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DESCRIPTION OF THE INFLUENCE OF FREEZING ON THE QUALITY OF EGG-WHITE CREAMS FOR PASTRIES

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Abstract: *Egg-white creams are used for decorating pastries and have high humidity, which means short storage terms, due to fast microbiological activity. Storage prolongation of creams for pastries can be reached by freezing. After freezing-defrosting organoleptic, physical, chemical and microbiological parameters, and their structural-mechanical properties in creams samples were determined. The results show that sensory and physical-chemical indicators of defrosted samples after 30 days remain unchanged in comparison with the indicators of creams before freezing; after 90 days the consistency, stability and forming ability significantly changed. So, 90 days of storage in freezer conditions is inappropriate. In the further studies of defrosted (after 30 days) samples quality indicators show that the recoverability, morbidity and plasticity significantly differ from the structural-mechanical properties of the fresh cream, which means that it is more expedient to freeze creams in composition with pastries. The study of sorption processes showed that if the storage humidity reaches 70%the samples will start to dry out. After studying the microbiological parameters, the maximum storage terms after defrosting were determined.*

Keywords: *pectin, semi-finished goods, sodium alginate, long storage, microbiological parameters.*

1. Introduction

Egg-white creams are finishing products for pastries decoration. They give them special taste and aroma. Creams have a smooth structure with high concentration of air, which is saturated with mass during whipping. Density of egg-white cream is 520±60 kg/m3, moisture content – 30±2 [1]. High humidity of raw egg-white creams is a favorable environment for the development of microorganisms, including pathogens. To prevent the negative impact of microorganisms different preservative agents - sorbic and benzoic acids and their salts are used. However, the introduction of chemical agents is harmful to the human body, so their number is strictly regulated [2], [3].

Question of the hour is the prolongation of the storage life of such products without affecting on their nutritional value. Recently, manufacturers use freezing of dairy creams as a method of storage more frequently [4], [5], [6], [7]. However, detailed studies on frozen pastry with raw egg-white creams in the literature were not found.

Even small variations in the process can cause instability and inconsistency of production quality indicators. To prevent sedimentation and to ensure the microbiological stability of cream various technological methods are used, such as baking, boiling and addition of different

structurants [8], [9], [10]. Biological value of creams is low, so we propose to enrich them with blackberry and sea-buckthorn puree, because these berries are rich in vitamins, minerals and dietary fibers [11], [12].

The use of sodium alginate, pectin with different degree of methoxylation and dietary fibers (berries puree) in technologies of egg-white creams promotes the stabilization of it. Also, it helps to form small ice crystals both in cells and intercellular space (much smaller than in creams without structurants).Therefore, the product does not "flow" while defrosting [13], [14], [15]. That's why it was interesting to determine the effect of freezing and defrosting on the quality parameters of creams with improved recipes [16].

2. Material and Methods

Samples of egg-white creams: with sodium alginate and low-methoxy pectin (SA and L-pectin), with sodium alginate and high-methoxy pectin (SA and H-pectin), with blackberry puree and sea-buckthorn puree were frozen to -25 °C in special plastic containers (1000 cm^3). The time of absolute freezing was fixed by measuring the temperature inside samples. Complete freezing of creams was reached after 6 hours.

Frozen cream samples were stored for 30 and 90 days at the temperature of -25 ° C. Defrosting process took place at a temperature of +4...+6 ° C. Creams were fully defrosted in 5 hours.

Sorption processes were determined on Mc Bean scales with precision ±0.001 mg.

The structural and mechanical properties were determined with Structurometer ST-1. Results were calculated by formulas 1-3:

$$M = \frac{H_0 - H_1}{H_0 + H_1} \quad (1)$$

$$P = \frac{H_0 - H_2}{H_0 + H_1} \quad (2)$$

$$RA = 1 - \frac{H_0 - H_2}{H_0} \quad (3)$$

where M – morbidity, P – plasticity, RA – recoverability, H_0 – height before pressing, H_1 – general deformation, H_2–elastic deformation.

Descriptive analysis was used to evaluate smell, taste, color and consistency of samples. About 20 g of sample from each cream were dispensed into small plastic cups and served to judges (20 trained people). The evaluation session was conducted at room temperature. Drinking water was provided for mouth rising between samples.

The density of cream was obtained by weighing a cup filled with 100 ml sample.

Microbial determination was done in compliance with LVS ISO 21257-2:2008.

pH was measured by AZ-8690 pH-meter, precision 0.01(standard method LVS ISO 5542:2010).

Moisture content was determined by verified balance with precision ±0.001g; mass loss was determined by weighing samples on scales (LVS ISO 1442: 1997).

3. Results and Discussion

One of the most important quality parameter of pastries is sensory evaluation.

The comparison of samples before and after freezing-defrosting showed that in general the indicators didn't change. Sensory evaluation of defrosted after 30 days storage samples suggest that all the indicators remain unchanged compared to indicators of creams before freezing. So, smell, color, taste are inherent with fresh creams. But some changes were noticed in consistency.

The consistency of cream remains homogeneous, even fluffy, but forming ability is worse than before freezing.

Table 1

Sensory indicators of egg-white creams

Indicators		**Egg-white cream with H-pectin and SA**	**Egg-white cream with L-pectin and SA**	**Sea-buckthorn cream**	**Blackberry cream**
Color	Before	White, correspond to its normative		Light orange color	Light viola color
	30				
	90				
Taste	Before	Sweet		Sweet with sea-buckthorn taste, little bit sour	Sweet with blackberry taste
	30				
	90				
Aroma	Before	Correspond to egg-white cream		Pleasant odor of sea-buckthorn or blackberry	
	30				
	90				
Consistency	Before	Smooth, lush, well structured, stable, good forming ability			
	30	Smooth, less lush, well structured, enough forming ability, stable		Smooth, enough lush, well structured, well forming ability, stable	
	90	Not stable, smooth, structure is weak, forming ability is bad			

After 90 days all the samples retained their color, taste, and other indicators. However, the consistency significantly changed, it is not stable, not structured enough and the forming ability is very bad. Results of the stability analysis of 30 days frozen creams show that creams after freezing-defrosting retain their stability for 3 days, on the 4th day the stability is 94-97%, while at freezing during 90 days the stability is already lost after 2 days, on 3rd day the stability is 89-93%. So, samples after 90 days of storage lose its consistence and are unstable after 2 days. That indicates the infeasibility of using 90-day freezing of egg-white creams. To set the feasibility of 30 days freezing physical and chemical properties were determined.

The density and active acidity remained unchanged, and the humidity varies slightly in creams. For example, in a sample of the cream with L-pectin and with blackberry puree the humidity increased. Moisture parameters deviate at1% and remain within the norm, because the creams with hydrocolloids can bind more water [17].

While freezing-defrosting two main processes occur: cryodenaturation of protein and partial syneresis of protein-polysaccharide gel that impairs its quality. In creams with complex of hydrocolloids pectin and sodium alginate, they firmly bind water, preventing changes in the structure of protein molecules and preventing denaturation processes. But during long-term freezing polysaccharide frame also undergoes compression.

Of course, the structural-mechanical parameters in protein creams vary.

Table 2

Physical and chemical indicators of creams after 30 days freezing

Indicators	Egg-white cream with H-pectin and SA		Egg-white cream with L-pectin and SA		Blackberry cream		Sea-buckthorn cream	
	before	after	before	after	before	after	before	after
Density, kg/m³(±2.9)	482	482	485	485	506	506	514	514
Humidity,% (±0.75)	28	28	28	29	30	30	30	31
Active acidity(±0.03)	4.8	4.8	5.3	5.3	4.7	4.7	5.1	5.1

Table 3

Structural-mechanical indicators of creams

Indicators		Plasticity,% (±2)	Morbidity,% (±1.5)	Recoverability,% (±3)
Egg-white cream with H-pectin and SA	before	19.8	17.1	69.9
	after	25.8	29.5	60.2
Egg-white cream with L-pectin and SA	before	14.7	18.9	62.0
	after	32.1	36.8	53.1
Blackberry cream	before	17.0	17.8	71.8
	after	25.0	30.1	61.6
Sea-buckthorn cream	before	26.0	28.0	63.4
	after	34.3	41.1	51.4

The analysis of received data shows that in defrosted samples plasticity and morbidity significantly increase compared to samples that have not been frozen. The dependence between different types of creams remains the same as in cream samples before freezing. These changes can be associated with partial syneresis of protein-polysaccharide complex and some cryodenaturation. As a result of this processes recoverability decreases. These results show the infeasibility of freezing creams as semi-finished goods, it is better to freeze them as a part of finished pastry.

Studying the sorption processes of creams after defrosting allows to give the recommendations of storage conditions and implementation of cakes and pastries with protein cream after freezing and defrosting.

The isotherms show that after thawing samples have different natures of the hysteresis loop with or without puree. Sorption for all samples in the area begins on monomolecular layer. Thus, the value of water adsorbed is the same for all samples – about 1%. In the area of multimolecular adsorption significant changes in the nature of the samples saturation water vapor also occurs. Sorption is carried out slowly; maximum value for φ = 75% ranged 2-7%.The most significant modification curves are in the area of capillary moisture - the third zone. Adsorption curve rises sharply. However, the greatest values φ = 100%, the amount

of adsorbed moisture of all samples is about the same and ranges from 60-68%. This means that the samples will behave almost identically during storage, slowly remove water – similar to the classic egg-white cream.

With the relative humidity φ = 75% samples of creams will dry out.

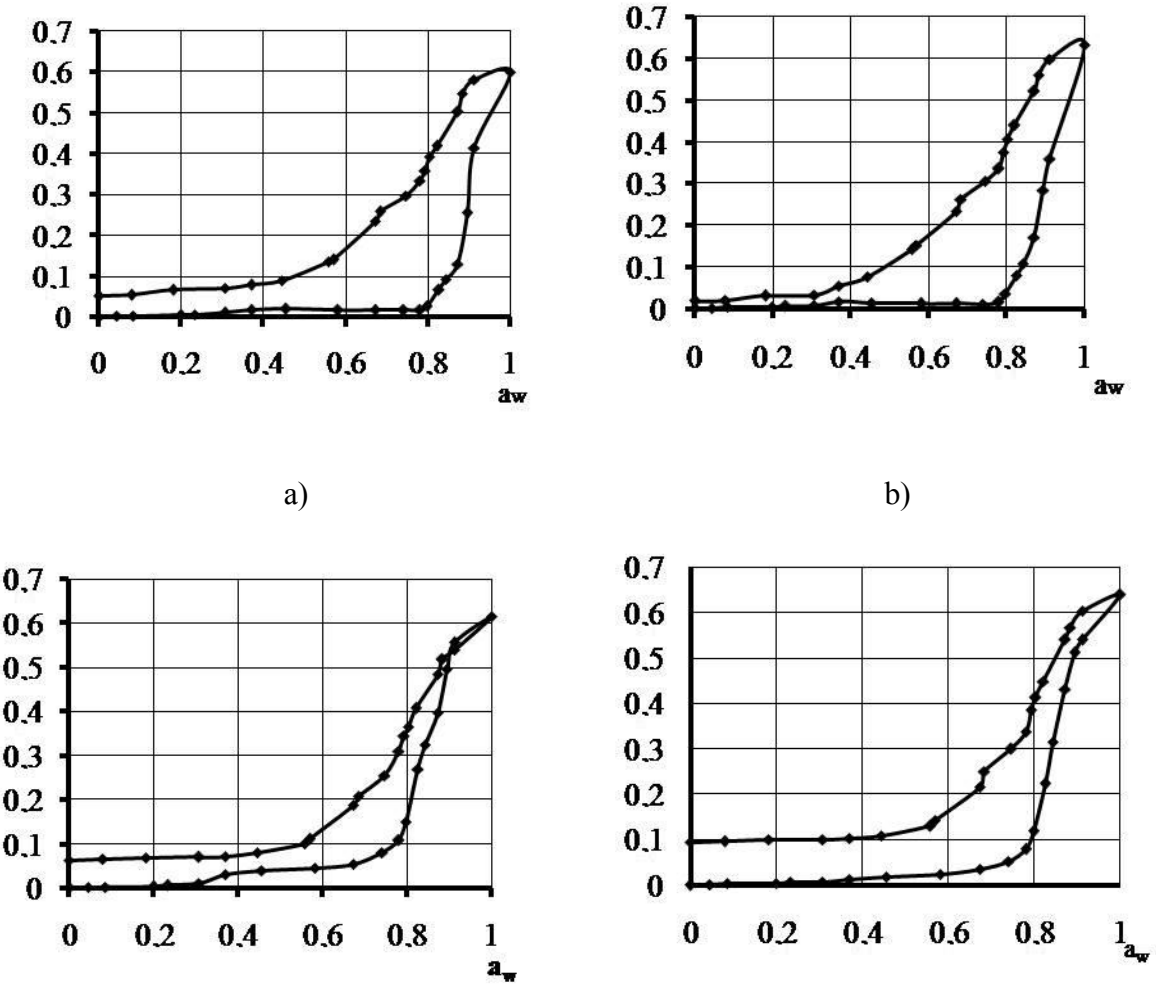

Fig. 1 – Sorption isotherms of defrosted creams with SA and L- pectin (a), with SA and H- pectin (b), sea-buckthorn puree (c), blueberry puree (d)

Previous research showed that freezing-defrosting increases the amount of free moisture in creams, microbial activity could increase. It would determine the microbiological samples protein creams after thawing.

Determination was conducted for 4 days. Microbiological analysis of samples of creams showed that the number of MAFAM, yeasts and molds are acceptable in 3 days of storage, after 3rd day (except creams with low-methoxy pectin) they do not correspond to requirements of normative documentation. These data suggest that the maximum period of storage after freezing is 3 days. During this time, the content of microorganisms in creams is within the norms stipulated in regulatory documents for cakes and pastries.

Table 4

Microbiological indicators of creams in 1 g

Day of storage	Cream	MAFAM		SUB	Bacteria	Fungi and yeast	
		norm	result			norm	result
1	Egg-white cream with H-pectin and SA	1.0×10^4	5.3×10^2	2.1×10^2	0.6×10^2	100	<10
2			6.9×10^2	3.8×10^2	1.6×10^2		30
3			8.3×10^3	4.2×10^2	7.1×10^2		50
4			8.9×10^3	2.3×10^3	9.9×10^2		130
1	Egg-white cream with L-pectin and SA	1.0×10^4	2.1×10^2	1.1×10^2	1.0×10^2	100	<10
2			6.6×10^2	2.3×10^2	1.0×10^2		10
3			6.4×10^3	3.4×10^2	6.8×10^2		50
4			8.4×10^3	1.1×10^3	8.9×10^2		90
1	Blackberry cream	1.0×10^4	2.4×10^2	1.5×10^2	1.0×10^2	100	10
2			2.9×10^2	1.6×10^2	1.8×10^2		40
3			3.1×10^3	1.9×10^2	7.2×10^2		40
4			7.6×10^3	1.0×10^3	1.4×10^3		110
1	Sea-buckthorn cream	1.0×10^4	2.4×10^2	1.4×10^2	1.5×10^2	100	10
2			4.0×10^2	2.4×10^2	2.5×10^2		40
3			4.3×10^3	8.4×10^2	7.9×10^2		80
4			9.6×10^3	1.2×10^3	9.7×10^2		100

4. Conclusions

The organoleptic and physical-chemical properties are not affected, moisture is increased and stability – decreased because of partial cryodenaturation of protein, and some syneresis of gel. The optimal period of storage in frozen state of our creams is 30 days. The structure of creams corresponds to the norm, structural and mechanical properties show that creams should be frozen as a finished product but not semi finished. Analyses of microbiology and stability indicators allow us to determine the maximum period of defrosted creams storage - 3 days. Received results of research indicate the feasibility of egg-white creams freezing as the way of storage life prolongation.

5. References

[1]. JAKUBCZYK, E., NIRANJAN, K., Transient development of whipped cream properties. Journal of food engineering, 77.1: 79-83, (2006)

[2]. STEWART, C. M., COLE, M. B., SCHAFFNER, D. W., Managing the risk of staphylococcal food poisoning from cream-filled baked goods to meet a food safety objective. Journal of Food Protection, 66.7: 1310-1325, (2003)

[3]. HAN, F., et al., Determination of benzoic acid and sorbic acid in food products using electrokinetic flow analysis–ion pair solid phase extraction–capillary zone electrophoresis. Analytica chimica acta, 618.1: 79-85, (2008)

[4]. CAMACHO, M. M., MARTÍNEZ-NAVARRETE, N., CHIRALT, A., Stability of whipped dairy creams containing locust bean

gum/λ-carrageenan mixtures during freezing–thawing processes. Food research international, 34.10: 887-894, (2001)

[5]. SELOMULYO, V. O., ZHOU, W., Frozen bread dough: Effects of freezing storage and dough improvers. Journal of Cereal Science, 45.1: 1-17, (2007)

[6]. DENG, J., et al. An improved protocol for rapid freezing of protein samples for long-term storage. *Acta Crystallographica Section D: Biological Crystallography*, 60.1: 203-204, (2004)

[7]. LEWIS, D. F. Microstructure of frozen and dairy-based confectionery products. *Structure of dairy products*, 236-258, (2007)

[8]. VAN DER PLANCKEN, I., VAN LOEY, A., HENDRICKX, M. E., Foaming properties of egg white proteins affected by heat or high pressure treatment. *Journal of Food Engineering*, 78.4: 1410-1426, (2007)

[9]. MUTHUKUMARAN, A., RATTI, C., RAGHAVAN, V., G., Foam-mat freeze drying of egg white and mathematical modeling Part I optimization of egg white foam stability. *Drying Technology*, 26.4: 508-512, (2008)

[10]. YANG, X., FOEGEDING, E. A., Effects of sucrose on egg white protein and whey protein isolate foams: factors determining properties of wet and dry foams (cakes). *Food Hydrocolloids*, 24.2: 227-238, (2010)

[11]. HASSIMOTTO, N. M. A., et al. Physico-chemical characterization and bioactive compounds of blackberry fruits (Rubus sp.) grown in Brazil. *Food Science and Technology (Campinas)*, 28.3: 702-708, (2008)

[12]. ZEB, A., Chemical and nutritional constituents of sea buckthorn juice. *Pakistan Journal of Nutrition*, 3.2: 99-106, (2004)

[13]. REGAND, A., GOFF, H. D., Structure and ice recrystallization in frozen stabilized ice cream model systems. Food Hydrocolloids, 17.1: 95-102, (2003)

[14]. THIEBAUD, M.; DUMAY, E. M.; CHEFTEL, J.-C., Pressure-shift freezing of o/w emulsions: influence of fructose and sodium alginate on undercooling, nucleation, freezing kinetics and ice crystal size distribution. *Food Hydrocolloids*, 16.6: 527-545, (2002)

[15]. FAYDI, E.; ANDRIEU, J.; LAURENT, P., Experimental study and modelling of the ice crystal morphology of model standard ice cream. Part I: Direct characterization method and experimental data. *Journal of Food Engineering*, 48.4: 283-291, (2001)

[16]. KAMBULOVA, J., SOKOLOVSKA I., Studying the influence of structure forming agents on egg white foaming process. Science works of NUFT, 50: 113-118, (2013)

[17]. SMIDSRØD, O., Molecular basis for some physical properties of alginates in the gel state. Faraday discussions of the Chemical Society, 57: 263-274, (1974)