

Improving the Preservation Methods of Quality Characteristics During Long-Term Storage of Bread

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Abstract— This article presents the results of a study on the use of betulin nanosuspension in order to increase the shelf life of bread made of wheat flour. The content of betulin in nanosuspension is 0.5%. The dosage of nanosuspension in the amount of 2% by weight of the flour corresponds to the recommended daily dose of betulin. Betulin nanosuspension has the ability to increase the bioavailability of the dispersed phase due to the micronization of insoluble betulin and to decent resistance to gravity separation. The best positive effect is established from the use of betulin nanosuspension in combination with lecithin: the strength characteristics of the dough loosening and product volume increase, the crumb's rheological properties change, the thin-walled small-pore structure is formed, the crumbiness of the sample with the betulin nanosuspension after 120 hours is 50% lower than in the control sample.

Keywords—bread freshness, nanosuspension, betulin, emulsifier.

I. INTRODUCTION

Grain products can not be stored for a long time, as they are subject to drying, aging and microbiological deterioration. Under normal storage conditions, consumer properties of bread gradually deteriorate, and under adverse conditions it may become moldy or deteriorate as a result of the development of rope spoilage.

Therefore, the problem arises of the maximum preservation of consumer freshness of bread products [1-13]. By consumer freshness is meant a set of quality indicators, the level of which practically differs little from the indicators of a fresh product. Practically fresh bread should have a good compressibility of the whole product, the necessary softness and elasticity of the crumb, a pleasant taste and a fairly intense aroma.

Development of recipes of wheat bread, preserving nutritional value and a set of necessary consumer properties within 7-10 days is one of the innovative directions of the food industry. In the context of industrialization the development of this direction is primarily due to the territorial length of the Russian Federation and the complexity of logistics operations in severe climatic conditions [14]. The production of bread is organized around the clock, and trade is usually done during the day, in connection with which the consumer receives bread with signs of stale. When storing bread products, the process of drying bread products, mainly crusts and subcortical layers of the crumb, occurs, which gives the products the excessive hardness - rigidity. In parallel with this, the process of the

aging of the colloidal crumb systems, first of all, starch, and then the protein part, is going on. These changes cause hardening of the crumb structure and its crumbiness. During storage, the aroma of bread deteriorates, as evidenced by a decrease in the content of bisulfite-binding compounds.

In order to increase the period of preservation of the freshness of bread, it is necessary, firstly, to minimize its drying during storage, and secondly, to add substances that slow down or mask the process of staling.

The purpose of these studies was to develop ways to preserve the freshness of long-life bread.

II. METHODS

Betulin (triterpenoids in nature are found in fruits and vegetative parts of plants) - for example, birch bark extract contains triterpenes such as: betulin, betulinic acid, betulon. In terms of their beneficial effect, the triterpenes of the lupane series are not inferior to tanites and dihydroquertecins, they also have diverse - hypolipidemic, hypocholesteric, antioxidant, antiseptic activity.

The greatest difficulty in its use is the sparingly soluble in water and organic solvents, the crystalline form of its existence in a free form. The principal factor constraining the practical use of betulin in pharmacology is its low solubility in water. Betulin (molecular weight 442.7 g / mol) - a crystalline substance in the form of white or yellowish needle crystals, slightly soluble in organic solvents, fats, practically insoluble in water (solubility in water 0.9 g / 100 g at 20 °C)[15].

Today there is a growing interest in the use of nanosuspensions in the food industry due to their potential health benefits associated with their consumption:

1. Nanosuspensions have the ability to increase the bioavailability of the dispersed phase, and their small particles contribute to a smooth and creamy organoleptic property.
2. Nanosuspensions can be designed as transparent or translucent, with good resistance to gravity separation.
3. These unique characteristics make them attractive for use in multi-functional products.

To prepare a safe suspension with a high degree of dispersion, selection of high-quality and multifunctional surfactants is necessary.

The objects of study were samples of dough and bread made from wheat flour of the highest grade, with the addition of Betulin nanosuspension in the amount of 2% by weight of

the flour [16]. The control served as a sample of bread without the addition of a betulin nanosuspension.

Experienced options:

- Option 1 - nanosuspension of betulin with calcium emulsifying agent lactylate stearoyl;
- Option 2 - Nanosuspension of betulin with an emulsifier of polyglycerol fatty acid esters;
- Option 3 - nanosuspension of betulin with emulsifier lecithin.

For research, the dough was prepared using the straight method according to GOST 27669-88 “Baking wheat flour. Method test laboratory baking bread”.

III. RESULTS

The dough is kneaded by hand. At the beginning, they poured some of the water with the pressed yeast diluted in it, then the rest of the water with a dissolved amount of salt, betulin nanosuspension, and added flour in two steps. Dough kneading time was 7 minutes. The initial temperature of the dough was 28 °C; the final temperature of the dough was 29 °C.

Dough fermentation conditions - at a temperature of 35 °C and relative air humidity of 75%.

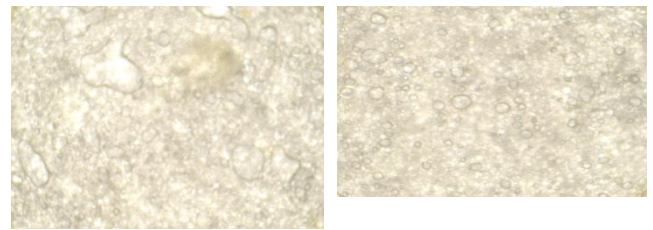
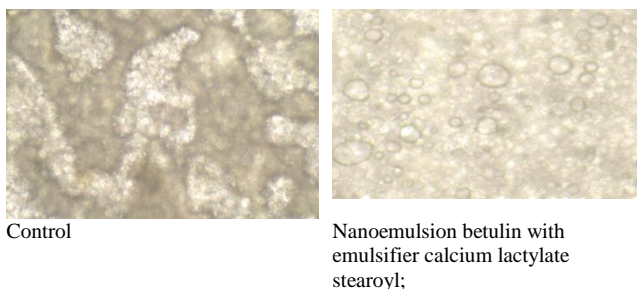
The humidity of the dough, the change in the volume of dough during fermentation, the acidity at the end of fermentation, the duration of proofing of dough pieces (in minutes) are presented in Table 1.

TABLE I. QUALITY INDICATORS OF DOUGH DURING FERMENTATION

Experienced options	Indicators						
	Humidity, %	The volume of dough during fermentation, cm ³				Acidity, deg	τ proofing dough pieces, min
		at the beginning of fermentation	In 30 min	In 60 min	In 90 min		
Control	42.0	130	200	277	324	2.2	40
Option 1	42.5	130	203	254	320	2.6	45
Option 2	42.5	130	220	310	340	2.4	45
Option 3	42.5	130	210	310	350	2.4	45

The dough with the addition of nanosuspension betulin (options 1 and 3) in the kneading is more plastic and elastic, with well-developed gluten (visual analysis). After 30 and 60 minutes of fermentation, the volume of the test control and test samples increased markedly.

The effect of betulin nanosuspension on the microstructure of dough is shown in Figure 1.



Nanoemulsion of betulin with emulsifier polyglycerol of fatty acids Betulin nanoemulsion with lecithin emulsifier

Fig. 1. Effect of betulin nanosuspension with different emulsifiers on dough microstructure.

The figures clearly show that the protein matrix is developed; the starch grains and air bubbles in the test sample are most evenly distributed (option 3). Uniform distribution of the fractional composition leads to improved rheological properties of the dough and bread quality.

Table 2 shows the average results of physico-chemical and organoleptic assessment of the quality of bread.

TABLE II. EVALUATION RESULTS OF THE BREAD QUALITY

Name of bread quality indicators	Prototypes of the bread			
	Control	Option 1	Option 2	Option 3
Porosity of bread, %	73.0	76.0	74.0	77.8
Specific volume, cm ³ /g	3.40	3.85	3.62	4.40
Dimensional stability, (H/D)	0.45	0.48	0.46	0.52
The humidity of the crumb, %	41.0	42.0	42.0	42.5
Acidity, deg	2.5	2.5	2.2	2.6
Structural and mechanical properties of crumb, ΔH gen.	17.2±1.5	18.6±1.8	19.8±2.0	21.4±1.7
ΔH plast	12.2±2.1	12.8±2.5	13.6±2.0	14.2±2.2
ΔH elast	5.0±0.4	5.8±0.5	6.2±0.6	7.2±0.4
Organoleptic evaluation three hours after baking, points	96	97	96	99

A positive effect from the use of betulin emulsion has been established: in all respects: the strength characteristics of dough loosening and product volume increase, the rheological properties of the crumb change, a thin-walled, fine-porous structure is formed.

According to research, we can conclude that the sample of bread using the betulin nanosuspension with lecithin emulsifier (option 3) had the most optimal characteristics.

Prototypes of bread were put in storage and the state of freshness of bread was evaluated by organoleptic and physico-chemical parameters.

Bread samples were stored in plastic packaging without clamping the neck of the bag at a temperature of 20 ± 2, recording changes in quality indicators.

Evaluation of the freshness of products was carried out on a 100-point scale [16]. When evaluating the total scores are

divided into categories as follows: “very fresh” - 100.0-80.0, “fresh” - 79.9 - 60.0, “moderately hard-bodied” - 59.9 -40.0, “stale” -39.9 - 20.0, “very stale” - below 19.9 points.

The sample, in which the organoleptic quality assessment of bread showed that adding porousness of betulin to the nanosuspension improves crumb porosity, it becomes more developed, uniform, delicate and elastic, retains freshness for seven days, compared to the control, signs of staleness appear on the third day of storage.

The freshness of bread is determined by such quality indicators as crumbiness, crumb hydrophilicity, amount of shrinkage, change in crumb moisture, and the amount of aromatherapy compounds. Figure 2 shows the results of a point organoleptic evaluation of bread during storage.

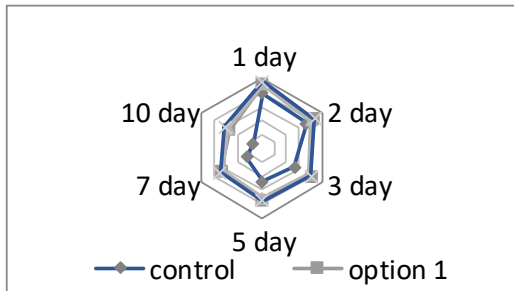


Fig. 2. Profilogram of organoleptic evaluation of bread during storage

The crumbiness increases during crumb storage; after 120 hours in the control sample it was 12%, in the samples with nanosuspension of betulin from 6 to 8%. The magnitude of shrinkage in betulin nanosuspension samples was significantly lower than in the control sample.

IV. CONCLUSION

The researchers believe that surface-active substances form a complex with an amylose fraction of starch, in which the linear fraction of starch, amylose, forms a helical configuration that includes a monoglyceride molecule. This compound is water insoluble. The practically immobile amylose fraction forms a gel phase between starch granules. This results in a softer crumb of baked bread. The formation of complexes between monoglycerides and amylose has a great effect on storage. During the formation of complexes, the flexibility of amylose molecules decreases and, consequently, the rate of its retrogradation, and hence of starch, decreases. This phenomenon is associated with an increase in the compressibility of the crumb of bread and the delay in its staling (as a result of a decrease in the rate of crystallization of starch).

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