flour, bread made from wheat flour with different content of green wheat germ juice were identified as objects of study. The physico-chemical processes occurring in yeast-free dough and ready-made bread from wheat umka were studied with the introduction of green wheat germ juice in an amount of 5-20% by weight of water. Changes in the mass of products and the mass fraction of moisture during storage led to the conclusion that the introduction of green wheat germ juice slows down the staleness of bread. As a result, based on a complex quality indicator, it was determined that the recipe for bread made from wheat flour with the content of wheat grass juice in the amount of 5% by weight of water would be optimal. The degree of satisfaction of the daily requirement for basic nutrients was calculated by introducing bread from wheat flour into the diet with the addition of green wheat grass juice in the amount of 5%.

1 Introduction

The health of people nowadays is largely determined by the nature, level and structure of nutrition. Under the current environmental conditions, nutritional imbalance, among other factors, leads to a decrease in immunity and an increase in the level of morbidity. Correction of the diet with the help of foods of increased nutritional value, including bread, is one of the most effective measures that allows you to activate the body's defences in adverse living conditions and improve health [1-3]. The issue of the availability of bakery products of increased nutritional value to the consumer remains relevant, especially for the regions of the Krasnoyarsk Territory. The nutritional value of the finished bread depends on the content of nutrients in it (carbohydrates, proteins, vitamins, macro- and microelements) and on ensuring the optimal flow of technological processes at all stages of preparation. The use of natural plant additives intensifies the microbiological and biochemical processes in the dough, improves the properties of gluten, the structure of the dough, and improves the quality indicators of finished products, organoleptic characteristics: taste and aroma [4].

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Green wheat grass juice is a source of nutrients, vitamins, macro- and microelements, enzymes, amino acids, including essential ones, helps regulate sugar levels, reduces the risk of developing cardiovascular diseases and diseases of the gastrointestinal tract. The chlorophyll contained in the juice has bacteriostatic properties, stimulates the production of hemoglobin and red blood cells in anemia. Green wheat germ juice is well suited as an enriching additive for wheat bread for the dough to acquire structural and mechanical properties of the required quality and to comply with physical, chemical, colloidal, biochemical and microbiological processes at all stages of preparation. Therefore, it was decided to use juice from green wheat germ with a solids content of 6% as an additive to yeast dough [5-7].

The purpose of the work is to develop a technology and recipe for bread made from wheat flour with the addition of green wheat germ juice to improve the quality and life expectancy of the population of the Russian Federation as part of the implementation of the contract for research and technological work on a grant on the topic "Development of science-based recipes and shock freezing technology bakery products and bread with a prolonged shelf life, increased nutritional value using products of processing of regional vegetable raw materials of the Krasnoyarsk Territory.

2 Objects and methods of the research

The juice of green wheat sprouts was taken as the objects of study with the following indicators: solids content - (6.0±0.04)%, protein - (12.4±0.05)%, sugar - (6.48±0 .03)%, ash - (0.09±0.03)%, consistency - homogeneous opaque liquid, without coarse particles; color - uniform throughout the mass, saturated dark green; smell - appropriate, herbal; the taste is sweet [6]. In order to introduce the results of scientific research into real industrial production, we used Witgrass juice produced by the trade and production company Prorostki (STO 64082567-001-02015, Krasnoyarsk).

Also, yeast dough made from wheat flour and bread made from wheat flour with different contents of green wheat germ juice were identified as objects of study. To determine the rational dosage of green wheat grass juice, the test process and trial laboratory baking of bread from wheat flour with the addition of green wheat grass juice in an amount of 5-20% by weight of water were carried out. Organoleptic indicators of finished semi-finished products were determined on a 5-point scale [8]. Physical and chemical parameters were determined in accordance with the existing regulated methods using the ELVIZ-2S moisture analyzer and the Expert-001 liquid analyzer. To optimize the recipe composition of wheat flour bread with the addition of wheat grass juice, a modified standard qualimetric method for determining the dynamic complex quality index was used according to the equation:

$$K_{\sum}(t) = \sum_{i=1}^{n} \mu_i k_i(t), \quad (1)$$

where $K_{\sum}(t)$ is dynamic complex indicator of the quality of the technological process; μ_i is weight coefficient of the i-th single indicator; $k_i(t)$ is the value of a single indicator of the quality of the technological process; n is the number of single indicators; t is the period of time for which single quality indicators and a dynamic complex indicator of the quality of the technological process are determined.

The single indicators of the quality of the production process are selected the folowing ones: $k_1(t)$ – indicator of organoleptic evaluation; $k_2(t)$ – humidity indicator; $k_3(t)$ – acidity pH value; $k_4(t)$ – indicator of change in the specific volume of the dough; $k_5(t)$ – bread porosity index.

A single indicator of the quality of the technological process was calculated by the formula:

$$k_i(t) = \frac{x_i}{\max x_i}, \quad (2)$$

where x_i– significant values; $\max x_i$ – their corresponding maximum values [9].

Statistical processing of the results obtained was carried out in the Microsoft Excel and Statistica 6.1 programs using the nonparametric Kolmagorov-Smirnov test. The difference in comparison of mean values was considered significant at $p<0.05$.

The evaluation of the nutritional value of bread from wheat flour with the addition of wheat grass juice was carried out according to the norms of the average daily requirement for basic nutrients and energy [10].

3 Results and discussion

Yeast dough was prepared using a non-dough method, which involves direct kneading of the dough with the simultaneous addition of all the raw materials specified in the recipe. After kneading for 20±10 minutes, the finished dough was left for 45±10 minutes for the development, growth and reproduction of yeast during fermentation. Then, the finished dough was punched and cut from wheat flour, the resulting blanks were left for final proofing for 60 ± 10 minutes. With an increase in the dosage of green wheat grass juice, the amount of di- and polysaccharides in the dough increases, which are an additional nutrient medium for yeast. In the process of studying the yeast dough from wheat flour with the replacement of part of it with the juice of green wheat germ in the amount of 5-20%, changes in the duration of fermentation were noted. The results showed that when green wheat grass juice is added in an amount of 10–15% to the mass of water, the maximum dough height is observed, while compared with the control sample, it increased by 82–86%, respectively, in the same period of time. With the introduction of green wheatgrass juice in an amount of 5%, the height of the test increases by 67% compared to the control sample in the same period of time. In the sample with 20% green wheatgrass juice content, intensive growth was observed at the beginning of fermentation, but by the end of fermentation, the dough height increased by 64% compared to the control sample. This can be explained by the continued active development of yeast in the dough, the appearance of additional bonds at the points of contact between proteins and dough polysaccharides. In this regard, it can be assumed that the addition of green wheat germ juice leads to the formation of bonds that strengthen the dough structure.

All ready-made dough samples were subjected to an organoleptic evaluation according to the following indicators: surface condition, degree of looseness, consistency, color, smell. The data obtained is shown in Figure 1.

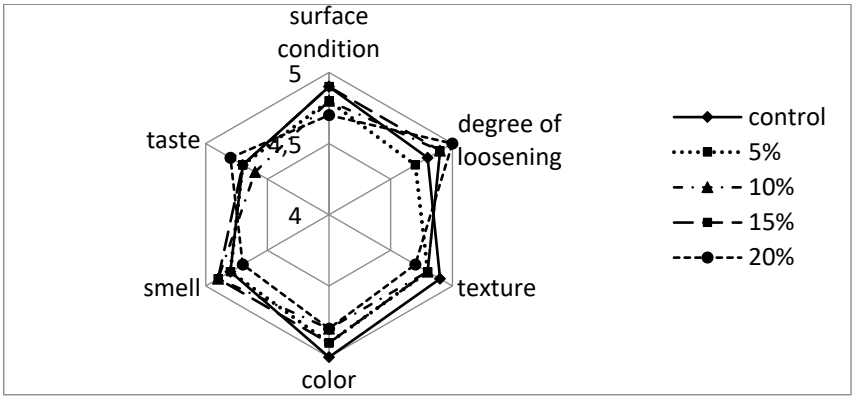

Fig. 1. Organoleptic parameters of dough samples with different content of wheat grass juice (M±m) (n=6).

According to the experts, a high overall score (4.8-4.9) was noted for test samples with a dosage of green wheat germ juice of 5-15%, while the resulting semi-finished products have a convex surface, a mesh structure and good looseness, which indicates a normal process fermentation. Test samples with a dosage of green wheat grass juice of 20% have a convex surface, a mesh structure of the dough and good looseness, and a sour smell and taste are also noted, which significantly reduced the rating.

Moisture, acidity (pH) and effective viscosity were determined from the physicochemical parameters of the finished dough samples.

An increase in humidity promotes the development of yeast and lactic acid bacteria, which in turn speeds up the fermentation process, however, excessive moisture in the dough can lead to a deterioration in the quality of finished products from it. The moisture content of ready-made dough samples with a content of green wheat grass juice of 5-20% is shown in Figure 2. Dynamics of moisture change: the introduction of green wheat grass juice into the recipe for unpaired yeast dough increases the moisture content of the finished semi-finished product as the dosage increases. So the moisture content of the finished dough containing 5% juice of green wheat germs practically does not differ from the moisture content of the control sample. In the finished dough containing 10-20% green wheat germ juice, the increase in moisture compared to the control sample was 7.8-16.7%, respectively.

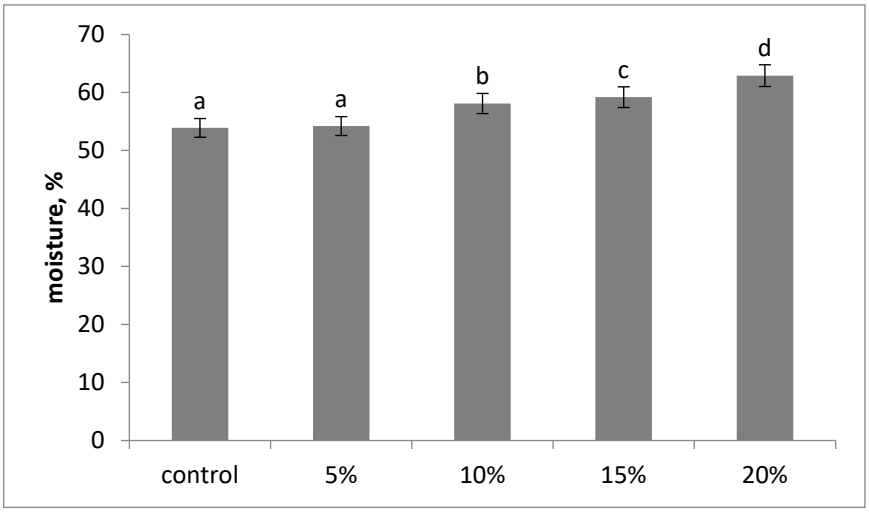

Fig. 2. Moisture content of prepared dough samples with different contents of green wheatgrass juice (M±m) (n=6) (within group differences, multiple comparison of means are indicated by different letters, LSD test, $p<0.05$).

Increased acidity indicates that an excess amount of lactic acid was formed in the dough during the fermentation process, which leads to a decrease in dough looseness, a deterioration in the quality of finished products and the appearance of a sour taste. The acidity of the finished dough with a content of 5-10% juice of green wheat germ increases by 2.9-5.9%, respectively, in comparison with the control sample. In dough containing 15-20% green wheat germ juice, acidity increases by 7.4-8.2%, respectively. The data obtained are shown in Figure 3.

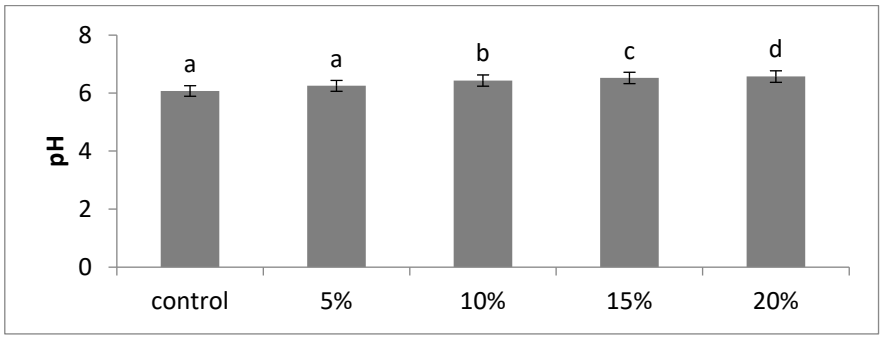

Fig 3. Acidity of finished dough samples with different content of green wheatgrass juice (M±m) (n=6) (within group differences, multiple comparison of means are indicated by different letters, LSD test, $p<0.05$).

Analysis of the data showed that the best results are observed in semi-finished products of yeast-free dough with the content of green wheat grass juice in the amount of 5-15%.

To substantiate the recipe for bread with green wheat grass juice, bread samples were baked from wheat flour, in which organoleptic and physico-chemical parameters were determined two hours after baking.

For finished products, organoleptic indicators are decisive. The data obtained is shown in Figure 4.

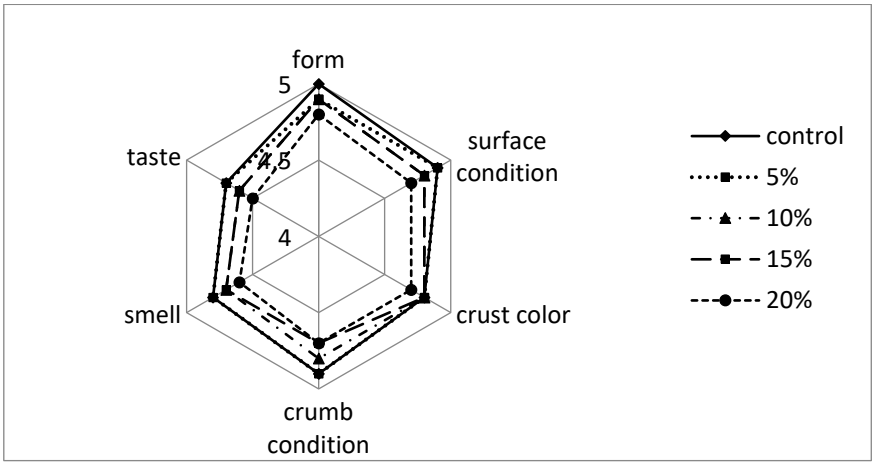

Fig. 4. Organoleptic characteristics of bread samples with different content of green wheat germ juice (M±m) (n=6).

According to the experts, a high overall score (4.8-4.9) was noted for bread samples with a dosage of green wheat germ juice of 5-10%. Bread quality was assessed according to a point system, taking into account all indicators and their significance coefficient.

The maximum values of porosity of finished products were observed when replacing 10% of water with green wheat germ juice. The data obtained is shown in Figure 6.

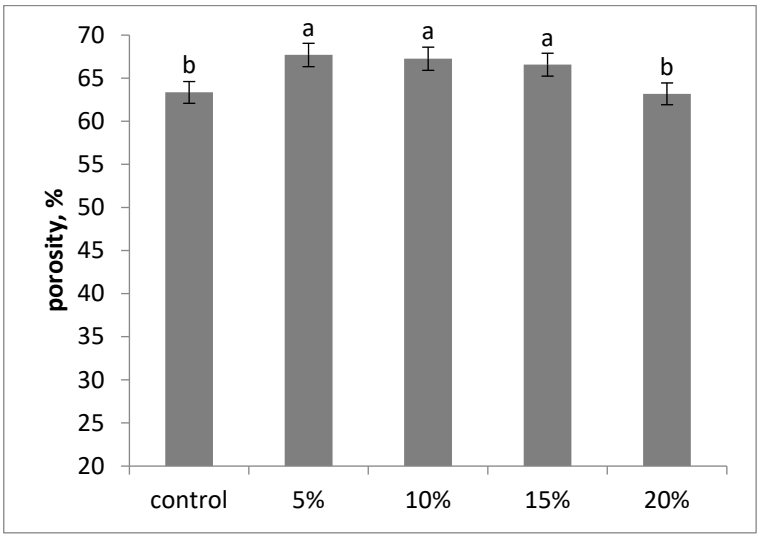

Fig. 5. Change in the porosity of bread from wheat flour depending on the juice content of green wheat germs (M±m) (n=6), different letters indicate intra-group differences, multiple comparison of means, LSD test, $p<0.05$).

The highest value of the complex indicator was obtained for samples of bread from wheat flour with the introduction of 5% green wheat germ juice. The data obtained are shown in Figure 6. Based on complex studies and analysis results, the optimal recipe composition of bread made from wheat flour with the addition of green wheat grass juice was determined.

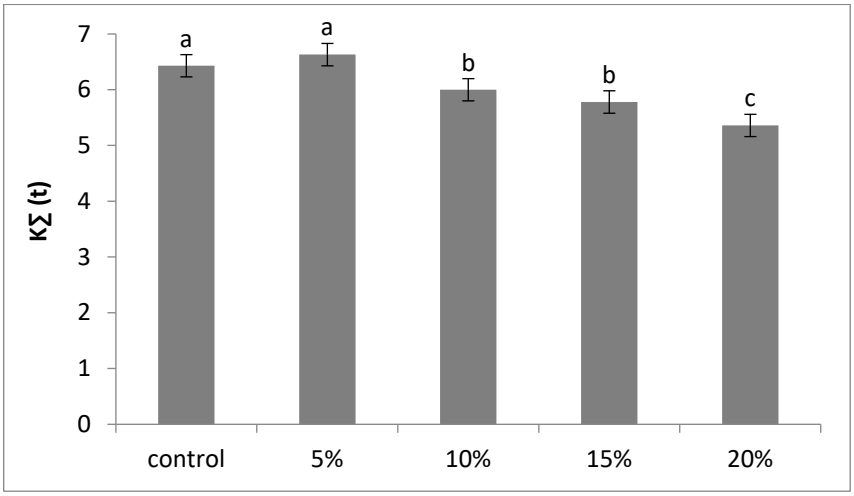

Fig. 6. Values of complex indicators of the quality of bread from wheat flour with the addition of green wheat germ juice.

For bread made from wheat flour with the addition of green wheat germ juice with the optimal recipe composition, the process of staleness was studied by changing the mass fraction of moisture and the mass of products during storage, compared with a control sample for 96 hours of storage. The results are shown in Figures 7-8.

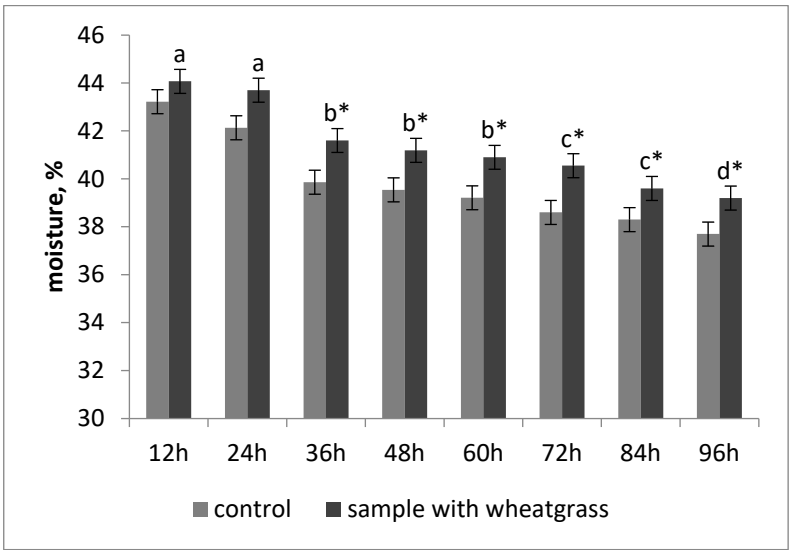

Fig. 7. Change in the mass fraction of moisture of bread from wheat flour during storage (M±m) (n=6), (different letters indicate intra-group differences, * - difference from control, multiple comparison of means, LSD, Mann-Whitney tests, p<0, 05)

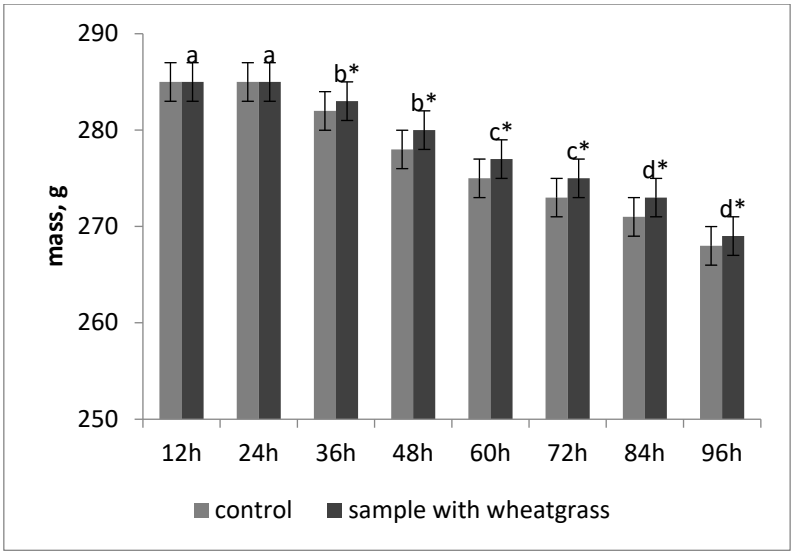

Fig. 8. Change in the mass of bread from wheat flour during storage (M±m) (n=6), (different letters indicate intra-group differences, * - difference from control, multiple comparison of means, LSD, Mann-Whitney tests, p<0.05).

Bakery products were packed in consumer packaging made of polyethylene food film in the form of a separate sliced product and stored in wooden trays in the expedition room at t=18±2ºC and 75% humidity. After 96 hours of storage, the mass fraction of moisture in bread from wheat flour (control sample) decreased by 12.8%, bread from wheat flour with the addition of green wheat grass juice - by 11.05%. Weight loss of the control sample after 96 hours of storage amounted to 6.1%, bread from wheat flour with the addition of green wheat grass juice - by 5.6%.

The results of the scoring organoleptic assessment of the freshness of bread throughout the entire shelf life are shown in Figure 9.

According to the results of an organoleptic evaluation, bread with green wheatgrass juice retained its freshness for 72 hours.

Thus, the analysis of the organoleptic indicators of freshness, moisture loss and mass of finished products during storage allows us to conclude that the introduction of green wheat grass juice slows down the staleness of bread. This process is explained by the high water-holding capacity of the protein not only in the process of dough formation and baking, but also in the storage of finished products.

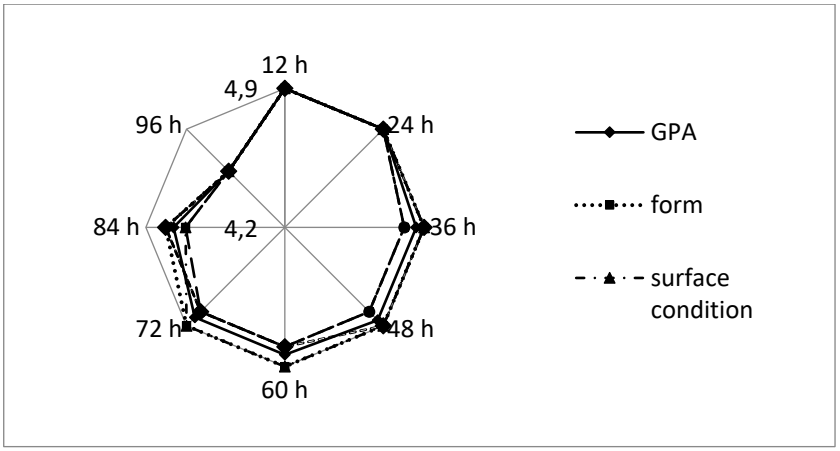

Fig. 9. Organoleptic assessment of the freshness of new types of bread (M±m) (n=7).

The nutritional value of wheat flour bread with green wheat germ juice was evaluated. Table 1 shows the level of satisfaction of the daily requirement of the human body for basic nutrients due to 100 g of wheat flour bread with green wheat germ juice [10].

Table 1. Evaluation of the nutritional value of wheat flour bread with green wheat germ juice (100 g).

Indicator	**Value**	**Average daily requirement, mg, g/day, TR CU 022/2011**	**Degree of satisfaction, %**
Protein, %	11.5	75	15.3
Carbohydrates, %	49	365	13.4
Vitamin B_1, mg %	0.16	1.4	11.4
Vitamin B_2, mg %	0.1	1.6	6.3
Vitamin B_6, mg %	0.3	2	15.0
Calcium, mg %	47.8	1,000	4.8
Iron, mg %	1.3	14	9.3
Magnesium, mg %	29.3	400	7.3

Thus, studies have shown that eating 100 g of wheat flour bread with the addition of wheat grass juice satisfies the daily requirement of the human body for protein 15.3%, carbohydrates - 13.4%, vitamin B1 by 11.4%, B2 - 6.3%, B6 - 15.0%, in iron - 9.3%, magnesium - 7.3%, calcium - 4.8%, which indicates a high nutritional value of the product.

4 Conclusion

As a result of the study, a positive effect of green wheat germ juice on reducing the duration of fermentation was noted. The technology and recipes of a semi-finished yeast dough made from wheat flour with a juice content of green wheat germs of 5-20% by weight of water have been studied. All the obtained semi-finished products of the finished dough have high organoleptic characteristics. In ready-made semi-finished dough products, with an increase in the introduced juice of green wheat germ, moisture and acidity (pH) increase. Based on the calculated dynamic complex quality index, the optimal percentage for making bread from wheat flour will be the introduction of green wheat germ juice in an amount of 5% by weight of water. An analysis of the organoleptic indicators of freshness, moisture loss and mass of finished bread during storage allows us to conclude that the introduction of green wheat grass juice slows down the staleness of bread. Satisfaction of the daily requirement of the human body in physiologically functional food ingredients of wheat flour bread with the addition of green wheat germ juice is: in protein 15.3%, carbohydrates - 13.4%, vitamin B_1 by 11.4%, B_2 - 6.3% , B_6 - 15.0%, in iron - 9.3%, magnesium - 7.3%, calcium - 4.8%.

The research was carried out under the contract for the implementation of scientific and technical work: "Development of scientifically based recipes and technology for shock freezing of bakery products and bread with a prolonged shelf life, increased nutritional value using processed products of regional vegetable raw materials of the Krasnoyarsk Territory."

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