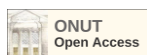




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FLOUR QUALITY STABILIZATION AT A LOW PRODUCTIVITY MILL

Abstract

The article provides an analysis of the quality indicators of wheat flour and their stabilization with the help of enzyme preparations. 12 samples of industrially milled flour produced at a mill with a productivity of 70 tons per day were studied. It was established that the Whiteness indicator in the studied flour samples was stable and averaged 57 units. According to the gluten content and gluten deformation index, the studied samples were stable and met the requirements of regulatory and technical documentation. The largest fluctuations were noted for the Falling Number indicator. The Falling Number indicator in the studied flour varied from 309 s to 477 s. To stabilize the quality of finished products, the FN indicator in flour was adjusted by adding the enzyme preparation "Amilorizine". Addition of Amilorizine did not change the whiteness of the flour, the gluten content and its elastic properties. However, the indicator of the Falling Number in flour varied inversely proportionally depending on the amount of the added enzyme preparation. Addition of Amilorizine in the amount of 0.03 % reduced the Falling Number by 15-18 s, 0.06 % – by 30-35 s, 0.12 % – by 55-65 s. Analysis of the baking test results showed that the loaf from control samples of the flour without the addition of the enzyme preparation had a light, pale color of the crust compared to the other samples, the crust of which acquired a light yellow and light brown color. The addition of the enzyme preparation led to an increase in the volumetric yield of loaf. The volume of the studied samples increased by 10-25 % at the maximum dosage of the enzyme preparation, the appearance of the finished loaves became more attractive - the color of the crust acquired a more golden-brown color, the surface became even and smooth. According to the results of the research, a positive effect of Amilorizine on the baking quality of flour was revealed. The use of an enzyme preparation will allow to stabilize the Falling Number in flour with low amylolytic activity of its own enzymes without deterioration of other technological indicators.

Key words: wheat flour, flour quality, enzyme preparations, additives, stability, baking properties.

Introduction

Recently, the quality of wheat flour has been showing a tendency to deteriorate, which is becoming a serious problem for the baking and confectionery industries, for which flour is the main raw material. In today's conditions, the flour milling industry faces various challenges in ensuring stable product quality, because the properties of flour depend on many factors: wheat variety, grain growing and storage conditions, and the sophistication of processing technology.

Adverse climatic conditions, such as droughts or excessive rainfall, negatively affect the yield and chemical composition of grain. Violation of storage conditions also causes a deterioration in its properties, in particular, an increase in enzyme activity, which can lead to defects in flour. Such fluctuations mean that flour produced from different batches of grain can differ significantly in baking properties, which is critical for the stable production of bakery and confectionery products with high and predictable consumer properties. Solving these problems requires an integrated approach.

Literary review

Numerous studies by domestic and foreign scientists have established [1-7] that the baking properties of flour largely depend on the state of two important complexes: protein-proteinase and carbohydrate-amylase. The first affects the formation of gluten, and the second - on the breakdown of starch during fermentation, which in

turn determines the structure and texture of bread.

To adjust the protein-proteinase and carbohydrate-amylase complexes and ensure the specified quality and stability of flour properties in the technological process, food additives or baking improvers are used. This helps to stabilize the properties of flour and obtain a final product with the necessary characteristics, even in the absence of ideally high-quality raw materials. Thanks to this technological solution, it is possible to adapt flour to different recipes, which is important for modern industry, which is focused on a diverse range of products and stable quality [8-10].

According to the Law of Ukraine, a food additive is a food product that has or does not have nutritional value, which is usually not consumed as a separate food product and is not the main ingredient of a food product and is added to a food product for technological purposes in the process of production, packaging, transportation or storage and as a result becomes an integral part of this product.

Today, several groups of technological additives are known, – improvers of oxidative and reductive action, enzyme preparations, surfactants, dry wheat gluten, etc., which facilitate the achievement of the necessary baking properties and product stability.

To improve baking properties and stabilize certain quality indicators of wheat flour in bread baking technology, mainly five types of enzymes are used. Amylases contribute to the conversion of starch into sugars and



dextrins, oxidases provide whitening of the dough, hemicellulases and proteases affect the structure of gluten: hemicellulases improve its mechanical properties, and proteases reduce elasticity. Lipases, acting on the gluten framework, slow down the process of bread staling and preserve the freshness of the crumb due to the formation of an amylase-lipid complex [11, 12].

In many European countries, the practice of introducing enzyme preparations directly at flour milling plants is widespread. This approach allows for more effective control of flour quality and stabilization of its characteristics, even if the raw materials have different properties. This solution is especially useful for industrial production, as it allows for the effective use of wheat of different qualities. These technological solutions make production more flexible and less dependent on fluctuations in the quality of raw materials, contributing to the production of consistently high-quality flour. This is especially true for countries with a developed baking industry, where the standards for the quality of the final product are very high.

The Ukrainian market offers a wide range of enzyme preparations (EP) from Novozymes, the German company Mühlenchemie, and Enzyme LLC.

Formulation of the problem

The purpose of the study was to analyze the quality indicators of wheat flour and their stabilization using enzyme preparations.

The object of the study is the baking quality of wheat flour.

The subject of the study is 12 samples of industrially milled flour produced at a mill with a capacity of 70 t for day in the Kyiv region; mixtures of high-grade flour with the enzyme preparation "Amilorizin".

Materials and methods

The gluten content and gluten deformation index in flour were determined by manual washing according to the GOST 27839-88 method, the Falling Number – according to DSTU ISO 3093:2019, the whiteness of flour – by measuring the reflection coefficient from the

flour surface according to DSTU GOST 26361:2019. Laboratory bread baking test was carried out according to the GOST 27669-88 method in terms of 100 g of flour: the amount of water and the mass of flour were determined based on the initial moisture content of the flour, the mass of pressed yeast was 3.0 g, salt – 1.3 g, sugar – 4.0 g. Mixing of dry components (flour, salt, sugar) was carried out in a 5-liter hook mixer with a yeast suspension with water for 3 min. During the fermentation of the dough in a thermostat at a temperature of (31 ± 1) °C, the dough blanks were passed three times after 90, 150 and 180 min from the start of fermentation. The final proofing of the formed blanks was carried out in baking molds at a temperature of 32 °C and a relative humidity of 70-85%. The end of proofing was determined by the condition and type of the dough blanks. The bread was baked in a laboratory oven at a temperature of 220-230 °C with mandatory humidification of the baking chamber. The duration of bread baking was 20-25 min.

Results of the study and their discussion

The mill implemented two-grade 75% milling of wheat grain, including high-grade flour – 55-60 %, first grade flour – 15-20 %. The quality indicators of the studied flour samples are given in table 1.

High-grade wheat flour produced at domestic enterprises must meet the requirements of the industry standard GSTU 46.004-99 "Wheat flour. Technical conditions". Among the main quality indicators by which flour is controlled at the mills are: granularity, whiteness, gluten content, gluten deformation index and Falling Number.

The gluten content and gluten deformation index affect the elasticity of the dough, allowing it to rise well and keep its shape. Flour with a high gluten content creates a porous structure and a larger volume of finished pastries, making it more friable. In addition, gluten helps to retain moisture, which increases the shelf life of products. During the studied period, the gluten content in flour was 25.0-25.8%, the gluten deformation index was 60-67 units, which indicates the stability of this quality indicators.

Table 1 – Quality indicators of high-grade industrial flour

Sample	Moisture content, %	Whiteness, un.	Gluten content, %	Gluten deformation index, un.	Falling Number, s
1	13.5	58	25.0	60	392
2	12.7	58	25.6	60	477
3	14.0	57	25.8	65	371
4	13.5	57	25.6	60	309
5	14.6	57	25.4	65	372
6	13.1	56	25.2	65	383
7	13.5	56	25.0	60	392
8	13.9	58	25.4	67	347
9	14.0	57	25.2	60	362
10	13.0	57	25.8	60	379
11	12.1	58	25.2	60	438
12	14.0	57	25.8	65	371
Min	12.5	56	25.0	60	309
Max	14.6	58	25.8	67	477
Average	13.5	57	25.4	62	383



Whiteness characterizes the degree of extraction of peripheral parts of the grain from flour during selective grinding. The higher the grade of flour, the higher the requirements for its whiteness. According to the requirements of GSTU 46.004-99, the whiteness of high-grade flour must be at least 54 units. The whiteness indicator was stable and averaged 57 units.

The Falling number indicator according to the standard for graded wheat flour should be at least 160 s. In all samples, the Falling Number was over 300 s, which meets the requirements of GSTU 46.004-99, but such a value of the FN indicates a low activity of amylolytic enzymes, in particular amylases, which are critically important for the conversion of starch into sugars that feed yeast. With a high Falling Number in flour, due to reduced enzymatic activity, the yeast does not have enough sugars for effective fermentation, which leads to weak dough rise and a reduced amount of carbon dioxide formed. As a result, the finished bread loaf has a smaller volume, a pale crust and a less pronounced taste and aroma.

According to [10], the optimal value of the FN indicator for bakery flour varies within 270-330 s. The FN indicator in the studied flour samples varied from 309 to 477 s. To stabilize the quality of the finished product, it is necessary to adjust the Falling Number in the flour.

The influence of the enzyme preparation Amylorizin produced by Enzyme LLC on the baking properties of flour was further investigated. The main enzyme of Amylorizin is fungal alpha-amylase, which acts as a catalyst in the process of hydrolysis of alpha-1,4-glycosidic bonds in starch molecules. Its action contributes to a rapid decrease in the viscosity of gelatinized starch solutions. The end products of the action of α -amylase on starch are low-molecular soluble dextrans with a small content of mono- and disaccharides (glucose and maltose) [13].

For the research, 4 flour samples with different values of the Falling Number were selected (table 2). Mixing of flour with the enzyme preparation was carried

out on a laboratory mixer CHOPIN MR Mixer for 30 min. Addition of Amylorizin was carried out in an amount of 0.03 %; 0.06 % and 0.12 % of the flour mass. Approximate rates of addition of the enzyme preparation for stabilization of the Falling Number in high-grade flour were established in previous studies [14].

The addition of the enzyme Amylorizin did not lead to a change in the whiteness of the flour, the gluten content and its elastic properties. However, the Falling Number indicator in the flour changed inversely proportionally depending on the amount of the added preparation. The addition of Amylorizin in an amount of 0.03 % reduced the Falling Number by 15-18 s, 0.06 % – by 30-35 s, 0.12 % – by 55-65 s.

A direct method for assessing the influence of additives on the baking properties of flour is a baking test. Analysis of the baking test showed that the control samples of flour without the addition of the enzyme preparation had a light, pale crust color (Fig. 1), the bread crust acquired a light yellow and light brown color after adjusting the FN indicator in the flour.

All bread loaf samples had a regular shape, a smooth and even surface, developed and uniform porosity. The porosity varied within 80-85 %.

Alpha-amylase activity is directly related to the quality of bread. The volume of bread loaf in the initial flour samples ranged from 380 cm³ (sample 1, Falling Number 477 s) to 470 cm³ (sample 4, Falling Number 309 s). The addition of the enzyme preparation led to an increase in the volumetric yield of bread (Fig. 2) due to the stabilization of the Falling Number indicator in flour. The volume of bread increases with increasing additive content, reaching a maximum volume at an enzyme preparation content of 0.12 %. The increase in the volume of the studied bread samples was 10-25 %.

When adding the enzyme in the maximum amount of 0.12 %, the appearance of the finished breads became more attractive - the color of the crust became more golden-brown, the surface became even and smooth.

Table 2 – Quality indicators of flour mixtures with the enzyme preparation Amylorizin

Sample	Content additives, %	Whiteness, un.	Gluten content, %	Gluten deformation index, un.	Falling Number, s
1	0	58	25.6	60	477
1/01	0.03	57	25.3	60	459
1/02	0.06	57	25.4	61	442
1/03	0.12	57	25.4	61	416
2	0	57	25.8	65	371
2/01	0.03	58	25.9	65	356
2/02	0.06	58	25.8	66	337
2/03	0.12	58	26.0	65	309
3	0	58	25.4	67	347
3/01	0.03	58	25.5	69	329
3/02	0.06	57	25.3	67	315
3/03	0.12	58	25.4	66	282
4	0	57	25.6	60	309
4/01	0.03	59	25.6	60	290
4/02	0.06	57	25.7	61	276
4/03	0.12	58	25.4	61	253

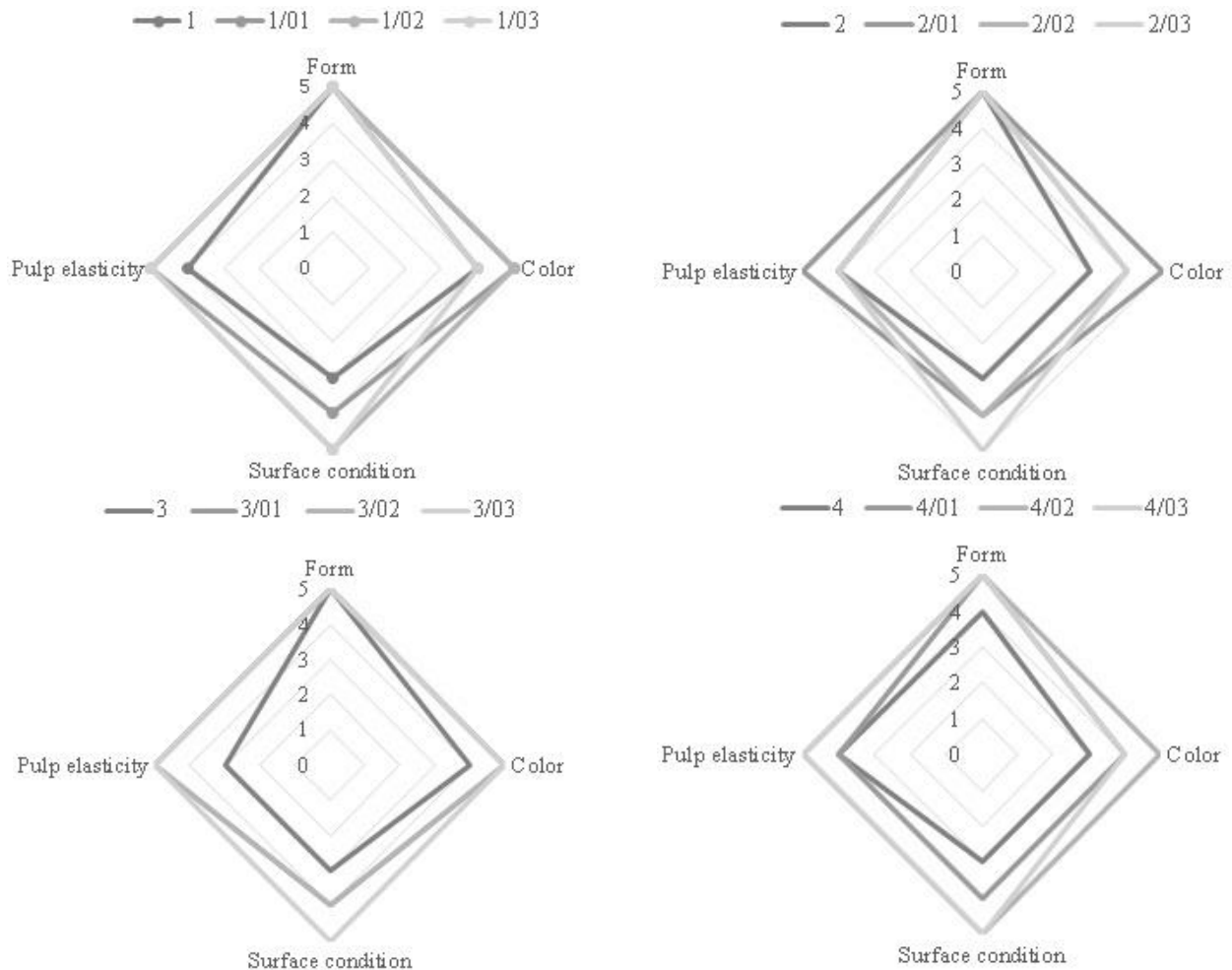


Fig. 1. Scoring of bread loaf with the addition of enzyme preparation Amylorizin

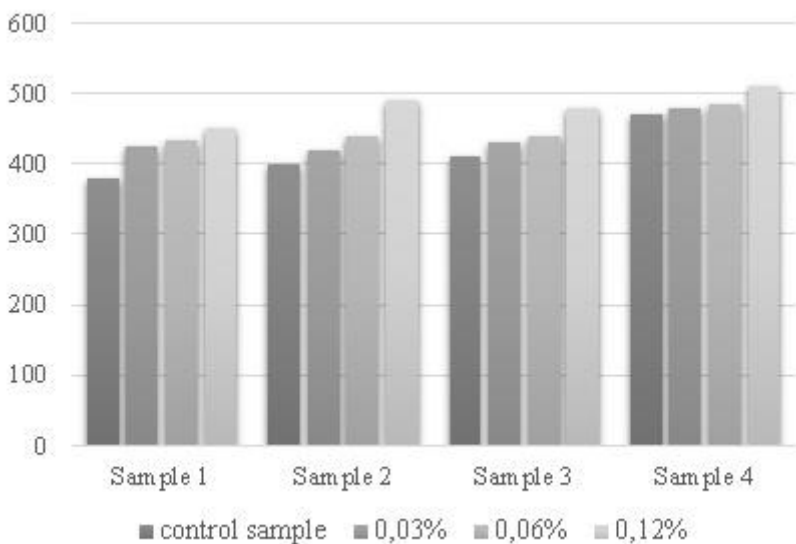


Fig. 2. Bread volume with different contents of the enzyme preparation Amylorizin

Conclusion

According to the results of the conducted studies, a positive effect of the enzyme preparation Amylorizin on the quality of flour was revealed. Adding the enzyme preparation in an amount of 0.03% led to a decrease in the Falling Number by 15-18 s, 0.06% - by 30-35 s, 0.12% - by 55-65 s. The loaf volume increased by 10-25% at the maximum dosage of the additive, the consumer properties of bread improved. At the same time, the use of the enzyme preparation does not have a significant effect on other technological indicators of flour quality.

The use of the enzyme preparation will allow stabilizing the Falling Number indicator in flour with low activity of its own enzymes without worsening other technological indicators.

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СТАБІЛІЗАЦІЯ ЯКОСТІ БОРОШНА НА МЛІНІ НЕВИСОКОЇ ПРОДУКТИВНОСТІ

Анотація

У статті наведено результати дослідження 12 зразків борошна індустріального помелу, виробленого на млині потужністю 70 т/доб. Досліджувані зразки борошна вищого сорту мали майже стабільні показники якості: вміст клейковини у борошні становив 25,0-25,8 %, індекс деформації клейковини 60-67 од., білість 56-58 од. Найбільшу мінливість мав показник число падіння, який змінювався у досліджуваних зразках борошна від 309 до 477 с. Для стабілізації якості готової продукції необхідно здійснити корегування показника число падіння у борошні. У роботі було досліджено вплив ферментного препарату Амилоризин виробництва ТОВ «Ензим» на хлібопекарські властивості борошна. Внесення ферментного препарату не призвело до зміни білості борошна, вмісту клейковини та її пружних властивостей. Проте показник число падіння у борошні обернено-пропорційно змінювався в залежності від кількості доданого препарату. Додавання Амилоризину у кількості 0,03 % зменшувало число падіння на 15-18 с, 0,06 % – на 30-35 с, 0,12 % – на 55-65 с. Хліб, випечений з контрольних зразків борошна мав світлий, блідий колір скоринки, проте після коригування числа падіння у борошні, скоринка хліба набула світло-жовтого та світло-коричневого забарвлення. Активність альфа-амілази має пряме відношення до якості хліба. Об'єм хліба у вихідних зразках борошна коливався від 380 см³ (зразок 1, ЧП 477 с) до 470 см³ (зразок 4, ЧП 309 с), пористість змінювалася в межах 80-85 %. Додавання ферментного препарату призвело до збільшення об'ємного виходу хліба за рахунок стабілізації показника число падіння у борошні. Об'єм хліба збільшувався із зростанням вмісту добавки, досягаючи максимального об'єму при її вмісті у кількості 0,12%. Збільшення об'єму досліджуваних зразків хліба становило 10-25 %. Зовнішній вигляд готових хлібців став більш привабливим – колір скоринки набув більш золотисто-коричневого забарвлення, поверхня стала рівною та гладкою. Використання ферментного препарату дозволить стабілізувати показник число падіння у борошні з низькою активністю власних ферментів без погіршення інших технологічних показників.

Ключові слова: пшеничне борошно, якість борошна, ферментні препарати, добавки, стабільність, хлібопекарські властивості.

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