

# DEVELOPMENT OF TECHNOLOGY OF THE PRODUCTION OF YEAST-FREE WHEAT BREAD USING SPONTANEOUS FERMENTATION LEAVENS

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## Abstract.

Lately, an increased interest in the production of bread on leavens is observed, the important advantages of which are the production of functional products of increased consumer value and resistance to microbial contamination during storage and sale. The formation of the leaven microbiome and their technological properties depends mainly on the composition of the nutrient substrate. The purpose of the research was to develop a technology for yeast-free wheat bread of increased nutritional value on a leaven of spontaneous (natural) fermentation. The research methods were traditional for laboratories of bakery enterprises. A technology for the production of spontaneous fermentation leavens using germinated wheat grain, soybean meal flour and grape pomace powder as a nutrient substrate, respectively, 50.0 (permissible 70.0%), 40.0 and 10.0% in the composition of the leaven nutrient substrate has been developed. The optimal dosage of the leaven is 25.0% (permissible 30.0%) to the mass of flour to obtain high-quality products from wheat flour with average baking properties. The authors consider it possible to use spontaneous fermentation leavens in the production of yeast-free bread.

**Keywords:** spontaneous fermentation leaven, nutrient substrate, wheat flour, wheat grain, soybean cake, grape pomace, yeast-free bread, quality.

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**Introduction.** The importance of bread products in the human diet, as the only product that does not palls on and is consumed by the majority of the population daily throughout their lives, is undeniably enormous. These products perform regulatory functions in the human body, and can exhibit lipotropic, detoxifying, antioxidant and other valuable properties to varying degrees depending on the recipe and cooking technology. Bread gives the food products consumed with it the necessary consistency and structure that contributes to the effective functioning of the gastrointestinal tract, ensuring more complete absorption of various types of food by the human body [1; pp. 19-26, 2; pp. 243-257, 3; pp. 31-32].

Nevertheless, recently, very contradictory information has appeared about the harm of bread prepared with thermophilic yeast. It is claimed that traditional yeast bread weakens the body's defenses due to the presence of residues of special nutritional substances (technical ammonium sulfate, purified ammonium sulfate, technical aqueous ammonia, thermal orthophosphoric acid, technical sulfuric acid (improved), potash, etc.) used to grow yeast [4, pp. 117-120]. It should be noted that these arguments are not sufficiently substantiated, since the yeast production technology itself provides for filtration, washing and pressing before use, which reduces the degree of contamination to a minimum.

Another argument of fans of yeast-free bread is the release of fusel oils and toxic high-molecular alcohols during yeast fermentation, which has also not been proven. It is known that the main products of yeast activity are ethyl alcohol and carbon dioxide, which are necessary for obtaining high-quality bread [4; pp. 117-120].

There is data [5, 6, 7] that yeast cells in the human gastrointestinal tract produce toxic substances that contribute to the development of dysbacteriosis. Therefore, according to

the conclusion of academician F. Uglov [6], yeast components entering food provoke the production of additional ethanol in the body, which leads to the development of acidosis. The body fights acidosis by intensively spending the most important alkaline reserve, i.e., Ca, Mg, Fe, K, Na, which inevitably leads to their painful fragility of bones and the development of osteoporosis at any age, so more and more attention is paid to yeast-free bread.

Recently, in the production of wheat bread using express technologies, chemical leavening agents are increasingly used, which include sodium dihydrogen phosphate, sodium dihydrogen pyrophosphate (E 450), sodium bicarbonate, calcium monophosphate, ammonium tartrate, etc. Uncontrolled use of phosphates can lead to an imbalance in the body between phosphorus and calcium. Excessive consumption of phosphates is fraught with deterioration of calcium absorption, which leads to deposition of calcium and phosphorus in the kidneys and contributes to the development of osteoporosis [5].

The solution of the problem can be expanding the range of yeast-free types of bread and bakery products, which also has both its advantages and disadvantages (Table 1).

**Table 1.**

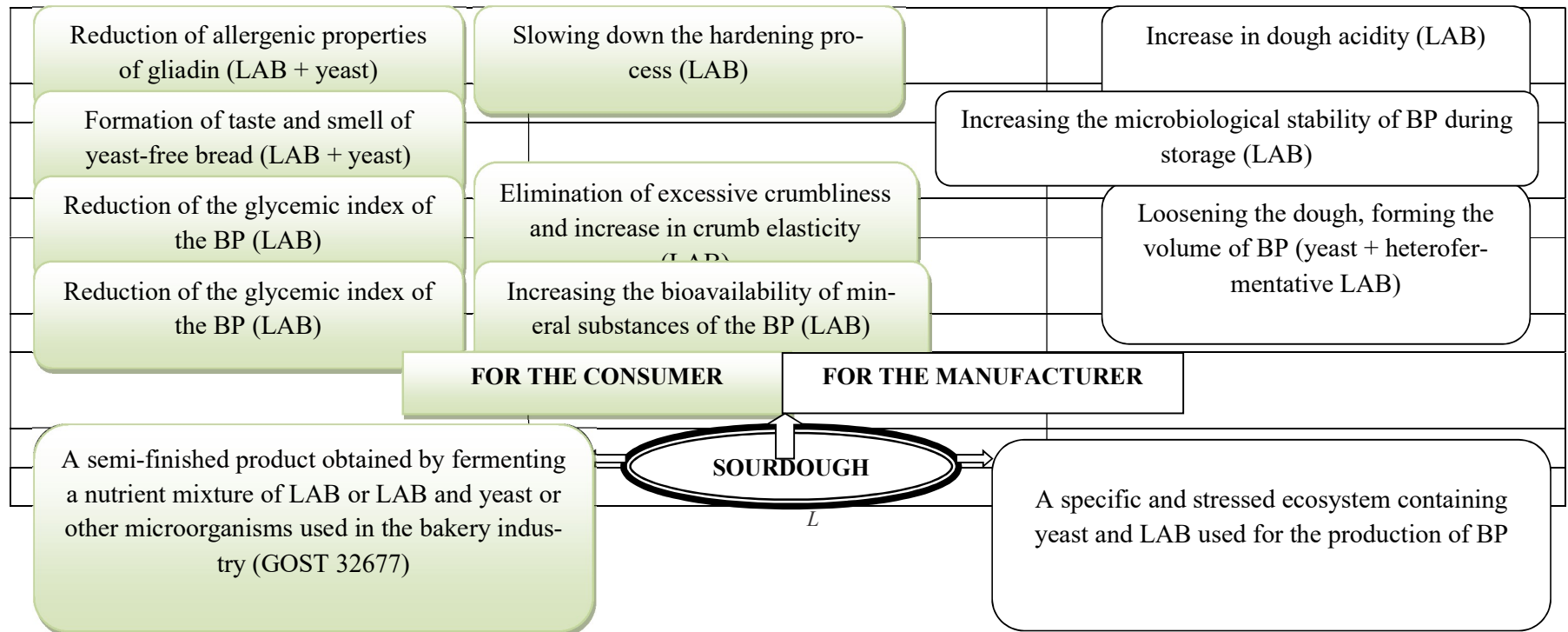
## Analysis of the advantages and disadvantages of the production of yeast-free bread

<i>Aspect</i>	<i>Advantages</i>	<i>Disadvantages</i>
Benefits for the health	Suitable for people with yeast intolerance and allergies	- Less nutritious when using simple recipes
Effect on bread flavor and crumb texture	Good texture (crisp crust and dense crumb) in some types of yeast-free bread (e.g., matzo)	- Firmer and less porous

		crumb compared to yeast or leaven breads - Less variety of flavors and textures
Production process	<i>Simplicity:</i> The process of making yeast-free bread is often simpler, since it does not require time for the maturation of flour semi-finished products (sourdough, leaven), it is prepared in a single-phase (sourdough-free) way, which simplifies the technological process and reduces the time for making bread	<i>Dough does not rise:</i> In the absence of yeast, the dough does not rise, which requires the use of other methods to achieve the desired result, such as the use of baking powder, sourdoughs or special additives
Shelf life	<i>Long shelf life:</i> Less probability to mold due to low humidity	<i>Drying speed:</i> Loses freshness quickly, especially without additional humectants
Consumer preferences	<i>Dietary restrictions:</i> Suitable for vegans and people with certain dietary restrictions	<i>Popularity:</i> May be less popular with consumers accustomed to traditional yeast bread and require recipe modifications to achieve desired quality

This bread is a healthier option for older people with certain dietary restrictions and provides certain texture and taste characteristics. The benefits of making yeast-free sourdough bread for producers and consumers, as well as the main classification features of this type of semi-finished products are summarized and presented in Fig. 1 [8; p.528].

Fig. 1. The importance of bakery sourdoughs for the consumer and producer of bakery products:



LAB – lactic acid bacteria, BP – bakery products.

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In addition, the presence of yeast with high maltase activity in individual sourdoughs allows using them in accelerated dough preparation schemes [9; p. 97].

Three main actions can be distinguished to improve the nutritional value and safety of bread:

1. reducing the content of phytic acid,
2. isolating exopolysaccharides that act as prebiotics,
3. hydrolysis of the prolamins fraction of protein, which makes the product accessible to people suffering from gluten enteropathy [10; pp. 7-9, 11; pp. 57-59].

Therefore, research in this area is currently very promising.

**Methods.** The purpose of the research was to develop a technology for yeast-free wheat bread of increased nutritional value based on spontaneous (natural) fermentation sourdough.

*Objects of research:* first grade wheat flour, germinated wheat grain, soybean cake (flour), grape pomace (powder), spontaneous fermentation sourdough, bread.

In the work, a sourdough prepared from varietal wheat flour (prototype) and a sourdough whose nutrient mixture substrate consisted of germinated wheat grain, semi-defatted soybean meal, and grape pomace powder (test) were used. The bread was prepared using a standardized recipe for bread made from 1<sup>st</sup> grade wheat flour prepared using traditional technology on thick dough with pressed baker's yeast (prototype). The test bread samples were prepared using spontaneous fermentation sourdough (SFS), which replaced the required amount of yeast (yeast-free bread) and some of the 1<sup>st</sup> grade wheat flour. A series of corresponding test laboratory bakes was conducted using a standard technique. The quality of the bread was analyzed for compliance with the requirements of the interstate standard GOST 27842-88 "Bread from wheat flour. Specifications according to generally accepted standard techniques". The generally accepted and special methods for assessing the quality of raw materials, semi-finished products and finished products were used.

**Results and discussion.** Production experience in breeding SFS showed that spontaneous microflora is not stable enough, and the breeding process itself is quite lengthy. In order to intensify this process, it is advisable to use non-traditional sources of essential nutrients that are not inferior, and in some respects superior to the chemical composition of varietal wheat flour. At the same time, it is important to preserve the natural composition of acid-forming and yeast microflora for wheat dough.

It should be noted that the own microflora of the flour is practically no different from the original microflora of the wheat grain from which it was obtained; the amino acid composition of soybean cake (meal) is closest to proteins of animal origin, therefore it has a high degree of digestibility by microorganisms; grape pomace is a source of glucose and fructose, minerals,

vitamins and other biologically active substances necessary for the metabolism and ontogenesis of microorganisms, in this case, acid-forming bacteria and yeast.

A comparative analysis of the chemical composition of the main nutrients of germinated grain with 1<sup>st</sup> grade wheat flour showed that the mass fraction of dry matter in the grain decreased by an average of 1.7 times, which, naturally, led to a decrease in the content of biologically active substances in it. However, to use this grain in the development of SFS, it was dried to the original moisture content, therefore, in the amount of main nutrients it was practically not inferior to the chemical composition of the original grain, that is, before drying. Germination of grain contributed to bringing the ratio of proteins and fats closer to the optimal value (Table 2).

**Table 2.**  
**Chemical composition of wheat grain before and after germination and 1<sup>st</sup> grade wheat flour**

Nutrients	Mass fraction of nutrients, in % of dry matter / rank			
	Wheat grain		Wheat flour grade 1 (WF1)	±Δ, in % of GG relative to WF1
	before germination	after germination (GG)		
Proteins	13.50±0.5	14.32±0.5	12.86±0.4	+ 10.20
Fats	2.26±0.2	2.17±0.3	1.68±0.2	+22.58
Carbohydrates:	71.40±0.7	64.22±0.8	78.70±0.5	+ 14.48
-starch and dextrin	52.80±0.4	48.11±0.3	64.85±0.5	- 2.12
-mono- and disaccharides	6.36±0.6	13.74±0.8	8.20±0.5	+ 40.32
-fiber	12.24±0.3	2.37±0.7	5.65±0.3	- 138.40
Dry matter	<b>90.80</b>	<b>54.40</b>	<b>87.00</b>	- 61.40
Energy value, kcal	<b>305</b>	<b>162</b>	<b>260</b>	- 60.50
Minerals, including:				
calcium (Ca)	0.065	0.056	0.027	+ 51.78
magnesium (Mg)	0.132	0.152	0.053	+ 65.13
sodium (Na)	0.001	0.032	0.001	+ 97.00
phosphorus (P)	0.432	0.378	0.135	+ 64.29
iron (Fe)	0.005	0.003	0.002	+ 33.33

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Vitamins, including:				
riboflavin (B2)	0.0002	0.0003	0.0001	+ 66.67
pyridoxine (B6)	0.0006	0.0005	0.0002	+ 60.00
tocopherols (E)	0.0040	0.0020	0.0030	- 50.00

The obtained results prove the possibility of replacing varietal wheat flour in the composition of the SFS with germinated wheat grain.

However, in order to reduce the duration of the propagation cycle (5-7 days) of this type of sourdough cultures by enriching the nutrient substrate with nutrients necessary for the vital activity of microorganisms, in addition to germinated grain, the following raw materials were selected: soybean cake (meal), as a source of valuable vegetable protein, grape pomace as a source of simple sugars, minerals and vitamins.

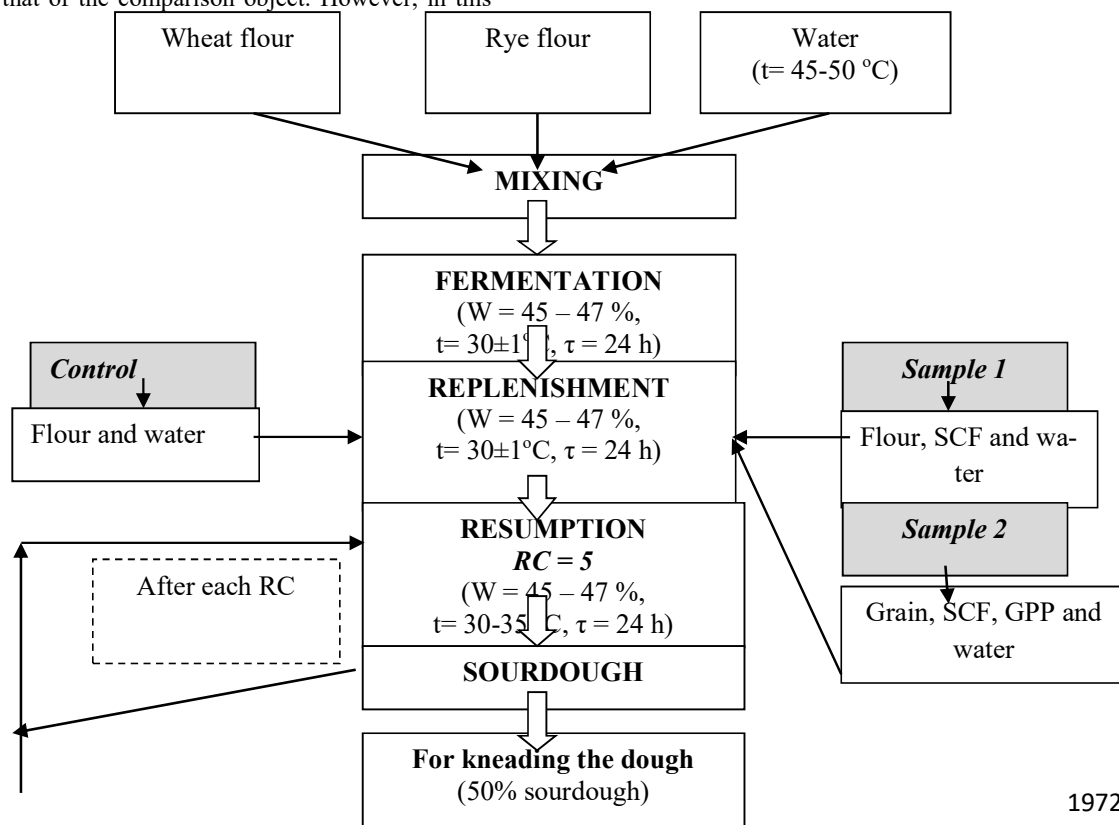
The studied samples of soybean cake met the requirements of Sanitary rules and norms No. 0366-19 of the Republic of Uzbekistan (clause 9.1) and TR CU 021/2011. Soybean cake flour (SCF) was obtained by grinding it to the size of dietary flour. As a result of heat treatment and pressing, without the use of chemical solvents, polysaccharides are broken down into monosaccharides, *easily digestible by microorganisms*.

It was established that the composition of SCF is almost completely free of starch, and the mass fraction of proteins and fats on average 3.7 and 6.2 times, respectively, exceeded similar values in WF1. The caloric content of the object of study is 1.3 times higher than that of the comparison object. However, in this

case, SCF was used as a *protein enrichment* of the nutrient substrate from germinated grain for breeding SFS. SCF proteins in terms of the amount of essential amino acids are almost as good as the “ideal” protein according to FAO/WHO. This raw material contains almost 2.0 times more water-soluble proteins than wheat flour, which is important, since it is the water-soluble proteins in the sourdoughs that are more quickly subjected to hydrolytic breakdown into peptides and amino acids necessary for the growth and development of fermentation microflora.

Grape pomace powder (GPP) was positioned in this case as a source of simple sugars, minerals and vitamins in the composition of the substrate for breeding SFS. It was found that in terms of sanitary and hygienic quality indicators, this raw material met the requirements of Sanitary rules and norms No. 0366-19 and TR CU 021/2011. It was found that *glucose* dominated in GPP, the mass fraction of which amounted to an average of 48.35% of the total amount of sugars, followed by fructose - 39.41%, then sucrose - 12.24%. At the same time, the mass fraction of mono- and disaccharides in varietal wheat flour did not exceed 10.42% of the total mass of carbohydrates, and in germinated grain - 21.40%. In terms of mineral and vitamin content, GPP significantly exceeds the comparison samples.

SFS was prepared in three variants: control (comparison sample) - on WF1 (100.0%); experiment 1 - first-grade wheat flour: SCF in a ratio of 50.0:50.0%, respectively; experiment 2 - sprouted grain: SCF: GPP in a ratio of 50:40:10, respectively, according to the technological cycle shown in Fig. 2.



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**Fig. 2. Technological cycle of breeding and reproduction of SFS:**

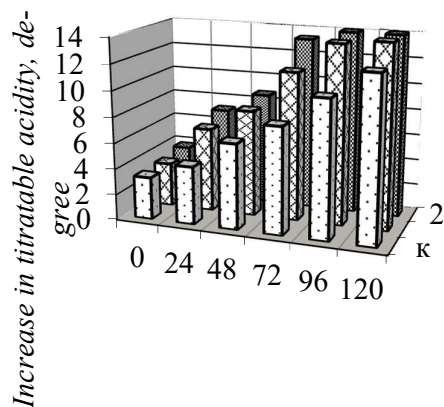
*W* – humidity of SFS, %;  $\tau$  – fermentation duration, h.;  
*t* – temperature, C; RC – resumption cycle.

Analysis of the chemical composition of the nutrient substrate of SFS (Table 3) showed that in experimental variant 1 the mass fraction of proteins, fats, mono- and disaccharides, fiber, exceeded similar indicators of WF1 on average by 2.3, 2.6, 1.6 and 2.0 times, in variant 2 - by 2.0, 3.6, 2.0 and 1.7 times, respectively. In variant 1, as expected, the mass fraction of proteins was higher than in variant 2 by almost 4.00% (abs.). At the same time, variant 2 was characterized by an increased content of mono- and disaccharides.

**Table 3.**  
**Chemical composition of the nutrient substrate for spontaneous fermentation sourdoughs for the main macronutrients**

Nutrients	Mass fraction of nutrients, in % per 100 g of dry matter of the mixture				
	Experiment on variants		Wheat flour 1 <sup>st</sup> grade (WF1)	$\pm\Delta$ , in % relative to WF1	
	1	2		Exp 1	Exp 2
Proteins	30.05	26.06	12.86 ± 0.4	+17.19	+13.20
Fats	6.06	6.08	1.68 ± 0.2	+4.38	+4.40
Mono- and disaccharides	13.00	16.54	8.20 ± 0.5	+4.80	+8.34
Fiber	10.80	9.63	5.65 ± 0.3	+5.15	+3.98
Dry matter	90.00	90.20	87.00	+3.00	+3.20

It was established that the most intensive process of acid formation was observed, as expected, in the 2<sup>nd</sup> variant, followed by the 1<sup>st</sup> variant, then the control (C) (Fig. 3).



Thus, according to this indicator, the sourdough in the control variant was ready for further use after 120 hours (12.5±0.2 degrees), in experimental variant 1 - after 96 hours (13.7±0.3 degrees), variant 2 - after 72 hours (13.3±0.1 degrees), that is, it was ready for further use 48 hours earlier than the control.

The lifting force of the studied SFS in the variants before kneading the dough averaged 24, 20 and 15 minutes, which characterizes them as a semi-finished product of the required quality (no more than 25 minutes for thick sourdough).

The analysis of the species and quantitative composition of the fermentation microflora in the studied SFS samples (Table 5) also confirmed the probability of reducing the process of hatching experimental sourdough samples by 24 and 48 hours, respectively. Upon reaching the ratio of bacteria and yeast recommended for wheat sourdoughs, close to 100:1, respectively.

**Table 4.**  
**Changes in the microbial landscape in the standard (control) and experimental variants of SFS during the breeding process**

No	Breeding period, hours	Total microbial count, (N×10 <sup>7</sup> ) CFU/g	Total yeast count, (N×10 <sup>7</sup> ) CFU/g	Ratio of bacteria (B) to yeast (Y), B:Y
Control				
1.	24	36.4	0.7	52:1
2.	48	151.2	2.4	63:1
3.	72	510.6	6.9	74:1
4.	96	626.4	7.2	87:1
5.	120	999.6	9.8	102:1
Experiment 1				
1.	24	43.2	0.8	54:1
2.	48	180.9	2.7	67:1
3.	72	615.6	7.6	81:1
4.	96	1081.5	10.5	103:1
5.	120	1311.0	11.4	115:1
Experiment 2				
1.	24	77.4	0.9	86:1
2.	48	518.4	4.8	108:1
3.	72	1512.5	12.5	121:1
4.	96	1715.2	13.4	128:1
5.	120	1690.0	13.0	130:1

Among all the tested samples of SFS, in terms of the intensity of acidification of the biomass of acid-forming and yeast microflora, as well as in terms of the rate of maturation of sourdoughs, variant 2 was recognized as the best.

Then a series of laboratory bread baking was carried out according to the method according to GOST 27669-88 with the addition of 25.0% of SFS to

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the mass of flour. The comparison sample was bread made on flour sourdough without additives. The quality of the bread was assessed by organoleptic and physicochemical indicators for compliance with the requirements of GOST 27842-88.

The baking data showed that the addition of the studied SFS to the dough in an amount of 25.0% of the recipe amount of flour, along with a positive effect on the maturation processes of the dough, allows getting finished products of improved quality. Thus, the products were distinguished by a sufficiently developed porosity structure, intense crust color, a clearly expressed pleasant taste and aroma. It should be noted that depending on the additive introduced, the bread crumb was colored in the corresponding color. According to organoleptic indicators, the experimental bread samples were recognized as the best (Table 5).

In products with experimental SFS, with the same proofing duration (~30 min.), an increase in bread porosity was found compared to the control by an average of 8.0% and the yield by 0.5% (relative to the control variant with SFS) and 1.5% (relative to the standard yield for varietal wheat bread). The experimental bread samples retained the main features characterizing the freshness of this product for up to 72 hours of storage, namely, crumbliness and swelling of the bread crumb.

**Table 5.**  
**The influence of SFS on the quality of bread made from first-grade yeast-free wheat flour**

Indicator	Values of bread quality indicators by variants		
	According to GOST 27842-88	Control	Experiment
Appearance			
- shape	Corresponding to bread shape, with a convex top crust		
- surface	Without large cracks and tears		
- color	From light yellow to dark brown		
Crumb condition:			
- well baked	Well baked,	Not baked enough,	Baked, not damp to the touch
- kneaded	not damp to the touch	slightly damp to the touch	
- kneaded	Without lumps and traces of under-kneading		
- porosity	Developed, without voids and compactions	Not sufficiently developed, uneven	Developed, pores are small and medium, thin-walled
Taste	Characteristic of this type of product, without foreign taste		With a pleasant sour taste

Humidity, %	No more than 45.0	44.5± 0.5	44.7± 0.5
Acidity of crumb, in degrees	No more than 3.0	2.8± 0.1	2.8± 0.2
Porosity, %	No less than 68.0	65.0±0.5	73.0±0.5
Yield, in %	133.0	134.0	134.5

**Conclusion.** Thereby, the feasibility of producing yeast-free bread for preventive and dietary nutrition for certain alimentary-dependent diseases and contraindications on spontaneous (natural) fermentation sourdoughs is substantiated. Replacing baking yeast or chemical dough leavening agents in the recipe for bread made from varietal wheat flour with spontaneous fermentation sourdoughs with minor adjustments to the process parameters will improve consumer properties, as well as extend the freshness period of these products, and expand the “healthy food” market segment. This determines the implementation of the priority areas of the development strategy of the Republic of Uzbekistan in the field of healthy nutrition of the population and food security, the economic component in terms of reducing the cost of production due to the creation of a waste-free technology for the complex processing of our own plant materials.

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