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DEVELOPMENT OF TECHNOLOGICAL SOLUTIONS FOR FLOUR PRODUCTION WITH SPECIFIED QUALITY PARAMETERS

D. Zhygunov, doctor of technical sciences, associate professor, *E-mail*: dimius75@gmail.com
V. Kovalova, post-graduate student, *E-mail*: k.vasilisa@ukr.net
M. Kovalov, candidate of technical sciences, senior lecturer, *E-mail*: mak2111@ukr.net
A. Donets, candidate of technical sciences, senior lecturer, *E-mail*: andrey.donets2011@gmail.com
Department of Technology of Grain Processing
Odessa National Academy of Food Technologies, Odessa, Kanatnaya Str., Ukraine, 65039

Abstract. Today, bakery and milling industry is actively developing, as well as other branches of food industry. This is due to the applying of new foreign trends to the technology and range of products of the Ukrainian market. In these conditions, the classic offering of flour is already inadequate. To meet the needs of modern bakeries, milling industry is facing a new challenge: production of flour grades with specified quality parameters.

The article considers the technological and baking properties of flour from all systems of the technological process of a flourmill with a capacity of 300 tons per day. Studies have shown that flour from first-quality systems is whiter by 15–20 units, is by 1.0–1.8% lower in ash, by 1–3% lower in protein, by 2–4% lower in gluten with more elastic properties, has a Falling Number higher by 80–110 s, a water absorption capacity lower by 1–5%, a damaged starch value lower by 1–3 UCD as compared to flour from systems of some other quality. Technological solutions are developed for producing a special flour grade by its selection and mixing from the streams of the 1st break system (B1/B2), 1st reduction system (C1/C2), 2nd sizing system (R2), and 1st vibratory bran finisher system (V1). It has been found that the developed grade of flour – patent superior grade flour – meets the requirements and has high baking performance. It has a gluten content higher by 2%, Falling Number lower by 20 s, and Starch Damage less by 2 UCD, as compared to patent high grade flour. This makes it possible to obtain bread larger in volume by 55 cm^3, with smooth, even crust, elastic white crumb, and uniform porosity (80%). According to rheological characteristics determined with a Mixolab device, patent superior grade flour has a higher Water Absorption Index, a higher Viscosity Index, a lower Gluten+ Index, and a lower Amylase Index than patent high grade flour. The developed technological solutions for producing flour with specified quality parameters have been introduced at the flourmill with an equipment package, from the company *Alapala* (Turkey), with a capacity of 300 tons per day.

Keywords: wheat flour, whiteness, gluten content, falling number, water absorption capacity.

РОЗРОБКА ТЕХНОЛОГІЧНИХ РІШЕНЬ ДЛЯ ВИРОБНИЦТВА БОРОШНА ІЗ ЗАДАНИМИ ПОКАЗНИКАМИ ЯКОСТІ

Д.О. Жигунов, доктор технічних наук, доцент, *E-mail*: dimius75@gmail.com
В.П. Ковальова, аспірант, *E-mail*: k.vasilisa@ukr.net
М.О. Ковальов, кандидат технічних наук, старший викладач, *E-mail*: mak2111@ukr.net
А.О. Донець, кандидат технічних наук, старший викладач, *E-mail*: andrey.donets2011@gmail.com
Кафедра Технології переробки зерна
Одеська національна академія харчових технологій, вул. Канатна, 112, м. Одеса, Україна,65039

Анотація. У статті розглянуто технологічні і хлібопекарські властивості борошна з усіх систем технологічного процесу борошномельного заводу продуктивністю 300 т/добу. Дослідження показали, що борошно з систем першої якості характеризується більшою на 15–20од. білістю, меншою на 1–1,8% зольністю, меншим на 1,0–3,0% вмістом білка, меншим на 2–4% вмістом клейковини з більш пружними властивостями, більшим на 80–110с числом падіння, меншою на 1–5% водопоглинальною здатністю, меншим на 1-3UCD значенням пошкодженого крохмалю в порівнянні з борошном систем другої якості.

Розроблено технологічні рішення для виробництва борошна із заданими показниками якості шляхом його відбору і змішування з потоків 1-ї драної (B1/B2), 1-ї розмельної (C1/C2), 2-ї шліфувальної (R2) і 1-ї віброцентрофугальної (V1) систем. Досліджено якість отриманого борошна, встановлено, що розроблений сорт борошна – «вищий покращений» має високі хлібопекарські показники: кількість клейковини – 28,2%, індекс деформації клейковини – 75од., водопоглинальна здатність – 58,5%, число падіння – 315с, пошкодження крохмалю – 22,5UCD.

Ключові слова: пшеничне борошно, білість, кількість клейковини, число падіння, водопоглинальна здатність.

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Introduction. Formulation of the problem

According to the regulatory documents, wheat flour of five grades used for various purpose is produced in Ukraine. In most countries of the world, wheat flour produced has a wider range of applications. For example, in the neighboring country of Byelorussia, more than 20 grades of flour are produced, each recommended to be used for its specific purpose. In most European countries, flour is divided into types (grades), each of which also has recommendations for use.

High competition on the bakery products market makes hard demands for flour produced in flourmills. They include, firstly, the stable, high baking properties of flour for producing the main group of bakery products, and secondly, the production of flour with specified quality parameters for different purposes. When there is no quality raw material (wheat grain), with deviations in the enzyme complex and the state of biopolymers due to adverse climatic conditions, pest damage to cereal stocks, unfavorable storage conditions, the task of the production of flour for a specific purpose can be solved by the formation of flour from various systems of the technological process at flourmills [1].

Analysis of recent research and publications

Production of flour with specified quality parameters can be solved by using new varieties of wheat grain, by improving the stage of end products formation from individual flour streams that have specific technological properties and chemical composition, and by the addition of technological additives into the flour [2,3]. To obtain certain grades of flour for producing bakery products, it is necessary to know the quality of flour from each system of the technological process. That makes it possible to mix different streams thus forming special flour grades, the quality of which would meet the requirements of bakery enterprises [4].

Different parts of grain have different structure, chemical composition, physical, chemical, and baking properties. So the flour of a certain grade sold to a consumer should have restrictions as to its quality in accordance with the standards. That is why the technology provides for blending different flour streams, in a certain proportion, until homogeneous, which results in a new flour grade or type [5].

Knowing the flour quality parameters for each system and understanding the regularity of their changes depending on the above factors, we can efficiently manage the course of grain processing and obtain the best results of milling, including the maximum possible yield of patent flour with high baking properties [6,7].

To evaluate the properties of flour, it is necessary to use not only the methods provided for in the Industry Standard of Ukraine 46.004-99, but also the modern ones that give more accurate results less dependent on the human element.

One of these methods is determining the water absorption capacity and rheological properties by means of a Mixolab device manufactured by *Chopin Technologies* (France). It only takes it 45 minutes to evaluate comprehensively the flour quality parameters that depend on the protein content in the grain and its quality, on the properties of the starch and the carbohydrate-amylase complex of flour. Besides determining how these individual components of the flour effect on the quality of the dough, the device also allows determining their interaction in the process of making flour into dough and in dough formation, the activity of enzymes, and the effect of various additives and ingredients on the dough quality. Each phase of the regular schedule (time of formation, weakening of proteins, gelatinization of starch, amylolytic activity, and starch thickening) is automatically evaluated on a scale from 0 to 9 and is displayed on a graph with 6 axes, each corresponding to a certain quality parameter [8-10].

The degree of starch damage is an important indicator of baking quality. At present, there is a modern automated method for determining damaged starch with the *SDmatic* device manufactured by *Chopin Technologies*, which meets world standards AFNOR V03-731, AACC 76-33, and ICC 172 [11,12].

In a lot of developed countries, this device is used in flourmills to control the flour quality and the operation of roller mill machines (such parameters as parallelism, pressure, clearance, wear), and to optimize the grinding quality in different systems of the technological process [13].

The literature review indicates the lack of research of the quality of Ukrainian flour obtained from new flourmills using modern equipment in compliance with international standards. For such enterprises, there are no recommendations for the production of flour with specified technological properties at the stage of end products formation.

The purpose of the work is to develop technological solutions for the formation of flour with specified quality parameters by improving the stage of end products formation in high capacity flourmills.

To achieve the goal, you need to solve the following **tasks:**

– to investigate the quality of flour streams from all systems of the technological process;
– to form flour with the specified quality parameters (the patent superior grade);
– to analyze the quality of the flour grade developed;
– to carry out the production testing of the results.

Research Materials and Methods

For the study, samples of flour were selected from all systems of the technological process and end products of a flourmill with an equipment package from the *Alapala* company, Turkey, with a capacity of 300 tons per day. The technological scheme of the plant includes:

- 5 break systems (B1-B5), the 1st and 2nd break systems having a double roller machine without intermediate screening (B1/B2); the 3rd (B3g, B3f), the 4th (B4g, B4f), and the 5th (B5g, B5f) systems divided into coarse and fine;
- 3 sorting systems (Div-1-2, Div-3 – sorting intermediate products, Div-4 – sorting bran products);

- 5 bran finisher systems (BR1-BR5) and 2 vibratory bran finisher systems (V1, V2);
- 5 purifier systems (S1-S5) to enrich intermediate products;
- 5 sizing systems (R1-R5), the first of which divided into coarse (R1C) and fine (R1F);
- 7 reduction systems (C1-C7), with the 1st and 2nd ones realized on a double roller machine without intermediate screening (C1/C2) [14].

The samples of flour were grouped according to their quality at different stages of the technological process: first-quality break systems (B1/B2, B3), tailing break systems (B4, B5, V1, V2), first-quality sorting systems (Div 1-2, Div3), tailing sorting systems (Div 4), first-quality sizing systems (R1C, R1F, R2, R3), tailing sizing systems (R4, R5), first-quality reduction of (C1/C2, C3, C4), tailing reduction systems (C5, C6, C7). The quality of flour was evaluated by physical, biochemical, and rheological characteristics.

A milling blend of grain of wheat of the 2nd and 3rd grades (according to Industry Standard of Ukraine 3768-2010) in a proportion of 45% to 55% was being processed when the flour samples were selected. A mixture of wheat grain (harvested in 2016) had the following characteristics: moisture – 12.8%; grain bulk density – 780 kg/m^3; gluten content – 22.2%; gluten deformation index – 75 units.

For the formation of flour with specified parameters, the following quality characteristics in flour streams from different systems were determined: moisture content, whiteness, ash content, gluten content, gluten deformation index, protein content, sedimentation test (by the Pumpyansky method), Falling Number (FN), starch damage (measured with an SDmatic device), water absorption capacity (WAS) and rheological properties of the dough (measured with a Mixolab device), baking properties (by the laboratory baking test).

The moisture content of the flour was determined by drying a 5 g sample at a temperature of 130°C for 40 min. in accordance with GOST 9404-88, the whiteness of the flour was measured in accordance with GOST 26361-84 by means of an R3-BLIK device, the ash content by the burning method in accordance with GOST 27494-87, the gluten content by handwashing the dough made from 25 g of flour with 14 ml of water, the gluten deformation index with an IDK-M device according to GOST 27839-88, the protein content by the infrared spectroscopy method using an Inframatic 8600 Instrument. The sedimentation test, which is used for a more detailed assessment of the protein-proteinase complex, is determined in many countries by the Zeleny test, but in our work, we used the Pumpyansky method [15], which does not require special equipment, is not time-taking, and shows a similar result.

The Hagberg index (Falling Number, FN) was determined to evaluate the carbohydrate-amylase complex, which characterizes the potential activity of alpha-amylase, on a Falling Number device. The method is based on the rapid gelatinization of a water-based suspension of flour in a boiling bain-marie, followed by measuring the degree of dilution of starch gel under the action of alpha-amylase [16,17].

The amount of damaged starch (Starch Damage) was determined with a modern automated device SDmatic manufactured by *Chopin Technologies* (France), which complies with international standards AFNOR V03-731, AACC 76-33, and ICC 172. The operation of this device is based on the amperometric method of analysis of damaged starch. It consists in measuring the absorption of potassium iodide molecules in suspensions by damaged starch molecules. The more damaged the starch is, the more molecules of the produced iodide will be absorbed. The device creates and measures the amperage in the suspension during the chemical reaction. A significant amperage drop indicates a high content of damaged starch. The instrument readings are expressed as AI, % (iodine absorption percentage) and converted to UCD (Chopin-Dubua units) [13]. The formulae presented by the manufacturer of the device can be used for equivalent calculations in other units of measurement.

Water absorption capacity (WAC) and rheological properties of the dough were determined with a modern device Mixolab that allows simultaneous evaluation of protein-proteinase and carbohydrate-amylase complexes within 45 minutes in accordance with the international standard ICC 173/1. To evaluate comprehensively the baking properties of the flour, a loaf of bread was baked in the laboratory according to the method standardized as GOST 27669-88, with the ingredients taken proportionally to 100 g of flour. The quantity of water necessary for doughing was calculated on the basis of the moisture content of the flour. Yeast (3 g), sugar (4 g), and salt (1.3 g) were added according to the formulation. The dough was kneaded and panned manually. It was leavened in a thermostat at a temperature of 31±1 °C for 180 minutes. Bread was baked in a laboratory oven at a temperature of 220–230 °C, the baking chamber being moisturized. The baking time was 20–25 minutes.

Results of the research and their discussion

Due to the rapid development of baking industry (large enterprises as well as mini-bakeries), we can have a wide range of high quality bakery products. Raw materials with high baking properties should be used to obtain bakery products of such a level. However, the flour of patent high grade produced by flourmills in accordance with the Industry Standard of Ukraine 46.004-99 does not always meet the requirements of bakeries, so bakery industry makes certain requirements for the production of special grades of flour (Table 1).

Table 1 – Requirements for flour quality

Parameter	Requirements for the patent superior grade flour (flour with specified parameters)	Requirements for the patent high grade flour (in accordance with the Industry Standard of Ukraine 46.004-99)
Moisture, %	no more than 15.0	no more than 15.0
Whiteness, units	no less than 58	no less than 54
Gluten content, %	no less than 27.0	no less than 24.0
Gluten deformation index (GDI), units	no less than 70	no less than 70
Falling Number, s	270–330	no less than 160
Water absorption capacity (WAC), %	no less than 58	no limitation
Starch damage, UCD	19–23	no limitation
Volume of bread, cm^3	no less than 450	no limitation
Porosity of bread, %	no less than 75	no limitation

Whiteness and ash content are the main technological characteristics that help determine the grade of flour in flourmills. On the first-quality systems of the break and the reduction processes, the whiteness of the flour is higher by 15–20 units, as compared to the tailing systems of the break and the reduction processes. The ash content on these systems is, respectively, lower – 0.38–0.55 % (Fig. 1). Reducing the whiteness and, correspondingly, increasing the ash content of the flour obtained on the tailing systems indicate a significant content of the peripheral grain parts that contain pentosans and non-gluten proteins, which noticeably affect the baking properties of these streams. Therefore, detailed studies of the quality of flour streams are important to evaluate them fully.

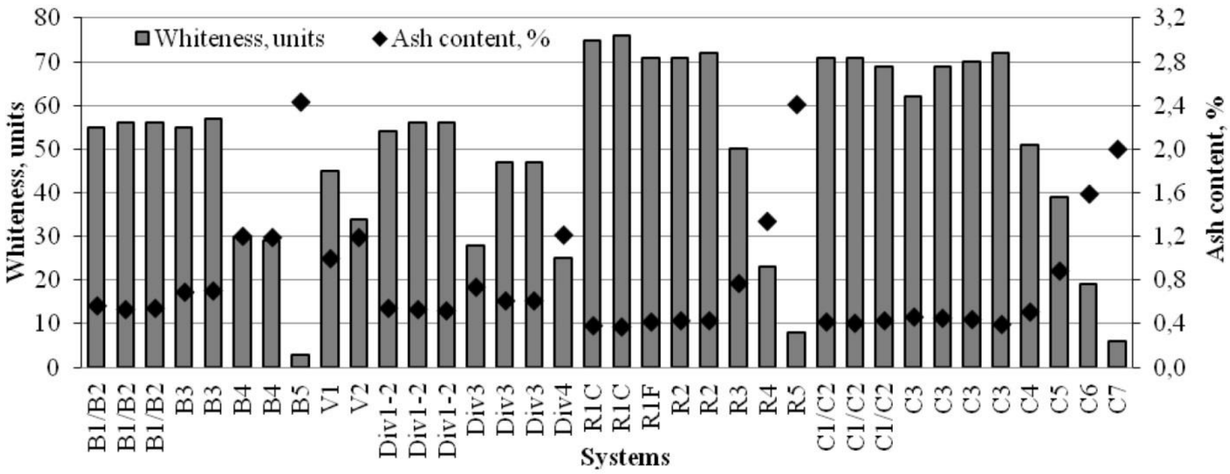

Fig. 1 Ash content and whiteness of flour in different graded milling systems

Flour obtained in different systems of the technological process is of different chemical composition, and, consequently, differs significantly in the gluten content (Fig. 2). A high gluten content is observed in individual streams of flour obtained in break, sorting, and bran finisher systems. This is due to intermediate protein getting into the flour in these systems. This protein is formed at the stage of the primary grinding of the grain and can easily form gluten. The gluten content ranges from 25.8% (R1F) to 28.0% (R3) in the first three sizing systems, and from 23.9% (C5) to 27.2% (C3) in reduction systems. In the last sizing and reduction systems, gluten is not washed out, because the content of non-gluten protein and water-soluble fractions increases due to contamination with particles of germs, bran, the aleuronic layer, all containing a lot of albumins, nucleoproteins, and highly active proteolytic enzymes.

There were significant changes in the structural and mechanical properties of gluten in flour streams, depending on the group of technological process systems as to their quality (Fig. 2). The gluten deformation index varies from 48 units (Div3) up to 70 units (B3) in first-quality break and sorting systems. The gluten is more elastic (52–67 units) in first-quality sizing and reduction systems, as the flour is obtained from the central parts of the endosperm. High values of the gluten deformation index (78–80 units) are characteristic of tailing systems, i. e., as to its the physical properties, gluten is more elastic. The quality of wheat flour gluten depends on many conditions and is a parameter much more variable than the gluten content, although between these two characteristics, there is a close relationship [18].

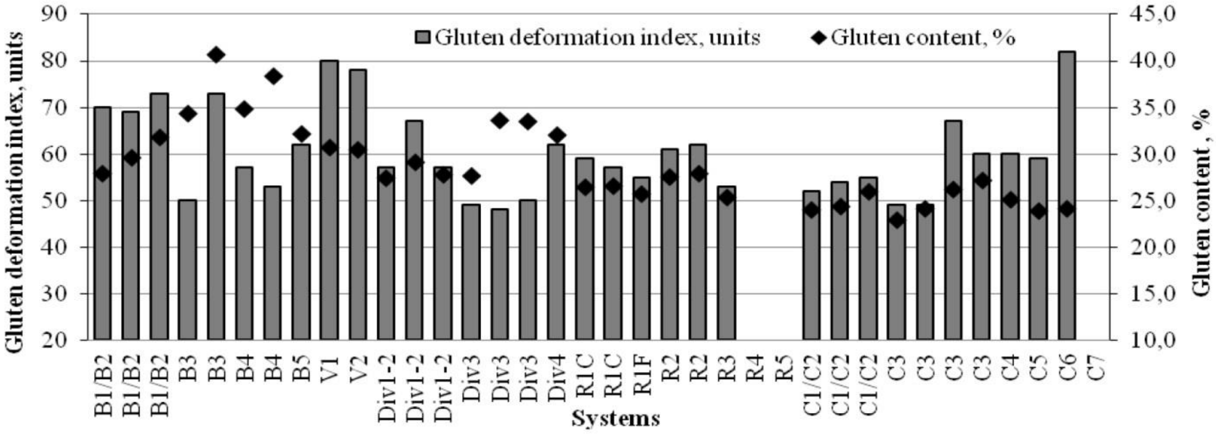

Fig. 2 Gluten content and gluten deformation index in flour in different graded milling systems

The protein content of individual flour streams increases from the first grinding systems to the last ones, both in the break process and in the sizing and the reduction processes (Fig. 3). As a rule, the flour from the first systems of the sizing and reduction processes is the lowest in protein (10.4–11.0%), and that from the last systems of the break, sizing, and reduction processes is the highest (11.8–17.8%).

It should be noted that the protein content in flour from break systems is 1–2 % higher than in that from reduction systems of the same quality. The quality parameters of flour from the break systems (B4, B5), sizing systems (R4, R5), and reduction systems (C7) show the highest protein (13.9–17.8 %) and are of interest, too.

Determining the sedimentation of flour is based on the ability of gluten-free proteins to swell in weak acid solutions. Typically, this parameter varies greatly, from 20 ml to 70 ml. According to the data obtained after years of research, gluten can be considered strong and of high baking properties if the sedimentation value is more than 45 ml, of average quality – 36 ml to 45 ml, and weak or of defective quality with sedimentation lower than 36 ml. Weak flour is unfit for baking bread of satisfactory quality, unless mixed with flour of higher baking qualities.

According to the sedimentation value, flour streams from the last break systems (15–26 ml) and the last sizing and reduction ones (18–26 ml) have the worst baking properties, which is due to the presence of bran with high proteolytic activity.

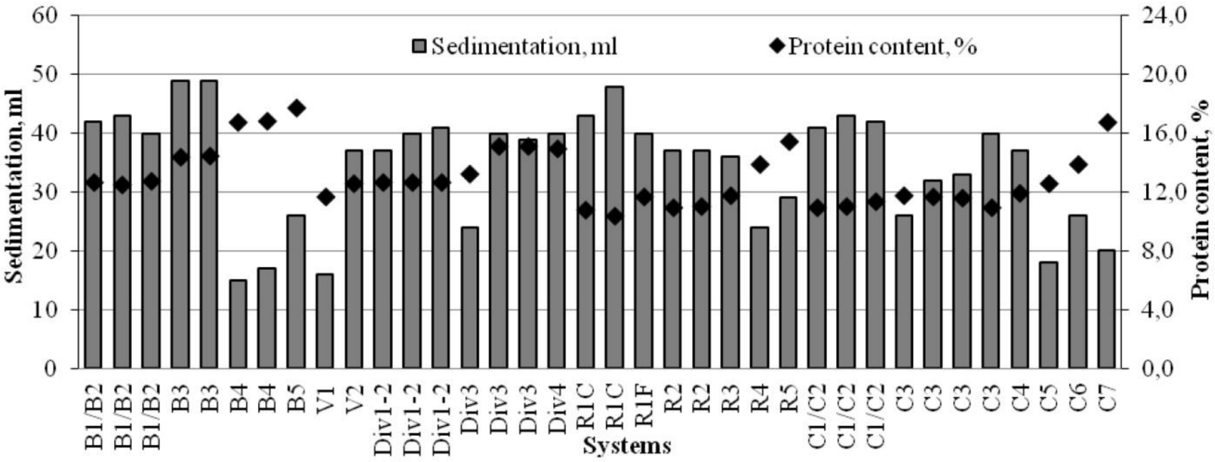

Fig. 3 Sedimentation and protein content indices of flour in different graded milling systems

The Falling Number characterizes the amylolytic activity of flour. It was going down from the first systems to the last ones, both in the break and in the reduction processes. In the first-quality systems of the break and the sorting processes, the minimum Falling Number in the 4th break system (B4) was 290 s. In the reduction and sizing processes in all first-quality systems, the value of the Falling Number (325–360 s) is close to the optimum as to the baking properties (270–230 s) [3]. Significantly higher amylolytic activity is characteristic of flour streams from the break and reduction tailing systems, which is explained by the presence of parts of the bran (Fig. 4).

At flourmills, to control the operating modes of grinding systems, the value of starch damaged (SD) should be monitored and optimized, since it can have both a positive and a negative effect on the baking properties of the flour. Increasing the number of SD accordingly increases the water absorption capacity of the flour. However, an excessively high level of SD leads to the formation of too sticky dough, to a long pre-maturation period, and to unwanted darkening of the crust. The optimum value of the SD varies depending on what the flour is to be used for, and largely depends on the protein content, on the activity of alpha-amylase, and on the type of bread that is baked from the flour.

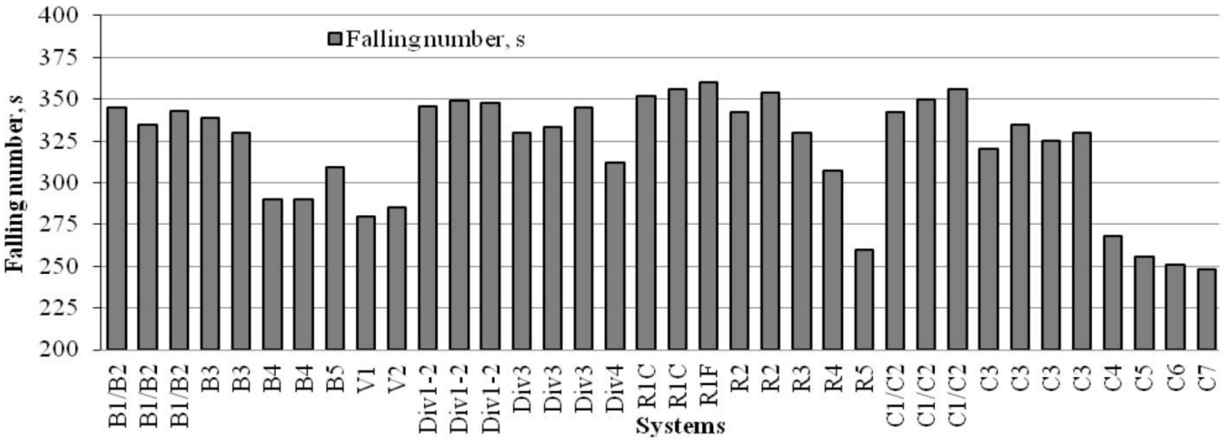

Fig. 4 Falling Number value of flour in different graded milling systems

The research has revealed that damaging the starch grains of wheat flour is different for all systems of the technological process, which is explained by different operation modes of the grinding systems. Thus, in the break systems, the values of SD ranged from 17.1 to 23.8 UCD, in the sorting systems, from 8.2 to 23.3 UCD, in the sizing systems, from 19.5 to 29.6 UCD, in the reduction systems, from 18.0 to 30.7 UCD (Fig. 5). The lowest starch damage is in the flour from the 2nd sorting system (Div3) – 8.2 UCD. This is due to the removal of a large fraction of flour from the third break system, which is confirmed by the value of ash content of the flour from this system (Fig. 1). The largest value of the SD is on the 6th reduction system – 30.7 UCD, which is typical for the tailing system of the reduction process. Similar data have been obtained on the R3, R4, R5 and C7.

It is known that water absorption capacity (WAC) values from 58 to 60% are characteristic of flour with high baking properties. The WAC of flour depends, firstly, on the presence of pentosans contained in the aleuronic layer and in the bran; secondly, on the protein content (the higher the protein content, the higher the value of the WAC is); thirdly, on the number of damaged starch grains, which depends on the operating modes of rollers mills.

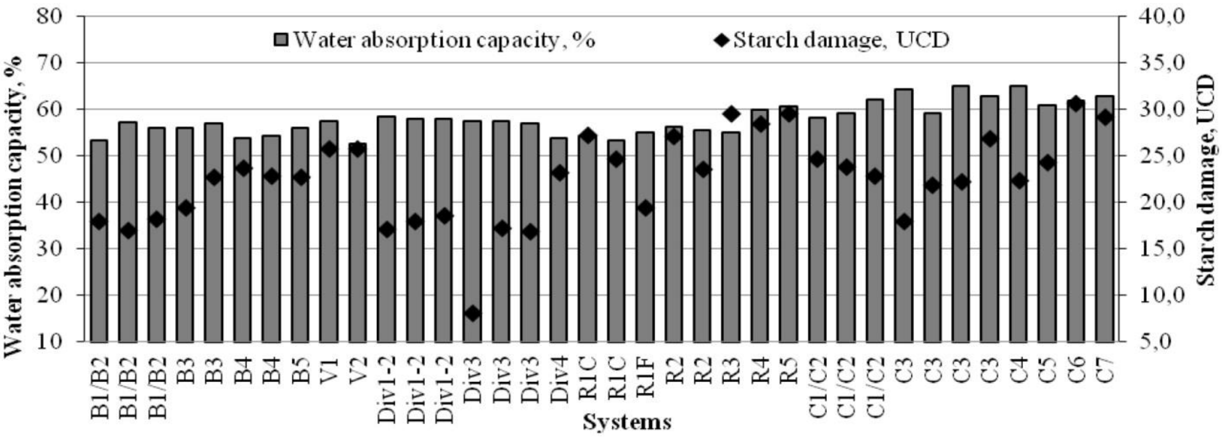

Fig. 5 Water absorption capacity and starch damage values of flour in different graded milling systems

A laboratory baking test, as the main indicator of the baking properties of the flour, has shown that the best volume and porosity of bread (Fig. 6) were those of the flour samples with high protein content, enough gluten with elastic properties, optimum values of FN, SD, and WAC. The worst characteristics of the baked bread were in the flour samples from the last systems of the reduction and sizing process, where gluten – the main factor for obtaining high quality bread products – is not formed (Fig. 2).

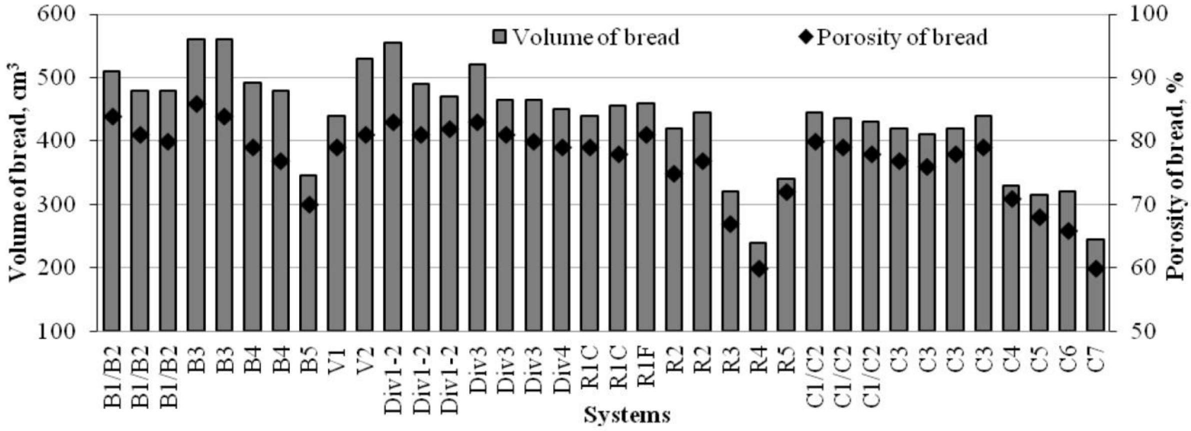

Fig. 6 Volume and porosity of bread from flour in different graded milling systems

The balance between the water absorption capacity, the protein content, the number of damaged starch granules, and the activity of alpha-amylase should be achieved to produce flour with high baking properties. The SD values obtained have made it possible to adjust the operating modes of the systems, namely, to reduce the total extraction of B1/B2, to reduce the partial extraction in C1, and to increase the partial extraction in the C2 systems. That is why it was decided to form a flour grade with the specified quality parameters – patent superior flour.

The results of the flour streams analysis from all systems of the technological process have shown that none of the streams meets the requirements for the production of the special grade (patent superior flour). So it was decided to form a special grade from several flour streams – B1/B2, C1/C2, R2, V1. Mixing these streams allows obtaining flour of the required quality.

Flour from the B1/B2 has a high protein (12.6%) and gluten (29.0%) content, a satisfactory gluten deformation index (70 units), but insufficient whiteness (56 units), and an insufficient starch damage value (18.2 UCD). Low protein (11.2%), too high a gluten deformation index (57 units), high whiteness (71 units), a sufficient damaged starch content (24.6 UCD) are characteristics of the systems R2, C1/C2, but gluten is higher in R2 (27.5%) than in the system C1/C2 (25.0%). V2 is the system of tailing quality. Low whiteness (45 units), medium protein (12.0%), high gluten (30.5%), with a gluten deformation index of 80 units, and satisfactory amylolytic activity (FN – 280 s) are characteristic of this system. Thus, flour with the specified quality parameters was obtained by mixing these flour streams. This allowed obtaining flour that had a number of advantages compared with the patent high grade flour obtained in the same flour-mill (Table 2).

Table 2 – Values of quality indicators of flour with specified quality parameters

Parameter	Quality of patent superior grade flour (with specified quality parameters)	Quality of patent high grade flour
Moisture content, %	14.5	14.2
Whiteness, units	60	60
Gluten content, %	28.2	26.3
Gluten deformation index (GDI), units	75	70
Falling Number, s	315	335
Water absorption capacity (WAC), %	58.5	57.5
Starch Damage, UCD	22.5	24.5
Volume of bread, cm^3	505	450
Porosity of bread, %	80	78

All quality indices of the special grade comply with the requirements (Table 1). The flour has high baking properties. The patent superior grade flour, as compared to the patent high grade flour, has a gluten content higher by 2 %, a Falling Number smaller by 20 s, and starch damage less by 2 UCD, which results in 55 cm^3 larger bread volume. Bread from this flour has smooth, even crust, elastic white-colored crumb, and uniform porosity (80%).

The value of Water Absorption Capacity (WAC) ranging 58 to 60% is characteristic of flour with high baking properties. The Absorption Index of patent high grade flour is 3, while for patent superior grade flour, it is 4. The WAC value of patent high grade flour is 57.5%, while for the patent superior grade flour, it is 58.5%, i. e. 1% higher, as seen from the Mixolab profile (Fig. 7).

The Mixing Index depends on the dough's behavior during dough mixing and on its stability. The higher the Mixing Index, the higher the stability of the dough is. A high Mixing Index does not signify the high quality of the end product – it must be taken into account that everything depends on the flourmill process and the purpose of the flour [3,4]. Low values of the Mixing Index in flour samples indicate the optimum value for obtaining high quality bread. This index for patent superior grade flour was a bit higher than in patent high grade flour, the index values being 3 and 2, respectively, which is better for bread.

The Gluten+ Index is determined while heating the dough (from 30 to 60°C). It is the time when starch granules begin swelling, keeping the molecular structure unchanged. Lower consistency of the dough is due to the breakdown of hydrogen compounds that bind protein molecular chains. A low index means a significant reduction in the dough consistency in this phase, and a high value of this index (7 and 6 for patent high grade flour and patent superior grade flour, respectively) indicates high stability of the protein structure.

The Viscosity Index describes the phase in which the greatest number of physico-chemical and biochemical parameters interact. At this stage, proteins start playing a minor role, as water is transferred from protein compounds to starch. The maximum viscosity depends on two interrelated factors: starch gelatinization and enzyme activity. Average values (Index=6) mean the average consistency of the dough during baking.

The Amylase Index shows the amylolytic activity of alpha amylase: a high index of amylolytic activity corresponds to a high value of the Falling Number. The value of the Amylase Index for patent high grade flour is higher by one than that for the patent superior flour grade (7 and 6, respectively), which is confirmed by the value of the Falling Number being higher by 20 s for patent high grade flour.

The Retrogradation Index of starch is directly related to the final product's ability to resist staling and keep its marketable condition. The higher the Retrogradation Index, the stronger is the crystallization of starch. The value of the Retrogradation Index is 5 for both samples (Fig. 7).

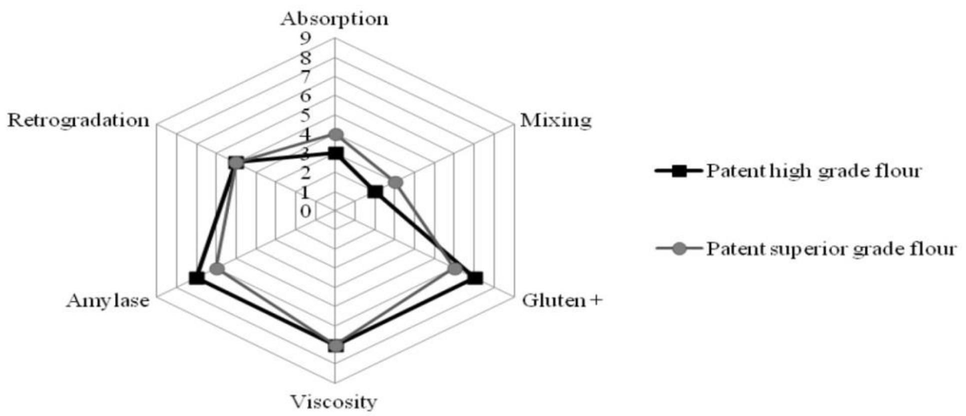

Fig. 7. Mixolab profile indices for patent high grade flour and patent superior grade flour

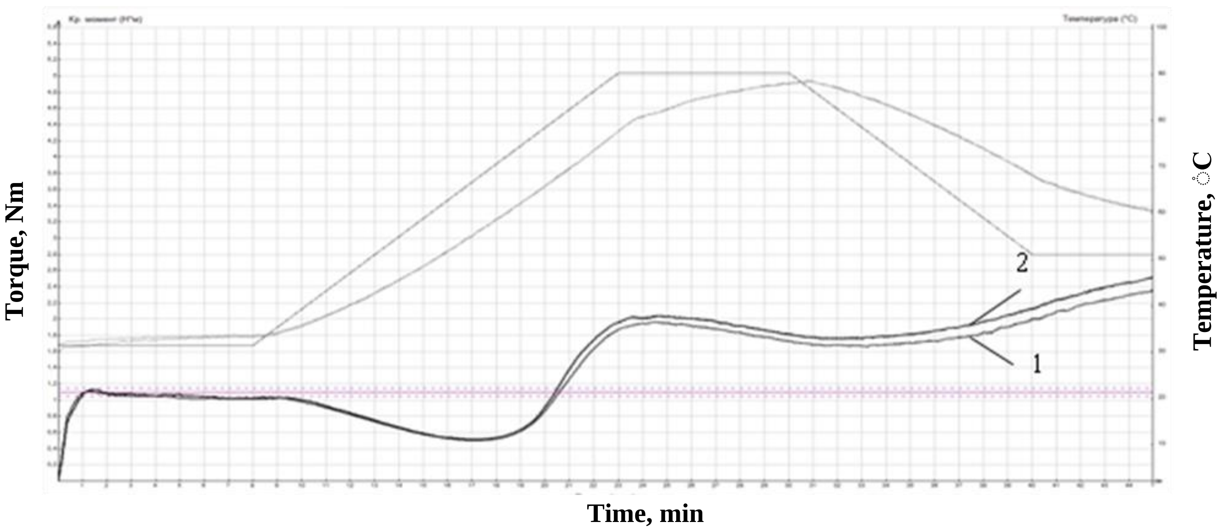

Fig. 8 Rheological curves of flour: 1 – patent superior flour grade; 2 – patent high grade flour

The analysis of the rheological curves has shown a sufficient time of dough formation (1.27–1.35 min) and high stability (9.75–9.78 min) (Fig. 8).

Approbation. The results of the work were implemented at the operating flourmill LLC *Vasylkivkhliboproduct*. A milling blend of II and III class wheat (harvested in 2016), in a ratio of 45% to 55%, was processed during production testing. The blend had the following characteristics: moisture content – 12.8%; vitreousness – 41%; grain bulk density – 780 g/l; gluten content – 22.2%; gluten deformation index – 75 units. The flourmill worked in the single-sort wheat milling mode (yield of flour of the patent first grade – 77.8%). The quality of the flour was: whiteness – 52 units; the gluten content – 27.2%; gluten deformation index – 75 units. The plant processed 300 tons of wheat according to this scheme. Another 300 tons of wheat was processed after the introduction of the model developed for the formation of the patent superior grade of flour. The flour of the patent first grade and of the patent superior grade was obtained, with the output 59.3% and 20.5%, respectively.

Conclusions

1. It has been established that the technological parameters of individual flour streams are different at each stage of the technological process and depend on the quality groups. In first-quality break systems, the flour characteristics are: whiteness lower by 15–20 units, the ash content higher by 0.1–0.3 %, protein higher by 1.5–2.5 %, gluten higher by 3–13 % and weaker in quality (by up to 10 units of gluten deformation index), the Falling Number the same, the water absorption capacity lower by 1–7%, and starch damage lower by 1.5–5.0 UCD, as compared to flour from first-quality reduction and sizing systems.

2. Breadmaking parameters of flour streams from all technological processes have been determined in a laboratory baking test. It has been established that flour streams from B1/B2, B3, V2, Div1-2, C1/C2 are characterized by the best baking properties, the bread volume being 480–550 cm^3.

3. Basing on the analysis of all flour streams, it has been decided to form a special flour grade *Patent Superior* from systems B1/B2, C1/C2, R2, V1. Blending these streams of flour made it possible to obtain flour of the specified quality. The resulting flour is characterized by high whiteness (60 units), high gluten (28.2%) having moderately elastic properties (gluten deformation index – 75 units), the optimum Falling Number (315 s) and the optimum water absorption capacity (58.5%), a sufficient starch damage value (22.5 UCD), and a high volume of bread (505 cm^3) with uniform porosity (80%).

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