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IMPROVING THE TECHNOLOGY OF YEAST DOUGH MADE IN AN ACCELERATED WAY

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INTRODUCTION

Studies of modern technologies of yeast products have confirmed that the main problem is the need to reduce the consumption of all types of resources through the use of accelerated dough methods. Accelerated technologies make it possible to set up the production of a wide range of products at small-capacity enterprises, such as: mini-bakeries, flour shops at supermarkets and restaurant enterprises (RE). However, today the reduction of the technological process occurs, as a rule, due to the use of artificial food additives, the negative impact of which on the health of the population is confirmed by many clinical studies[1]. One of the ways to solve the problem is to improve the technological process for the production of yeast dough through the development of accelerated technologies using natural plant materials instead of artificial improvers[2,3,4].

An analysis of the chemical composition of secondary products of potato processing (SPPP) indicates that they include a complex of substances that make it possible to improve the parameters of the technological process and reduce the consumption of the main raw material. Due to the adjustment of the chemical composition of the SPPP by the methods of low-temperature processing, it is possible to control the processes that occur during the maturation of the yeast dough. The development of technology for additives from SPPP will also partly solve the problem of non-waste processing of potatoes.

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The relevance of the work is due to the need to create an accelerated technology for yeast dough by using an additive from SPPP as a source of easily digestible sugars, which makes it possible to speed up the technological process of dough formation due to the preliminary activation of yeast. The use of an additive from SPPP in the technology of products made from yeast dough will make it possible to rationally use raw materials, but also to create an accelerated technology for yeast dough without the use of hazardous substances.

1. Scientific and practical aspects of producing semi-finished products from yeast dough by accelerated method

1.1. Modern ways to improve the technological process for the production of products from yeast dough

In the practice of world bakery production in economically developed countries, the introduction of new intensive technologies focused on small-capacity bakeries and mini-bakeries is gaining increasing development. These technologies are more flexible than traditional ones, allow to quickly respond to market requirements in satisfying the population with fresh products, create bakeries and mini-bakeries with a reduced technological cycle[5]. Consequently, bakeries and mini-bakeries have a number of advantages over large bakeries: production mobility; timely provision of consumers with fresh and even hot products; reduction of transportation, which allows to reduce the cost of production, increase its microbiological safety, etc.; a combination of production and sales of products that increase the popularity of the institution (a bakery with a shop, a restaurant, a cafe) [6]. The most relevant in the technologies of yeast products in small bakeries working in one shift are accelerated dough methods[7]. The essence of accelerated dough preparation methods lies in the intensification of microbiological, biochemical and colloidal processes that occur during dough maturation [8,9,10].

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The longest process of the entire technological cycle for the production of yeast dough is the ripening process. The ripening process can be accelerated by the use of food additives or various methods of activating baker's yeast.

The main requirements for additives are their low cost and manufacturability (the additive must be easily introduced into the recipe mixture and evenly distributed in the dough). A promising direction in the development of technologies for products made from yeast dough is the use of low-value secondary raw materials of plant and animal origin, which is a source of enrichment of the nutritional and biological value of products, and also contributes to the intensification of yeast fermentation.

1.2. Analysis of ways to activate the yeast environment

The longest process of the entire technological cycle for the production of yeast dough is the ripening process. It is possible to speed up the ripening process of almost all types of dough through the use of food additives[11,12] or various methods of activating baker's yeast.

Enzymatic systems of energy metabolism of pressed yeast are adapted to the aerobic-sucrose environment and are not very suitable for the anaerobic-maltose environment of wheat dough. To adapt to a floury environment in order to restructure the energy metabolism of yeast from the respiration process to the fermentation process and enhance the synthesis of fermentation enzymes, it is recommended to introduce an additional operation into the technological process - preliminary activation of yeast[13].

In the technological practice of yeast dough production, there are chemical and physical methods of activating yeast cells.

For example, there is a known method for preparing dough using plasma-chemically activated aqueous solutions[14]. Scientific school of Dr. T. Lebedenko has been carried out a number of studies on the

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development of new and improvement of existing wheat bread technologies[15,16].

V. Drobot et al.[17] proposed a method for activating a yeast suspension by discrete-pulse introduction of energy for (9…11)•60 s. It has been found that this method of yeast pre-treatment improves the dough lifting strength, as well as the zymase and maltase activity of the yeast.

A method is known for activating yeast dough, which involves keeping yeast in an aqueous solution of xampan microbial polysaccharide, taken in an amount of 0.05-0.15% by weight of flour, at a temperature of 35 ºC for 40-60 s. Polysaccharides of plant and microbial origin contribute to the improvement of the physicochemical and rheological properties of the dough, an increase in the yield of products and a slowdown in the processes of staleness are observed [18].

E. Safonova et al.[19] proposed a method for producing yeast dough, including the activation of yeast in a water-flour-yeast suspension based on barley flour, which is kept for (30…35)•60 s at a temperature of 18…25ºC. The technological effect is to reduce the dough fermentation time by 20-40%, increase the manufacturability of the process and improve the porosity of finished products.

A known method for activating yeast dough involves keeping yeast in an aqueous solution of microbial xampan polysaccharide, taken in an amount of 0.05-0.15% by weight of flour, at a temperature of 35^0C for 40-60 s. Polysaccharides of plant and microbial origin contribute to the improvement of the physicochemical and rheological properties of the

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dough, an increase in the yield of products and a slowdown in the processes of staleness are observed [20,21.,22,23].

2. Object, materials and methods of research

2.1. Objects and materials of research

During the theoretical and experimental work, the production technology for the production of yeast dough using DPA obtained from SPPP was considered as the main object of research.

Within the framework of this object, the following basic materials were used: wheat flour according to DSTU 46.004-99, baker's yeast pressed according to GOST 171-81, drinking water according to DSanPiN 2.2.4-171-10, white crystalline sugar according to DSTU 4623:2006, aslt according to DSTU 3583-97, cooking fat according to GOST 28414-89, dry egg powder according to GOST 30363-96, Secondary products of potato processing were obtained at potato storage facilities in Kyiv, dry potato additive the laboratory. The objects of research were: dry potato additive, model systems containing dry potato additive in different ratios; yeast semi-finished product is made in an accelerated way. The organizational aspects of the scientific work consisted in conducting a series of studies aimed at studying the characteristics of the initial components, selecting rational ratios of prescription components, organoleptic, physicochemical, structural and mechanical properties, technological indicators of the semi-finished product and products based on it, establishing the possibility of practical use of the developed technology in working conditions

2.2. Research methods

Studies of the organoleptic, physicochemical and microbiological characteristics of model systems, semi-finished products and culinary products were carried out using modern methods according to standard methods using appropriate instruments. The selection of samples and their

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preparation for research was carried out according to the standard method. Yeast zymase and maltase activity was determined according to the standard method and expressed in minutes, which was spent to release 10 cm^3 of carbon dioxide during fermentation of 5% glucose or maltose solution. Counting the number of yeast cells – using the Goryaev camera. Experimental studies of SPPP drying were carried out by the radiation method in a thin fixed layer on a fluoroplastic surface, which ensures that the product does not stick to the plate surface. The final moisture content of DPA was determined by drying to constant weight using a drying cabinet SNOL 3.5.3.5.3.5/3.5 I2. The study of the fractional composition of sugars in SPPP was carried out by the spectropolarimetric method. Determination of the lifting force of yeast dough samples was carried out by an accelerated method according to the standard method. The quantity and quality of gluten were determined according to GOST 27839-88, the physical properties of gluten were studied on a ВДК-1device. When selecting samples and preparing them for research, let's guide by the requirements of the current DSTU.

2.3. Processing of research results

The results of experimental studies were subjected to statistical processing by the method of minimum squares to determine the error of the data obtained. For the series of each experiment, the average value of the indicator was calculated using the formula:

$$\overline{\mathrm{Y}} = \left[\sum_{i=1}^{k} N_i \times \mathrm{Y}_i \right] \div N \,, \tag{2.1}$$

where Ỳ – arithmetic mean of the result; Y_i – value of the result in each experiment; N – the number of parallel experiments.

Next, the dispersions of the arithmetic mean value of the result S^2 were evaluated for each series of experiments according to the formula:

$$S^2 = \left[\sum_{i=1}^{N} (Y_i - Y)^2 \right] \div (N-1), \tag{2.2}$$

The research results were processed by the methods of mathematical statistics using a PC.

3. Substantiation of technological parameters obtaining dry potato additive from secondary products of potato raw processing

3.1. Substantiation of technological parameters for the preparation and processing of secondary products of potato processing

The working hypothesis of this work involves the development of an accelerated technology for semi-finished yeast products by adding SPPP into the recipe in order to intensify the technological process of their production. In fig. 3.1, a model of the technological process for obtaining DPA from SPPP is proposed, which determines the strategy for further research.

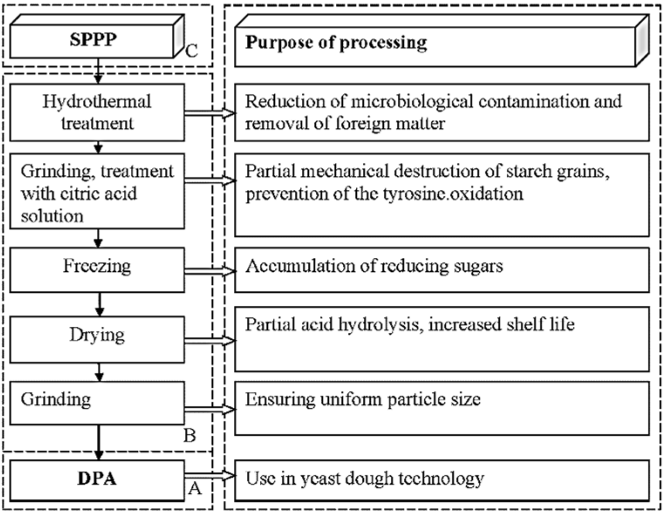

Fig. 3.1 Model of the technological process for obtaining DPA from SPPP

The above model provides for: the use of SPPP (subsystem C), which makes it possible to rationally use secondary raw materials, as well as the development of a fundamentally new technology for obtaining a sweetener from starch-containing raw materials. Subsystem B includes the substantiation and regulation of the course of the technological process for obtaining DPA. Subsystem A determines the possibility of using SHD in the production of yeast dough when extracting part of the sugar from the recipe. After previous studies on the establishment of rational modes for obtaining DPA from SPPP [24,25,26], the technological scheme for obtaining a dry potato additive received the following form (Fig. 3.2)

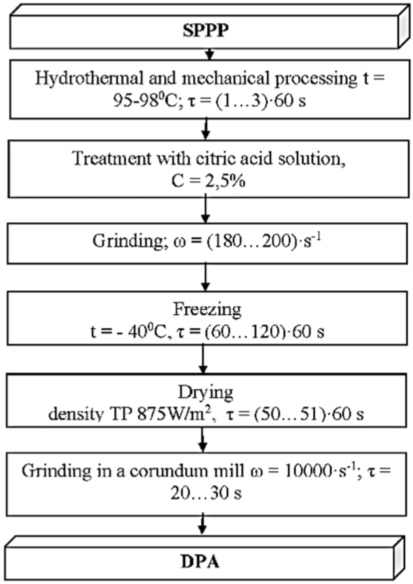

Fig. 3.2 Scheme of the technological process for obtaining DPA from SPPP

Also, on the basis of previous studies[27], the DPA effect on the parameters of pre-activation of yeast was substantiated. The analysis of the obtained results showed that the DPA addition into the activation medium makes it possible to reduce the lag phase to 1 hour, that is, the adaptation of yeast cells in the presence of the additive occurs much more intensively. The average

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specific yeast growth rate for the "yeast: water: DPA" sample is 0.45…0.46•60^{s-1}, for the "yeast: water: sugar" sample – 0.36…0.37•$60s^{-1}$, for "yeast: water: flour" sample – 0.24...0.25•$60s^{-1}$and for the "yeast: water" sample – 0.16...0.17•$60s^{-1}$. The stimulating effect of DPA can be explained by the presence of simple sugars in the composition.

3.2. Study of the chemical composition of dry potato additive

The next stage of research was the study of the general chemical composition of DPA. Conducted experimental studies have established the content of moisture, starch, reducing sugars and minerals. Table 3.1 shows the chemical composition of DPA.

Table 3.1

Chemical composition of DPA after drying (X±m, m ≤0,05)

Name of indicators	The content of the DPA constituent substances after drying
Humidity, %	12,0
Ash, %	1,15
Starch, %	8,0
Dextrins, %	0,1
Reducing sugars (%), including:	5,0
Sucrose	0,04
Glucose	1,52
Fructose	1,47
Maltose	2,04
Protein (%), including:	7,26
Valine	0,24
Isoleucine	0,06
Leucine	0,15
Lysine	0,16
Threonine	0,24
Cystine + glycine	0,36
Phenylalanine + tyrosine	0,27
Arginine	0,54
Minerals (mg/100 g), including:	
Calcium	10,02
Potassium	568,24
Magnesium	23,07
Sodium	28,12
Phosphorus	58,09
Ferum mcg/100 g	887,31
Zinc mcg/100 g	357,31
Manganese, mcg/kg	154,36
Copper, µg/kg	170,24
Cobalt, mcg/kg	5,36

The results of studies of the DPA chemical composition showed that the resulting additive contains sugars in its compound, the most specific weight of which is glucose, fructose and maltose. It is known that proteins significantly improve the vital activity of yeast cells; studies of the DPA amino acid composition indicate that the additive contains amino acids necessary for the metabolism of yeast cells[28].

It should be noted that the presence of amino acids in the yeast preactivation medium will promote the process of reproduction and budding of yeast[29].

Also, studies of the DPA mineral composition proved that the resulting product contains such biogenic substances as K, Ca, P, which affect the metabolism of yeast cells, as well as Zn, Cu, Co, Fe, Mn, etc., necessary for growth.

4. Influence of dry potato additive on the technological process of yeast dough production and investigation of its quality

4.1. Study of the effect of dry potato additive on the biotechnological properties of baking yeast Saccharomyces cerevisiae

An important technological significance in the production of yeast dough is the quality of the used baking yeast Saccharomyces cerevisiae. The effectiveness of the DPA influence on the dynamics of growth and reproduction of baker's yeast was carried out by determining the total amount of yeast using the microbiological method. The studies were carried out on four model systems (Figure 4.1): “yeast: water”, “yeast: water: sugar”, “yeast: water: DPA” and “yeast: water: flour”. The concentration of sugar, flour, and DPA in a solution of yeast with water was 1:5 according to[30].

The analysis of the obtained results shows that the DPA addition into the activation medium makes it possible to reduce the lag phase to 1×60^2 s, i.e., the adaptation of yeast cells in the presence of the additive occurs more intensively than in samples of the yeast medium with sugar and flour. In addition, the DPA presence makes it possible to increase the rate of cell reproduction compared to other samples during their logarithmic growth. The stimulating effect of DPA can be explained by the presence of simple

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[30] Шестаков С. Д., Волохова Т. П. Новая эффективная технология активации хлебопекарных дрожжей. Хлебопечение России. 2000. № 6. С. 33–34.

sugars – fructose and glucose, as well as a sufficient amount of maltose. First, the yeast ferments simple sugars, and then changes to maltose fermentation already during the pre-activation period, which has a positive effect on the intensification of the gas formation process when all dough components are combined [31].

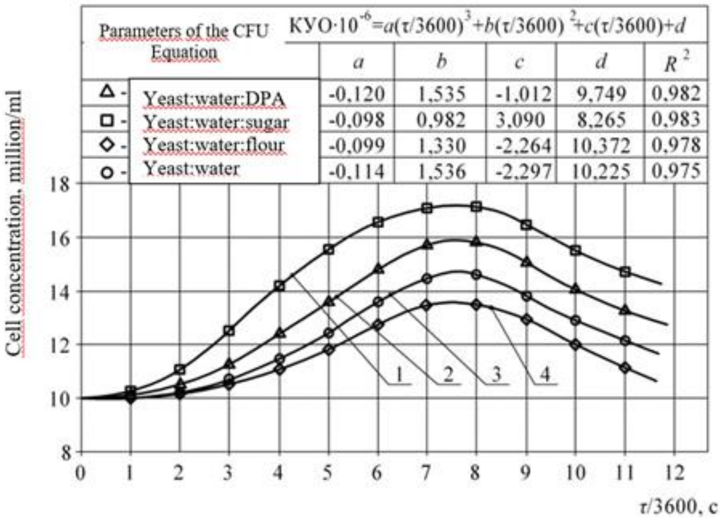

Fig. 4.1 Dynamics of reproduction of yeast cells depending on the type of nutrient medium

Based on the results obtained above, it is also possible to envisage an improvement in the indicators of winter activity. But, along with glucose, yeast dough also contains maltose, which, as it is known, is not directly absorbed by yeast, but is converted into glucose with the help of the fermentation enzyme produced by yeast, maltase (α-glucosidase).

The intensity of the energy metabolism of activated yeast was assessed by the rate of fermentation of hydrogen solutions of glucose and maltose, Fig. 4.2. The DPA concentration was varied as a percentage of the flour mass; yeast with sugar was used as a control sample.

[31] Exploring the effect of dry protein-carbohydrate semi-finished product on the structural-mechanical properties of yeast dough obtained by the accelerated technique / S. Popova et. al. // Eastern-European Journal of Enterprise Technologies. 2016. Vol. 5, Issue 11 (83). P. 39–45. doi: 10.15587/1729-4061.2016.81212

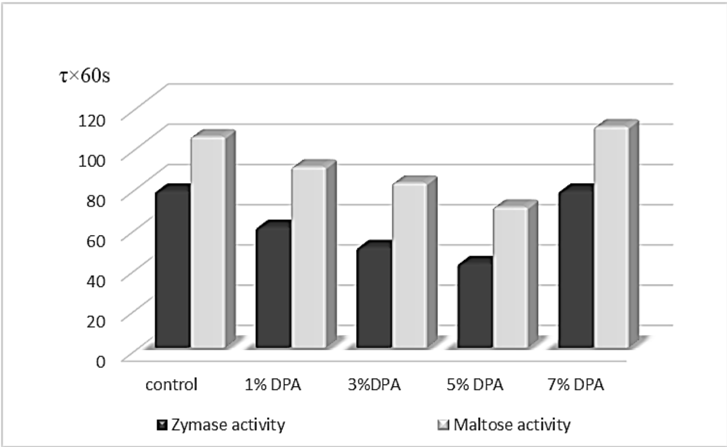

Fig. 4.2. Dynamics of dependence of winter and maltase activity on the DPA concentration

Analysis of the data obtained indicates that the zymase activity of the studied samples with a concentration of DPA 1; 3 and 5% improves by 16; 29 and 35%, respectively, and maltase – by 13; 21 and 32%, respectively, compared to the control sample. It should be noted that an increase in the concentration of DPA to 7% negatively affects the vital activity of yeast cells. This occurs due to an increase in the viscosity of the activation medium, as well as a high concentration of acid contained in the additive, which, in turn, contributes to the inhibition of the process of activation of the yeast enzyme system.

Therefore, the obtained results indicate that the DPA addition at a concentration of 5% to the flour mass improves the lifting power of the dough and accelerates the time of the first rise, in contrast to the control sample. This aspect makes it possible to predict the reduction in the time of the technological process of dough proofing, as well as the extraction from the prescription sugar.

4.2. Study of the functional and technological properties of the semi-finished product

Assessment of the state and properties of gluten dough using dry potato additive.

The leading role in the formation of wheat dough belongs to the protein substances of flour and starch, which can swell in the presence of water. However, these flour components have different water absorption capacity, which largely depends on the temperature and chemical composition of the liquid phase of the dough, the structure of the protein and the condition of the starch grains. That is why it is important to determine how DPA polysaccharides affect the state of the protein-proteinase complex of flour. The quality and quantity of gluten were determined in the samples after 20 minutes of rest after kneading the dough at a temperature of 30°C, which is optimal for ensuring maximum swelling of gluten proteins.

The dough was kneaded at the same duration and intensity of the process, since redox reactions play a significant role in the formation and preservation of the properties of the structural framework of the dough. Stirring the dough in an air atmosphere causes the oxidation of sulfhydryl groups by oxygen with the formation of disulfide bonds, including transverse ones, which strengthens the structure of the protein.

The research results in Table 4.1 indicate that the DPA addition to the dough leads to an increase in the yield of dry gluten by 2-7%. A direct dependence of the yield of dry gluten on the concentration of the additive was also noted. Elasticity indicators grow by 15%. There is also an increase in the extensibility of gluten by 16%.

Table 4.1

DPA impact on the quality of dough gluten ($\overline{X}$ ±m, m ≤0,05)

Indicator	**Additive concentration in % by weight of flour**				
	0%	**1%**	**3%**	**5%**	**7%**
Physical properties of raw gluten					
Yield of crude gluten, %	32,2	32,9	34,8	35,6	37,0
Elasticity (ВДК-1) units.	59	60	62	68	70
Extensibility, cm	10	10,2	10,5	10,6	12
Yield of dry gluten, %	12,0	12,3	12,5	12,6	13,0
Moisture content, %	63	64	64	64	62
Organoleptic properties of raw gluten					
Color	Light	Light cream			Cream
Elasticity	Good				Average

It should be noted that the use of the additive contributes to an increase in the amount of raw gluten by 2-13% compared to the control. This phenomenon is most likely associated with the interaction of SH-groups of proteins with organic acids of the additive and a partial content of polysaccharides in gluten.

4.3. Schematic diagram of the accelerated technology of the yeast semi-finished product

On the basis of a series of previous studies, a basic technological scheme for the production of a yeast semi-finished product with the DPA addition at the stage of yeast activation has been developed. 4.3.

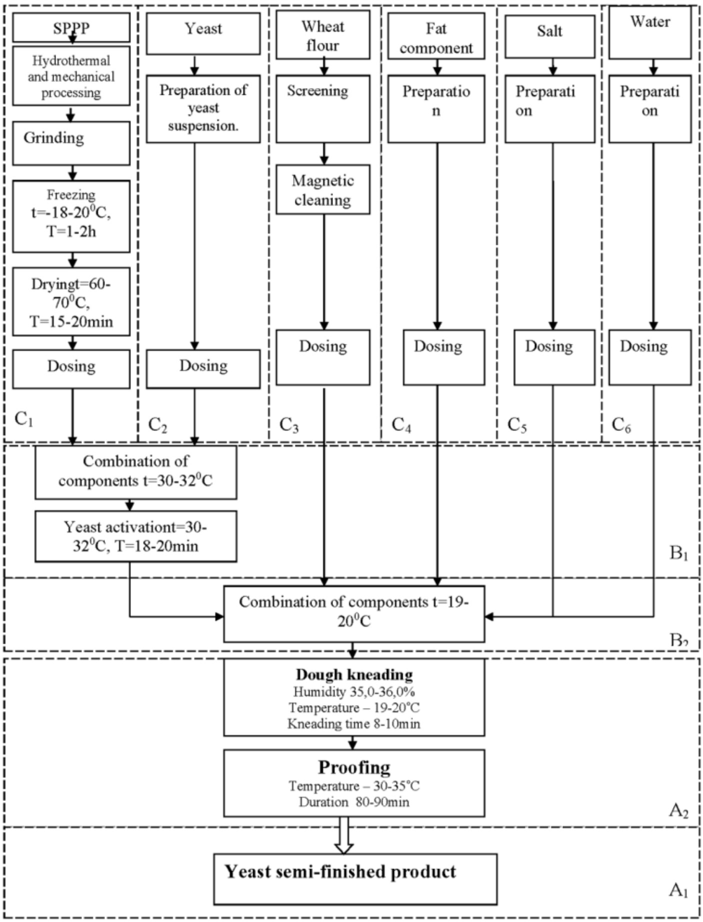

Fig. 4.3. Schematic diagram of the accelerated technology of the yeast semi-finished product

4.4. Consumer properties of yeast products using dry potato additives.

To study the DPA effect of on the main indicators of the quality of bakery products, trial laboratory baking was carried out.

The control samples of the dough were prepared in a non-dough way with sugar, the studied samples - in an accelerated way with the introduction of an additional operation – preliminary activation of yeast in a medium with the DPA addition with a concentration of 1-7% without the sugar provided for in the recipe. The next stage of research was the establishment of physicochemical and organoleptic quality indicators of control and test samples. During laboratory baking, DPA was added to the recipe in the amount of 1; 3; 5 and 7% by weight of flour, the mass of dough pieces was 200 grams.

The study of the quality indicators of products was carried out 4×60^2 s after baking. The research results are presented in Table 4.2.

Table 4.2

Physico-chemical quality indicators and general bakery evaluation of products ($\overline{X}$ ±m, m ≤0,05)

Indicator	DPA mass fraction %, by weight of flour				
	Control	1%	3%	5%	7%
Physical and chemical indicators of product quality					
Humidity, %	43,1	43,2	43,1	43,1	43,3
Specific volume, cm^3/g	3,56	3,62	3,74	4,11	3,61
Form stability N/A	0,39	0,41	0,42	0,44	0,40
Porosity, %	68,0	71,0	73,0	74,0	67,0
Acidity, hail	3,0	3,0	3,1	3,3	3,6
The value of baking, %	9,1	9,0	9,0	8,9	9,0
Desiccation value, %	4,4	4,3	4,3	4,2	4,5
Organoleptic indicators of product quality					
Crust color	Light	light yellow			Brown
Appearance of the crust	Convex, without tears and cracks				
The nature of the crumb on the cut	White with good elasticity	Cream with good elasticity			Cream with medium elasticity
Porosity status	Fine, uniform, medium thickness			Fine, fairly uniform, medium thickness	
Taste and aroma of products	Specific to this type of product				Somewhat specific

The research results show that the DPA addition to the formulation of the accelerated technology of flour products leads to a decrease in the baking of finished products by 2-16%, as well as an increase in the moisture content of the crumb of products by 2-3%. When adding DPA in the amount of 1; 3 and 5% by weight of flour, there is an increase in the specific volume of products by 13-16%. Also, the form stability of products is increased by 3–11%, porosity by 4–8% compared with control samples.

Based on the results of technological studies, 4 technologies of flour culinary products were developed using the developed semi-finished product from yeast dough, recommended for widespread implementation in the practice of restaurant enterprises.

Prospects for further research in this direction are to determine the nutritional value of the developed flour culinary products.

CONCLUSIONS

1. An analysis of literary sources shows that the most promising direction for the development of bakery production is the development of new product technologies with a simplified or shortened production cycle.

2. On the basis of the conducted studies, the parameters and modes of the process for obtaining DPA from SPPP have been determined and a technological scheme was developed. It has been established that DPA contains important macro- and microelements, as well as a sufficient amount of protein necessary for the growth of yeast cells.

3. It has been determined that the DPA addition into the activation medium accelerates the adaptation of yeast cells. The DPA addition at a concentration of 5% to the mass of flour improves the lifting force of the dough and accelerates the time of the first rise, in contrast to the control sample.

4. A basic technological scheme of yeast dough made in an accelerated way has been developed, rational parameters of the technological process for its production have been determined. Researches of physicochemical and organoleptic indicators of quality of yeast products have been carried out.

SUMMARY

Analysis of literary sources showed that the most promising direction for the development of bakery production is the development of new product technologies with a simplified or shortened production cycle. After all, the main disadvantage of yeast dough products is the duration of the technological process. Therefore, many Ukrainian and foreign researchers have devoted their scientific research to improving the

technology of yeast dough. The elimination of this disadvantage becomes possible due to the intensification of the technological process, namely: the introduction of accelerated technologies for the preparation of yeast dough and the improvement of the biotechnological properties of yeast, including the preliminary activation of yeast. As a nutrient medium for yeast, the use of an additive obtained from secondary products of potato processing (SPPP) is proposed. It has been proven that the use of this additive in the technology of products from yeast dough will allow rational use of raw materials, but also create an accelerated technology of yeast dough without the use of hazardous substances.

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