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EXPLORING THE EFFECT OF DRY PROTEIN-CARBOHYDRATE SEMI-FINISHED PRODUCT ON THE STRUCTURAL-MECHANICAL PROPERTIES OF YEAST DOUGH OBTAINED BY THE ACCELERATED TECHNIQUE

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Доведена перспективність використання сухого білково-вуглеводного напівфабрикату (СБВН) у технології дріжджового тіста, отриманого прискореним способом. Досліджено структурно-механічні, пружньо-еластичні та реологічні властивості тіста в залежності від концентрації СБВН. Встановлено, що використання СБВН в технологічному процесі виробництва дріжджового тіста надає можливість корегувати силу борошна та цілеспрямовано впливати на реологічні властивості тіста

Ключові слова: сухий білково-вуглеводний напівфабрикат, суха картопляна добавка, дріжджове тісто, структурно-механічні властивості, реологічні властивості

Доказана перспективность использования сухого белково-углеводного полуфабриката (СБУП) в технологии дрожжевого теста, полученного ускоренным способом. Исследованы структурно-механические, упруго-эластичные и реологические свойства теста в зависимости от концентрации СБУП. Установлено, что использование СБУП в технологическом процессе производства дрожжевого теста дает возможность корригировать силу муки и целенаправленно влиять на реологические свойства теста

Ключевые слова: сухая белково-углеводная смесь, сухая картофельная добавка, дрожжевое тесто, структурно-механические свойства, реологические свойства

1. Introduction

Significant changes in the conditions of life and labour of society caused imbalance between consumer demand and proposals in the market of bread and bakery products, which necessitates extending their product range for the production of new products with improved consumer properties [1].

Bread and bakery products have very large physiological importance in human nutrition as they are related to the products of mass consumption and possess digestibility that does not decrease over the course of daily use. Bread is characterized by favorable consistence and structure that provides the most efficient work of the digestive system and contributes to the fuller assimilation of other products by the human organism. Bread provides about 50 % of the daily need in energy, the group B vitamins and up to 75 % of the need in plant protein.

The assortment of bread and bakery products have been actively developed recently, but the most popular with consumers are the products of medium and low-price segments. These products have unbalanced amino acid composition and unstable quality due to low technological properties of the basic raw materials, which negatively affects the process of yeast fermentation.

A widespread use of additives of various operating principles contributes to solving these problems in the bread and bakery industry [2]. Their use makes it possible to eliminate the points of risk of the technological process, caused by the single phase process of preparing dough, unstable quality of flour, variety of functional properties of the raw materials [3].

A promising direction in the development of technology of bread is the use of low-grade secondary raw materials of plant and animal origin, which are a source of enrichment of food and biological values of products [4] and contributes to the intensification of yeast fermentation [5, 6].

2. Literature review and problem statement

The problem of enrichment of bread and bakery products has been relevant for several decades now and it is still unresolved in the bread and bakery sector [7, 8]. A promising direction of solving this problem is the use of side and secondary products of the raw dairy products processing that enrich bread and bakery products with valuable proteins, essential macro- and microelements [9], as well as positively affect their quality indicators [10].

Studies of the technology of using the products of the raw dairy products processing in the bread and bakery production were carried out by many researchers [3, 7, 11].

A technology of yeast dough with high biological value, produced by the accelerated technology, was proposed. The technology is based on using two additives – dry potato additive (DPA) [12] and dry protein-carbohydrate-semi-finished product (DPCS) [13]. DPA, which is obtained from the secondary products of the processing of potato, contains a significant amount of reducing sugars and helps activate yeast in the yeast dough. DPCS allows enriching bread and bakery products with full milk protein, pectins, vitamins, essential macro- and microelements.

DPCS is obtained due to the deposition of protein substances from the secondary products of milk processing with the use, as acidifier and precipitant, of puree from the berries of dogwood and blackthorn that contain significant amounts of organic acids, proteins, pectin substances and calcium that are the additional centers of coagulation. A technological process of the production of DPCS includes pasteurization of skimmed milk at temperature 80±2 °C with curing for 5 min. and cooling to 10...12 °C, followed by its coagulation using the coagulant (pasteurized at temperature 90 °C for 5...7 min. and homogenized puree from the berries of dogwood or blackthorn, or their mixture in the amount of 40...50 % by weight of fat-free milk), curing for 3...4 hours, removal of serum by self-pressing for 30 min, homogenization of protein-carbohydrate clod, its hot air drying at temperature 85...90 °C to the content of dry substances 92...94 %, crushing the granules to the size of particles 20...40 μm, addition of sugar in the amount of 10 % by the method of blending, stirring and packing. A ready dry mixture is a powder of white-pink color, with no lumps, with humidity not exceeding 8 %, with sour-sweet taste, with smell peculiar to milk and dogwood or blackthorn, or a mixture from dogwood and blackthorn, it has good solubility, even in cold water.

Most researchers point out [14] that the use of milk proteins positively affects the nutritional value of bread and its organoleptic characteristics, increasing specific volume, improving the state of the crumb and coloring the crust. Along with that, it is impossible not to consider the influence of proteins of dairy products on the processes of fermentation, properties of gluten and rheological properties of yeast dough. On one hand, milk proteins contribute to the increase in the activity of the yeast, and, on the other hand, it leads to certain deterioration in the quality of gluten, due to a dehydration effect of lactose on gluten and its hardening [15]. Change of gluten causes the reduction of viscosity and elasticity of the dough [16]. Twofold effect of milk protein on the properties of yeast dough and finished products [17] requires correct approach to using this ingredient.

Milk proteins have high bufferness, which is the major cause of the reduction in intensity of the dough fermentation, since a result of it, pH of dough remains within the range, in which the action of amylolytic enzymes and the accumulation of water-soluble carbohydrates necessary for fermentation are limited [18]. The application of DPA in combination with DPCS has to contribute to the elimination of this problem since it increases the vital functioning activity of yeast, intensifies the process of gas formation in the dough, and provides an increase in its specific volume during fermentation. The composition of DPA includes reducing sugars needed for the biochemical and microbiological processes. Accelerating the process of fermentation of dough is also contributed by the introduction from DPCS of significant amount of nitrogenous and mineral substances that enhance feeding the yeast.

The use of milk proteins leads to an increase in the moisture-absorbing capacity of yeast dough, enhancing at the same time its strength characteristics: increased stability, elasticity, decreased dilution [19].

It was established [20] that the reduction in the negative impact of milk proteins on the structural-mechanical properties of dough is facilitated by their introduction to the mixtures with organic acids that have high reactivity and act as oxidants of the SH-groups of milk proteins. In this case, the SH-groups are converted to –S–S–, resulting in the oxidizing inactivation of the –SH groups of milk proteins, the proteinase and its activators. As a result of "stitching" of protein by the created disulfide bonds-bridges, there is a strengthening of its intra globular structure, which is turned denser and more rigid. This leads to the improvement in the structural-mechanical properties of the dough, its gas- and shape-maintaining capacity that ultimately provides for the possibility to obtain finished products of high quality.

The existence of organic acids of the berries of dogwood and blackthorn in DPCS make it possible to predict the absence of significant negative impact of DPCS during production of dough by the accelerated way due to the activation of DPA yeast.

Summing up, we can conclude that milk protein significantly affects the rheological indicators of dough, both positively and negatively, which necessitates thorough research into the rational amount of dry milk-plant semi-finished product. Thus, the introduction of DPCS to yeast dough requires mandatory studies of their effect on the structural-mechanical properties of dough.

3. Aim and objectives of the research

The purpose of the conducted research is a scientific substantiation of structurally-mechanical properties of yeast dough, prepared by the accelerated technique through preliminary activation of yeast in the medium of dry potato additive depending on the concentration of dry protein-carbohydrate semi-finished product.

To achieve the goal, the following tasks were set:

– to explore physical properties of dough during mixing depending on the concentration of DPCS;

– to give a comprehensive assessment of the effect of DPCS on the structural-mechanical properties of dough during its fermentation;

– to explore the changes in efficient viscosity and shear stress on the shear rate depending on the concentration of DPCS to the mass of flour.

4. Materials and methods of research into using DPCS in the accelerated technologies of yeast dough

A methodological basis of conducting comprehensive research is the establishment of optimal concentration of DPCS depending on the indicators of structural-mechanical and rheological properties of yeast dough, prepared by the accelerated technique through preliminary activation of yeast in the nutrient medium of DPA. The methodology of the study of the use of DPCS in the accelerated technologies of yeast dough is described in more detail in paper [21].

5. Results of research into effect of DPCS on the structurally-mechanical properties of dough prepared by the accelerated technique

In a previous article [12], there was conducted a series of research into intensification of the process of maturation of yeast dough. As a result, it was proposed to use DPA obtained from the secondary products of potato processing (SPPP) at the stage of activation of yeast in the technology of products from yeast dough. As a result of the studies, the effectiveness of using DPA on the technological process of preparation of yeast dough was proven, moreover, it was established that preliminary yeast activation makes it possible to reduce the time of preparation of yeast dough by 35–40 %. [12].

The chemical composition of DPCS was also examined, it was found that the additive contains in its compound high-grade milk protein (over 10 %), pectin, easily digestible sugars, vitamins, macro- and microelements. It was also proven that the use of DPCS will not slow down technological processes that take place in the dough that is made on the pre-activated yeast medium [6].

Formation of the physical properties of dough depends on many factors, mostly on the ratio of biopolymers of flour, condition of its protein-proteinase complex and on the formulation of the dough. DPCS contains in its compound high-grade milk protein, sugars, vitamins, macro- and microelements that may significantly affect the formation of structurally-mechanical properties of dough. Hence the relevance of research into the influence of DPCS and its concentration on the structural-mechanical properties of yeast dough. The physical properties of dough were determined both during mixing in dynamic recording devices (Brabender farinograph) and during its fermentation for 135·60 s (Brabender extensograph). This enabled us to provide a comprehensive assessment of the impact of DPCS on the structural-mechanical properties of yeast dough. Results of digital decoding of the dynamics of formation of yeast dough with the addition of DPCS in varying concentrations, formation and destruction of its structure in the process of mechanical treatment by the Brabender farinograph are presented in Table 1.

Research results demonstrated that increased concentration of DPCS contributes to the increase in moisture absorption capacity index by 9 % for the flour of batch No. 1 and by 12 % for the flour of batch No. 2. This result is explained by the presence in the DPCS of proteins and hydrophilic polysaccharides. From a technological point of view, the increased moisture absorption capacity of dough will increase the output of finished goods.

The indicator of dilution describes the ratio of solid and liquid phases, condition and stability of proteins in dough. The obtained results indicate a positive impact of DPCS on the structural-mechanical properties of dough during its kneading. We observed decrease in the indicator of dilution by 3–10 % for the flour of batch No.1 and by 3–8 % for the flour of batch No.2 with the DPCS concentration of 5–15 %. The existence of acids in DPA, as well as of proteins and pectins in the composition of DPCS, which intensify the swelling and peptization of proteins and increase the hydrophilicity of dough colloids, clearly contribute to the reduction of indices of dilution of dough, that is, they make it stronger.

According to the results of analysis of obtained farinograms, we discovered that the addition of DPCS insignificantly affects duration of the dough formation but makes it possible to prolong indicators of its stability in relation to the both reference samples.

Table 1

Impact of DPCS on the process of dough formation ($\overline{X}\pm m$, $m\leq 0,05$)

Name of sample	Name of indicator					
	Moisture absorption capacity cm^3/100 g	Duration of dough formation, min	Stability, min	Elasticity, min	Dilution during kneading, gear units	Dough consistence, gear units
wheat flour (batch No. 1)						
Reference	65	2,5	2,8	71	55	500
5 % DPCS	67	3,0	3,0	72	52	500
10 % DPCS	69	3,0	3,5	73	49	500
15 % DPCS	71	3,0	4,0	79	45	500
20 % DPCS	74	3,5	4,5	80	38	500
wheat flour (batch No. 2)						
Reference	55	1,5	1,5	60	40	500
5 % DPCS	59	2,0	2,0	62	37	500
10 % DPCS	61	2,0	2,5	65	35	500
15 % DPCS	63	2,0	3,0	67	32	500
20 % DPCS	67	2,6	3,5	70	30	500

In the sample of dough with DPCS concentration of 20 %, indicator of dilution increases by 17 % for the flour of batch No. 1 and by 10 % percent for the flour of batch No. 2, which indicates that such concentration of additive is rational only in the case of using the flour with satisfactorily weak gluten.

It is known that in the process of fermentation dough undergoes the deformation of stretching. To ensure an increase in gas- and shape-forming capacity of dough it is necessary to achieve optimal ratio of elasticity and extensibility of dough. With regard to this, we carried out the study of influence of DPCS on the rheological properties of dough using the Brabender extensograph. Results of digital decoding of the extensogram are listed in Table 2.

The results we obtained indicate that the increase in the DPCS concentration contributes to strengthening the dough. Changes of such indicator as energy in the process of fermentation of wheat dough gives the possibility to estimate the strength of flour: energy is directly proportional to the strength of flour.

Table 2

Effect of DPCS on the properties of dough according to the Brabender extensograph ($\overline{X}\pm m$, $m\leq 0,05$)

Name of sample	Stretching resistance (elasticity) P_c, units eks.	Extensibility L, mm	Energy, cm^2	Ratio of stretching resistance to extensibility P_c/ L
Wheat flour (batch No.1) In 45·60 s of fermentation				
Reference	620	169	81,1	3,6
5 % DPCS	650	167	82,4	3,9
10 % DPCS	670	166	84,2	4,0
15 % DPCS	690	165	89,3	4,2
20 % DPCS	710	164	92,5	4,3
In 90·60 s of fermentation				
Reference	600	178	78,0	3,3
5 % DPCS	640	175	83,0	3,5
10 % DPCS	630	174	84,5	3,6
15 % DPCS	640	172	85,9	3,7
20 % DPCS	690	170	89,5	4,0
In 135·60 s of fermentation				
Reference	570	197	67,5	2,8
5 % DPCS	590	195	70,0	3,0
10 % DPCS	600	194	72,5	3,1
15 % DPCS	610	191	78,3	3,2
20 % DPCS	660	190	80,0	3,4
Wheat flour (batch No.2) In 45·60 s of fermentation				
Reference	630	170	76,5	3,7
5 % DPCS	650	168	79,0	3,9
10 % DPCS	660	166	81,0	4,0
15 % DPCS	670	164	82,5	4,1
20 % DPCS	680	160	84,0	4,2
In 90·60 s of fermentation				
Reference	540	181	70,5	2,9
5 % DPCS	560	179	74,0	3,1
10 % DPCS	570	177	76,5	3,2
15 % DPCS	580	174	77,8	3,3
20 % DPCS	600	172	80,0	3,5
In 135·60 s of fermentation				
Reference	530	184	65,0	2,8
5 % DPCS	550	180	69,3	3,0
10 % DPCS	560	178	71,4	3,1
15 % DPCS	570	176	73,6	3,2
20 % DPCS	580	174	75,3	3,3

Adding DPCS increases energy indicators of dough during its fermentation, which has a certain dependency on the amount of DPCS that is introduced; this phenomenon indicates an increase in the indicators of strength of flour. The increase in stretching resistance testifies to the process of strengthening the gluten frame of dough, confirming results of the previous research. The process of strengthening of dough contributes to an increase in the indicators of extensibility and energy of dough in the process of fermentation.

An analysis of the data from Table 2 indicates that the concentration of DPCS at 20 % disagreeably increases the indicator of energy, which leads to a proportional growth of indicators of the strength of flour. The samples of dough with the concentration of DPCS at 20 % have too much elastic structure, which is why further examination of the sample of dough at this concentration of additive is not rational.

The shortcoming of extensograph is the inaccuracy of results since the studies using this device are conducted with the non yeast dough and do not allow taking account of the factors that occur as a result of alcohol fermentation of the yeast dough.

Given the above, further research was carried out using the viscometer Rheotest RN4.1, which provided for the possibility of obtaining absolute values of the indicators at the shear rate of 0,3–6,5 s^{-1}.

The study was performed to determine viscosity and shear stress of yeast dough of the reference sample of humidity 38 % and the examined samples with the addition of DPCS at concentration 5; 10 and 15 % by weight of flour. Temperature of the samples (32 °C) was uniform throughout the entire volume, temperature fluctuations amounted to 0,1 °C during experiment, the samples were of homogeneous consistence.

Table 3 displays experimental results of research into effective viscosity η_{ef} and shear stress θ of the dough samples depending on the shear rate.

Table 3

Effect of DPCS on the changes in effective viscosity and shear stress on the shear rate ($\overline{X}\pm m$, $m\leq 0,05$)

Shear rate, 1/s	Reference		DPCS 5 %		DPCS 10 %		DPCS 15 %	
	Effective viscosity, Pa·s	Shear stress, Pa	Effective viscosity, Pa·s	Shear stress, Pa	Effective viscosity, Pa·s	Shear stress, Pa	Effective viscosity, Pa·s	Shear stress, Pa
0,33	7350	2460	7100	2140	8560	3350	8920	3060
0,88	4800	4210	4660	4100	5220	4650	5710	5020
1,32	3810	5040	3860	5100	4500	5950	4830	6390
1,83	2890	5300	3020	5530	3790	6940	4250	7530
2,34	2420	5660	2720	6270	3400	7870	3550	8470
2,85	2210	6300	2610	7450	2960	8630	3340	9520
3,36	2060	6940	2480	8320	2850	9560	3070	10300
3,87	2000	7720	2360	8850	2840	9890	3050	10680
4,38	2030	8300	2040	9040	2660	10030	3030	11100
4,89	1740	8520	1870	9130	2400	10140	2620	11100
5,43	1530	8470	1750	9200	1730	10210	1840	10930
5,92	1300	8250	1590	9180	1650	10190	1580	10740
6,44	1170	7970	1280	9260	1240	10080	1210	10400

Processing of results of the experiment allowed us to obtain dependency of effective viscosity on the shear rate:

$$\eta_{ef} = a \cdot e^{\frac{b}{\dot{\gamma}+c}}, \qquad (1)$$

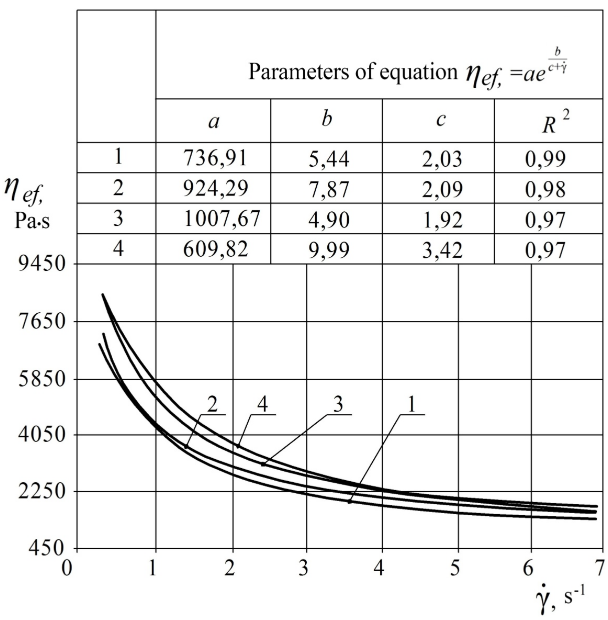
where η_{ef} is the effective viscosity; $\dot{\gamma}$ is the shear rate; a, b, c are the empirical coefficients.

For all examined samples, the curves of dependency of shear stress on the shear rate are approximated by a function of the Herschel-Bulkley law:

$$\theta = \theta_0 + k \cdot \dot{\gamma}^n, \qquad (2)$$

where θ is the shear stress; θ_0 is the boundary of fluidity; k is the coefficient of consistence; n is the indicator of fluidity.

Fig. 1, 2 display the curves of change in effective viscosity and shear stress of the examined samples.



	a	b	c	R^2
1	736,91	5,44	2,03	0,99
2	924,29	7,87	2,09	0,98
3	1007,67	4,90	1,92	0,97
4	609,82	9,99	3,42	0,97

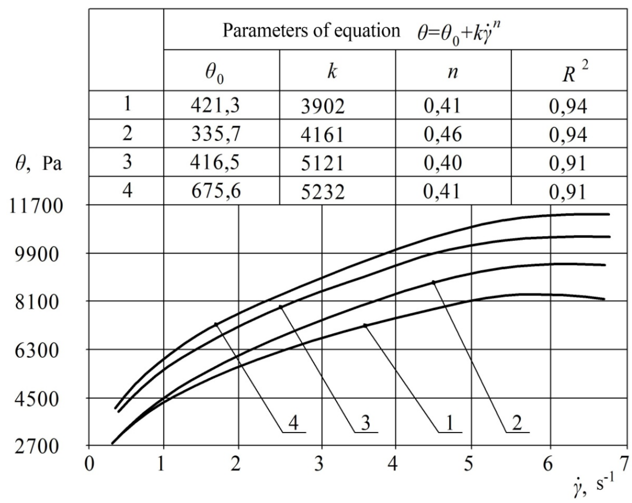
Fig. 1. Dependency of effective viscosity on shear rate: 1 — reference sample; 2 —5 % DPCS; 3 — 10 % DPCS; 4 — 15 % DPCS by weight of flour

It should be noted that the pattern of changes in effective viscosity and shear stress is equal to the reference and examined samples of dough.

Adding DPCS to dough at such concentration insignificantly affects the indicators of effective viscosity, but depending on the concentration of the additive, the values of shear stress at one rate increase because shear stress is the most sensitive indicator of changes in the properties of raw materials. With an increase in the content of additive, there is an improvement in the indicators of shape-forming capacity by 10–18 %.

At the next stage we determined the nature of change in the shear stress on the shear rate of the reference and examined samples.

The graphs demonstrated in Fig. 2 have the form characteristic for visco-plastic solid-like systems. Results of the experimental research of all samples revealed that they have a stable structure, the destruction of which starts only after reaching the specified stress.



	θ_0	k	n	R^2
1	421,3	3902	0,41	0,94
2	335,7	4161	0,46	0,94
3	416,5	5121	0,40	0,91
4	675,6	5232	0,41	0,91

Fig. 2. Dependency of shear stress on shear rate: 1 — reference sample; 2 — 5 % DPCS; 3 — 10 % DPCS; 4 — 15 % DPCS by weight of flour

With an increase in shear rate, viscosity falls for all the samples examined. With an increase in shear rate, a sharper decrease in viscosity occurs at the change in low velocities. When the shear rate increases to 3 s^{-1}, viscosity decreases by approximately 65–70 %, and in the range of rates 3...6,5 s^{-1} by 15–20 %. As can be seen from the graphs shown in Fig. 1, effective viscosity falls with the increasing shear rate, reaching the lowest value at the rate of order 6,5...7 s^{-1}, which corresponds to the largest destruction of structure.

The rate of change in the values of shear stress is the largest in the section of change in shear rate also to 3 s^{-1}. With increasing shear rate, the changes in shear stress values become almost constant.

With stresses below the boundary, which characterizes strength of the spatial structure, there is a slow flow of the creep type. At such a very slow flow, the structure collapses but manages to recover again. This flow is due to the almost constant largest viscosity in the area of low shear stresses.

With increasing percentage content of DPCS, the absolute values of magnitudes of effective viscosity and shear stress of dough increase in comparison with a reference sample.

The above described research established that the best indicators of structural-mechanical properties of dough are demonstrated by the samples with the DPCS concentration of 15 % by weight of flour. Thus, we consider rational to introduce DPCS in the amount of 15 % by weight of flour because this concentration does not worsen organoleptic indicators, improves structural-mechanical and rheological properties of dough.

Thus, the examined samples of dough with DPCS have a stable structure that will ensure the absence of adhesion of the dough to the working bodies of technological equipment and will improve the efficiency of its performance.

6. Discussion of results of research into the influence of DPCS on the structural-mechanical properties of yeast dough prepared by the accelerated technique

A question of the development of ways to regulate and intensify technological processes in the preparation of products from yeast dough, the design of safe measures to improve their consumer properties, food value and microbiological indicators remains relevant.

The work proposed to use DPA obtained from SPPP as an activator of the yeast medium, which contributes to the intensification of the process of dough preparation by (60...90)·60 s. To increase the food and biological value of the finished product we also suggested using DPCS that contains in its compound high-grade milk protein (over 10 %), pectin, easily digestible sugars, vitamins, macro-and microelements. A formulation composition was designed of the dough semi-finished products manufactured by the shortened technology with the addition of DPCS at concentration of 5, 10, 15 and 20 % by weight of flour. We examined structural-mechanical and rheological properties of dough semi-finished products, of the reference and examined samples.

As a result of the conducted studies of structural-mechanical and rheological properties of yeast dough, it was found that the addition of DPCS to formulation composition of yeast dough contributes to strengthening of the gluten frame of spatial grid of dough semi-finished products. The strengthening of dough is reflected in the increasing stability of the dough with the addition of DPCS and reduction in its dilution. In addition, the process of strengthening the dough contributes to an increase in the indicators of extensibility and energy of dough in the process of fermentation. It is proved that the examined samples of dough with DPCS have a stable structure that will ensure the absence of adhesion of dough with the working bodies of technological equipment.

The designed accelerated technology of yeast dough using DPCS will make it possible to manufacture a wide range of products at the enterprises with low capacities such as: mini-bakeries, flour mills at supermarkets and at restaurants. In addition, chemical composition of the additive will increase the nutritional and biological value of the finished products.

7. Conclusions

As a result of the studies we established that DPCS positively affects the structural-mechanical and rheological properties of dough, obtained by the accelerated technique.

1. According to the results of analysis of received farinograms, it was discovered that adding DPCS to formulation composition of yeast dough contributes to the increase in the indicator of moisture absorbing capacity that ultimately will increase the output of finished goods. The results we obtained of the indicator of dough dilution indicate a positive impact of DPCS on the structural-mechanical properties. The existence of acids in the composition of DPA, as well as of proteins and pectins in the composition of DPCS helps reduce the indicators of dough dilution, that is, it makes it stronger. According to the results of analysis of received farinograms, we discovered that adding DPCS insignificantly affects duration of the dough formation, but allows prolonging the indicators of its stability in relation to the both reference samples. The strengthening of dough, reduction in the compliance of its high molecular polymers (proteins) to the action of proteolytic enzymes is reflected in the increasing stability of the dough with the addition of DPCS and reduction of its dilution.

It was also found that the concentration of DPCS in the amount of 20 % by weight of flour opens prospects for further research into such concentration of the additive in combination with flour with satisfactorily weak and weak gluten.

2. To study the properties of dough during kneading and fermentation, we used such recording devices as the Brabender farinograph and extensograph. It was found that adding DPCS increases energy indicators of dough during its fermentation, which has a certain dependency on the amount of DPCS introduced; this phenomenon indicates increasing indicators of strength of flour. An increase in the resistance to stretching is the evidence to the process of strengthening of the gluten frame of dough, confirming results of the previous research. The process of strengthening of dough contributes to an increase in the indicators of extensibility and energy of dough in the process of fermentation.

3. Adding DPCS to dough insignificantly affects the indicators of effective viscosity, and depending on the concentration of the additive, the values of shear stresses at one rate increase because shear stresses is the most sensitive indicator of changes in the properties of raw materials. With the increased content of additive, we observed improvement in the indicators of shape-forming capacity by 10–18 %. With increasing percentage content of DPCS, the absolute values of magnitudes of effective viscosity and shear stress of dough increase in comparison with a reference sample. Thus, the examined samples of dough with DPCS have a stable structure that will ensure the absence of adhesion of dough with the working bodies of technological equipment that will contribute to the efficiency of its performance.

At this stage of the research, the optimal concentration of DPCS by weight of flour that we determined is 15 %.

In further research it is planned to establish effect of DPCS on the rheological properties of dough during its fermentation, to explore consumer properties of products manufactured by the accelerated technology with the addition of DPCS.

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