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### Research Article

## Studies on the chemical composition of the fermented wheat product of increased food value as a promising raw material for breadmaking

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### Abstract

The object of the study is a fermented wheat product with increased nutritional value. This product was obtained by steeping and germinating wheat grain in a solution of the enzyme preparation until sprouts no more than 2 mm in length appeared. Then it was dried and ground. The aim of the work is to study the chemical composition of the fermented wheat product to be used in the production of bakery products. It was established that in germinating wheat grain the amount of proteins and fiber increases 1.6 and 2.5 times respectively; the amount of total carbohydrates lowers (62.4 %) as a result of a decrease in the starch content (60.0 %), along with an increase in mono- and disaccharides by a factor of 1.5. Vitamin content (B complex) in the test product was found to be as follows: B<sub>1</sub> – 0.19 mg, B<sub>2</sub> – 0.09 mg, B<sub>3</sub> – 7.24 mg, B<sub>4</sub> – 0.089 mg, B<sub>5</sub> – 0.67 mg, B<sub>6</sub> – 0.12 mg, B<sub>9</sub> – 0.017 mg. Potassium is shown to predominate in the fermented product as for macro elements. After germination its amount increases twofold. Iron is the most abundant trace elements in the analyzed product (7.2 mg.100 g<sup>-1</sup> of product). Studies made into amino acid composition showed that the content of lysine amounts to 637 mg.00 g<sup>-1</sup> of product, leucine - 1145 mg.100 g<sup>-1</sup> of product. The data obtained make it possible to recommend a fermented wheat product for obtaining bakery products with an anti-stress effect and increased biological value.

**Keywords:** fermented wheat product of increased nutritive value, wheat flour, chemical composition, protein, starch, carbohydrates, vitamins, minerals, amino acid.

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## **Introduction**

One of the main problems facing the society these days is the fight against stress. Stresses in the modern world pose a great danger for every person, especially for young people. They negatively affect physical and mental health of people, their ability to make the right decision at the right time. Frequent stresses deplete the nervous system, and sooner or later can lead to disorders, which may require medical care. When the body functions in such an "accelerated" regime for a certain period of time, the consumption of proteins, vitamins, minerals, etc. increases. Under stresses and many diseases of the nervous system, changes in diet and introduction of functional foods rich in proteins, carbohydrates, macro and microelements, fiber and vitamins make the situation easier (Shazzo et al. 2000).

Excellent representatives of functional products are fermented wheat products with increased nutritive value. They are products obtained by steeping and germinating wheat grains in a solution of the enzyme preparation until sprouts no more than 2 mm in length appear. Enzyme preparation Viscoferm (Novozymes, Denmark) in the amount of 1.8-2.2 mg/kg was used to treat wheat grain. Fermentation process was carried out at the temperature 20-25<sup>0</sup> C for 3-4 hours. Then the grain was germinated for 24 hours. Then the process is followed by drying and grinding processes (Urbanchik et al. 2016).

In the process of germination, there is an increase in the content of vitamins, mineral and water-soluble substances in the grain, new compounds that are not present in the "sleeping" grain of wheat are formed. At the germination stage, grain contains maximum amount of useful nutrients that are perfectly assimilated by the body. Thus, the composition of the germinated grain includes: vitamins B, K, E, D, P, and other vitamins, minerals such as iron, iodine, potassium, selenium, copper, zinc, chromium, as well as amino acids, fatty acids, enzymes, fiber, phytohormones, many of which are anti-stress components. All this contributes to strengthening of immune system, fight against stress, metabolic acceleration, including repair of body's tissues and cells, prevention of cancer and the nervous system diseases (Selhub et al. 2010).

The use of an enzyme preparation in steeping and germinating of wheat grain provides a significant

reduction in germination time and high quality of the finished product (Baranzelli et al. 2018).

The aim of the work was to study the chemical composition of a fermented wheat product to be used in breadmaking and to obtain bakery products of increased nutritional value with an anti-stress effect.

## **Materials and Methods**

The work was funded by the Belarusian Republican Foundation for fundamental research. The research was conducted in the laboratories of the Department of technology of bread products of the Mogilev State University of Food Technologies. Experiments were repeated 3–5 times. The results were processed by statistical methods with the probability of 0.95. Error experience of 5.0 %. The article presents the arithmetic means of the values obtained.

### **Materials**

**Raw materials.** The object of the study was a fermented wheat product of increased nutritional value (fermented product). Top grade wheat flour M54-28 (top grade wheat flour) and first grade wheat flour M36-30 (first grade wheat flour) were used as check samples. Quality indices of wheat flour complied with the requirements of STB 1666-2006. «Wheat flour. General specifications».

### **Methods**

Methods of the analysis generally accepted in industry and scientific institutions of the Republic of Belarus were used in the study. Flour samples were selected according to GOST 27668. Organoleptic parameters were determined according to GOST 27558, moisture content - according to GOST 9404, flour acidity - according to GOST 27493, flour falling number value - according to GOST 27676, autolytic activity - according to GOST 27495, quality and amount of gluten - according to GOST 27839, size of flour particles - according to GOST 27560, protein in flour - according to GOST 10846, fat in flour - according to GOST 29033, starch in flour - according to GOST 10845, fiber in flour - according to GOST 13496.2, Zn content in flour- according to STB 1313, Fe content in flour- according to GOST 26928, K content in flour- according to GOST 23268.7, I content in flour- according to EN 15111,

vitamins in flour - according to GOST 7047, amino acids in the flour - according to MBI.MN 1363.

### Results and Discussion

According to the organoleptic characteristics, the fermented product is a powdered substance from greyish-white to gray-cream color; taste that is characteristic for this type of product has no extraneous taste, is not sour and not bitter; odor that is characteristic for this type of product has no musty, moldy and other extraneous smells.

A comparative analysis of the average values of physico-chemical quality indicators of samples of fermented product and wheat flour is shown in Table 1.

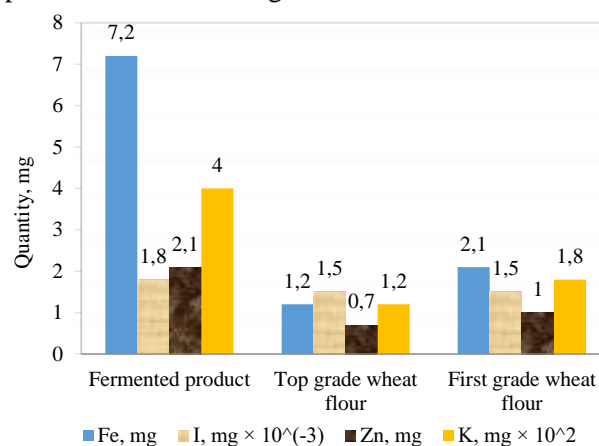
**Table 1.** Physico-chemical quality indicators of product samples

Indicator	Values of analyzed samples		
	Fermented product	Top grade wheat flour	First grade wheat flour
Mass fraction of protein,%	16.5±0,3	10.3±0.1	10.6±0.2
Mass fraction of fat,%	1.3±0.05	1.1±0.02	1.3±0.04
Mass fraction of carbohydrates,%	62.4±1.5	70.1±1.8	68.5±1.4
, including:			
mass fraction of starch,%	60.0±1.2	68.5±1.7	66.7±1.5
mono-, disaccharides,%	2.4±0.1	1.6±0.06	1.8±0.07
Mass fraction of fiber, %	10.1±0.6	3.5±0.5	4.4±0.5
Mass fraction of moisture, %	10.4±0.5	12.2±0.8	13.5±0.6
Ash content,%	1.6±0.03	0.5±0.01	0.7±0.02

Table 1 shows that during wheat grain germination, changes in grain chemical composition occur. Thus, the fermented product is rich in proteins and fiber, the content of which increased 1.6 and 2.5 times respectively, compared with top grade wheat flour and first grade wheat flour. The amount of total carbohydrates decreased (62.4%) as a result of a decrease in the starch content (60.0%), which is hydrolyzed to maltose during hydrolysis, which leads to 1.5 fold increase of the proportioned fraction of mono- and disaccharides in the product. The increased content of sugars indicates a high activity of amylolytic enzymes, resulting in high

sugar content of this product as a factor determining the process of baker's yeast life in the preparation of bread and keeping its freshness during storage. Ash content significantly increased (1.6%) in the fermented product as compared to that of top grade wheat flour (0.5%) and first grade wheat flour (0.7%). The content of fats practically did not change. Such a change in the chemical composition of the fermented product is characteristic only during the appearance of sprouts ranging from 1 to 2 mm in germinated wheat grain. Further, the content of healthy nutrients goes down, and the taste qualities of the germinated grains become worse and coarser in taste (Shazzo et al. 2000).

In addition to the basic nutrients (proteins, fats, carbohydrates), the fermented product also contains mineral substances (iron, iodine, potassium and zinc) which contribute to nervous system strengthening and fighting stress. The ratio of antistress minerals of the samples of the fermented product is shown in Fig. 1.



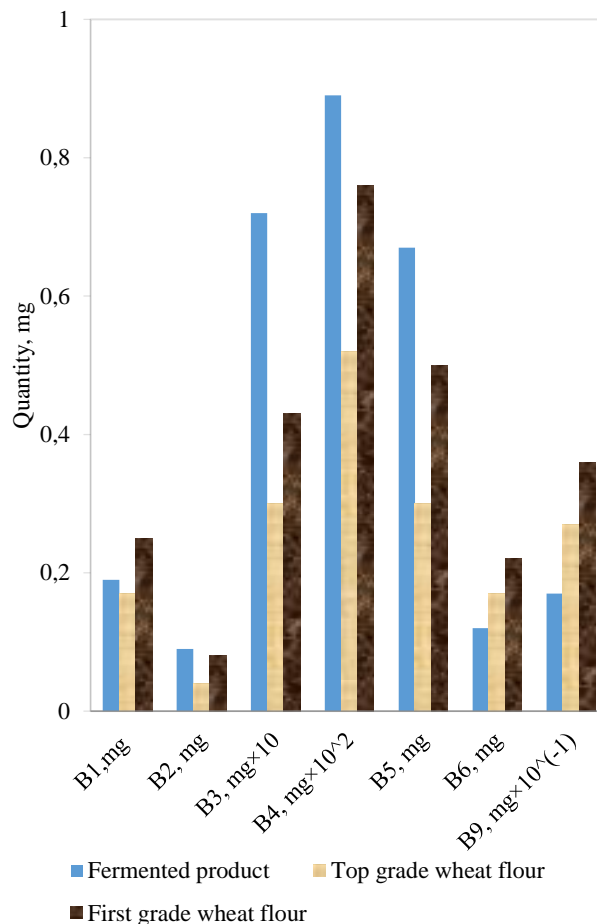
**Figure 1.** Ratio of basic minerals in product samples

According to Figure 1, one can see high content of potassium, iron and zinc which are anti-stress minerals that increase the nutritional value of the fermented product and contribute to the production of bakery products having antistress properties. As for macro elements potassium predominates. Its amount has increased twice as much after germination Iron (7.2 mg . 100 g<sup>-1</sup> of product) is the most abundant trace elements in the analyzed product after fermentation. The content of zinc also increased significantly (2.5 fold increase). At the same time, the amount of iodine changed insignificantly compared to that of top grade wheat

flour and first grade wheat flour and equals to  $1.8 \times 10^3 \text{ mg} \cdot 100 \text{ g}^{-1}$  of product.

It should be noted that the human body cannot synthesize most of the vitamins, but they are on the list of essential substances that the human body should take with food. The biological role of vitamins in the body is to maintain metabolic activity, accelerate all chemical reactions, neutralize free radicals and carcinogens. The most important vitamins in stress situations are B complex vitamins, since they favorably affect the nervous system. Vitamins of this group are recommended in stress situations and in periods of depression. Vitamin B<sub>1</sub> prevents the development of irritability and rapid fatigue. Vitamin B<sub>2</sub> improves the functioning of nerve cells and activates metabolic processes. If this vitamin is deficient, a prolonged depressive condition may develop. Vitamin B<sub>3</sub> struggles with the problem of bad sleep. Due to the fact that the element improves blood circulation, it positively affects the functioning of the cardiac system. Vitamin B<sub>4</sub> is considered as one of the best natural sedatives. It affects the nervous system, contributing to its relaxation and soothing. Vitamin B<sub>4</sub> inhibits the function of the thyroid gland and slows heart work as well as stimulates the activity of the gastrointestinal tract. Vitamin B<sub>5</sub> can suppress diseases, because poor emotional state of the mind may cause infection in the body. Lack of vitamin B<sub>6</sub> causes irritability of a person. Vitamin B<sub>9</sub> takes part in the activity of the nervous system. When this vitamin is deficient sense of fear and anxiety develops, memory is getting worse, a mental disorder may begin (Skurihina et al. 1987).

Data of the comparative analysis presented in Figure 2 showed that vitamins in the fermented product are represented by a high content of B complex vitamins: B<sub>1</sub> (thiamine) – 0.19 mg, B<sub>2</sub> (riboflavin) – 0.09 mg, B<sub>3</sub> (nicotinic acid, PP) – 7.24 mg, B<sub>4</sub> (choline) – 0.089 g, B<sub>5</sub> (pantothenic acid) – 0.67 mg, B<sub>6</sub> (pyridoxine) – 0.12 mg, B<sub>9</sub> (folic acid) – 0.017 mg.



**Figure 2.** Comparative analysis of B complex vitamins in the fermented product

Fermented product also contains vitamin E (tocopherol). However, its quantity is  $0.92 \text{ mg} \cdot 100 \text{ g}^{-1}$  of product, which is approximately twice as low as that of top grade wheat flour and that of first grade wheat flour, the content of this vitamin in which is 1.5 and 1.8  $\text{mg} \cdot 100 \text{ g}^{-1}$  of flour respectively. In addition to the high content of vitamins and mineral substances significant amount of proteins (16.5%) and especially the balance of its amino acid composition is a great advantage of the fermented product. Amino acid composition of the samples of the fermented wheat flour product is shown in Table 2.

**Table 2.** Amino acid composition of the product samples

Aminoacid	Values of product indicators, mg.100 g <sup>-1</sup>		
	Fermented product	Top grade wheat flour	First grade wheat flour
<i>Essential aminoacids:</i>			
Valine	623±15	390±11	510±13
Isoleucine	787±18	430±12	530±15
Leucine	1145±21	850±18	880±19
Lysine	637±12	250±8	290±7
Methionine	10±0,5	100±3	160±5
Threonine	724±15	270±7	330±9
Phenylalanine	772±16	500±13	585±14
<i>Nonessential amino acids:</i>			
Alanin	722±12	332±7	359±9
Arginine	650±14	417±13	500±11
Aspartic acid	745±14	435±11	411±10
Histidine	445±11	230±6	220±6
Glycine	739±12	371±9	384±9
Glutamic acid	5158±38	3479±26	3220±28
Proline	1141±19	1198±18	1050±17
Serin	711±14	516±10	454±9
Tyrosine	552±10	312±8	300±7
Cysteine	259±6	219±5	240±8

The results of the studies of the amino acid composition showed that the quality of the proteins of the fermented product is high enough because of the significant content of essential amino acids, in particular, lysine (2.5 times as high as that of top grade wheat flour and that of first grade wheat flour). The essential amino acid involved in the mechanism of optimal assimilation of proteins is leucine, the content of which is 1.5 times as high as that of the fermented product. The product is characterized by high concentration of glutamic acid (5158 mg.100g<sup>-1</sup>) which normalizes metabolism in the human body; isoleucine which is a part of natural proteins; valine which is one of the starting materials in the biosynthesis of pantothenic acid; arginine which is a nitrogen donor, as well as a low level of methionine which enhances the metabolism of fats in the body and proline which is glutamic acid precursor.

From the data presented in Table 2, it can be seen that the fermented product is limited in methionine and cysteine, but the cysteine contained in it is

somewhat higher than that of top grade wheat flour and first grade wheat flour.

Thus, the conducted studies make it possible to assert that the fermented wheat product is a functional product and can be used as a raw material component in the production of baked goods for special purposes that allow the human body to fight against stress, drowsiness and depression.

## Conclusions

The results of experimental studies of the chemical composition of the fermented wheat product with increased nutritive value are presented. A comparative analysis is made into its chemical composition and physico-chemical parameters of the quality of the fermented product and top grade wheat flour and top grade wheat flour. It is shown that when germinating wheat grain the amount of protein and fiber increases 1.6 and 2.5 times respectively; fat content practically does not change (1.3%); the amount of total carbohydrates lowers (62.4%) as a result of a decrease in the starch content (60.0 %) that turns into maltose during the germination process. This change leads to an increase in sugars in the fermented product by a factor of 1.5. It is also shown that there is an increase in anti-stress vitamins (B<sub>3</sub>, B<sub>4</sub> and B<sub>5</sub>) and mineral substances (potassium, iron, zinc, iodine) in the fermented wheat product, which indicates the possibility of its use in managing stress situations and nervous system diseases, as well as shows its high nutritional value. The amino acid composition of the fermented product was determined, indicating its balance, high quality of proteins and good digestibility by the human body, which makes it possible to use the fermented product in the production of bakery products with an anti-stress effect along with an increase in their biological value.

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