New technologies for the production of wheat bread long-term storage under the conditions of new industrialization

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***Abstract* — The gist of this article boils down to the problem of providing hard-to-reach areas of the Russian Federation and Sverdlovsk region with bread, as well as the need to develop a method for preparing long-term storage of bread. Nowadays in the context of industrialization the bread intended for long-term storage is necessary in hard-to-reach areas of Sverdlovsk region, participants of expeditions, workers of logging, geological parties, etc. Taking into account the constant demand for such products, it is necessary to develop new approaches to their creation. Experimentally proved that the use of wheat flour with a low content of amylose helps to preserve the freshness of bread-on the 10th day of storage, the specific volume of crumb decreased by 39 %. We investigated the effect of the addition of betulin, lowland, at the suppression of potato disease of bread. It was determined that each of the components has little effect on the suppression of potato disease, and the use of these additives in the complex gives a synergistic effect of suppressing the development of potato disease. The article has a practical focus on the findings and recommendations: the use of wheat flour with a low content of amylose, and the simultaneous introduction of a complex additive consisting of nisin, betulin and ascorbic acid in an amount of 0.05% to the mass of flour allowed to obtain wheat bread with high consumer characteristics with a shelf life of at least 10 days.**

Keywords—industrialization, bread freshness, potato bread disease, bread quality, consumer properties.

I. INTRODUCTION

Development of recipes of wheat bread, preserving nutritional value and a set of necessary consumer properties within 7-10 days is one of the innovative directions of the food industry. In the context of industrialization the development of this direction is primarily due to the territorial length of the Russian Federation and the complexity of logistics operations in severe climatic conditions [1-20]. The area of the Sverdlovsk region is 194307 sq km. It is 17th place in Russia in size.

It should be noted that in Russia bread is a product of particular importance: the population traditionally uses bread as a mandatory accompaniment to soups, second courses, snacks and salads at any time of the year. Despite the fact that in the last decade the consumption of bread in Russia has decreased from 66 to 49 kg per year per person, bread is a necessary product for every family, a strategic product to ensure food security of the country. The decrease in the consumption of bread by the population is connected, first of all, with the growth of living standards and incomes of the population, its demands in expanding the range of bread. Today, the population needs not just cheap bread, but bread with high nutritional value, special organoleptic characteristics.

Shelf life of wheat bread in the package 72 hours, after this time, the bread is removed in the implementation and goes for processing. In the conditions of the city we can see the presence of a developed bakery production, so this scheme works successfully. But what about the population living in remote small settlements? Today, according to the data of the Ministry of Agriculture and AIC, in the Sverdlovsk Region there are 1,158 remote or inaccessible settlements with a population of 1 to 1,080 people. Such settlements do not have their own bakeries and products are delivered there 2-3 times a month, or the trade is carried out using the “auto-shop on wheels” system.

In addition, in the Sverdlovsk region there are settlements that are subject to flooding every year during the flood: these are the major cities of Irbit, Artemovsky, Beloyarka and others. In emergency situations, it is not always possible to produce fresh bakery products, so bread with an increased shelf life is a necessary resource for the life of the population in emergency situations. Taking into account the above mentioned problems, the formulation of wheat bread with a shelf life of 7-10 days with the preservation of traditional consumer characteristics seems to the authors relevant and urgent, that is why it determined the purpose of further research.

In the course of research, the following tasks were solved: 1) preservation of bread freshness; 2) inhibition of potato disease of bread and molding for 10 days; 3) developed bread from wheat flour of 1 grade should maintain traditional consumer characteristics during storage for at least 7 days.

II. MODELING OF LONG-TERM STORAGE WHEAT BREAD RECIPE

The main task facing the developers is to reduce the rate of staling of bread (loss of moisture, reducing starch retrogradation), maintaining the moisture content of the bread crumb, as well as the suppression of potato bread disease caused by Bac. Subtilis, which is often seen on the 2-3 day storage of wheat bread.

If the stale bread and the preservation of the softness of the crumb can be dealt with by using various packages made of modern materials, optimizing technological processes and selecting raw materials, including making sublimated dry gluten, the suppression of potato disease is more difficult. Potato disease affects the crumb of wheat bread, which loses its natural taste and aroma, becomes sticky, when the bread breaks, mucous, stretching threads with a sharp specific smell and unpleasant taste are observed.

The problem of potato disease remains relevant not only in regions with a hot climate. Flour from infected grain can be in any batch. According to the «Rules of the technological process in the mills», part 1, «it is necessary to evenly use the stocks of grain from different growing areas, types and quality in grain stores, use the grain of the new crop within two to three months after harvesting and grading the past years of harvest, if such a grain is in the enterprise.

Today, the developers have the following methods to suppress potato disease of bread: increase the acidity and lower crumb moisture, increase the sugar and fat content in the recipe of products up to 15-20% by weight of flour, or use inhibitors of potato disease of bread (lysozyme, lowlands) [21].

As it is known, the main characteristics of the dough, and therefore bread, are affected by the quality of wheat flour gluten, since gluten proteins are hydrophilic, capable of swelling, which forms the qualitative characteristics of the dough and bread as a whole. Wheat flour contains about 10-12% of gluten proteins, whereas starch ranges from 60 to 70%. At the same time, the starch contained in wheat flour is a mixture of amylose and amylopectin polysaccharides. Amylose is a soluble polysaccharide of a linear structure, while amylopectin is insoluble and has a branched structure. Wheat contains amylose in the range of 20-25%, amylopectin - 75-80%. Since wheat flour with low amylose content has low dough viscosity and high water absorption capacity, amylose retrogradation occurs faster than amylopectin, therefore using wheat flour with low amylose content can reduce the rate of staling. bread [22].

In the course of these studies, the development of bread for long-term storage set three objectives: 1) reduce the rate of starch retrogradation by using wheat flour with a low amylose content; 2) use inhibiting ingredients that can suppress the development of potato disease; 3) developed wheat bread should be stored for at least 10 days, while having traditional consumer characteristics.

Birch bark extract betulin and a natural antibiotic secreted by lactic acid bacteria nisin (E234), which is inhibited by the development of spores of Bacillus mesenterius and Bacillus subtilis, were used as inhibitor ingredients. Betulin - birch bark extract, white powder, odorless, with a weak astringent taste, consists of a mixture of natural triterpene compounds, the main of which is triterpene alcohol betulin . Adequate consumption standards of betulin are included in the Unified sanitary-epidemiological and hygienic requirements for goods subject to sanitary and epidemiological supervision (approved by the Decision of the Customs Union Commission No. 299 of May 28, 2010) and constitute 40 - 80 mg per day [23].

Research results have shown that each of these ingredients individually slightly reduces the rate of development of potato disease, and betulin also provokes the appearance of mold. However, when nisin and betulin were used in a ratio of 2: 1 in the amount of 0.025% and 0.05% of the mixture to the mass of flour, this complex gave a synergistic effect and well suppressed the development of potato disease, as well as positively influenced the development of porosity in bread. Ascorbic acid strengthening component, as well as insignificantly, but increasing its acidity, ascorbic acid was also used as part of a complex additive, which was used in dough kneading. Thus, the composition of the complex additive for the suppression of potato dough disease included: nisin - 40 wt.% :, betulin - 20 wt.% :, ascorbic acid 40 wt.%.

III. STUDY OF CONSUMER CHARACTERISTICS OF WHEAT BREAD DURING STORAGE

The amylose content was determined by the standard photocolorimetric method using a calibration curve according to GOST ISO 6647-1-2015 «Figure Determination of amylose. Part 1. The control method» on the spectrophotometer SF-46. To do this, skim flour was treated with sodium hydroxide solution, after which iodine solution was added, which forms an amyloid-iodine complex with amylose, then the optical density was determined on an SF-46 spectrophotometer at a wavelength of 720nm. The calibration graph of the dependence of the optical density of the solutions on the mass fraction of amylose in wheat flour 1 grade is presented in Figure 1.

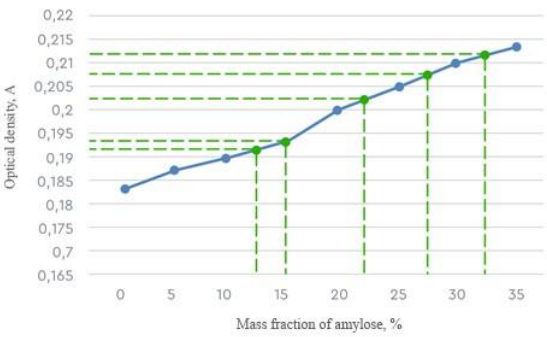

Fig. 1. Calibration graph of the dependence of the optical density of solutions on the mass fraction of amylose in wheat flour 1 grade.

To characterize the degree of freshness of the bread, the device used is the ST-1 structure meter. It has been used to determine the total deformation of the crumb of bread (ΔHtotal), which characterizes its compressibility. Table 1 shows data on the effect on the total deformation of the crumb (compressibility) of wheat bread during storage from flour with different amylose content.

TABLE I. THE TOTAL DEFORMATION OF THE CRUMB (COMPRESSIBILITY) OF WHEAT BREAD DURING STORAGE OF FLOUR WITH DIFFERENT AMYLOSE CONTENT

Mass fraction of gluten,%	**The amylose content in flour, %**	**ΔHtotal**				
		day 1	**day 3**	**day 5**	**day 7**	**day 10**
30,6	23,0	14,23	10,21	5,40	5,11	4,76
32,8	15,0	13,97	10,00	8,98	7,90	7,87
35,4	27,0	13,87	11,12	6,50	5,20	4,40
34,6	14,0	14,30	12,20	9,21	9,01	8,74
32,0	32,0	13,00	9.70	3,14	3,10	2,87

Traditionally it is believed that if the total crumb deformation (compressibility) decreases by 40% or more, then the bread is stale. The table shows that the low amount of amylose in the starch of wheat flour significantly reduced and the rate of staling of bread, even for 10 days of bread storage, the total crumb deformation (compressibility) did not reach 40%.

It goes on to say that low amylose flour was used to knead the dough using the straight-line method from infected Bac. Subtilis wheat flour. A complex additive was added to the dough to suppress the potato bread disease. To determine the effect of nisin, betulin-based, ascorbic acid-based complex additives on the quality indicators of wheat bread, test laboratory baking of wheat bread (control) and bread made from wheat flour with the addition of a complex additive in the amount of 0.025% and 0.05% to the total weight of flour was performed.

After baking and cooling, all samples were packed in paper and plastic bags and placed in a thermostat, where they were incubated at 37°C. The quality indicators were checked on 1;3;5;10 days of storage. The preservation of the freshness of wheat bread was judged by the change in the overall crumb strain (compressibility). The results of the analysis are presented in tables 2-3.

From table 2 it can be seen that the most effective is the dosage of a complex additive in an amount of 0.05% to the mass of flour.

TABLE II. MICROBIOLOGICAL INDICATORS OF WHEAT BREAD WITH A COMPLEX ADDITIVE TO SUPPRESS POTATO

Sample/the contents of the complex additive, %	**The number of colonies of Bacillus subtilis and Bacillus mesentericus in the studied samples after 5 days of incubation of the sample in a thermostat at a temperature of 37 ° C**	**Mold, KOE/g**			
		day 1	**day 3**	**day 5**	**day 10**
Control (without complex additive)	Solid growth	0	7	24	112
Sample 1 (0.025 %)	10	0	0	2	15
Sample 1 (0.05 %)	Not detected	Not detected			

The results showed that the number of colonies of Bacillus subtilis and Bacillus mesentericus in the studied samples after 5 days of incubation of the sample in a thermostat at 37°C was not detected in the sample wheat bread, comprising 0.05% of a complex additive for suppression of potato disease of bread, while in the control sample, clear signs of disease-specific odor, sticky crumb, partially with stretch thread. A sample with a complex additive in the amount of 0.05% retained good organoleptic characteristics without signs of potato disease [24].

Thus, on the basis of the conducted research, it can be concluded that the use of flour with a reduced content of amylose together with the use of a complex additive based on nisin, betulin, ascorbic acid in an amount of 0.05% to the mass of flour allows to obtain wheat bread of long storage (up to 10 days) with traditional organoleptic characteristics – baked,

with developed porosity, thin-walled, regular shape and light brown crust during the entire storage (table 3).

TABLE III. ORGANOLEPTIC AND PHYSICO-CHEMICAL PARAMETERS OF THE SAMPLE WITH THE INTRODUCTION OF A COMPLEX ADDITIVE IN AN AMOUNT OF 0.05% TO THE MASS OF FLOUR

Name of indicators	Bread quality indicators
Organoleptic characteristics	
Shape	proper
Crust surface	smooth
Color Crust	light brown
Propecia	baked, not wet to the touch
Colour	light gray
Color uniformity	uniform
Elasticity	medium
Porosity	medium uniform thin-walled, well developed
Taste and smell	peculiar to wheat bread, without extraneous taste and signs of potato disease
Physical and chemical indicators	
Volumetric output, $cm^{3/}$/g of flour	14,2
Humidity, %	43,5
Acidity, degrees	3,5
Porosity, %	72,0

These studies require continuation in order to establish the technological parameters of the dough preparation by the sponge and non-sponge method, to establish the degree of influence of the complex additive on the lifting force of the dough, the development of the porosity of the bread crumb, which is an important component of competitiveness in the context of industrialization.

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