PERIÓDICO TCHÊ QUÍMICA

ARTIGO ORIGINAL

ESTUDO DA QUALIDADE DE TRIGO E PÃO DE CLASSE BAIXA OBTIDOS PELO MÉTODO DE ENSAIO ACELERADO

STUDY OF THE QUALITY OF LOW-CLASS WHEAT AND BREAD OBTAINED BY THE ACCELERATED TEST METHOD

ИССЛЕДОВАНИЕ КАЧЕСТВО ПШЕНИЦЫ НИЗКОГО КЛАССА И ХЛЕБА, ПОЛУЧЕННОГО УСКОРЕННЫМ МЕТОДОМ ТЕСТОВЕДЕНИЯ

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RESUMO

A qualidade do pão é determinada pela qualidade das matérias-primas utilizadas e, principalmente, farinha e água, como principais tipos de matérias-primas. O artigo apresenta os resultados de um estudo das propriedades físico-bioquímicas, indicadores de panificação pelo método acelerado, obtidos a partir de farinha de trigo mole finamente moída 3, 4, 5 e classes externas. Uma massa de cozimento preparada de maneira acelerada por 2-3 minutos pode melhorar suas propriedades reológicas, reduzir o tempo de cozimento para 36 minutos, melhorar a qualidade do pão da farinha de trigo mole de baixa qualidade. De acordo com o objetivo do estudo, foram estudadas as alterações nas propriedades físico-químicas dos grãos de trigo mole 3, 4, 5 e fora das classes, foi obtida farinha de trigo integral moída finamente separadamente do trigo mole de diferentes classes, e foi estudada a qualidade do pão preparado pelo método de teste acelerado da farinha de trigo mole. classes diferentes. Em geral, todas as amostras de trigo podem ser classificadas como recomendadas para consumo, uma vez que aumentaram os parâmetros organolépticos e físico-bioquímicos das propriedades reológicas em comparação com uma amostra de trigo fora da classe. Assim, os resultados de estudos utilizando o método de teste acelerado mostraram que o trigo das classes 3, 4 e 5 estudadas formavam as propriedades necessárias dos produtos semiacabados e contribuíam para melhorar a qualidade dos produtos de panificação e melhorar sua qualidade.

Palavras-chave: *trigo, farinha, qualidade, pão, indicador*.

ABSTRACT

The quality of bread is determined by the quality of the raw materials used, and above all, flour and water as the main types of raw materials. The article presents the results of a study of physico-biochemical properties, indicators of bread baking by the accelerated method, obtained from finely ground soft wheat flour 3, 4, 5, and out-of class. A baking dough prepared in an accelerated way for 2-3 minutes can improve its rheological properties, reduce baking time to 36 minutes, improve the quality of bread from low-quality soft wheat flour. In accordance with the purpose of the study, the changes in the physicochemical properties of soft wheat grains 3, 4, 5 and out-of class were studied, finely ground whole-ground flour separately from different classes of soft wheat grains was obtained, and the quality of bread prepared using the accelerated test method from soft wheat flour was studied, different classes. In general, all wheat samples can be classified as recommended for consumption since they have increased organoleptic and physico-biochemical parameters of rheological properties compared to a wheat sample out-of class. Thus, the results of studies using the accelerated test method showed that wheat of classes 3, 4, and 5 studied formed the necessary properties of semi-finished products and contributed to improving the quality of bakery products and improving their quality

Keywords: *wheat, flour, class, bread, indicator*.

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АННОТАЦИЯ

Качества хлеба определяются качеством используемого сырья и, прежде всего, муки и воды, как основных видов сырья. В статье приведены результаты исследования физико-биохимических свойств, показателей выпечки хлеба ускоренным методом, полученного из тонкоизмельченной муки зерна мягкой пшеницы 3, 4, 5 и вне классов. Хлебопекарное тесто, приготовленное ускоренным способом в течение 2-3 минут позволяет улучшить его реологические свойства, сократить время выпечки до 36 минут, повысить качество хлеба из муки мягкой пшеницы пониженного качества. В соответствии с целью исследований в работе были исследованы изменения физико-биохимических свойств зерна мягкой пшеницы 3, 4, 5 и вне классов, получена тонкоизмельченная цельносмолотая мука отдельно из зерна мягкой пшеницы разных классов, исследована качества хлеба, приготовленного ускоренным методом тестоведения из муки мягкой пшеницы разных классов. В целом, все образцы пшеницы, можно отнести к рекомендуемым для потребления, поскольку они обладают повышенными органолептическими и физико-биохимическими показателями реологическими свойствами по сравнению с образцом пшеницы вне класса. Таким образом, результаты проведенных исследований с применением ускоренного метода тестоведения показали, что пшеница исследованных 3, 4 и 5 классов формировали необходимые свойства полуфабрикатов и способствовала улучшению качества хлебобулочных изделий и повышению их качества.

Ключевые слова: пшеница, мука, сорт, хлеб, показатель.

1. INTRODUCTION

In recent years, bread has been regarded as a functional food product through which a person receives the biologically active compounds he needs. Based on research by both Kazakhstani and foreign scientists, for the development of a wide range of bakery products, including for dietary nutrition, bread production technologies using innovative methods of making bread are promising and more practical (Pashchenko *et al*., 2008; Auerman, 2002; Moore *et al*., 2009). In the northern regions of Kazakhstan, the specific volumes of low-quality soft wheat harvests are increasing annually. The volumes of 3, 4, and 5 classes of wheat are especially increasing. Restoring the quality of flour, dough, bread in the baking process is of great relevance. For Kazakhstan, which has great potential, the production of wheat grain and the preservation of harvested, improving, and restoring its qualities is of crucial strategic importance.

1.1. Literature analysis and problem statement

The prerequisites for this study is that to achieve a well-loosened structure of the baking dough, and it is necessary to provide for an increased amount of baking yeast, which can cause the manifestation of negative properties of the product. Recently, there has been a lot of talk about yeast, the benefits, and harms of which are being called into question. The thing is that when yeast enters the body during active reproduction, they begin to consume, along with carbohydrates, all those useful vitamins, and minerals that come with food. And this means that a person does not receive them, which in the future leads to their deficiency and depletion of the body (Yakiyayeva *et al*., 2016; Sereev, 2014; Slavin, 2004). Bakery yeast in a duet with flour can upset the acid-base balance. Excessive consumption of buns can lead to the formation of an acidic environment, which is fraught with chronic constipation, gastritis, ulcers, as well as the occurrence of osteoporosis. Stimulate the growth of malignant tumors. This proposition was proved by a scientific experiment conducted by the French scientist Etienne Wolf. Yeast causes diseases of the heart, lungs, and liver (Magomedov *et al*., 2010; Li *et al*., 2013).

To intensify the process of maturation of semi-finished products after kneading, enhanced mechanical processing of dough during kneading is used, the ideas of which were popular already in the 20s. At this time, it began to produce kneading machines intensive principle (Magomedov *et al*., 2007; Mei *et al*., 2016; Sandhu *et al*., 2011).

Professor Elton, together with staff at the British Bakeries Research Institute in Chorleywood in the 1930s, conducted research on the effects of intensive kneading on ripening dough. The results served as the basis for the development of technology for intensive preparation of the dough with a shortened fermentation cycle (Chorleywood method). The main idea of this method was that by increasing by 4-5 times the mechanical processing of the dough against the usual one, it is possible to intensify and accelerate the maturation process of the dough, reducing its fermentation time by 1-1.5 hours (Rolfe, 2000; Weststrat *et al*., 2002; Kim *et al*., 2003; Janssen *et al*., 2017).

The positive effect of mechanical stress during the kneading process on the speed and quality of wheat dough was confirmed by N.F. Prokopenko, V.V. Ionova, V.M. Donchenko. Work in the field of kneading theory, calculation of the operating parameters of kneading machines, and experimental studies of the specifics of processes during intensive kneading were performed at the Ukrainian State University of Food Technologies (I.M. Roiter, A.T. Lisovenko, V.N. Kovbasa, I.N. Litovchenko) Based on these works, a number of fundamentally new dough mixing machines have been created (Roberfroid, 2002; Dziki *et al*., 2014; Han *et al*., 2011).

Scientists have studied the dough kneading in a vacuum, in an atmosphere of air, oxygen, nitrogen, hydrogen and carbon dioxide. The fact of mechanical capture (occlusion) by the test during the mixing process of significant quantities of gas in the atmosphere of which the test is being mixed was established. It was found that if the dough is kneaded in an atmosphere of oxygen enriched air, then these gas bubbles formed in the dough during its kneading are a factor in the oxidative effect of oxygen on the corresponding components of the test, especially on its protein-proteinase complex (Agil *et al*., 2012; Tsyganova *et al*., 2012).

However, none of these methods eliminate the introduction of yeast into the dough. Many of them even require an increase in the amount of yeast added to the dough.

One of the ways of loosening bakery semi-finished products, excluding the introduction of yeast, is the mechanical way of loosening the dough.

A known method of mechanical loosening of dough by knocking down part of it, which consists of the following: part of the dough (in a relatively liquid and cold state) is knocked down for 5 minutes in a special knocking machine of strong and heavy construction. After a break, the whipped mass is fed into a conventional kneading machine, in which the dough is kneaded, which then goes for cutting and baking (Satsaeva *et al*., 2016; Dashen *et al*., 2016; Hemdane *et al*., 2015).

However, these methods were used only for the preparation of dough from wheat flour and did not find application in industry.

An analogue for the creation of innovative equipment and technology for functional bakery products with a shortened production cycle is the development of knock-down functional bread technology from wheat flour by scientists of the Voronezh State Technological University of Engineering Technologies (VSTUET) (Magomedov *et al*., 2010; Rak *et al*., 2018; Ktenioudaki *et al*., 2015).

In recent years, ozone, ions, ozone, ion-ozone, and electronic technology are finding wider applications in the food industry, which has several advantages over special additives and technologies. The use of ion-ozone technology agents with many useful properties (bactericidal, redox, etc.) in food production is the latest trend and represents a promising direction in food production (Fratelli *et al*., 2018; Ukrainets *et al*., 2016; Ye *et al*., 2012). Currently, scientists from the Almaty Technological University are conducting research on the use of ozonized, ionized and ionized water in the production of flour, bakery, pasta, flour confectionery from wheat flour and flour from a mixture of wheat, grain, oilseeds and legumes to improve quality, safety and environmental purity of finished products (Iztaev *et al*., 2018).

In order to solve the above problems, we prepared yeast-free dough and bread from different classes of soft wheat and studied the physico-biochemical, rheological properties, qualities, cooking time, and other indicators.

1.2. Aims and objectives of the study

The purpose of the research work is to use the accelerated test method developed by scientists of Voronezh State University with the aim of improving the physico-biochemical and rheological properties of low-class soft wheat samples.

To fulfill the purpose of the scientific work, we selected samples of soft wheat 3, 4, 5, and out-of classes.

Based on the objectives of the study, the following tasks were set:

- to investigate and determine the physico-biochemical properties of low-class soft wheat flour;

- determine changes in amino acid content and draw comparative conclusions;

- to determine the rheological properties of dough and bread made from soft wheat flour 3, 4, 5, and out-of classes.

2. MATERIALS AND METHODS

The following raw materials were used for the manufacture of the test samples: soft wheat flour 3,4,5 and out of classes, edible salt (GOST R 51574-2000), drinking water (SanPiN 2.1.4.1074-01).

The following research objects were used to conduct experimental studies: grain samples of soft wheat of classes 3, 4, and 5 and wheat out-of class from northern Kazakhstan. These samples were ground at a laboratory mill installation of the Voronezh State University of Engineering Technologies and were intended for baking by the accelerated method of testing bread from whole-ground wheat of the above classes (Figure 1).

Figure 1. *The experimental setup for the preparation of the test accelerated methods*

Studies to determine the physico-biochemical properties of grain, amino acids and proteins were carried out on the basis of the Almaty Technological University, and the production of finely ground and whole flour from different classes of soft wheat and bread baking using the accelerated test method based on the Voronezh State University of Engineering Technologies.

Physico-biochemical and biochemical (moisture, nature, vitreous, quantity, and quality of gluten, grinding size, ash content, mass fractions of fat, protein, fiber, and amino acids) were determined in wheat grain.

In the finished bread, moisture, acidity, porosity, as well as shape stability and specific volume were determined.

The moisture content of the flour was determined by the accelerated method, according to GOST 9404-88. The content of raw gluten was controlled according to GOST 27839-88. The quality of raw gluten was determined by measuring its elastic properties, according to GOST 27839-88. The ash content of flour was determined according to GOST27494-87 using an accelerator - nitric acid and expressed as a percentage. The mass fraction of protein was determined according to GOST 10846-64, the fat content was determined according to GOST 29 033-91, the mass fraction of fiber was carried out according to the Wend method. The mass fraction of amino acids was determined according to M-04-38-2009. The vitreous nature of wheat grains was determined on a diaphragmoscope according to GOST 10987-76, the nature of grain on a liter purk according to GOST 10840-64, the mass fraction of 1000 grains according to GOST 10842-89.

Flour from whole-ground wheat grain was obtained by disintegration-wave grinding on a disintegrator (Figure 2). Wheat grains are fed into the working chamber 2 through the feed funnel 1, which is equipped with a grate for additional removal of weed particles exceeding the size of the grains.

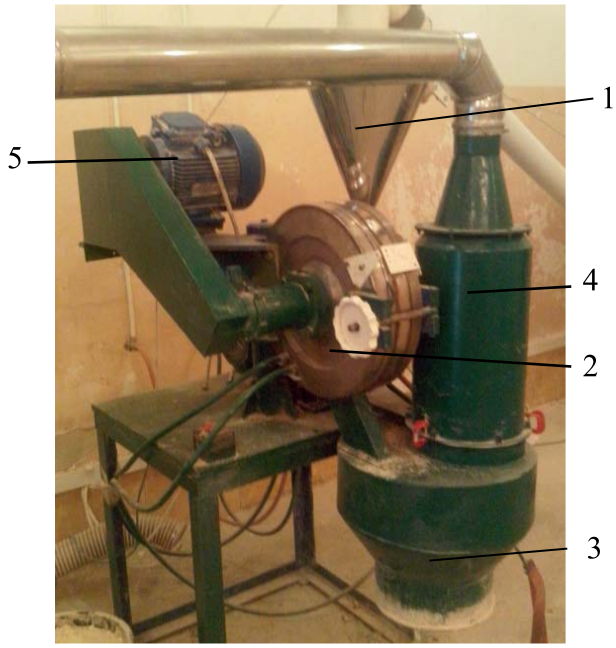

Figure 2. *Appearance of the disintegrator: 1 - loading funnel, 2 - working chamber with grinding disks, 3 - unloading hole, 4 - filter, 5 - electric motor*

The electric motors 6 drive the grinding disks 3 and stand in such a way that the movement of the magnetic disks occurs to meet each other. Due to this design feature, a high number of revolutions (18000-25000 rpm), and a small gap between the pins of the grinding disks, the grains are crushed with a higher degree of dispersion than other types of mills, which allows obtaining a high quality product.

In addition, in a very short period of time, synchronized conditions for the interaction of the field and matter at the atomic-molecular level arise in the chamber. This causes positive changes in the physicochemical state of the surface structure, which is the mechanical activation of the feedstock.

Through the inlet, the gap of which is regulated depending on the selected raw material in accordance with its size, the mass enters the working chamber, where it is ground. Ready flour through the discharge opening 4 is fed into the bag.

3. RESULTS AND DISCUSSION:

Studies were conducted on the physico-biochemical properties of the obtained flour from low classes of common wheat.

Determination of the vitreous nature of wheat samples showed that grains of classes 3 and 4 were vitreous with some content of partially vitreous grains, unlike wheat of class 5 and wheat out-of class, which had more powdery grains.

Table 1 shows the quality indicators of samples of wheat flour.

The quality and quality of bread products depends on the quantity and quality of gluten flour. Gluten in the baking industry has two main functions: it is a plasticizer, that is, it plays the role of a kind of lubricant, which gives the mass of starch grains fluidity, and a binder that combines starch grains into a single test mass. The first property of gluten allows you to mold the dough, the second to keep the form given to the dough. The uniqueness of gluten lies in the fact that the gluten frame formed during the pressing of the dough, which holds the mass of starch grains.

The results obtained indicate that the amount of gluten in a sample of grain, class 3 wheat, is normal, in contrast to samples of class 4 wheat, where the amount of gluten is 2% less and 5% less for wheat.

The quality of gluten shows that the readings of all samples are normal and approximately the same. This is due to the formation of hydrogen bonds between oppositely charged active centers of individual protein molecules due to active microclusters and disulfide bonds due to the oxidation of sulfhydryl groups under the influence of peroxide compounds of treated wheat, which strengthen the protein structure and reduce the activity of proteolytic enzymes.

The results showed a slight improvement in the elastic properties of the gluten prototypes, a decrease in moisture and hydration ability, an increase in the dry gluten content compared to wheat out-of class.

An important indicator of flour is its ash content. Ash content, due to its sharp unevenness in the components of grain, is of great industrial importance as a means of monitoring the grinding process and the quality of the flour. The ash content of the flour and its color are influenced by the ash content of the grain.

As a result of the research, the ash content of only 3 classes of wheat can be considered, although reduced, but the norm. The remaining samples, due to the conducted steel, have a high ash content, i.e., high content of minerals.

Fiber, despite the fact that it is not absorbed by the body, plays an important role in digestion, providing mechanical movement of food along the gastrointestinal tract. The results showed that the control sample and wheat of classes 3 and 4 have good indicators, in contrast to the wheat of class 5, where the fiber content is too high (Magomedov *et al*., 2007).

The protein content in wheat in all samples is below normal, but class 3 wheat is the most acceptable result. The fat content in all samples except class 4 wheat is normal. The wheat of the 3rd class again has the best result.

The change in the physicochemical properties of the grain is probably due to the dissociation of molecules with the formation of reactive compounds and the formation of a larger number of microclusters from wheat associates with an increase in the duration of its processing.

Grinding coarseness (particle size distribution, flour particle size) has a significant effect on the physical, structural, and mechanical properties of the dough and the finished bread. Other things being equal, flour size of its particles in the range of 150 to 400 microns does not significantly affect the quality of bread. But very large grains of particles with a size of 400 to 500 microns do not have time to completely saturate with moisture during the kneading and preserve their individuality. The size of flour from soft wheat varieties was evaluated according to GOST by descent / passage through silk sieves No. 43/35.

The amino acid composition of 3, 4, 5, and non-cool varieties of soft wheat was determined. The results of changes in the content of non-essential and essential amino acids are presented in Figures 3-6 and tables 2-5.

A number of studies have shown that lysine and arginine tend to increase with decreasing wheat protein content (Table 3). The greatest discrepancies are between leucine + isoleucine (table 2). Stable differences in the concentration of amino acids between high- and low-protein wheat have been proved for lysine, which is higher in low-protein wheat, proline, and phenylalanine, which are found in lower amounts in low-protein wheat (table 4).

The results obtained from table 5 indicate that the essential amino acid threonine has the highest concentration among all the essential amino acids in class 3 — 0.16%. Essential amino acids - lysine and phenylalanine are contained in small quantities.

Given the constancy in the content of most amino acids, it seems more likely that such discrepancies reflect differences in different classes of wheat rather than differences in research methods.

Since the quality of bakery products depends not only on the properties of raw materials but also largely on the rheological properties of semi-finished products, it was advisable to study the effect of wheat of classes 3, 4, and 5 on the rheological properties of the dough.

The dough was prepared by mechanical loosening under pressure in an experimental laboratory unit developed at the Department of Technology of Baking, Pasta, and Confectionery at the Voronezh State Technological Academy.

It consists of a whipping chamber, an asynchronous electric motor, a control panel, a compressor, a thermostat, and a discharge opening. The installation works as follows: the recipe components of the dough are fed through the loading hole into the kneading case of the batch mixer, in which the kneading organ is installed in the form of a whisk, driven by an electric motor through a speed variator. At the end of loading, the kneading case of the kneading machine is hermetically closed by a lid and kneading the dough for 3-5 minutes at a kneading organ rotation speed of 5 s-1. Then, atmospheric air under a pressure of 0.3-0.4 MPa is introduced into the chamber through the nozzle under excess pressure into the kneading case.

During the dough kneading, thermostatically controlled water (20-25 °C) is continuously supplied to the shirt of the dough mixer. In this case, the recipe components are knocked down, and the test mass is saturated with air (Magomedov *et al*. 2010).

Baking bread was carried out according to the following conditions: kneading and kneading the dough lasted 3-5 minutes, baking finished bread was carried out 30-35 minutes, without fermentation, and the total time spent on one type of bread was only 33-40 minutes. The results of the study are shown in Fig. 7-8 and in table 6.

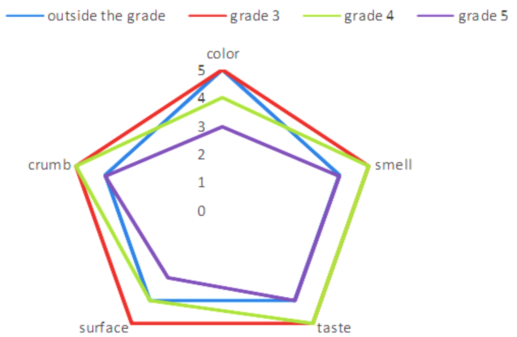

Figure 7. *Profilogram of organoleptic indicators of wheat bread*

From Figures 7 and 8 show that wheat out-of class - the crumb is poorly loosened, the surface is uneven, there are small cracks, the smell is not pronounced, the color is brown.

Class 3 wheat - the bread structure is developed, the crumb is characterized by high porosity. No cracks are observed, the color is yellow-brown, the smell is pleasant. The taste is pleasant and harmonious.

Class 4 wheat - the taste is pleasant. The crumb has a uniform structure. The color is brown, and the surface is flat, the smell is pleasant.

Class 5 wheat - taste with a touch of bitterness, dark brown. The crumb is medium, with highly developed porosity; the shape of the product is not correct.

Based on the results of wheat grains, it was advisable to study its effect on the quality of bread. The quality of bakery products was judged by physico-chemical parameters: humidity, acidity, porosity, as well as shape stability and specific volume. The preparation of the test was carried out in a random manner (table 6).

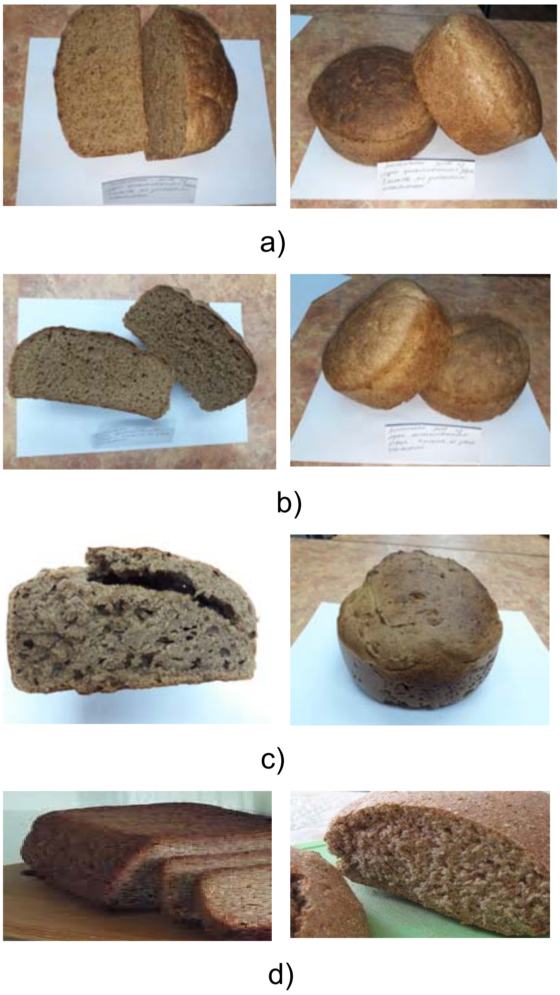

Figure 8. *Type of bread obtained from the accelerated method from whole-ground flour of soft wheat grain of different classes: a) bread learned in an accelerated way from grain of 3 class soft wheat; b) bread, learned in an accelerated way from grain 4 classes of soft wheat; c) bread learned in an accelerated way from grain of class 5 soft wheat; d) bread learned in an expedited way from soft wheat grain out-of class*

For all experimental bread samples, compared with a wheat sample out-of class, an increase in the shape stability index from 0.40 % to 0.50 % (in the third class of wheat), in the specific volume indicator up to 3.6 cm^3/g (in the third class of wheat) was revealed) and porosity from 48 to 52 % (table 6).

The results are due to the strengthening of gluten and a change in the rheological properties of the test.

Table 6. *Change in the quality indicators of bread from different classes of soft wheat*

Samples	Bread quality indicators				
	Form stability, %	**Specific volume of bread, cm^3/g**	**Humidity, %**	**Acidity, degree**	**Porosity, %**
Out-of-class wheat	0,40	3,20	41	4,8	48
wheat 3 class	0,50	3,60	41	4,2	46
wheat 4 class	0,47	3,51	41	4,4	48
wheat 5 class	0,45	3,44	40	4,9	52

An increase in the specific volume indicator for wheat samples of classes 3, 4, and 5 by 125, 117.5, and 112.5% and porosity by 112.6, 111.2, and 108.4%, respectively, was established, which was due to an increase in the plasticity of the dough and an improvement in lifting yeast strength.

4. CONCLUSIONS:

Summing up, we can say with confidence that the use of the accelerated test method allows improving the performance of class 3 wheat dough, as well as ready-made bread made from whole wheat of different classes has the best performance. Thus, it is possible to recommend further study of the rheological properties and quality indicators of wheat bread from different classes.

As a result of the study, it was found that the amount of gluten in class 3 soft wheat flour is normal, and for samples of class 4 soft wheat, the amount of gluten is 2% less and for class 5 wheat less than 5%. Also, the ash content of only 3 classes of wheat was reduced, but it corresponded to the norm, and the remaining samples had elevated ash contents, i.e., high levels of minerals. The protein content in wheat in all samples was below normal, but the most acceptable result was in soft wheat class 3. The fat content in all samples except class 4 wheat was not lower than the established norm. The best result was shown by a sample of wheat class 3.

With the intensive mechanical loosening of the dough, starch grains increase in volume, become looser and are easily amenable to the action of amylolytic enzymes. The linear fraction of starch - amylose, which forms the inner part of starch grains, hydrolyzes faster than amylopectin, which constitutes its outer part and has a branched structure.

An important role in the starch hydrolysis by a-amylase is played by proteolytic enzymes. Proteases, by carrying out limited protein cleavage, contribute to the release of amylases from the bound state and also hydrolyze the part of the storage proteins that are firmly bound to the surface of starch granules, while the access of the enzyme to the substrate is facilitated. Under the action of proteolytic enzymes, the complex structure of a protein molecule is simplified, its ability to swell decreases and the solubility of proteins increases.

The main reaction catalyzed by proteolytic enzymes is the hydrolysis of the peptide bond in the molecules of proteins and peptides.

To determine the rheological properties of low-class soft wheat, the dough was prepared and investigated, and the bread was baked. Kneading and kneading the dough was 3-5 minutes, baking the finished bread was carried out for 30-35 minutes, without fermentation, and the total time spent on getting one type of bread was only 33-40 minutes. As a result, it was proved that we used the technology of making dough and bread improves the quality of gluten, increases the rheological properties, and reduces time.

In the study of amino acids, it was determined that the essential amino acid threonine in class 3 is 0.16%, compared with other samples a significantly high amount. It was also found that lysine and arginine tend to increase as the protein content of wheat decreases, and the greatest differences are between leucine + isoleucine.

As a result of the hydrolysis of test proteins under the action of a protease, polypeptides, peptides, amino acids are formed.

Protein molecules contain reactive SH groups that are able to oxidize under the influence of oxygen. When knocking down the components of the dough under pressure, the semifinished product is saturated with atmospheric oxygen.

The addition of the enzyme preparation GC-106 to the dough during intensive churning and saturation with air oxygen increases the solubility of proteins, reduces the ability of the protein molecule to swell, which will provide a significant increase in the foaming of the semi-finished product, a decrease in the specific power per batch, thereby reducing energy consumption, and increasing the elasticity of the foam, its stability.

In addition, the action of enzymes (a-amylase and protease) on starch and protein of flour during churning contributes to the intensive formation of substances that determine the taste and aroma of bread. At this stage, a number of products of enzymatic hydrolysis of proteins and starch (low molecular weight nitrogenous substances, polypeptides, peptides, amino acids, carbonyl compounds) are formed, which participate in the formation of the taste and aroma of the yeast-free product, as well as the melanoid formation that occurs during baking of bread. As a result, melanoidins are formed, which color the peel, and intermediate and by-products of this reaction, which also participate in the formation of the taste and aroma of the finished products.

In Figure 9, a physical model of the degradation of starch and wheat flour protein in a yeast-free dough is presented.

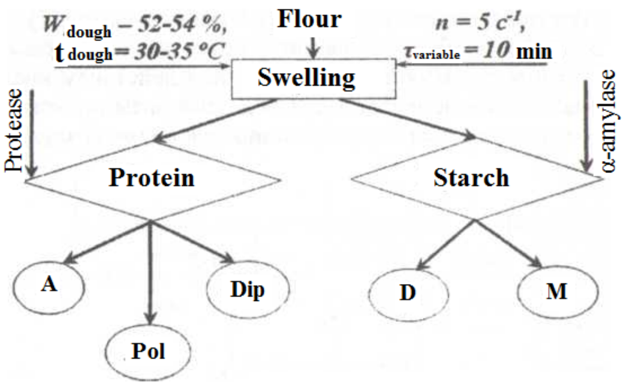

Figure 9. *Physical model of the process of destruction of starch and protein of wheat flour in a yeast-free dough: D – dextrins, M – maltose, A – amino acids, Pol - polypeptides, Dip – dipeptides; W_{dough} – dough humidity,%, t_{dough} – dough temperature, ° C, p - kneading organ rotation frequency, s-1, $\tau_{variable}$ - mixing time, min*

When knocking down the components of the dough under the pressure of compressed air, the semifinished product is intensively saturated with oxygen. At the same time, the structural and mechanical properties of the dough are improved, and its bulk mass is reduced. This is due to a decrease in the number of SH groups and the formation of S-S bonds in the protein structure, which contribute to the strengthening of the protein structure and, accordingly, the foam film. Thus, intensive mixing and knocking down of the test with the saturation of air oxygen in the presence of the enzyme preparation GC-106 accelerates the processes of protein hydrolysis, while their solubility increases, the foaming of the semi-finished product increases, the formation of substances involved in the melanoidin formation reactions intensifies, the specific power for kneading decreases.

Therefore, enzymatic hydrolysis of the main components of flour with a mechanical method of loosening and forcing it will allow you to get the dough and bakery product with optimal structural and mechanical properties and a full-fledged taste and aroma.

We made the following conclusions:

1. The accelerated test method improves physico-biochemical and rheological indicators by almost 2 times;

2. The time to get one type of yeast-free bread is 33-40 minutes, including the preparation and baking process. Compared with traditional methods, this indicator, on average, reduces the time of receipt by 3 times.

3. The resulting bread products are used for functional purposes and provide the population with healthy nutrition.

5. REFERENCES:

1. Agil, R., Hosseinian, F. Dual Functionality of Triticale as a Novel Dietary Source of Prebiotics with Antioxidant Activity in Fermented Dairy Products. J. Plant Foods for Human Nutrition, **2012**, 67 (1), 88–93.
2. Auerman, L. Ya. Technology of baking production: textbook. St. Petersburg: Profession, **2002**, 416.
3. Dashen, M. M, Edia-Asuke, U. A., Amapu, T. Y, et. al. Effect of fermented dough on the organoleptic quality and shelf-life of bread. Journal of Microbiology Research, **2016**, 1 (1), 104–114.
4. Dziki, D., Rozylo, R., Gawlik-Dziki, U., Swieca, M. Current trends in the enhancement of antioxidant activity of wheat bread by the addition of plant materials rich in phenolic compounds. Trends in Food Science & Technology, **2014**, 40, 48-61.
5. Erkmen, O. Uses of Ozone to Improve the Safety and Quality of Foods. J. Gida Teknolojisi, **2001**, 5 (3), 58–64.
6. Fratelli, C., Muniz, D. G., Santos, F. G., Capriles, V. D. Modelling the effects of psyllium and water in gluten-free bread: An approach to improve the bread quality and glycemic response. Journal of Functional Foods, **2018**, 42, 339–345.
7. Han, H. M., Koh, B. K. Antioxidant activity of hard wheat flour, dough and bread prepared using various processes with the addition of different phenolic acids. Journal of Science and Food Agricultural, **2011**, 91, 604-608.
8. Hemdane, S., Leys, S., Jacobs, P. J., Dornez, E., Delcour, J. A., Courtin, C. M. Wheat milling by-products and their impact on bread making. Food Chemistry, **2015**, 187, 280-289.
9. Iztaev, A., Kulazhanov, T., Yakiyayeva, M., Maemerov, M., Iztaev, B., Mamayeva, L. The Efficiency of Ionocavitational Processing and Storage in the Nitrogen Medium of Oilseeds. Journal of Advanced Research in Dynamical and Control Systems, **2018**, 7, 2032–2040.
10. Janssen, F., Pauly, A., Rombouts, I., Jansens, K. J. A., Deleu, L. J., Delcour, J. A. Proteins of Amaranth (Amaranthus spp.), Buckwheat (Fagopyrum spp.), and Quinoa (Chenopodium spp.): A Food Science and Technology Perspective. J. Comprehensive reviews in food science and food safety, **2017**, 16(1), 39-58.
11. Kim, J. G., Yousef, A. E., Khadre, M. A. Ozone and its Current and Future Application in the Food Industry. J. Advances in Food and Nutrition Research, **2003**, 45, 167–218.
12. Ktenioudaki, A., Alvarez-Jubete, L., Smythc, T. J., Kilcawley, K., Rai, D. K., Gallagher, E. Application of bioprocessing techniques (sourdough fermentation and technological aids) for brewer's spent grain breads. Food Research International, **2015**, 73, 107-116.
13. Li, M., Peng, J., Zhu, K. X., Guo, X. N., Zhang, M., Peng, W., & Zhou, H. M. Delineating the microbial and physical–chemical changes during storage of ozone treated wheat flour. J. Innovative Food Science & Emerging Technologies, **2013,** 20, 223–229
14. Magomedov, G. O., Ponomareva, E. I. Scientific and practical fundamentals of

the technology of whipped functional bakery products (monograph). Voronezh: VGTA, **2010**, 248.
15. Magomedov, G. O., Ponomareva, E. I., Krutskikh, S. N., Shelest, T. N., Levin, Yu. N. The influence of various factors on the rheological properties of a whipped yeast-free test. J. Storage and processing of agricultural raw materials, **2007**, 5, 42-46.
16. Mei, J., Liu, G., Huang, X., Ding, W. Effects of ozone treatment on medium hard wheat (Triticum aestivum L.) flour quality and performance in steamed bread making. CyTA-Journal of Food, **2016**, 14, 449–456.
17. Moore, J., Luther, M., Cheng, Z., Yu, L. Effects of baking conditions, dough fermentation, and bran particle size on antioxidant properties of whole-wheat pizza crusts. Journal of Agricultural and Food Chemistry, **2009**, 57, 832-839.
18. Pashchenko, L. P., Zharkova, I. M. Technology of bakery products. Moscow: KolosS, **2008**, 389.
19. Rak, V., Yurchak, V., Bilyk, O., Bondar, V. Research into techniques for making wheat bread on hop leaven. Eastern-European Journal of Enterprise Technologies, **2018**, 1 (11 (91)), 4–9.
20. Richardson, D. P. Functional Food and Health Claims. J. The world of Functional ingredients, **2002**, 9, 12–20.
21. Rolfe, R. D. The Role of Probiotic Cultures in the Control of Gastrointestinal Health. The Journal of Nutrition, **2000**, 130 (2), 369S–402S.
22. Roberfroid, M. B. Global view on functional foods: European perspectives. British Journal of Nutrition, **2002**, 88 (S2), S133–S138.
23. Sandhu, H. P., Manthey, F. A., Simsek, S. Quality of bread made from ozonated wheat (Triticum aestivum L.) flour. Journal of the Science of Food and Agriculture, **2011**, 91, 1576–1584.
24. Satsaeva, I. K., Gasieva, V. A., Teboeva, A. K., Farnieva, Ya. S. The way to improve the quality and safety of bakery products from wheat flour by improving the technology of hop yeast. J. Vestnik KrasGAU, **2016**, 2, 118–124.
25. Sereev, I. Effect of spring biomass removal on expression of agronomic traits of winter wheat. World Applied Sciences Journal, **2014**, 30 (3), 322-329.
26. Slavin, J. Whole grains and human health. J. Nutrition Research Reviews, **2004**, 17, 99-110.
27. Tsyganova, T. B., Gakova, O. A. Improving the quality of bakery products based on the regulation of water properties. J. Bakery of Russia, **2012**, 1, 20-21.
28. Ukrainets, A., Kochubei-Lytvynenko, O., Bilyk, O., Zakharevych, V., Vasylchenko, T. A study of the effect of enriched whey powder on the quality of a special-purpose bread. Eastern-European Journal of Enterprise Technologies, **2016**, 2 (11 (80)), 32–41.
29. Wandersleben, T., Morales, E., Burgos-Díaz, C., Barahona, T., Labra, E., Rubilar, M., *et al*. Enhancement of functional and nutritional properties of bread using a mix of natural ingredients from novel varieties of flaxseed and lupine. J. Food Sci-Tech Brazil, **2018,** 91, 48–54.
30. Weststrat, J. A., van Poppel, G., Verschuren, P. M. Functional foods, trends and future. British Journal of Nutrition, **2002**, 88(S2), S233–S235.
31. Yakiyayeva, M., Iztaev, A., Kizatova, M., Maemerov, M., Iztaeva, A., Feydengold, V., Tarabaev, B., Chakanova, Zh. Influence of ionic, ozone ion-ozone cavitational treatment on safety of the leguminous plants and oil-bearing crops at the storage. Journal of Engineering and Applied Sciences, **2016**, 11(6), 1229-1234.
32. Ye, E. Q., Chacko, S. A., Chou, E. L., Kugizaki, M., Liu, S. Greater whole-grain intake is associated with lower risk of type 2 diabetes, cardiovascular disease, and weight gain. The Journal of Nutrition, **2012**, 142, 1304-1313.

Table 1. *Quality indicators of wheat flour*

Indicator	Norm on ND	Wheat out-of class	Wheat 3 classes	Wheat 4 classes	Wheat 5 classes
Humidity, %	14,0-15,0	12,6	12,7	12,7	12,8
Nature, g / l	760	787,7	790,5	796,7	813,9
Mass of 1000 grains, g		29,3	37,48	31,88	35,42
Mass fraction of protein, not less than %	14,0	12,4	13,17	11,02	11,26
Mass fraction of fat,%	1,6-3,2	1,74	1,62	1,14	1,16
Mass fraction of fiber,%		8,4	8,7	10,41	9,8
Mass fraction of ash,%	1,97	1,36	1,42	1,37	1,11
Gluten mass fraction, not less than %	28,0	21,57	24,76	22,94	19,77
Gluten quality according to IDK-1, units	20-100	74	76,1	72,5	73,3

Table 2. *Composition of essential and non-essential amino acids of wheat out-of class*

N	Time	Component	Height	Start	End	Area	Conc., mg/l	Mass fraction of amino acids in %
1	7.518		1.262	7.357	7.623	69.78	0.00	0
2	7.677	arginine	0.499	7.623	7.768	16.91	19.0	0,23±0,09
3	10.700	arginine	0.688	10.627	10.808	21.63	10.0	0,12±0,04
4	11.410	tyrosine	0.823	11.323	11.508	28.79	30.0	0,36±0,11
5	12.173	histidine	0.338	12.082	12.250	12.54	12.0	0,14±0,07
6	12.352	leucine + isoleucine	1.224	12.250	12.608	97.07	35.0	0,42±0,11
7	12.692	methionine	0.160	12.608	12.783	7.349	6.10	0,07±0,02
8	12.907	valine	0.775	12.783	13.028	37.02	25.0	0,30±0,12
9	13.182	proline	2.395	13.028	13.332	120.7	74.0	0,89±0,23
10	13.425	threonine	0.512	13.332	13.528	22.42	15.0	0,18±0,07
11	14.052	serine	0.814	13.925	14.162	39.81	21.0	0,25±0,07
12	14.287	alanine	0.802	14.162	14.400	39.05	17.0	0,21±0,05
13	15.377	glycine	1.020	15.232	15.478	55.99	19.0	0,23±0,08

Table 3. *The composition of the interchangeable and essential amino acids of wheat 3 class*

N	Time	Component	Height	Start	End	Area	Conc., mg/l	Mass fraction of amino acids in %
1	7.232		1.202	7.105	7.395	68.17	0.00	0
2	7.458	arginine	0.527	7.395	7.522	14.56	16.0	0,20±0,08
3	10.265	lysine	0.746	10.190	10.437	24.04	12.0	0,15±0,05
4	10.908	tyrosine	1.095	10.820	11.065	38.8	40.0	0,50±0,15
5	11.152	phenylalanine	0.195	11.065	11.223	7.805	7.40	0,09±0,03
6	11.503	histidine	0.071	11.408	11.550	1.477	1.40	0,02±0,01
7	11.753	leucine + isoleucine	1.477	11.633	11.978	109.4	40.0	0,50±0,13
8	12.053	methionine	0.304	11.978	12.128	11.38	9.40	0,12±0,04
9	12.245	valine	0.924	12.128	12.357	39.99	26.0	0,33±0,13
10	12.505	proline	3.052	12.357	12.620	147.3	91.0	1,14±0,30
11	12.703	threonine	0.664	12.620	12.805	24.84	16.0	0,20±0,08
12	13.258	serine	1.022	13.145	13.367	45.76	24.0	0,30±0,08
13	13.468	alanine	0.906	13.367	13.582	39.48	17.0	0,21±0,06
14	14.440	glycine	1.338	14.308	14.588	68.8	23.0	0,29±0,10

Table 4. Composition of interchangeable and irreplaceable amino acids of wheat 4 class

N	Time	Component	Height	Start	End	Area	Conc., mg/l	Mass fraction of amino acids in %
1	7.437		0.943	7.345	7.548	38.75	0.00	0
2	7.673	arginine	0.478	7.548	7.832	25.43	29.0	0,29±0,12
3	10.735	lysine	0.757	10.657	10.822	23.9	11.0	0,11±0,04
4	11.452	tyrosine	1.070	11.340	11.545	39.04	40.0	0,41±0,12
5	11.642	phenylalanine	0.289	11.545	11.735	12.95	12.0	0,12±0,04
6	12.398	leucine + isoleucine	1.529	12.273	12.630	118.5	43.0	0,44±0,11
7	12.732	methionine	0.181	12.630	12.820	7.985	6.60	0,07±0,02
8	12.950	valine	0.946	12.820	13.068	44.75	30.0	0,30±0,12
9	13.242	proline	2.967	13.068	13.372	156.5	97.0	0,98±0,26
10	13.467	threonine	0.655	13.372	13.585	27.87	18.0	0,18±0,07
11	14.095	serine	0.998	13.968	14.205	47.42	25.0	0,25±0,07
12	14.338	alanine	0.914	14.205	14.452	43.47	18.0	0,18±0,05
13	15.435	glycine	1.288	15.283	15.627	71.55	24.0	0,24±0,08

Table 5. The composition of the interchangeable and essential amino acids of wheat 5 class

N	Time	Component	Height	Start	End	Area	Conc., mg/l	Mass fraction of amino acids in %
1	7.370		1.732	7.270	7.532	75.1	0.00	0
2	7.598	arginine	0.486	7.532	7.740	21.23	24.0	0,24±0,10
3	10.588	lysine	0.790	10.520	10.685	23.79	11.0	0,11±0,04
4	11.152	tyrosine	0.214	11.098	11.203	6.899	7.10	0,07±0,02
5	11.290	phenylalanine	1.065	11.203	11.370	34.33	33.0	0,33±0,10
6	12.222	leucine + isoleucine	1.609	12.082	12.473	114.7	42.0	0,43±0,11
7	12.548	methionine	0.207	12.473	12.633	7.876	6.50	0,07±0,02
8	12.765	valine	0.988	12.633	12.892	44.07	29.0	0,29±0,11
9	13.052	proline	2.961	12.892	13.175	142.3	88.0	0,89±0,23
10	13.273	threonine	0.663	13.175	13.360	25.24	16.0	0,16±0,06
11	13.895	serine	1.031	13.773	14.002	45.64	24.0	0,24±0,06
12	14.138	alanine	0.990	14.002	14.240	44.0	19.0	0,19±0,05
13	15.233	glycine	1.356	15.077	15.350	70.59	24.0	0,24±0,08

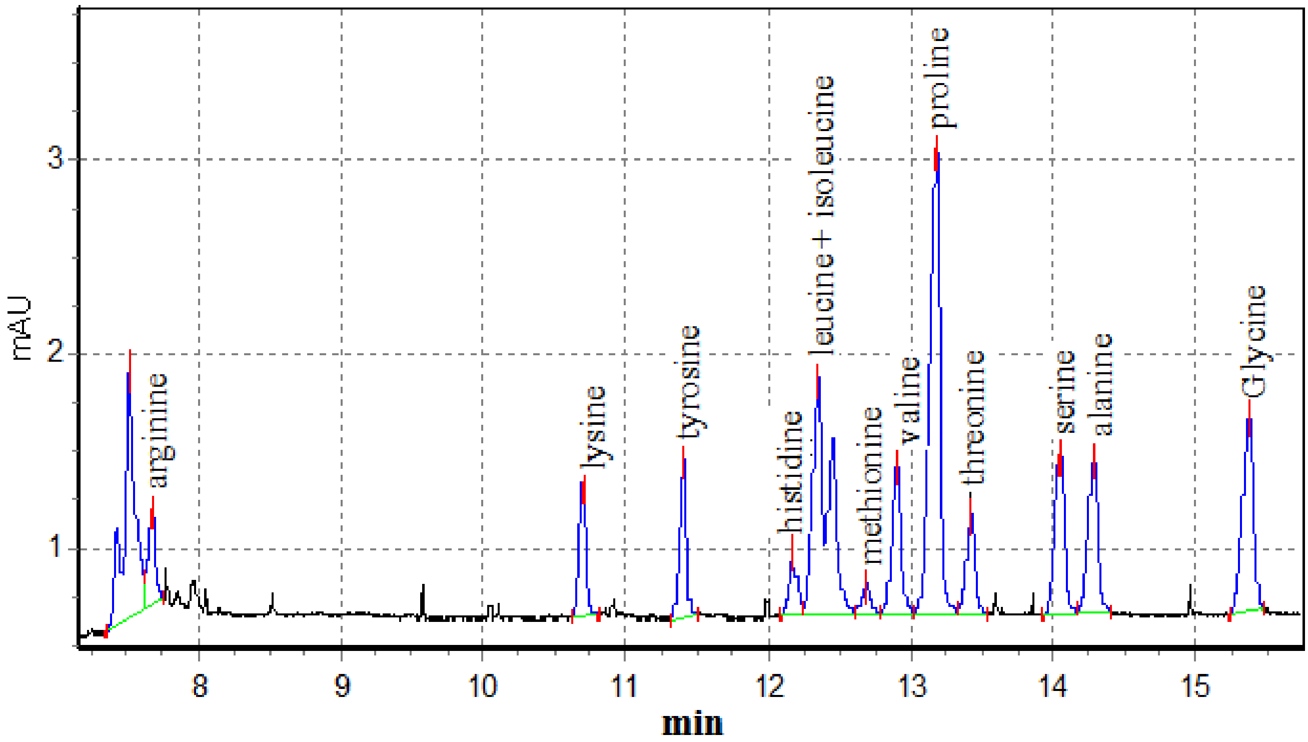

Figure 3. *The composition of the interchangeable and irreplaceable amino acids of wheat out-of class*

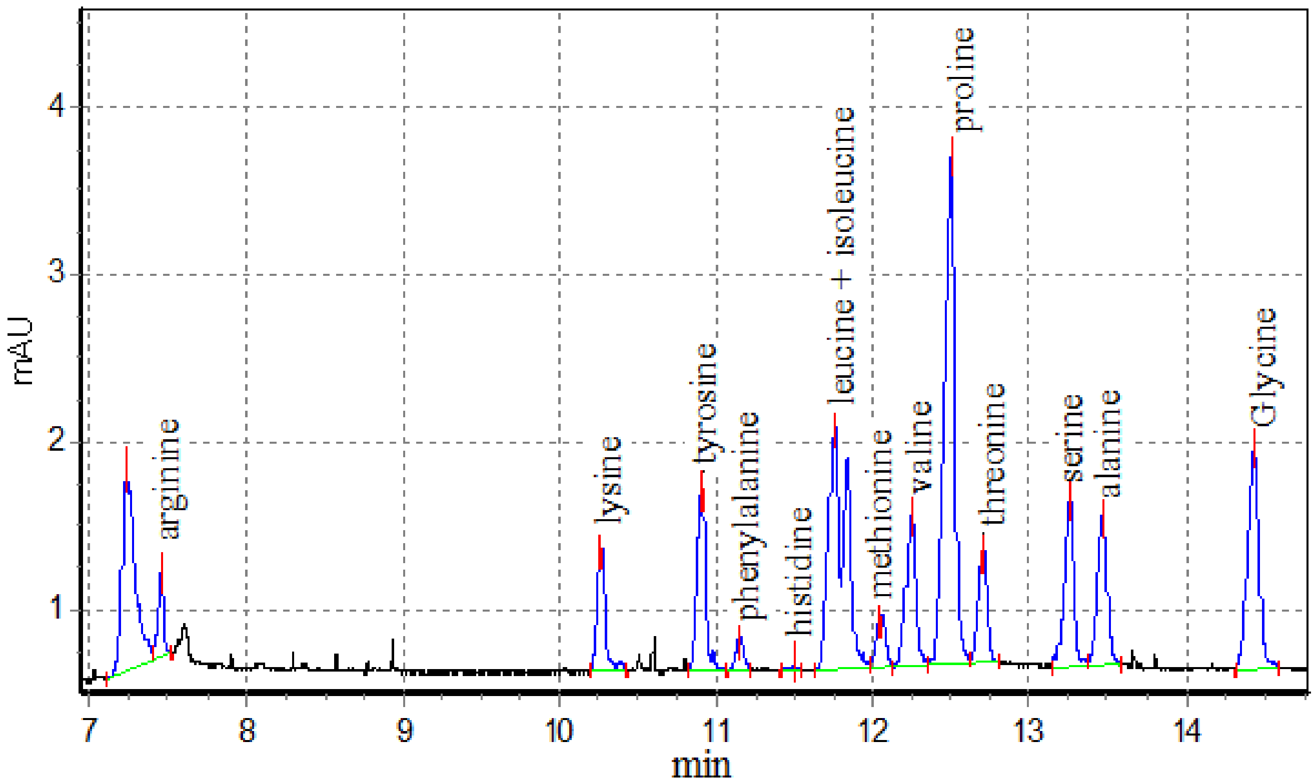

Figure 4. *Composition of interchangeable and irreplaceable amino acids of wheat 3 class*

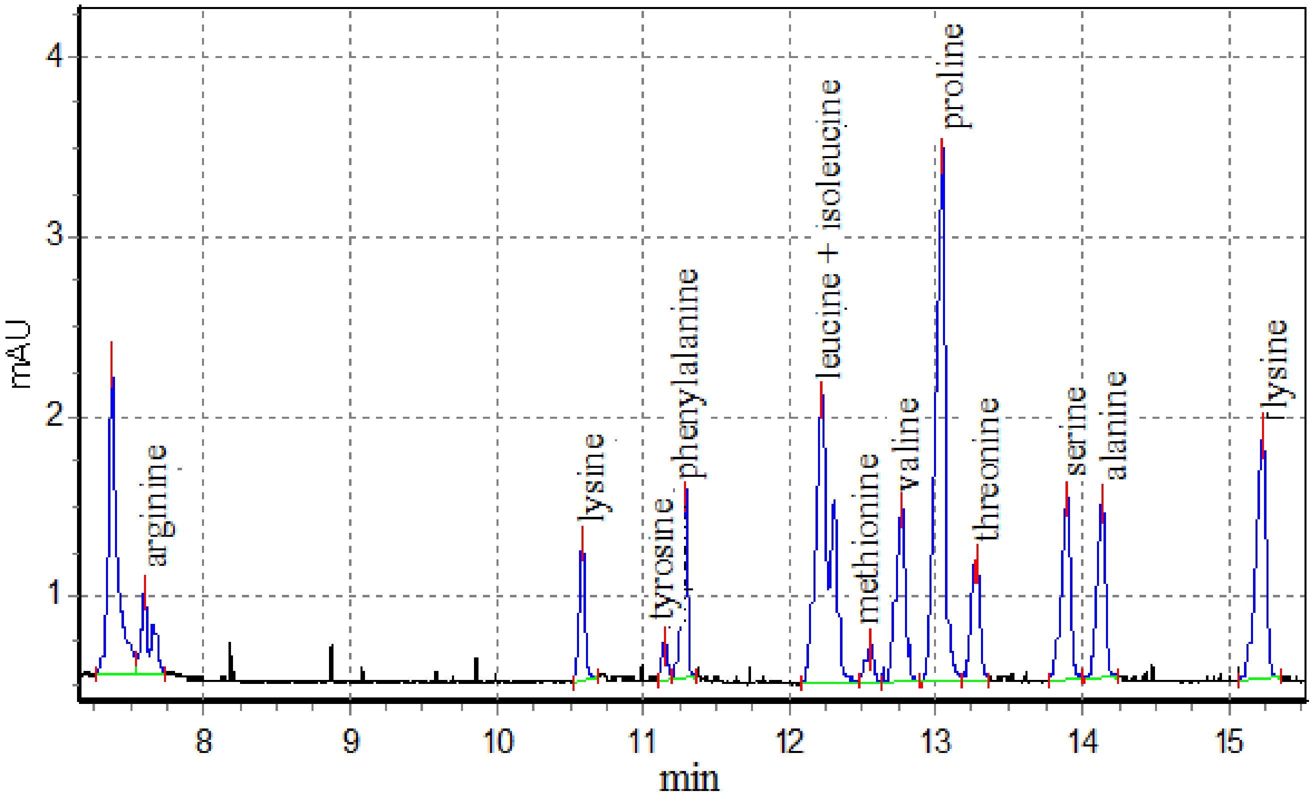

Figure 5. *The composition of the interchangeable and essential amino acids of wheat 4 class*

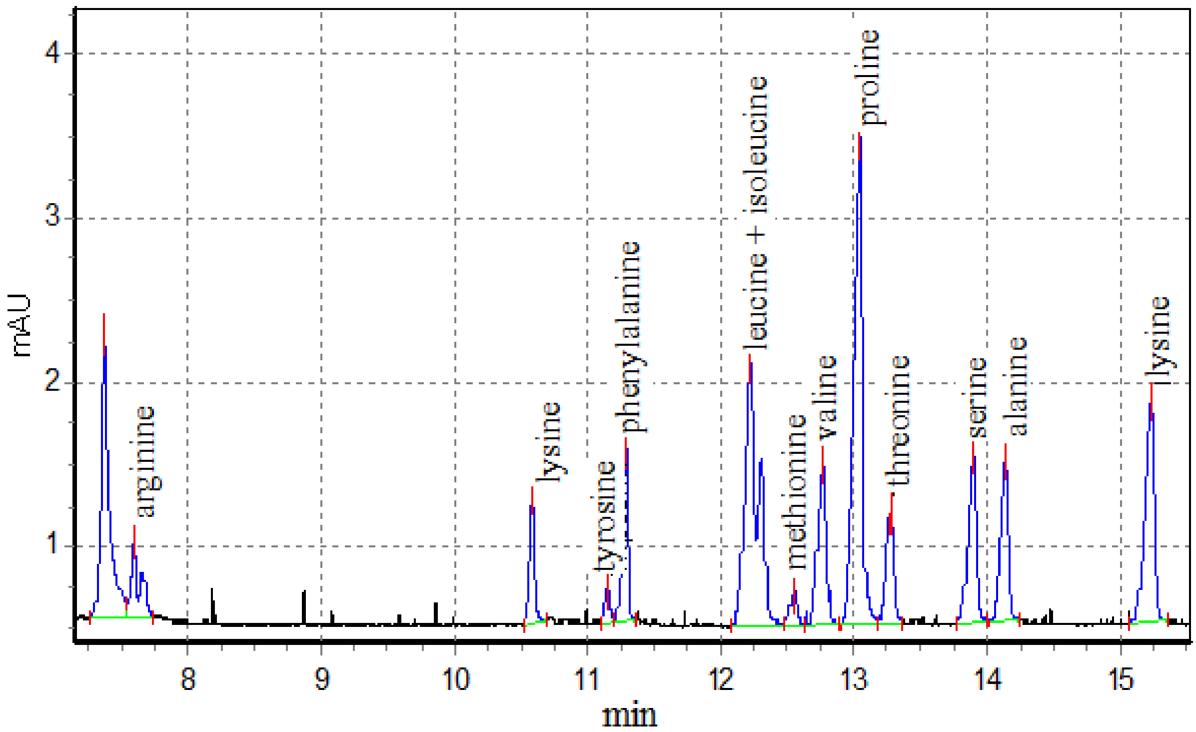

Figure 6. *Composition of interchangeable and essential amino acids of wheat 5 class*