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PRODUCTION TECHNOLOGY OF "BORODINSKY" BREAD IN THE TERMS OF "TERNOVSKY HLIBSAVOD" LLC

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Abstract. *Bread production technology is one of the main issues today, as bread is the main component of human nutrition. The technology of production of "Borodynskyi" bread by various methods of preparation was studied. According to the organoleptic indicators, namely: the condition of the crumb, color, structure, porosity, aroma and taste, the best indicators were the bread "Borodynskyi", made according to a modern recipe. It was established that the production of "Borodinsky" bread was more efficient with the modern recipe.*

Key words*: technology, bread, flour, assessment, quality, recipe.*

I. INTRODUCTION

Bread is one of the most common flour products in the daily human diet. For its preparation, they use the knowledge of scientists, engineers and technologists who are engaged in breeding new varieties of grain, follow techniques, create new recipes and monitor production.

Since ancient times, making rye bread has been considered a work of art. The basis for the production of rye bread was special sourdough. The sourdough recipe was passed down from generation to generation. Sourdough was considered leavened dough, which remained from the previous baking of bread. The taste and aroma of the bread depended on the quality of the leaven.

Nowadays, there are a large number of types of bread, which are made both at home and in large factories. Therefore, taking into account the variety of bread products, it is advisable to analyze the technology of production of bakery products.

II. ANALYTICAL REVIEW OF LITERATURE

2.1. History of "Borodinsky" bread

There are many legends about the origin of "Borodyn" bread. The most common version is the story about Margarita Tuchkova, abbess of Spaso-Borodino Monastery [2].

She was the wife of Alexander Tuchkov, a Russian general who died in the Battle of Borodino in 1812. After the death of her husband, Margarita Tuchkova (Naryshkina) became a nun and founded this monastery. It was supposedly there that they started baking the Borodino bread we know today. This is a beautiful story, but the problem is that until the 1930s, the word "Borodinsky" in relation to bread is not found anywhere in the sources [11].

The recipe for modern Borodino bread was specially developed in 1933 by the Moscow Baking Trust. The recipe for Borodino bread was replenished with one ingredient - coriander. Therefore, currently the recipe for Borodino bread includes: salt, yeast, sugar, rye malt, ordinary rye flour, molasses and coriander [3, 9].

"Borodinsky" bread has a smooth surface that does not contain cracks and is sprinkled with coriander, anise or cumin on top. The shape of the bread resembles an oblong loaf, with rounded blunt ends. The custard should be well baked, not sticky, elastic and slightly moist to the touch. The taste is sweet and sour, quite pleasant without signs of bitterness and extraneous crunch and taste on the teeth from mineral impurities. This is the bread of the highest quality [10].

2.2 Characteristics of raw materials for bread production

The main raw materials needed to make the dough are: flour, water, yeast or sourdough, salt. Additional raw materials include dairy products and milk, sugar, molasses, egg products, fats, vitamins, seeds of essential oil plants: vanillin, cinnamon, and others [7].

The basis of production is wheat (higher, first, second grade and upholstery) and rye (husked, seeded and upholstery) flour, sometimes corn or barley is added. For every 100 kg of flour, from 30 to 75 kg of water is used, depending on the grade and moisture content of the flour, the bread recipe, etc. [5, 11].

Different types of yeast are also used, which, when added to the dough, form carbon dioxide bubbles, as a result of which the structure of the bread becomes porous and acquires a characteristic smell and taste [1].

Water for cooking must meet sanitary standards in terms of bacteria content [5].

Salt must meet the requirements of the standard (for food purposes). For further use, it must be dissolved and filtered. Salt solution is added to the dough in the amount of 1.4-2.7% of the mass of flour, it plays a significant role in preventing the weakening of gluten [5].

Sugar is added to improve the technological properties of the dough. Put in the dough in a dissolved form [5, 9].

Egg (egg powder) and dairy products (dry milk, cheese, sour cream, whey) enrich products with complete proteins, fats, minerals and other substances, give them a bright taste and slow down the aging process [9].

With the addition of fats, the nutritional value and taste of bread increases, and in a small amount, its quality and shelf life improve. Liquid fats are filtered before being added to the dough, and solid fats are melted in advance [10].

Raisins, poppy seeds, spices, honey, fruit and vegetable juices, purees, pastes and some other types of raw materials improve the biological value of products, their appearance, taste and smell [4, 10].

2.3. Technological process of bread production

Bread production consists of five stages: preparation of raw materials, preparation and processing of dough, baking, cooling and storage of bread [1, 5].

Preparation of raw materials consists of the following stages: preparation of flour, production of yeast suspension and preparation of salt solution [6].

First, flour is prepared: it is mixed and sifted, magnetic impurities are separated. Then the water is heated to a certain temperature, salt is dissolved in it, the salt solution is filtered and allowed to settle. Yeast is dissolved in water, fats are cleaned and melted, and other additives are prepared [2, 7].

Dough preparation includes the following technological operations: dough kneading, its fermentation, dough kneading, fermentation, kneading the dough. The

dough is kneaded for 3-6 minutes until a homogeneous mass is formed. The duration of the fermentation of the foam is different: 1-3 hours [8].

Then all components of raw materials are dosed according to the recipe and mixed. Kneading the dough lasts 4-9 minutes. During the kneading of the dough and dough, the fermentation process begins. Fermentation temperature is 27-30°C [6, 8].

Fermented dough is processed in the following sequence: the dough is rolled and divided into pieces, each of them is given a rounded shape, the dough is allowed to stand, and then shaped [6].

With the help of rounding machines, the resulting pieces of dough are rounded to the shape of a layer. After that, the dough is left to rest for 5-8 minutes for proofing. After giving the semi-finished product the desired shape, it is sent for final curing, which lasts from 20 to 125 minutes. Formed pieces of dough are laid out on a belt conveyor, where the dough is finally proofed, and then the workpieces are delivered to the oven for baking by the same conveyor [11].

Baking is the last stage of bread production, which is carried out in bakery ovens of various designs [1, 10].

The product is baked at a temperature of 210 to 260°C for 7-14 to 50-60 minutes. Modes of baking bread depends on the type of products, on the type of flour, the moisture content of the dough, the mass and shape of the products, the method of baking, etc. [2, 5].

Hot bread requires care, because it can crumple, which worsens the appearance and porous structure of the crumb. Therefore, after baking bread before sending it to the retail network, it is transferred to the bread storage for cooling, and sold no earlier than three hours after baking [4, 8].

III. OBJECT, SUBJECT AND METHODS OF RESEARCH

Three recipes were used in the production of "Borodinsky" bread: the first recipe, which was known since 1929, the second - more modern, and the third - according to DSTU [7].

Recipe of 1929. Ingredients: upholstery rye flour, 2nd grade wheat flour, fermented rye malt, fresh yeast, salt, maltose molasses, sugar, coriander, water. For sourdough: mature rye sourdough, water, rye upholstery flour, a pinch (0.1 g) of instant yeast. For brewing: flour, fermented (red) malt, water. For the dough: brew, sourdough starter, water, rye flour. Dough: whole dough, salt, maltose molasses, sugar, water, wheat flour of the 2nd grade, rye flour, ground coriander [1].

Preparation: Sourdough. Dilute 45 grams of active rye sourdough with the required amount of water to a foamy mass, add rye flour, roll into a dense layer and leave for 5 hours to mature at 30°C [11].

Brewing Mix flour and malt, dilute them to 100 gr. of warm water, pour another 120 g into the resulting mixture. boiling water and stir. Cover with a lid and leave for saccharification of flour starch for 5-6 hours at 63-65°C. The mass will become much thinner and sweeter in taste, and the color will be chocolate [11].

Sponge. Mix the brew-water-leaven well. Add flour to the resulting mixture. Leave under the film for fermentation until the maximum yield (2-3 hours) at 32°C [11].

Dough. Dissolve salt-sugar-molasses in a small amount of water. Add the resulting mixture to the steam and stir. Combine rye and wheat flour and add steam to them. Knead until smooth. Leave to ripen under the lid or film for 45-60 minutes. Put the finished dough on a wet table and form a loaf with wet hands [11].

It should be well distributed in the form, form a semicircular "cap" and leave under the film for 45 minutes. During this time, the dough will rise to the edges of the form. By the time the dough rises, the oven should be preheated to the maximum temperature (260°C) [11].

Before putting it in the oven, you need to coat the bread with flour (flour + water) and sprinkle with coriander or cumin. Bake without steam for 15 minutes at the maximum temperature, then ventilate the oven, reduce the temperature to 150°C and bake for another 1.5-2 hours. Immediately smear the finished bread with jelly and leave it on a wire rack to cool [11].

A modern recipe. Ingredients: rye flour, wheat, malt, warm water, yeast, sugar, salt, coriander, cumin. Preparation: dissolve yeast and sugar in water, set aside for 15 minutes. You need to leave it until the yeast is completely dissolved. Pour malt, flour, the rest of the water, mix well. Add salt, coriander, cumin, and knead the dough. Cover with a lid and leave in a warm place for 1-2 hours. When the dough is ready, form a bun and set aside for another 2 hours. Then the blanks are placed in the oven for 35 minutes at 180°C [10].

Recipe for DSTU. Ingredients: rye flour, wheat, malt, water, hot water, honey, coriander, rye sourdough, sugar, salt, coriander in grains [10].

Preparation: Mix rye flour, malt, ground coriander. Pour boiling water, close the container well and leave for 2 hours in a warm place. Dilute salt, sugar, honey with warm water. Mix with leaven, water, two types of flour. Knead the dough to a thick consistency. Lubricate the container with oil, put the dough and cover with a lid. Leave for 3-4 hours. Heat the oven to 220 degrees, grease the dough with water, sprinkle with coriander seeds and bake for 20 minutes. Lower the temperature to 200°C and bake for another 60 minutes. The finished product should be covered and left to ripen for an hour [10, 11].

The preparation of "Borodinsky" bread according to three recipes shows that they differ in cooking time - the first recipe takes 12 hours, the second - 5 hours, and the third - 8 hours [9].

To obtain the required amount of products, the mass of dry substances and moisture in raw materials are calculated [3].

$$G_{\text{ср}} = G_{\text{с}} \cdot \frac{a}{100} \quad (1)$$

Where $G_{\text{ср}}$ – mass of dry substances in raw materials, kg;

$G_{\text{с}}$ – mass of raw material, kg;

a – content of dry substances in raw materials, % [3].

The amount of moisture in raw materials can be calculated in two ways [7]

$$G_{\text{вол}} = G_{\text{с}} - G_{\text{ср}} \quad (2)$$

Or

$$G_{\text{вол}} = G_{\text{с}} \cdot \frac{W}{100} \quad (3)$$

Where W - raw material moisture, % [7].

Salt and sugar are usually used in the form of solutions for uniform distribution throughout the mass of the dough [3, 7].

The amount of salt or sugar solution is calculated according to the formula [3]: $G_{\text{роз}} = \frac{G^{\text{б}}_{\text{заг}} \cdot m}{c}$ (4)

Where $G_{\text{роз}}$ – amount of solution, kg;

c – concentration of salt (sugar) in the solution, kg per 100 kg of solution [7].

The amount of water added to the dough with a solution of salt or sugar is calculated according to the formula [7]:

$$G_{\text{в}} = V \cdot \rho - G_{\text{с}} \quad (5)$$

Where V – volume of saline solution, l;

ρ – density of salt solution, kg/l;

$G_{\text{с}}$ – mass of dry salt (sugar), kg [3, 7].

IV. WORK RESULTS

4.1. Equipment for making bread

The following equipment was used for the production of bakery products: flour sifter, melting device, leavening tank, dough kneading machine, dough dividing machine, dough rounder, dough pre-exposure chambers, dough rolling machine, bakery oven, bread slicer, packaging machine, steam generator.

The flour sifter was used at the enterprise to automate the dough preparation process, to significantly improve the quality and taste of bakery and confectionery products. Its main purpose is the mechanized separation of flour from metal impurities and foreign particles, cleaning, fluffing, filling with oxygen.

Flour sifters are divided into vibrating (Pic. 1) and centrifugal (Pic. 2) according to productivity and the type of sieving.

The flour sifter of the vibrating type works on the principle of vibration of the sieve, into which the flour is fed in portions, sifted and enters the prepared containers. In a centrifugal flour sifter, sifting is carried out due to the rotation of the drum.

Pic. 1. Vibrating flour sifter

Pic. 2.. Centrifugal flour sifter

The melting apparatus (Pic. 3) was used to melt blocks of butter, margarine, and fats. Schematically, the technological process of melting the product was carried out as follows. The product in blocks was placed on the surface of a grate heated by water. The product melted and accumulated in the body bath, from where, as it filled, it was drained or pumped out through a faucet.

Pic. 3. Melting machine

The sourdough tank (Pic. 4) is intended for preparing sourdough. It works as follows: the necessary ingredients were placed in the drum and the lid was closed. With the help of the control panel, everything was well mixed, the required temperature was set and the raw materials were left until they were completely ready. The starter tank has a lid that helps prevent dust and other foreign objects from getting into the starter.

Pic. 4. Fermentation tank

The dough mixer (Pic. 5) was used for automatic dough kneading. The principle of operation: the dough components were poured into the bowl of the apparatus and

the apparatus was started. Using the timer, it was possible to quickly change the kneading speed and bring the dough to the desired consistency. The bowl is removed from the device, which made it easier to transport the dough.

Pic. 5. Dough kneading machine

After mixing the dough with all the ingredients, it was necessary to divide it into the required number of blanks of the same weight. For this purpose, a dough dividing machine was used (Pic. 6). The finished dough was loaded into the machine, and at the exit, the dough was cut into portions.

A dough rounder (Pic. 7) was used to give the blanks a rounded shape. The dough, already cut into portions, was put into the machine one by one, after which the already rounded workpiece was received.

Chambers for preliminary aging of the dough (Pic. 8) were used to create optimal conditions for fermentation of the dough. After the dough rounder, the blanks were sent to the pre-exposure chambers and remained there for a certain time.

Pic. 6. Dough dividing machine

Pic. 7. Dough rounder

Pic. 8. Dough pre-exposure chambers

A dough rolling machine (Pic. 9) was used to give the rounded blanks the correct cylindrical shape. Thanks to the process of rolling the dough, large gas bubbles break up into many small bubbles that are evenly distributed. This contributed to the formation of a porous, uniform and airy pulp.

Pic. 9. Dough rolling machine

The bakery oven (Pic. 10, 11) was used to bake a wide range of bread and bakery products.

Pic. 10. Bakery oven, view from the inside

Pic. 11. Bakery oven, exterior view

The bread cutter was used at the enterprise to cut ready-made bread products into pieces of a given thickness. Enterprises can use three types of bread cutters: automatic

(Pic. 12), semi-automatic (Pic. 13) and manual (Pic. 14). But for greater productivity, automatic ones are more often used.

Pic. 12. The bread slicer is automatic

Pic. 13. Semi-automatic bread cutter

Pic. 14. Manual bread cutter

The packaging machine (Pic. 15) was intended for packaging ready-made bread and bakery products, whole or sliced.

The steam generator (Pic. 16) was used at a bakery to maintain a certain percentage of dough moisture during its settling. This is necessary so that a dry crust does not appear on the raw dough.

Pic. 15. Packing machine

Pic. 16. Steam generator

4.2. Bread making technologies

Depending on the type of bread, different cooking technologies are used. So, for example, the following cooking technology was used for "Borodinsky" bread. Among the ingredients, we used (based on one loaf) rye flour - 1 tbsp. l., wheat - 300 g, malt - 2 tbsp. l., warm water - 300 ml., yeast - 1.5 tsp., sugar - 1 tbsp. l., salt - 1.5 tsp, coriander - 1.5-2 tsp, cumin - 1.5 tsp.

Preparation process: first, 1.5 tsp was diluted in 100 ml of water. yeast and 1 tbsp. l. sugar Mix thoroughly and leave the mixture for 10 minutes at room temperature. After the yeast has worked, 1 tbsp was poured into the mixture. l. rye flour, 300 g of wheat, 2 tbsp. l. malt, poured the rest of the water and mixed well. Then added 1.5 tsp. salt, 1.5-2 tsp. coriander, 1.5 tsp. cumin and knead the dough. Covered with a lid and left the dough in a warm place for 1.5-2 hours. When the dough was ready, it was taken out of the container and formed into a loaf. The workpiece was placed in a baking dish and left for another 1.5 hours. After the second stand, the form with the dough was sent to the oven for 30 minutes at 180°C. After baking, the form with the finished bread was removed from the oven and left to cool.

4.3. Calculations of the use of raw materials for "Borodinsky" bread

Calculations of the mass of dry substances and moisture in 50 kg of flour with a moisture content of 12.5%:

The content of dry substances in raw materials:

$$a = 100 - 12{,}5 = 87{,}5\%$$

Mass of dry matter:

$$G_{\text{ср}} = 50 \cdot \frac{87{,}5}{100} = 43{,}75 \text{ кг.}$$

Mass of moisture:

$$G_{\text{вол}} = 50 - 43{,}75 = 6{,}25 \text{ кг}$$

Determination of the maximum amount of flour in a vat with a capacity of 350 liters:

$$G_{\text{деж}} = 350 \cdot \frac{38}{100} = 133 \text{ кг.}$$

Determination of the amount of flour in the dough. 80 kg of dough with a moisture content of 50% is taken for kneading the dough:

$$G_{\text{оп}}^{\text{б}} = 80 \cdot \frac{(100 - 50)}{100 - 14{,}5} = 46{,}8$$

The amount of flour for kneading the dough:

$$G_{\text{т}}^{\text{зам}} = 125 - 46{,}8 = 78{,}2 \text{ кг}$$

Since the dough consists not only of water and flour, but also of salt and yeast,

you need to determine how much flour will be needed for 100 kg of dough:

$$G_{\text{т}}^{\text{б}} = \frac{100\,(100-46)-1{,}0\,(100-3{,}5)-0{,}3(100-75)}{100-14{,}5} = 61{,}9 \text{ кг.}$$

Consumption of dry salt for dough kneading:

$$G_{\text{с}} = 80 \cdot \frac{1}{100} = 0{,}8 \text{ кг.}$$

Sugar costs for dough kneading:

$$G_{\text{с}} = 80 \cdot \frac{1}{100} = 0{,}8 \text{ кг.}$$

Costs of coriander and cumin for dough kneading:

$$G_{\text{с}} = 80 \cdot \frac{0{,}5}{100} = 0{,}4 \text{ кг.}$$

We determine the required amount of salt and sugar solutions for kneading 80 kg of dough:

$$G_{\text{роз.с}} = 50 \cdot \frac{1{,}5}{25} = 3 \text{ кг;}$$

$$G_{\text{роз.ц}} = 50 \cdot \frac{5}{50} = 5 \text{ к.}$$

Calculation of yeast suspension:

$$G_{\text{др. сус}} = \frac{150 \cdot 1 \cdot (1+3)}{100} = 6 \text{ кг}$$

Determination of the mass of the dough:

$$G_{\text{т}} = \frac{93{,}62 \cdot 100}{100-43{,}5} = 165{,}7 \text{ кг.}$$

Determining the required amount of water for kneading the dough:

$$G_{\text{в}} = 165{,}7 - 122{,}4 = 43{,}3 \text{ кг.}$$

4.4. Assessment of bread quality

The consumer value of any food product and the demand for it are regulated by its quality. The quality of bread is formed by a number of factors, which include the quality of raw materials, compliance with the technological process and the safety of technological equipment, the quality of the work of producers, the quality of storage, transportation and sale of products, as well as the quality of product consumption, that is, the quality of production and the quality of post-production conditions of existence of products. Violation of the specified or one of these factors causes the receipt of lower quality, or even substandard products.

To ensure the quality of products, the enterprise controls the quality of raw materials, semi-finished products, compliance with technological process parameters, finished products before their sale.

The main organoleptic indicators of the quality of bread are: appearance, shape, color, condition of the surface and crumb. The physico-chemical parameters include: moisture, acidity, porosity, sugar and fat content (for products that contain sugar and fat).

The organoleptic method of analysis was used to determine the quality indicators of "Borodinsky" bread made according to three recipes. From the organoleptic indicators, the following were determined: appearance, shape of the bread, its color,

condition of the surface and crumb, character of porosity, taste and smell.

The organoleptic indicators of the quality of "Borodinsky" bread were characterized as follows: color "pale", "golden yellow", "light brown", "dark brown"; crust condition - "smooth", "uneven", "cracked", "undermined"; color of pulp - "white", "gray", "dark"; porosity - "uniform", "uneven", "shallow", "medium", "large", "thick-walled"; the elasticity of the pulp is "good", "average" or "poor", that is, the pulp is elastic, not sufficiently elastic or inelastic (Table 1).

Table 1. Results of organoleptic evaluation of bread

Indexes	Norms established by the standard	Actually the state of quality	Conclusion
Form	Oblong-square or oblong-oval	Oblong-square	Meets the requirements
Surface condition	Cracks with a height of no more than 1 cm are allowed	Minor crust cracks (0.3-0.5 cm wide)	Meets the requirements
The state of the pulp	Baked, not sticky	Baked, not sticky	Meets the requirements
Color	From light gray to dark brown	Light brown	Meets the requirements
Structure	Without lumps and traces of poor mixing	There are no lumps, the dough is well mixed	Meets the requirements
Character of porosity	Developed, without voids and seals. Not uniform is allowed	The porosity is uniform, with minor compactions	Meets the requirements
Aroma	Characteristic of this type of products, without extraneous smell	Characteristic of this type of products, without extraneous smell	Meets the requirements
Taste	Characteristic of this type of products, without extraneous aftertaste	Characteristic of this type of products, without extraneous aftertaste	Meets the requirements

Improvement of product quality assessment methods should be carried out by introducing objective instrumental and chemical methods.

4.5. Economic efficiency of research

Economic efficiency means the effectiveness of the economic system, expressed in the ratio of useful final results of its operation to the resources spent.

An economically justified determination of the amount of profit is of great importance for the enterprise, it allows to correctly assess its financial resources, the amount of payments to the budget, the possibility of expanded reproduction and material stimulation of employees. In addition, the implementation of the dividend policy of the joint-stock company also depends on the amount of profit.

At the same time, the economic and financial analysis of the results of the organization's economic activity allows for the development of a specific strategy and tactics for its development, identification and assessment of reserves for the growth of profit and profitability and ways of mobilizing them. This also applies to baking as a branch of agriculture.

Bread and bakery products have always been and are one of the most consumed

products. But at present, the economic efficiency of the enterprises of the bakery industry is quite low, as evidenced by the decline in the production of bread and bakery products.

Also, due to the increase in prices for raw materials, the average price of bread increased by an average of 15%. This can be seen on the example of the increase in prices for "Borodinsky" bread for 2021-2022, in particular in various grocery stores in the city of Mykolaiv (Table 2).

Table 2. Dynamics of the cost of "Borodinsky" bread in retail chains.

Grocery store	The cost of "Borodinsky" bread (0.5 kg), UAH	
	Year 2021	Year 2022
ATB	16	19
Tavria V	18	20
Silpo	21	26
Doyarushka	17	20
Velmart	20	25
Mida	14	16
Novus	24	28

Some of the actual directions for increasing the economic efficiency of activity at the enterprise level in the bakery industry are:

• technical re-equipment of the enterprise – this means replacing old equipment with new, more modern ones, or complete automation of the preparation process, starting from the supply of raw materials and ending with the packaging of the finished product;

• intensification of innovative activity - this can be done with the help of the release of new products or by reducing the cost of existing products by replacing certain raw materials with a cheaper analogue or removing a certain component from the recipe;

• increasing labor productivity - this can be done by improving work methods, motivating employees or coordinating management processes.

V. CONCLUSIONS

For the production of "Borodinsky" bread, modern powerful equipment, fast packaging and transportation to the places of sale of the product are used.

It has been proven that "Borodinsky" bread is made without the use of GMOs, but with the introduction of leavens.

According to organoleptic indicators: the condition of the crumb, color, structure, porosity, aroma and taste, the advantage was given to "Borodinsky" bread, which is made according to a modern recipe.

During the production of "Borodinsky" bread, it was established that the most effective for production is a modern bread recipe.

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