Research of bakery properties of varieties of selection rye

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Abstract. The Strategy for Improving the Quality of Food Products in the Russian Federation until 2030, approved by Government Order No. 1364-r of 29 June 2016, is aimed at ensuring full nutrition, preventing diseases, increasing the duration and quality of life of the population, stimulating the development of production and circulation of food products on the market of proper quality. One of the tasks facing the bakery industry is the need to restore the production of rye bread and varieties from a mixture of rye and wheat flour everywhere. Rye bread baking can be carried out not only in the conditions of large enterprises, but also in the conditions of low-capacity enterprises. The main task of rye selection is to improve existing varieties, that is, to create varieties with higher flour-baking qualities. The variety “Memory Bambisheva” refers to a steppe ecological group, Botanical varieties “Vulgare”. During the competitive test the average yield in the Saratov region amounted to 3.5-3.7 tons per hectare. The variety has a high winter hardiness, drought resistance to asphyxiation, morbid affection, and a good lodging resistance [1]. Studies of bakery properties of rye varieties “Saratov 7” and “Memory Bambisheva” are given, grade features of rye are noted, comparative assessment by technological indicators is carried out, technology of rye-wheat bread production is proposed. The obtained indicators show the expediency of introducing flour from white grain rye “Memory Bambisheva” into the raw material base of bakery products.

1. Introduction
Rye is one of the main grains cultures of the Russian Federation. The production volume of its grains in the country in recent years has been steadily increasing. According to the expert-analytical center of agribusiness "AB-Center" in Saratov oblast at the end of 2019 it occupies the fourth position in the ranking in the TOP 10 producers of rye in Russia. The total area of cultivation is 63.8 thousand hectares, representing 7.3% of the total crop in the country in 2019 gross relation to the 2018 was 88.9% thousand hectares.

In comparison with other grains crops, rye in many regions of the country forms a high yield and has a low cost of grains, the content of nutrients, vitamins and a number of essential amino acids, is a valuable raw material for production of bakery products.

However, the market share of rye flour bakery products in Russia is insignificant. Breeder’s Federal state scientific institution of South-East launched a new variety of ryes “Memory Bambisheva”. According to scientists of the research Institute, the main advantage of this variety is a
lower content of trypsin inhibitor – 1.7 compared to flour from grains of the standard "Saratov-7" – 2.16 mg/g [4,10,12].

In this regard, a promising source of raw materials for bakery products is flour of white-grain rye of the "Memory Bambisheva" variety. Insufficient study of bakery properties of rye "Memory Bambisheva" as an object of bakery products production prevents creation of new types of bakery products in the direction of expansion of rye-wheat and rye bread varieties.

2. The purpose of the study
The purpose of the study is to study the main characteristics of rye flour made of the winter rye variety "Memory Bambisheva" and to identify its influence on the quality of finished products.

3. The object of the study
The object of the study is grains of winter rye varieties "Saratov-7" and "Memory Bambisheva".

4. Materials and methods

4.1. Research of grains and flour.
The research was carried out at the Department of Food Technology, named after N.I. Vavilov SGAU, in the educational and scientific testing laboratory for determining the quality of food and agricultural products of FSBOU VO Saratov GAU and in the grains quality laboratory of FSBNU NIISKH South-East. Technological properties of grains and flour were analyzed according to the generally accepted methods in accordance with regulatory documentation [3,5,8].

Since the studied samples of rye grains did not contain weed and grains impurities, the process of preparing the rye grains for grinding included only hydrothermal treatment: the grains were moistened to 14-15% and dewed for 10 hours. The grains were ground at Brabender Mill. Grain yield does not exceed 44-45%. After the first stage of grinding the content of the receiver during 30°C was dispersed manually through a set of sieves with cell size: upper than 0.45 mm, lower than 0.38 mm [2,7,11].

4.2. Examination of test and finished products.
Experimental samples were prepared according to the unified formula "Ukrainian new bread" GOST 2077-84 with the addition of flour from white-grain rye of "Memory Bambisheva" 60% of the total amount of flour, the initial temperature of the dough is 28-29°C, the dough matures for 90 minutes. To prepare the semi-finished product, a method of dough-making on a thick leaven was used. The control sample was a semi-finished product with the use of rye-hulled flour of "Saratov 7", grade 60%.

The dependence of the viscosity of the system on the shear rate of the samples was determined on the Anton Paar Physia 102 rheometer (Austria) using parallel geometry of 20 mm in diameter, at 22°C. The instrument itself is designed to measure shear structural and mechanical characteristics. The rheometer can operate in both the shear rate control mode (CSR mode) and the shear stress control mode (CSS mode). The measuring cell of the device is a system of coaxial cylinders consisting of an external fixed cylinder with a cylindrical rotor immersed in it. The diameter of the inner cylinder – 26.7 mm, the outer cylinder – 28.9 mm, clearance between cylinders – 1.13 mm. The test medium was placed in the annular gap of the cylinders and thermostated. Processing of received data was carried out through the computer using special software Rheo Plus [9,13].

5. Discussion of the results
Grains quality is important for further use for processing and storage.
Based on the studies carried out, the indicators characterizing the technological value of winter rye grains were obtained, Table 1.
Table 1. Comparative characteristics of the grains of "Saratov - 7" and "Memory Bambisheva" variety.

| Name of an indicator | Value of indicators of grains |
|----------------------|-------------------------------|
|                      | "Saratov - 7" | "Memory Bambisheva" |
| State                | In a healthy not warming state |
| Color                | Light grey-green with an impurity of yellow. | Light yellow |
| Smell                | Characteristic of healthy rye grains, without mould, malt, dead and other foreign odors |
| Number of drops      | 171,0 | 200,0 |
| Mass fraction of moisture, % | 12,6 | 11,0 |
| Nature, g/l          | 654,0 | 814,0 |
| Weed impurity, %     | 0,03 | 0,02 |
| Grains impurity, %   | 2,57 | 1,59 |
| Pest infestation     | no | no |

The data of the table show that the class of luminous rye "Memory Bambisheva" exceeds the standard for the following physical and chemical indicators.

By grains nature the variety "Memory Bambisheva" exceeds the variety "Saratov - 7" by 24.5%. Nature indicator of grains quality serves as an indirect criterion of its flour-milling advantages.

According to the number of falls, the variety "Memory Bambisheva" exceeds the variety "Saratov - 7" by 16.9%. Rye grains having a drop in the number in the range of 140-200c provide good bakery advantages of flour. The higher the drop number, the higher the activity of alpha-amylase.

Laboratory grinding to determine the flour-milling properties of the original rye grains samples was carried out for each class separately, Figure 1.

Figure 1. Hulled rye flour
a) "Saratov - 7"  b) "Memory Bambisheva"

The quality of flour is shown in Table 2.

The whiteness index of flour at the class "Memory Bambisheva" exceeds by 46.3%; this is explained by the color of the grains endosperm.

Acidity and moisture of flour are a reliable indicator of the degree of freshness of flour and its storage duration. The studies were carried out under laboratory conditions at a temperature of 20-22 ° C and relative humidity of 45 -60% in the air. Changes in the moisture content of the flour are shown in Table 3.
Table 2. Comparative characteristic of quality of flour of grain varieties "Saratov 7" and "Memory Bambisheva"

| Name of an indicator       | Value of flour quality indicators of varieties | "Saratov -7" | "Memory Bambisheva" |
|----------------------------|-----------------------------------------------|--------------|---------------------|
| Color                      | Greyish-white with grains shell particle inclusions |              | Light yellow        |
| Smell                      | Characteristic of rye flour, without foreign smells, not closed, not mould |              |                     |
| Taste                      | Characteristic of rye flour, without foreign flavours |              |                     |
| Content of mineral impurity| When burning flour crust is not felt            |              |                     |
| Physical and chemical      |                                               |              |                     |
| Mass fraction of moisture, %| 11,4                                          | 10,6         |                     |
| Acidity, hail.             | 5,9                                           | 5,1          |                     |
| Whiteness, conventional    |                                               |              |                     |
| units of RP-BPL device     | 14,7                                          | 36,2         |                     |
| Device number of drops/s   | 179,0                                         | 188,0        |                     |

Table 3. Information on moisture change during flour storage.

| Name of an indicator       | Value of flour quality indicators of varieties | "Saratov -7" | "Memory Bambisheva" |
|----------------------------|-----------------------------------------------|--------------|---------------------|
| Reference value            | 11,4                                          | 10,6         |                     |
| Period of storage, months  |                                               |              |                     |
| 2                         | 11,0                                          | 10,1         |                     |
| 4                         | 10,9                                          | 10,0         |                     |
| 6                         | 10,6                                          | 9,6          |                     |
| Averages value             | 10,9                                          | 10,0         |                     |
| Maximum divergence, %      | 0,8                                           | 1,0          |                     |
| Maximum difference from average value, % | 0,5 | 0,6 | |

![Figure 2. Dependence of flour moisture on shelf life](image-url)
The effect of rye flour on the rheological properties of the dough was investigated. According to the obtained experimental data flow, curves of the obtained relationships of dynamic viscosity of the dough were constructed (η) from the speed of Stiga (γ) at a temperature of 22 °C, figure 3.

![Figure 3. Dependence of the dynamic viscosity of the dough on the shear rate](image)

Analysis of the results shows that as the shear rate increases, the viscosity decreases due to the significant chaotic arrangement of the particles in the stationary medium of the dough and the greater orientation of the particles in the direction of its flow under the influence of the increasing velocity.

Figure 3 shows that the degree of structure formation in the test sample is increased compared to the control sample, which makes it possible to recommend it for process control. Dough becomes more pliable and elastic, which leads to reduction of loads and energy spent on forming products, and production of bread of higher quality, which is due to the large presence of peptized proteins, which when kneading the dough quickly swell and peptize, mucus, dextrin, sugars, salt, organic acids, water-soluble vitamins and amino acids in flour.

Quality assessment of finished bakery products is given in Table 4.

| Quality indicators | Bread "Ukrainian New" with addition of rye flour of medium variety "Saratov - 7" | Bread "Ukrainian New" by adding whole-meal rye flour grace "Memory Bambisheva" |
|--------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Humidity, %        | 47,6                                                                            | 47,8                                                                            |
| Porosity, %        | 54,6                                                                            | 58,2                                                                            |
| Acidity, hail.     | 7,2                                                                             | 7,6                                                                             |
| Volume of bread, cm³ | 1690,0                                                                         | 1700,0                                                                         |

Test pieces made of flour of "Memory Bambisheva" grade have good ability to retain carbon dioxide, which leads to increase of volume of finished products, porosity of crumb. This is due to the presence of a significant amount of carbohydrates.
6. Conclusion
We investigated baking properties of grades of a rye of selection "Saratov - 7" and "Memory Bambisheva" in the Federal State Budgetary Institution NIISKH YUGO-VOSTOKA, Saratov. Bakery properties of grains and flour, as well as rheological properties of dough and quality indicators of finished products show the expediency of using flour from white-grains rye "Memory Bambisheva" as the main raw material for bakery products. The main advantage of flour is whiteness. It is assumed that the use of this raw material will increase the volume and porosity of products.

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