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Study The Effect Of Cryoprotectants On The Activity Of Yeast Cells And The Moisture State In Dough.

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ABSTRACT

The article describes the development of technology bread functional purpose using natural biocorrectors. When making pectin more intensively the process of fermentation of the dough and accelerates the process of proofing. Due to the technological properties of pectin, it is possible to maintain the viability of yeast cells and ensure the quality of the finished bread.

Keywords: cryoprotector, pectin, yeast, test semi-finished products, bread.

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INTRODUCTION

Still one of the most promising technologies in Russia in the bakery industry is the production of bread and bakery products from frozen convenience foods. Freezing is the oldest and extremely effective way to preserve foods.

In the production of frozen semi-finished products, it is possible to control the safety and quality of products, to respond quickly to market changes, the cost of transporting finished products is significantly reduced, it is possible to increase the network of bakeries, in places of sale, due to the possibility of using a minimum amount of equipment. Consumers of bakery products prefer freshly baked products, at any time of the day, in a wide range, produced in the traditional way, with useful properties, hypoallergenic, and most importantly - tasty. But there are problems with the satisfaction of this demand - skilled personnel and expensive retail space and the solution to this problem is “semi-finished technologies” [1, 2].

The use of frozen bakery semi-finished products, due to the modern rhythm of life, in connection with which consumers of bakery products arise, the need for semi-finished products that can be prepared without a large investment in time. In economically developed countries, the use of such semi-finished products is becoming increasingly widespread, as evidenced by the work of foreign scientists Basaran, A., Elhady E.A., Ribotta Pablo D., Vander Sluis S.M. [3, 4, 5, 6]. When freezing bakery semi-finished products, a problem arises related to the viability of yeast cells [7]. The main component that can be affected by changing temperatures is the yeast, which makes the dough and dough pieces airy. Also important are the enzymes that play the role of a catalyst in biochemical reactions, they are crucially contribute to the formation of taste, color and aroma of the finished product. Therefore, in addition to the choice of a suitable cryoprotectant, various temperature regimes of freezing play an important role [8].

MATERIAL AND METHODS

In order to select the optimum temperature for freezing, 16 samples were subjected to freezing. The first 8 samples (control, with the addition of pectin, sorbitol, fructose) were frozen at (-18) °C, the second 8 samples (control, with the addition of pectin, sorbitol, fructose), were frozen at (-4) °C, their storage was 30 days. Next, the samples were thawed in the microwave EMF (output power: 800 W, power: 1150 W) and in the workshop conditions (at a temperature of 20 °C and relative humidity of 40%), after which the counting method of microorganisms in the Tom Zeiss counting chamber was calculated live and dead yeast cells.

Therefore, studies have been conducted to study the activity of yeast cells, with different cryoprotectants under different modes of freezing (-4; -18 °C) and defrosting under conditions of EMF microwave and normal under natural conditions. The number of yeast cells was counted by microscopy in a Tom Zeiss chamber.

RESULTS AND DISCUSSION

The data of experiments on the counting of yeast cells under different conditions of freezing and thawing of the microwave EMT and the conditions of the workshop are presented in Table 1.

Table 1: The number of yeast cells in the test, with different cryoprotectants prepared under different conditions of freezing and thawing

Infused cryoprotectant	Content in dough		
	CFU (cl / cm^3)	live yeast cells,% of CFU in each sample	dead yeast cells,% of CFU in each sample
Dough without freezing			
Control	$3,1 \bullet 10^9$	95,5	4,5
Pectin	$2,98 \bullet 10^9$	97,0	3,0
Sorbitol	$2,28 \bullet 10^9$	95,5	4,5
Fructose	$2 \bullet 10^9$	86,5	13,5
Freezing at (-18) °C			

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Defrosting in EMI microwave			
Control	$1,1•10^9$	97,5	2,5
Pectin	$1,94•10^9$	98,0	2,0
Sorbitol	$1,91•10^9$	96,0	4,0
Fructose	$1,74•10^9$	97,0	3,0
Defrosting in the shop			
Control	$0,78•10^9$	80,0	20,0
Pectin	$2•10^9$	96,0	4,0
Sorbitol	$1,56•10^9$	84,0	16,0
Fructose	$1,4•10^9$	97,0	3,0
Freezing at (-4) °C			
Defrosting in EMI microwave			
Control	$0,13•10^9$	95,0	5,0
Pectin	$1,68•10^9$	96,0	4,0
Sorbitol	$1,32•10^9$	95,5	4,5
Fructose	$1,62•10^9$	98,5	1,5
Defrosting in the shop			
Control	$0,96•10^9$	87,0	13,0
Pectin	$2,18•10^9$	97,0	3,0
Sorbitol	$1,4•10^9$	94,0	6,0
Fructose	$0,74•10^9$	93,0	7,0

The table below shows that the number of yeast cells susceptible to freezing at different temperatures is more in the sample with the addition of pectin, unlike samples with sorbitol, fructose and the control sample. At a temperature of (-4) °C, the activity of the yeast is as low as possible, but without freezing the cellular water contained in the dough, since at a temperature of up to (-7) °C there is no energy-intensive transition from one aggregative state to another, the activity of the enzymes remains. At a temperature of (-18) °C, the fermentation of yeast completely stops, the activity of enzymes slows down, but does not completely stop. Temperature conditions should be chosen depending on the shelf life of products [9]. This experiment was laid for 30 days, so the number of yeast cells prevails in the first experiment, with freezing at (-18) °C. In the choice of conditions for defrosting, it can be seen that defrosting in the workshop conditions is more benign for yeast cells than defrosting in an EMF Microwave figure 1.

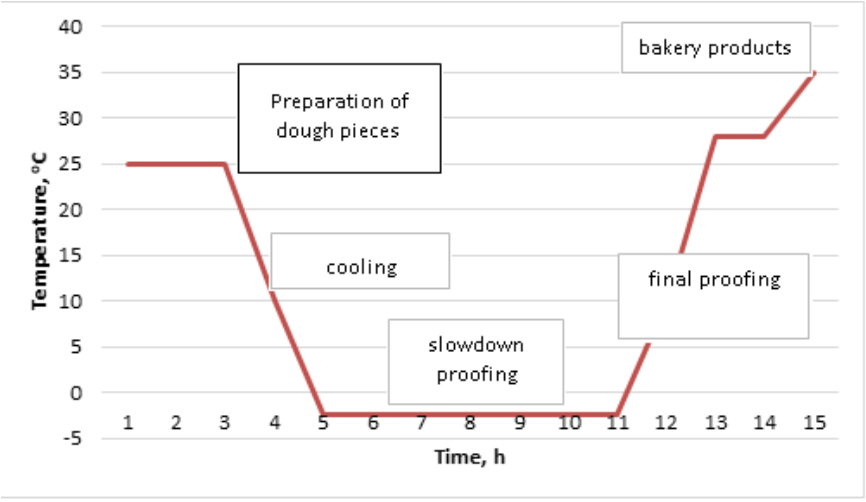

Figure 1: Slowing the dough proof

The process of slowing down the proofing, allows you to extend the proofing time, at a storage temperature up to (-6) °C. At the same time, the activity of the yeast is reduced to a minimum, but does not exceed the value of the energy-intensive freezing threshold. The activity of enzymes only slows down, but does not stop completely, with this process, it becomes possible to produce bakery products with high taste, with relatively low energy consumption [10].

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As can be seen from Figure 2, interrupting the proofing at temperatures up to (-18) °C leads to a complete cessation of the activity of the yeast, while the activity of enzymes continues, but at a lower level. This technology allows you to store products for a longer time, which is economically beneficial in the production of small batches of baking and a fairly wide range [11].

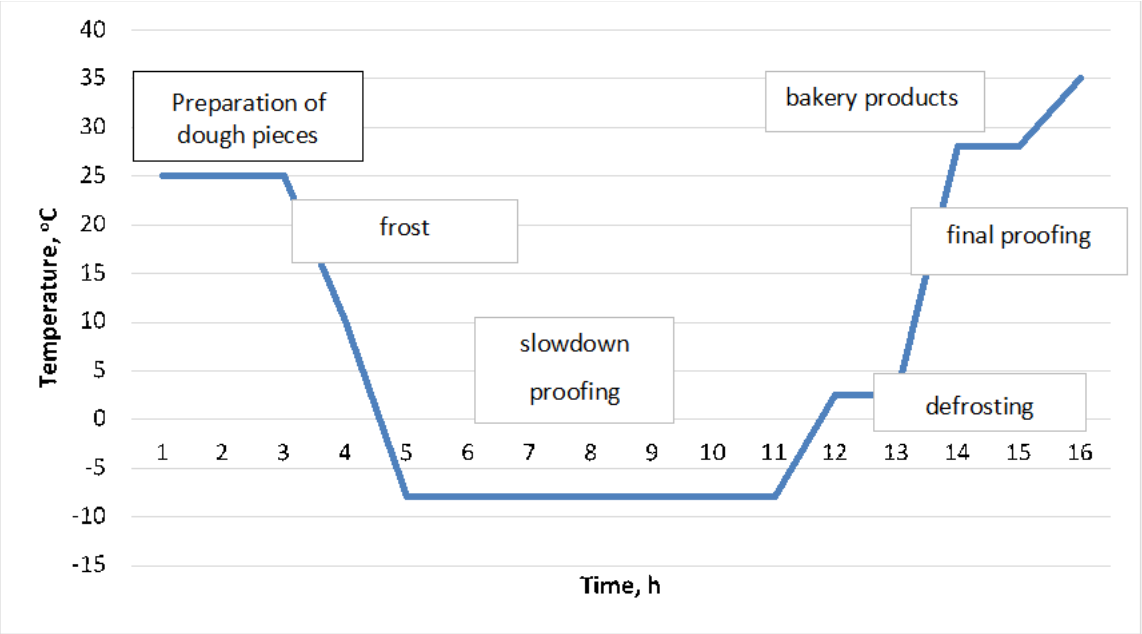

Figure 2: Interrupting proofing

The quality of yeast can be determined by the lifting force, the faster they raise the dough, the better their quality. This can be determined using the standard method [12] or by the rate of ascent of the ball of dough.

For faster and more convenient determination of the speed of lifting the ball of dough using the accelerated method proposed by A. I. Ostrovsky.

The method is based on the speed of lifting the

pellet in water, and the number of minutes it takes him to rise to the surface. The density of the dough is 1.4 g / cm^3, in the process of fermentation, this density decreases. High-quality yeast is considered to be those yeast, the rate of increase of which is 14-20 minutes.

We studied 8 samples, 4 of them (control, with the addition of pectin, sorbitol, fructose) were frozen at (-18) °C, 4 other samples (control, with the addition of pectin, sorbitol, fructose) at (-4) °C Next, the samples were thawed in the conditions of the workshop, the lifting force was determined by the method of A. I. Ostrovsky, table 2.

Table 2: Raising dough with the addition of cryoprotectants

Cryoprotector	Rising power of the yeast cells, min.
Freezing at temperature (-18) C	
Control	13
Pectin	12
Sorbitol	16
Fructose	18
Freezing at temperature (-4) C	
Control	15
Pectin	14

Sorbitol	17
Fructose	18

The data presented show that yeast subjected to freezing at a temperature of (-18) °C has the best lifting force. Comparing different samples, it is clear that a sample with the addition of pectin has a better lifting force than samples with sorbitol, fructose and a control sample.

Water is an integral part of the test and the state of the yeast cells directly depends on the state of moisture, whether it is in a bound or free state. In order to determine the state of moisture in the test, an NMR test was conducted, which was conducted at the All-Russian Research Institute of Oilseeds named after VS. Pustovoit, in the department of physical research methods, together with the doctor of technical sciences S.M. Prudnikov, on the instrument AMR analyzer AMB-1006M.

The basis of the method of NMR spectroscopy is the determination of the magnitude of the time of proton magnetic relaxation. Relaxation is a transition between energy states, restoring the usual Boltzmann distribution. Such a transition, as a rule, is not accompanied by radio frequency radiation. There are various types and mechanisms of relaxation [13].

After a certain period of time, short-term electromagnetic pulses in the region of resonance absorption are applied to a test substance in a magnetic field, and a spin echo signal appears in the receiving coil, the maximum amplitude of which is related to the transition time of the hydrogen nucleus from the excited state to the normal one. The proton magnetic relaxation time makes it possible to judge the mobility of water molecules in the sample under study [14].

When a quantum is absorbed by a quantum of electromagnetic radiation, it moves to a higher energy level, i.e. there is absorption of radiation, which is recorded by an NMR spectrometer. The absorption of electromagnetic radiation does not occur exactly at a certain frequency, but within a certain range of frequencies, i.e. real absorption lines in the NMR spectra are broadened.

A test tube with a uniformly distributed sample was placed in the NMR tube and the spin-spin relaxation of T_2 protons was immediately measured in the range of 0.1-150 ms. A study of the water absorption capacity of the test was carried out, in various ways: after kneading, 15 minutes later and 30 minutes after kneading. Four samples were studied: control, with the addition of pectin, sorbitol and fructose in each variant [14].

The resulting data was processed by an equation with several exponents using the least squares method using weighted averages. The experimental envelopes of the spinal echo signals of the protons of the samples under study were described by multiexponential functions and determined the values of the spin-spin relaxation times (T_2) and amplitudes of the NMR signals (A).

Based on the analysis of the nature of the dependences of the decays of the integral intensity of water protons, the groups of water protons with different values of the spin-spin relaxation time were determined in the samples studied: $T2_1$ = 0.1-10 ms (W_1), $T2_2$ = 10-100 ms (W_2), $T2_3$ = 100 - 500 ms (W_3), which were considered as moisture fractions with different bond strengths. The selected forms of moisture bond in the studied samples were characterized as W_1 - osmotically retained, bound moisture, W_2 - weakly bound useful moisture (ensures optimum test consistency), W_3 - weakly bound excess moisture (which forms crystals with decreasing temperature).

The nature of the dependences of the decays of the integral intensity of water protons in the test samples analyzed after mixing, after 15 and 30 minutes are presented in Figure 3 (a, b, c).

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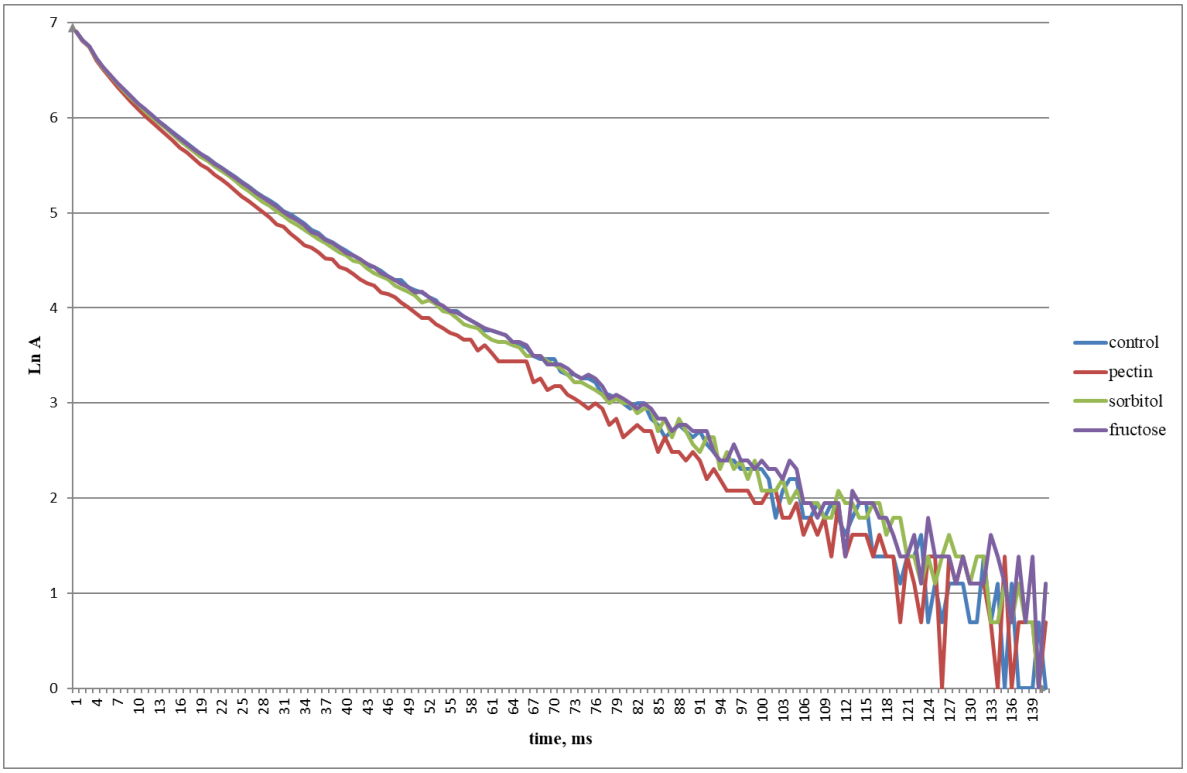
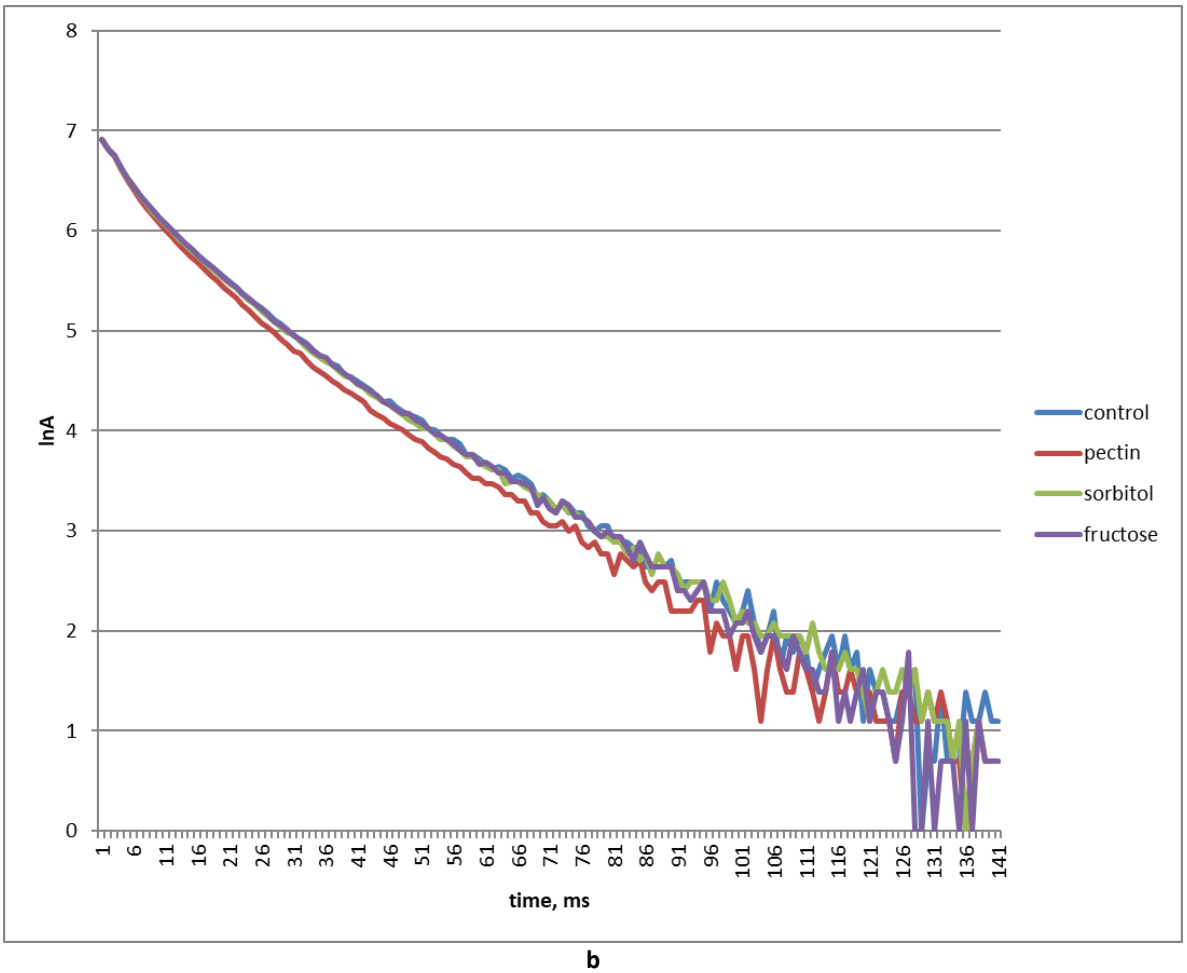


a



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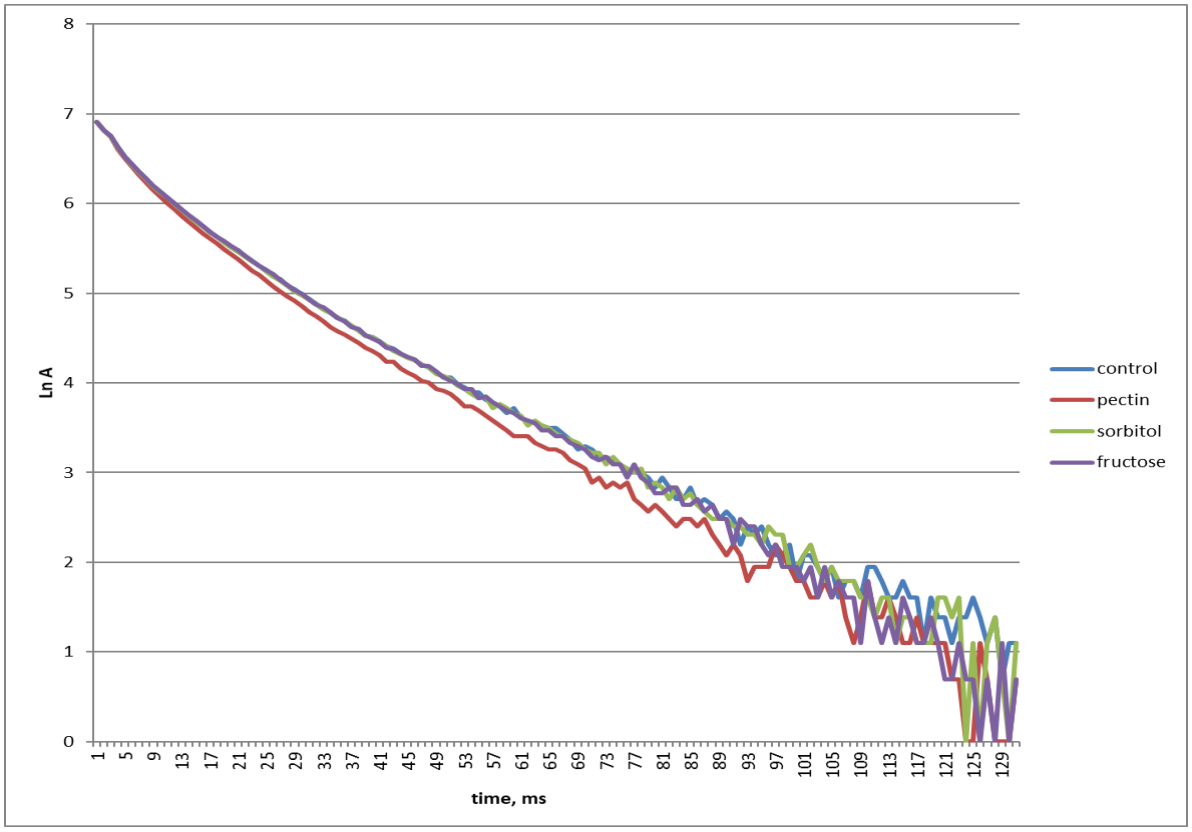

c

Figure 3: a) water absorbing ability of dough after mixing with the addition of pectin, sorbitol, fructose, b) water absorbing ability of dough 15 minutes after mixing with the addition of pectin, sorbitol, fructose, c) water absorbing ability of dough 30 minutes after mixing with the addition of pectin, sorbitol, fructose

It was found that the absorption of water, in the dough with the addition of pectin, is more intense in comparison with the control, fructose and sorbitol [9]. The binding of moisture, in the case of adding pectin during kneading, begins for the first time minutes after kneading. In the case of adding sorbitol, the binding of moisture begins 15 minutes after kneading the dough and in a sample with fructose after 30 minutes. The obtained results prove that the pectin introduced into the dough has the best water-absorbing ability, in comparison with the control, sorbitol and fructose. This result for IPN shows the advantage of pectin compared to other cryoprotectants, since the moisture in the bound state prevents the formation of ice crystals, which prevents the death of yeast cells.

It can be seen from Figure 3 (c) that if cryoprotectants are added to the dough, the moisture in the systems is mainly in the W_1 form and W_2 - the form, unlike the control sample, which contains up to 15% free moisture, 30 minutes after mixing, which is undesirable factor in freezing the dough.

CONCLUSION

Consequently, the conducted studies allow us to conclude that the use of pectin as a cryoprotector made it possible to preserve a greater number of yeast cells and at the same time they are in an active state.

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