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TECHNOLOGICAL PROCESS OF PREPARATION OF LIQUID YOURNESS UNDER DISCRETE OPERATING CONDITIONS OF BAKERY ENTERPRISES

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B.N.Amanov, H.B.Ergasheva, O.R.Qurbonov, D.R.Jabborova
Bukhara State Technical University
Bukhara, Uzbekistan
Bobbi.0727@mail.ru

Abstract

The traditional technology for preparing this bread with liquid sourdough with the brewing of part of the flour provides for its regular renewal in the production cycle with continuous operation of bakery enterprises. A study of the work of enterprises in modern conditions has shown that bread production can be carried out around the clock or with various technological breaks. This causes a discrete operating mode and is reflected in the operating schedule of the furnaces, and consequently in the entire production cycle.

Keywords

bread, discrete mode, liquid sourdough, bakery enterprises.

Currently, this figure is about 160 g, while previously it reached 500. As a result, there was a decrease in total production by an average of 26%. However, bread made from rye flour and its mixture with wheat remains in demand, the production of which varies slightly. The operating mode of modern enterprises depends mainly on orders from trade organizations for bread, which are unstable and fluctuate significantly during the week. The current trend continues throughout the year and is typical for all enterprises. At the same time, it is necessary to take into account the specifics of bread consumption, which requires the organization of daily production, regardless of the volume of requests received, since the consumer prefers freshly baked products [1,2,3,4].

Thus, a contradiction arose between the discrete mode of bread production and the need to implement a continuous technological cycle for preparing liquid sourdough using traditional technology [4,5]. Therefore, comprehensive research was carried out to develop a technology for preparing liquid sourdough in various operating conditions of modern bakery enterprises, ensuring the stability of its biotechnological properties and obtaining it in the required quantity[6,7,8].

When the volume of output changes or a technological interruption in the operation of bakery ovens, it becomes necessary to change the traditional ratio of components included in the semi-finished product, such as the liquid starter of the previous preparation and the nutrient mixture (50:50), towards increasing either the liquid starter or the nutrient mixture. This is accompanied by a change in the technological parameters of preparing the semi-finished product in a fairly wide range[9,10,11,12].

To establish the influence of technological parameters on the process of preparing liquid starter, the biotechnological properties of the semi-finished product were studied under conditions of an unstable preparation regime. The research results showed that fluctuations in technological parameters lead to changes in the quantitative composition of yeast and lactic acid bacteria cultivated in liquid starter[13,14]. Thus, a decrease in the duration of fermentation and temperature, an increase in the amount of tea leaves in the nutrient mixture and the duration of saccharification of the tea leaves led to a decrease in the ratio between yeast and lactic acid bacteria to 1:8. When these factors changed in the opposite direction, the ratio increased to 1:19. It should be noted that, despite individual changes in technological parameters, the recommended ratio between cultivated microorganisms, which should be 1:18–1:30, is not achieved. In addition, the presence of unusual yeast Saccharomyces was observed in the mass of the liquid starter. minor in amounts up to 35%. This development of microorganisms causes changes in the processes of acid accumulation and gas formation, the dynamics of which can be assessed by the acidity and lifting force of the liquid starter. Significant instability of these indicators was observed: the acidity of the semi-finished product ranged from 9.4 to 14.2 degrees, and the lifting force from 20 to 38 minutes. Using such a semi-finished product in the dough preparation process , there is a need to quickly adjust its properties, which requires certain qualifications of production personnel [15,16,17].

It is worth noting that the fluctuation of technological parameters in the conditions of discrete operating mode of bakery enterprises occurs constantly, and does not have a unified system, but at the same time it is necessary[18,19,20]. The choice of optimal technological parameters in a wide range should ensure not only the stability of the biotechnological properties of the liquid starter, but also its production in the required quantity, ensuring the fulfillment of requests from trade organizations for bread, while eliminating the influence of currently existing subjective factors based only on experience and qualifications of production personnel [21,22,23].

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One of these technological parameters is the amount of nutrient mixture used in the preparation of liquid starter in the production cycle, which, as has been established, under unstable operating conditions of the starter compartment can vary from 10 to 90%.

The nutrient mixture is a source of sugars fermented by cultivated microorganisms, and largely ensures the efficiency of the process of acid accumulation and gas formation during fermentation of liquid starter [24,25,26].

The results of the studies showed that when using a nutrient mixture in an amount of 40 to 60%, the dynamics are linear and complete, which indirectly indicates the symbiotic development of yeast and lactic acid bacteria. A decrease in the amount of the nutrient mixture of less than 40% and an increase of more than 60% significantly changes the dynamics of sugar fermentation, which indicates a disruption in the development of cultivated microorganisms [27,28].

At the next stage of research, the composition of the nutrient mixture with the optimal content of fermentable sugars, which is ensured by the amount of tea leaves added to it, was determined. For this purpose, a nutrient mixture was prepared containing tea leaves in an amount from 5 to 35% of the weight of the nutrient mixture in increments of 5% with a saccharification duration of 0 to 120 minutes, and their permissible ranges of variation were determined. Based on the research conducted, recommendations for the composition of the nutritional mixture were developed, presented in Table 1.

Table 1. Recommendations for the composition of the nutrient mixture used for preparing liquid sourdough under discrete operating conditions in bakery enterprises

Amount of infusion, % by weight of the nutrient mixture	Duration saccharification of tea leaves, min
5	up to 60
10	up to 30
15–30	up to 15
35	without saccharification

The fermentation temperature has a significant influence on the biotechnological properties of liquid starter, in particular on the qualitative composition of microorganisms [29]. The vital activity of individual types of microorganisms was studied, in particular the ratio between individual representatives of lactic acid bacteria and the number of dead yeast cells, in the

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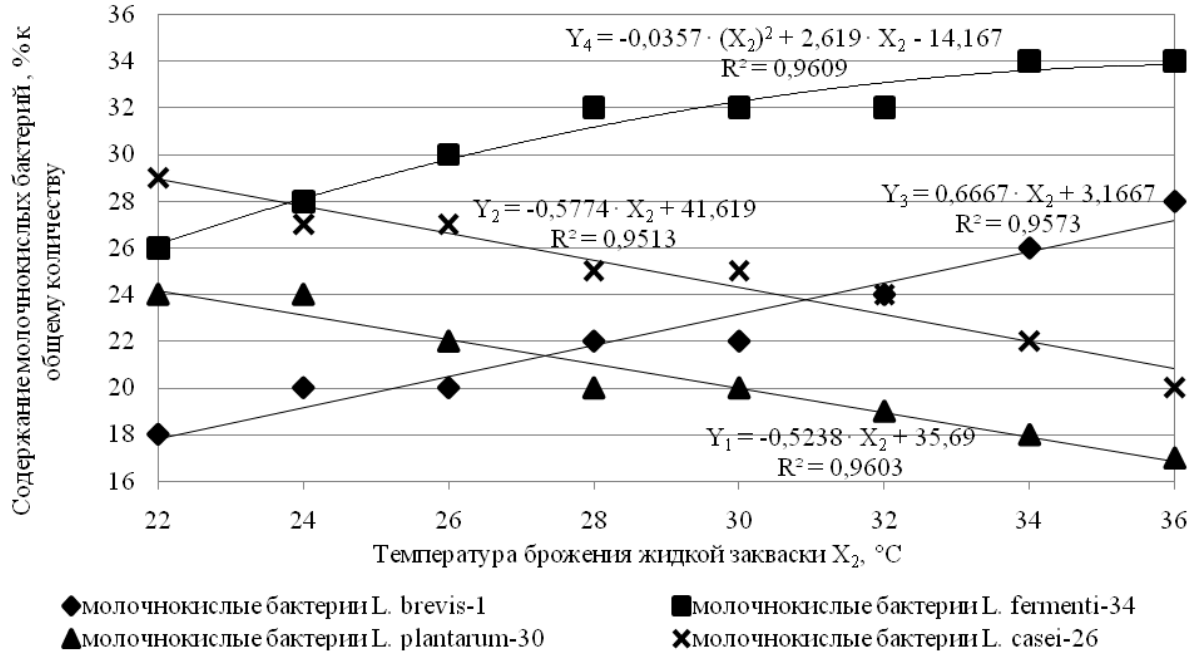
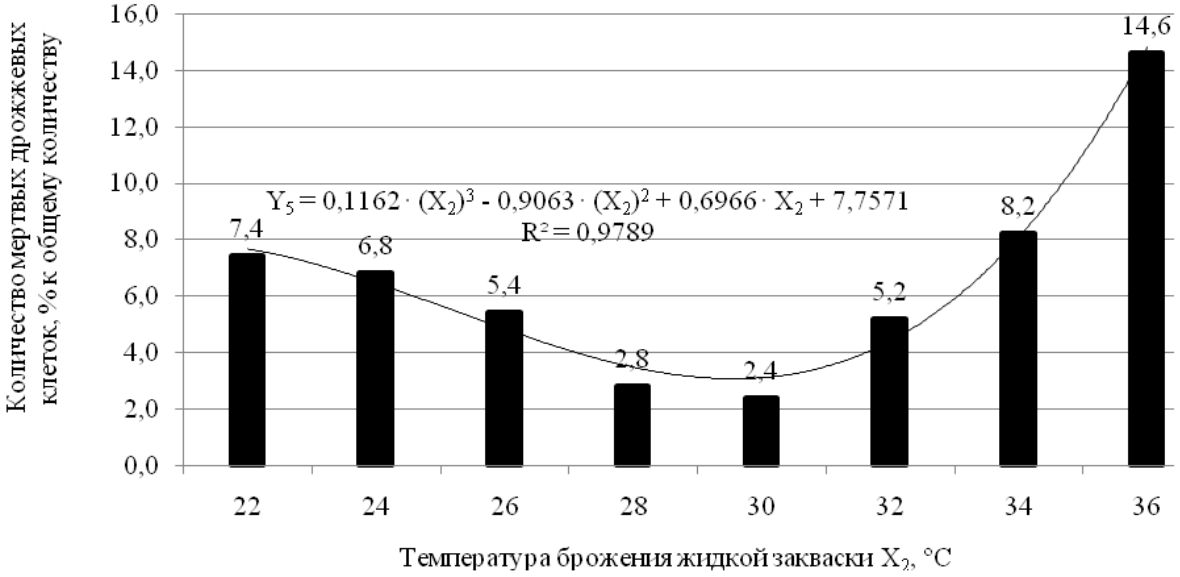
fermentation temperature range of liquid sourdough from 22 to 36 °C. The research results are presented in Figures 1 and 2.



Rice. 1. Qualitative composition of lactic acid bacteria



Rice. 2. Number of dead yeast cells

Analyzing the research results, we can say that varying the temperature in the range of 22–36 °C leads to disruption between individual representatives of lactic acid bacteria and leads to an increase in the number of dead yeast cells. It has been established that the optimal temperature should be considered 28–30 °C , which ensures the development of lactic acid bacteria in the optimal percentage (20% - L. plantarum-30, 25% - L. casei-26, 22% - L. brevis-1, 32 % – L. fermenti-34) and the permissible content of dead yeast cells (no more than 5.0% of the total) [4]. That is,

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deviation from the recommendations of technological instructions when preparing liquid sourdough in a discrete mode of operation of bakery enterprises in order to slow down or speed up the production cycle of its production is not acceptable [30,31,32,33].

It should be taken into account that the preparation of liquid starter in the production cycle is determined not only by technological parameters that ensure the stability of its biotechnological properties, but also by its constantly changing quantity, which depends on the variability of requests from trade organizations for products and on such factors as bread yield, mass fraction of flour moisture, duration of operation of the enterprise and others. As a result of the analysis of the interaction of the listed factors in the course of research, equation (5) was obtained, which makes it possible to establish the amount of liquid starter with stable biotechnological properties at each stage of its preparation in the production cycle, depending on the specific operating conditions of enterprises.

$$Y_6 = (65{,}094 - 8{,}083 \cdot X_3 + 0{,}203 \cdot X_1 + 47{,}319 \cdot X_2 - 0{,}104 \cdot (X_3)^2 + 0{,}048 \cdot X_3 \cdot X_1) \cdot 10^6, \quad (1)$$

$$Y_7 = 3{,}5744 - 0{,}015 \cdot X_3 + 0{,}010 \cdot X_1 + 0{,}176 \cdot X_2, \quad (2)$$

$$Y_8 = (67{,}608 - 0{,}244 \cdot X_3 - 0{,}065 \cdot X_1 - 0{,}009 \cdot (X_3)^2 + 0{,}003 \cdot X_3 \cdot X_1) \cdot 10^6, \quad (3)$$

$$Y_9 = 37{,}372 + 0{,}337 \cdot X_3 + 0{,}034 \cdot X_1 + 0{,}005 \cdot (X_3)^2 - 0{,}002 \cdot X_3 \cdot X_1, \quad (4)$$

$$Y_{10} = \frac{P \cdot \sum_{i=1}^{n} \left(\frac{Z_{2i}}{B_{xi}}\right) \cdot K \cdot \prod_{j=1}^{m} \left(1 + \left(\frac{100 - X_{3j}}{X_{3j}}\right)\right)}{\frac{T \cdot 60}{X_1} + 1}, \quad (5)$$

where Y_6 is the total number of lactic acid bacteria, units /g; Y_7 – acidity, degrees; Y_8 – total amount of yeast, units /g; Y_9 – lift force, min; Y_{10} – amount of liquid starter at the preparation stage in the production cycle, l; X_1 – duration of fermentation of liquid starter, min; X_2 – fermentation temperature, °C; X_3 – amount of nutrient mixture, % by weight of liquid starter; P – the amount of flour added to the dough with liquid leaven, % of the total amount of flour according to the unified recipe; i – number of types of bread made from rye flour and its mixture with wheat; Z_{2i} – application of trade organizations for the i- th name of bread made from rye flour and its mixture with wheat for the next day, kg; B_{xi} – the value of the planned or actual output of the i- th name of bread from rye flour and its mixture with wheat, %; K – coefficient taking into account the mass fraction of flour moisture W_m, %, the mass fraction of moisture of liquid leaven W_z, %, and its density ρ_z, kg/l ($K = (100 - W_m)/((100 - W_z) \cdot \rho_3)$; j – number of stages of

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preparation of liquid starter; T – duration of operation of the enterprise, hours [34,35,36,37].

For the purpose of rapid calculation in practical application, equation (5) was processed in the Microsoft software application Excel [38,39]. The result of software processing is the work plan of the starter department (Figure 3), which reflects the duration of preparation of the liquid starter, the amount of nutrient mixture introduced during its preparation, and the distribution of the liquid starter among the production containers involved in the technological process.

План работы заквасочного отделения 3/16		ВАРИАНТ 1					
Дата составления плана	Время возобновление жидкой ржаной закваски	Gзакв. пред., л / Gпс, л Емкость 1	Gзакв. пред., л / Gпс, л Емкость 2	Gзакв. пред., л / Gпс, л Емкость 3	Gзакв. пред., л / Gпс, л Емкость 4	Gзакв.т. (в расходную емкость), л	Рекомендуемое соотношение, % Gзакв. пред. / Gпс
10.03.2014	16.00	280 / 260	280 / 260	280 / 260	280 / 260	1030	52 / 48
	19.00	280 / 250	280 / 250	280 / 250	280 / 250	1030	53 / 47
	22.00	270 / 230	270 / 230	270 / 230	270 / 230	1030	54 / 46
	01.00	250 / 200	250 / 200	250 / 200	250 / 200	1030	56 / 44
	04.00	190 / 130	190 / 130	190 / 130	190 / 130	1030	59 / 41
	07.00	60 / 60	60 / 60	60 / 60	60 / 60	1030	50 / 50
	10.00	120 / 140	120 / 140	120 / 140	120 / 140		46 / 54
	13.00	260 / 260	260 / 260	260 / 260	260 / 260		50 / 50
11.03.2014	16.00	260 / 260	260 / 260	260 / 260	260 / 260		

Rice. 3. Work plan for the starter department

When implementing the work plan for the starter department according to the option shown in Figure 5, the biotechnological properties of the liquid starter were studied under production conditions: the total number of microorganisms and their qualitative composition, technological indicators [40,41,42]. The results of the studies showed that the preparation of liquid starter under the proposed conditions makes it possible to stabilize the ratio between cultivated microorganisms, eliminate the presence of unusual microbiological cultures in the semi-finished product, stabilize the acidity and lifting force at the level of 11.8 ± 0.2 degrees. and 26±2 min, respectively, which is consistent with the recommendations of the technological instructions [43,44,45].

The optimal ranges for varying the amount of the nutrient mixture used in the preparation of the liquid starter (40–60% by weight of the liquid starter), and the duration of saccharification of the tea leaves included in the nutrient mixture (up to 60 minutes), duration (180–300 minutes) and temperature were determined (28–30 °C) fermentation of liquid sourdough. Equations have been obtained that make it possible to predict the biotechnological properties of liquid sourdough and obtain it in the required quantity under discrete operating conditions of bakery enterprises [46,47].

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