

## Methods Of Application Of Probiotic Bacterial Preparations In The Production Of Rye Bread

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**Abstract.** The issues of solving the problem of rye bread production in the conditions of medium and low-power enterprises operating in discrete mode are considered. Currently, there is an increasing trend to replace traditional rye bread varieties with their imitators, that is, products that resemble the corresponding rye bread varieties in appearance, smell and taste. Therefore, research aimed at developing technologies that do not require constant and continuous updating of starter cultures is becoming increasingly important. Special attention of researchers is currently being paid to ready-made pharmacological commercial bacterial preparations containing such types of bacteria as rye semi-finished products. The aim of the study was to develop a technology for the production of rye starter cultures for low-power enterprises with a discrete mode of operation using dry probiotic bacterial preparations for probiotic purposes. The objects of the study were probiotic biologically active food additives "Lactonorm-H" and "Bifidonorm-H" produced by LLC "Sog'lomliknektari" of the Republic of Uzbekistan, rye floured flour with normal autolytic activity ( $42.8 \pm 0.5\%$ ), semi-finished products (starter cultures, dough), bread developed according to current standards and technological instructions. The experimental part of the work was carried out in the laboratories of the Department of Food Technology of the Bukhara Institute of Engineering and Technology. The dependence of the influence of the quantity and methods of introducing pharmacological preparations of freeze-dried lactic acid bacteria on the biotechnological properties of starter cultures and dough, the quality of finished products is described. The research methods were used by traditional laboratories of food production enterprises. The effectiveness of special technological methods of preliminary preparation of probiotic preparations, namely activation in a flour nutrient medium to activate their vital activity and reduce the lag phase, is substantiated. In the production of rye bread varieties by a single-phase (without leaven) method, it is advisable to use natural acidifying additives from vegetable raw materials that can also enrich the nutrient medium with nutrients necessary for microorganisms. The authors consider it possible to use probiotic drugs in the production of rye bread varieties, especially in enterprises with discrete operating modes.

**Keywords:** lacto- and bifidobacteria, rye flour, sourdough, dough, bread, quality.

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### Introduction.

In modern conditions, due to the changed structure of bakery enterprises, medium- and low-capacity production (bakeries, workshops) with discrete modes of operation have become dominant. As a result, certain difficulties arose in the production of bread and bakery products according to previously accepted classical technologies. This problem is especially relevant in connection with the specifics of the production of rye bread on sourdough, which predetermine their regular and continuous updating due to the possible development of undesirable microflora (for example, spore aerobes) and, as a

consequence, peroxidation of starter cultures, that is, an increase in the content of volatile acids, especially in regions with a hot climate, which includes Uzbekistan [1, pp.46-47].

It should be noted that when the content of volatile acids in the amount of more than 30.0% of the total acid content in rye dough, the taste of bread will be sharply acidic even at a normal level of total titrated acidity [2]. In addition, the starter cultures at the stage of the breeding cycle must be periodically updated using "pure" cultures of lactic acid bacteria purchased in specialized centers, which creates certain difficulties especially for enterprises located in marginal territories of the republic. Therefore, the trend is currently increasing to replace traditional rye bread varieties with their imitators, that is, products that resemble the corresponding rye bread varieties in appearance, smell and taste. Imitation of rye custard breads, such as "Borodinsky", is especially popular. For example, this type of product is prepared with the addition of wheat flour, rye malt and sugar. But at the same time, the unique properties of traditional rye bread varieties are lost. However, this is a necessary measure, since it has already been noted that the traditional production technologies of the latter are not acceptable in enterprises with a discrete mode of operation.

#### **Materials and Methods.**

The aim of the study was to develop a technology for the production of rye starter cultures for low-power enterprises with a discrete mode of operation using dry probiotic bacterial preparations for probiotic purposes.

The objective of the study was to determine the possibility of using pharmacological preparations of freeze-dried lactic acid bacteria (hereinafter ICD) in the technology of preparing rye starter cultures without a preliminary breeding cycle and determining their optimal sowing doses.

The objects of the study were probiotic biologically active additives (hereinafter dietary supplements) to food "Lactonorm-H" (O'zDSt ISO 9001:2015) and "Bifidonorm-H" (O'zDSt ISO 9001:2015) produced by LLC "Sog'lomliknektari" of the Republic of Uzbekistan, rye floured flour with normal autolytic activity ( $42.8 \pm 0.5\%$ ), semi-finished products (starter cultures, dough), bread, developed according to current standards and technological instructions.

The experimental part of the work was carried out in the laboratories of the Department of Food Technology of the Bukhara Institute of Engineering and Technology.

Thick starter cultures were prepared from rye flour according to the traditional recipe and technology (Table.1,2) in accordance with the methodological recommendations described in the manuals [3; 4, pp.277-279], using pure cultures of starter microorganisms (TU 9383-006-11163857-97). Experimental samples of starter cultures were prepared using ready-made dry probiotic bacterial preparations.

**Table 1. Recipe and modes of the distribution cycle of rye sourdough**

(for 100 kg of flour)

Raw materials, semi-finished products and parameters of the technological process	Phases of the rye sourdough dispensing cycle		
	I	II	III
MBC starting culture, kg	1,04	-	-
Peeled rye flour, kg	2,36	3,50	8,80
Water, kg	2,60	1,50	6,20
Sourdough, kg	-	5,00	10,00
<b>Total</b>	<b>5,00</b>	<b>10,00</b>	<b>25,00</b>
Temperature, °C	26-28	26-28	26-28
Duration, h	16-18	4-6	4-6
Humidity, %	58-60	58-60	48-50
Final acidity, degrees	6-8	8-10	11-14
Lifting force, min.	-	-	18-25

**Table 2. Recipe and preparation modes of thick rye sourdough and dough**

Raw materials, semi-finished products and parameters of the technological process	Raw material consumption, kg	
	Leaven	Dough
Leaven	19,00	57,00
Peeled rye flour, including in sourdough for dough	22,00 -	67,00 33,00
Pressed yeast	0,10	-
Edible table salt	-	1,50
Water	16,00	По расчёту
Temperature, °C	25-28	28-30
Duration, h	3-4	1,5-2,0
Humidity, %	48-50	$W_{\text{хл.}} \pm 0,5-0,1$
Final acidity, degrees	12-14	9-13
Lifting force, min.	18-25	15-18

In industrial starter cultures, the activity of bacteria was determined by the intensity of acid accumulation (by the difference between the titrated final and initial acidity), reducing activity (by the time of bleaching of methylene blue color) and the duration of ripening according to the generally accepted methods described in the manual [12].

The developed starter cultures were used to make bread from peeled rye flour (GOST 31807-2018). The quality of the dough and bread was analyzed in terms of physicochemical and organoleptic

indicators [12]. The reliability of the data obtained was also confirmed by the repeated experiments.

### **Discussion.**

Rye breads, which are in high demand among consumers, are functional bakery products. Rye flour is characterized by a high content of essential amino acids, individual minerals and vitamins relative to wheat flour, it contains a large amount of high molecular weight pentosans - mucus. These substances, possessing high hydrophilicity, participate in the formation of the structural and mechanical properties of rye dough, help to improve the functioning of the gastrointestinal tract, adsorb and remove metabolic products and other exogenous harmful substances and toxicants from the body. Consequently, this type of product is very important in nutrition [5, p.71-85; 6, pp. 32-33].

The development and improvement of technologies for the preparation of rye bread varieties are devoted to the works of many authors: Afanasyeva O.V., Kazanskaya L.N. Bogatyreva T.G., Polandova R.D., Kuznetsova L.I., Matveeva I.V., S.Ya. Koryachkina, Belyavskaya I.G. and others [6, p. 32-33; 7, p. 19-21; 8, p. 1-10; 9, p. 9-12; 10, pp. 189-195; 11, p.110-126], mainly aimed at developing various types of biological starter cultures, studying the influence of various types and strains of IBC and yeast, as well as non-traditional raw materials on the quality of starter cultures.

One of the promising directions for the fortification of biotechnological and antagonistic properties of ferments is the use of modern pharmacological bacterial preparations and dietary supplements containing bacterial species characteristic of the microflora of rye semi-finished products. It has been established that the microflora of rye starter cultures is quite diverse and is represented by bacteria (cocci, spore- and non-spore-forming rods) and fungi (yeast, mold). The dominant species in it are lactic acid bacteria (hereinafter LAB) of the genus *Lactobacillus*: *L. plantarum*, *L. brevis*, *L. fermenti*, *L. leichmanii*, *L. buchneri* with the predominance of the first two species. Bacteria of the *L. plantarum* homofermentative group are more energetic acid-formers, produce more aromatic compounds, but less volatile di- and tricarboxylic acids, compared to strains of the *L. brevis* heteroenzymatic group. *L. fermenti* is quite common, and *L. casei* and *L. buchneri* are found in smaller quantities. For thick rye starter cultures, two types of lactic acid bacteria are specific - *L. brevis* and *L. plantarum*, which is obviously associated with the temperature regime of the thick starter cultures, which is close to the optimal development temperature for these types of bacteria. Liquid starter cultures in terms of the species composition of acid-forming bacteria differ little from thick ones. Among acid-forming bacteria in liquid starter cultures, the dominant species are *L. plantarum*, *L. casei*, *L. fermenti*, *L. brevis*, *L. buchneri* [2; 5, p. 195-200; 11, p. 120-122; 12, p.101-103].

Along with the main groups of bacteria and yeast, rye flour contains a certain amount of bacteria of the *Bact. coli* and *aerogenes* or closely related *Bacillus levans*, which, along with lactic acid, also form a significant amount of volatile acids and gases (hydrogen, nitrogen and carbon dioxide). Bacteria of the

genus *Streptococcus*, cells of the hay bacillus - *Bacillus subtilis*, and the indisputable herbal bacillus - *Erwiniahelbicola* were also found. However, these bacteria, introduced into the leaven during refreshing and into the dough when mixed with flour, are not specific for the leaven. With a continuous method of conducting starter cultures, they are suppressed and replaced by bacteria of the first two groups. The yeast of the genus *Saccharomyces* dominates in the starter cultures, namely *S. cerevisiae* with an optimal temperature of vital activity - 30 ° C and *S. minor* - 25 ° C; wild yeast; starter yeast (R-14). Microscopic fungi of the genera *Rhizopus*, *Aspergillus* and *Penicillium* were also found in rye flour) [11, p.120; 12, p. 850-860; 13, pp. 13-14].

The use of dry bacterial preparations containing microorganisms specific to rye semi-finished products will intensify and simplify the distribution cycle of the technological process for breeding starters, reduce the risks from accidents of spontaneous fermentation, ensure the stability of the ripening of semi-finished products and improve the quality of bread. Technologies have been developed for the preparation of liquid wheat starter cultures using modern bacterial preparations: "Lactobacterinsiccum" and "Bifidumbacterin" (*Bifidumbacterinsiccum*). The advantage of dry preparations is that they are easy to use and store [8, p.2-3; 14, p. 100-109; 15, p. 12-18; 16, pp.106-107].

Starter compositions have been developed for starter microorganisms with various strains of lacto- and bifidobacteria, which have special, probiotic and antagonistic properties for the production of rye and rye-wheat breads. Is not it. Kuznetsova and others [15, p. 32-33; 16, p. 106-107; 17, p.11-13] for the dispensing cycle of starter cultures used compositions (in dry and liquid form) of bifidobacteria, lactobacillus *L. sanfranciscensis* E-36, a new strain of *L. plantarum* 52-AN. A technology has been developed for the production of custard varieties of bread on saccharified brewing, fermentation and fermentation is performed with compositions of different types and strains of IBC and yeast: when using a thick starter culture, this composition consists of two types of lactic acid bacteria *L. plantarum* (strain 63), *L. brevis* (strains 5 and 68) and *S. minor* yeast (Chernorechensky strain). When using rye KMKZ, along with the above types of bacteria *L. plantarum* (strain 30), *L. brevis* (strain 1), the composition includes *L. casei* (strain 26) and *L. fermenti* (strain 34), and when using liquid rye starter culture without brewing - the aforementioned composition of lactobacilli is used in combination with a mixture of the yeast *S. cerevisiae* (strain L-1) and *S. minor* (strain Chernorechensky). To obtain a fermented thermophilic brew, a monoculture of *L. delbrückii* MKB (strain 76) is used, and for its fermentation, a monoculture of the yeast *S. cerevisiae* (strain L-1) is also used.

G.S. Kachmazov et al. [18, p. 34-37] in the production of kvass for the preparation of lactic acid sourdough, the technology of preparation of sourdough cultures for rye and rye-wheat bread was used with the use of commercial preparations of freeze-dried lactobacilli, bifidobacteria and a complex

preparation "Linex" in the distribution cycle ... It was found that microorganisms from these preparations are able to grow and multiply on a nutrient substrate from grain raw materials.

The presented technologies for the preparation of starter cultures provide for the use of bacterial preparations in a dispensing cycle according to a three-phase scheme, which predetermines the need for continuous renewal. However, it is practically impossible to implement this technology in low-capacity enterprises. There remains the possibility of obtaining ferments according to a simplified scheme, namely, rye flour spontaneously sour from natural (wild) microorganisms [19, p. 1009 - 1022], or the development of technologies for the production of production starter cultures without a dispensing cycle, which can either be updated if necessary, or one-time portions can be prepared depending on the needs of production.

### Result.

The investigated dietary supplement "Lactonorm-N" is a dry powder from the microbial mass of living antagonistically active microorganisms - heterofermentative lactobacilli *Laktobacillusfermentum* No. 231, obtained by lyophilization, whitish or beige in color. One dose of the drug contains at least  $10 \times 10^6$  live lyophilized lactobacilli. The optimum temperature for growth and maximum acidity accumulation is 35-40 ° C, pH 5.0-6.0 [20, p. 221-223; 21].

BAA "Bifidonorm-N" is a microbial mass of live, antagonistically active bifidobacteria strains *Bifidumbacteriumbifidum* No. 1, 791, lyophilized in a culture medium with the addition of a protective sucrose-gelatinous milk medium; crystalline or porous mass with possible stratification of biomass in the upper part, beige or whitish in color, with a specific odor. One dose of the drug contains at least  $10 \times 10^6$  live lyophilized bifidobacteria. The optimum temperature for growth and maximum acidity accumulation is 35-40 ° C, pH 6.0-7.0 [14, p.100-109; 22, pp. 44-61; 23, pp.76-79].

To determine the optimal dosage of the studied bacterial additives, studies were carried out to study the dynamics of the accumulation of LAB and yeast in refreshed starter cultures in the dispensing and production cycles after 8-fold renewal.

The research results are presented in table 3.

**Table 3. The content of bacteria and yeast in the refreshed starter cultures in the distribution and production cycles**

Speciescomposition microbiotastarterculture	The number of microorganisms in the leaven, $N \times 10^7$ CFU / g		
	Bacteria (B)	Yeast (D)	B:D
Basic starter culture (batching cycle)	1986,5	11,4	174,2:1,0
Production starter culture in the ripening process:			
initial	88,5	2,3	38,5:1,0

After 1 hour	174,8	3,8	46,0:1,0
2 hour	311,2	5,7	54,6:1,0
3 hour	481,5	7,4	65,0:1,0

According to O.V. Afanasyeva (SPb F GosNIIKhp), the ratio of yeast and bacteria in high-quality thick rye starter cultures is 1: 60 - 1: 80 [2]. Consequently, the starter culture we obtained meets these requirements.

Test samples of starter cultures were prepared using dry lacto- and bifidobacterin in a ratio of 4: 1 according to 4 options (Table 4):

1 - with the activation of bacteria and the addition of yeast (the dosage of yeast is reduced by 2 times relative to the prescription amount) in a shortened (one-phase) dispensing cycle for preparing a thick starter culture;

2 - with the activation of bacteria without the addition of yeast (with a 2-fold reduction in the dosage of yeast) and the use of a shortened (one-phase) dispensing cycle for preparing a thick starter culture;

3 - without activating bacteria and excluding the distribution cycle for preparing thick starter culture (dosage of yeast according to the original recipe);

4 - without activating bacteria and preparing the dough in a one-phase (without sourdough) method (with a 2-fold increase in the dosage of yeast).

When removing a thick starter culture weighing 5.0 kg, 4 doses of dry lacto- and 1 dose of dry bifidobacteria were poured with water (hydromodule 1:10) and kept for 10-15 minutes. Then this suspension was mixed with a nutrient mixture of 0.45 kg of flour and 0.5 l of water to adapt the bacteria to the flour environment. The activation was carried out for 4-5 hours at a temperature of 33-35 ° C. The activated mass and yeast suspension were mixed with flour and water until a homogeneous mass was obtained and left to ripen (option 1). The fermented starter culture after the dispensing cycle was introduced into the production starter culture.

In the 2nd variant, the starter cultures were prepared in the same way as in the 1st variant, while the yeast suspension was added directly to the dough.

In the third variant, non-activated dry bacterial preparations were simply diluted with water (hydromodule 1:10) at a temperature of  $40 \pm 1$  ° C and left for 15-20 minutes. This suspension was introduced directly into the production starter culture without a dispensing cycle.

**Table 4. Recipe and modes of preparation of rye starter culture with bacterial preparations**

(for 100 kg offlour)

Raw materials, semi-finished products and parameters of the technological process	Raw material consumption by options, kg									
	I				II			III		IV
	Activation		SCP	PSC	Activationbacteria	SCP	PSC	PSC	Dough	Dough
	bacteria	yeast								
Peeledryeflour, kg	2,50	0,50	10,00	22,00	2,50	10,50	22,00	33,00	-	100,0
Peeled rye flour, including in sourdough for dough	-	-	-	-	-	-	-	-	67,00	-
	-	-	-	-	-	-	-	-	33,00	-
Water	2,45	0,45	11,00	16,00	2,45	11,45	16,00	22,90	По расчёту	
Suspension of lacto- and bifidobacterin, dm <sup>3</sup>	0,05	-	-	-	0,05	-	-	1,00	-	2,00
Pressedyeast	-	0,05	-	-	-	0,05	-	0,10	-	0,20
Activatedlacto- andbifidobacterin	-	-	5,00	-	-	5,00	-	-	-	-
Activatedyeast	-	-	1,00	-	-	-	-	-	-	-
Starter culture of the previous phase (SCP)	-	-	-	19,00	-	-	19,00	-	-	-
Productionstarterculture (PSC)	-	-	-	-	-	-	-	-	57,00	-
Edibletablesalt	-	-	-	-	-	-	-	-	1,5	1,5
<b>Total</b>	<b>5,00</b>	<b>1,00</b>	<b>27,00</b>	<b>57,00</b>	<b>5,00</b>	<b>27,00</b>	<b>57,00</b>	<b>57,00</b>	-	
Temperature, °C	35-37	28-30	26-28	25-28	35-37	26-28	25-28	25-28	28-30	28-30



Duration, h	3-4	1-2	10-12	3-4	3-4	10-12	3-4	3-4	1,5-2,0	1,5-2,0
Humidity, %	58-60	58-60	48-50	48-50	58-60	48-50	48-50	48-50	$W_{x/n} \pm 0,5-0,1$	
Final acidity, degrees	4-5	-	11-12	12-14	4-5	11-12	12-14	12-14	9-13	9-13

At the same time, the dosage of the drug was increased 5 times, that is, to obtain a thick starter culture, 20 doses of lacto- and 5 doses of bifidobacteria were used (option 3).

When preparing the dough by the one-phase (without fermentation) method (option 4), we used dry bacterial preparations, previously dissolved in water, which were introduced directly into the dough. At the same time, the dosage of the drug was increased 10 times, that is, to prepare a dough from 100 kg of peeled rye flour, 40 doses of lacto- and 10 doses of bifidobacteria were used.

The influence of probiotic bacterial preparations on the quality of thick rye starter cultures was investigated. The research results are presented in table 5.

**Table 5. Influence of probiotic bacterial preparations on the quality of thick rye starter cultures**

Thenameofindicators	Values of quality indicators of the starter culture prepared according to the options			
	Control	I	II	III
Acidity, hail:				
initial	6,10	6,30	5,40	4,85
theultimate	11,70	12,00	10,20	9,23
Intensity of acid accumulation, degrees	5,60	5,70	4,80	4,38
Recoveryactivity, min	87	85	102	115
Ripeningduration, min.	180	180	180	180

From the data in Table 5, it follows that the quality indicators of the test samples of the production starter culture in the 1st option are closest to the control values; in the other versions, the starter cultures did not gain the necessary acidity in 180 minutes, therefore, an increase in the time for their ripening is necessary. Theresearchresultsarepresentedintable 5.

The influence of the studied starter cultures on the quality of bread made from peeled rye flour was judged by the results of a test laboratory baking. The finished product was analyzed 14 ... 16 hours after baking. The research results are presented in table 6.

**Table 6. Influence of the method of preparation of thick starter cultures with probiotic preparations of the starter culture on the biotechnological properties of the dough and the quality of bread from peeled rye flour**

Thenam eof indicators	Indicators of the quality of dough and bread, prepared according to options				
	Control	I	II	III	IV
Dough					
Humidity, %	49,40	49,50	49,60	49,40	49,50
Acidity, hail:					
initial	6,40	6,60	6,00	5,60	5,20
theultimate	11,00	11,20	10,70	10,20	9,80
pH	4,80	4,76	4,86	4,90	4,97
Gas generating capacity, cm <sup>3</sup> CO <sub>2</sub> /100 g:					
during ripening	156	156	150	136	132
for 1 hour of ripening	78	78	75	68	61
Mass fraction of alcohol,% DM	0,74	0,74	0,71	0,64	0,62
Mass fraction of volatile acids,% acetic acid	0,29	0,29	0,28	0,25	0,24
Bread					
Humidity, %	48,80	49,00	49,00	49,00	49,00
Acidity, hail	9,00	9,20	8,80	8,530	8,12
Пористость, %	60,40	60,42	60,14	56,50	54,00
Specific volume, cm <sup>3</sup> / g	1,68	1,68	1,65	1,39	1,34
Form stability (H:D)	0,42	0,42	0,40	0,37	0,29
Quality	good	good	good	satisfactory	unsatisfactory

It has been established that the improving effect of the leaven depends on the preparation method. The best quality bread was obtained using activated bacterial preparations. To obtain high-quality products in a shortened cycle, it is necessary to increase the duration of maturation of the dough, which is not economically profitable, or the use of natural acidifying additives - processed products of fruit and berry or vegetable raw materials, including secondary ones.

## **Conclusion.**

Thus, the complex of theoretical and experimental studies carried out confirms the feasibility of using modern pharmacological bacterial preparations and biologically active additives containing the types of bacteria characteristic of the microflora of rye semi-finished products for the production of rye breads in a discrete mode of operation of bakery enterprises.

As a result of the study, it was found that probiotic preparations affect the biotechnological properties of rye semi-finished products and, as a consequence, the quality of finished products. It is especially effective to use the studied additives in activated form or to use natural acidifying additives, which will reduce the consumption of yeast and enrich the environment with nutrients that are vital for microorganisms.

The fundamental difference between the technologies we offer from the existing developments on the use of bacterial preparations in the production of bread is that in that case they are used as starter cultures for the distribution cycle for the preparation of starter cultures. And in our case, it is proposed either to significantly shorten this cycle (one phase instead of the traditional three), or to exclude it altogether from the technological process of preparing rye and rye-wheat breads, since, unlike pure cultures of lactic acid bacteria, these preparations are in step availability in almost all pharmacies.

The use of this raw material in the production of rye bread is cost-effective, and research in this direction is relevant and timely.

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