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MICROBIAL CHARACTERISTICS OF EGG-WHITE CREAMS WITH REDUCED SUGAR

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Abstract: *One of the most relevant problems in developed countries is the reduction of free sugars in confectionary goods. The article focuses on the microbial analysis of egg-white creams for cakes and pastries decoration with reduced sugar. It was determined the possibility of replacing the traditional sucrose by fructose or glucose in the technology of egg-white creams production. The results of research showed the possibility of reducing sugar in creams up to 40%. Sugar gives the products high dry matter content. Sugar reduction causes the growth of free humidity content and microbial activity in confectionary goods. The free humidity binding is provided by complex of polysaccharides – pectin and sodium alginate. The binding ability of structurants provides minor changes in humidity and pH of egg-white creams during storage. Creams with reduced sugar correspond to all the State standard requirements by microbial indicators. New recipes could be used in the production of cakes and pastries decorated by egg-white creams.*

Keywords: *glucose, fructose, sucrose, microbial activity, polysachharide complex.*

1. Introduction

In the new "Guideline: Sugar intake for adults and children" of The World Health Organization recommendations of reducing consumption level of free sugars are given [1-2]. Consumption of free sugars by adults and children should be reduced to less than 10% of the total caloric content of consumed food. A decrease to less than 5% of the total caloric content of consumed food will provide further health benefits. Based on these recommendations, developed countries have identified priority ways to improve the technology of food products, especially confectionery products with reduced sugar [3-5].

Previous studies determine that it is possible to reduce sucrose about 25% in the recipe of egg-white creams that are common semi-finished goods for cakes and pastries decorating [6]. Along with this, we have proposed to improve technological scheme of egg-white creams production and special diet food, which replaces sucrose by glucose or fructose. In new recipes the normative quantity of glucose is decreased about 30% in comparison to traditional recipes. The quantity of fructose is decreased about 40% without compromising the structural-mechanical, physico-chemical and organoleptic properties.

But, accordance to such parameters as high stability and sweetness of creams with reduced sugars is not enough for such product as egg-white cream. The determining factor to reduce sugar complies with the requirements of regulatory documents by microbial parameters of creams. Egg-white creams refer to products with high water activity in which (aw) 0.88-0.98. In such systems, a variety of bacteria, mold, and yeast can develop [7-9]. Sugar is a natural preservative [10-13], and the concentrations of sugar used in creams as a rule prevent the rapid growth of microorganisms. Therefore, the indicators of microbial safety were studied in creams with reduced sugars.

2. Matherials and methods

Three samples were analyzed: egg-white cream with sucrose (-25%), egg-white cream with glucose (-30%), egg-white cream with fructose (-40%). To stabilize the structure of egg-white foam, a complex of natural stabilizers – pectin and sodium alginate was introduced in cream recipe. Cream with sucrose and fructose is produced with technological scheme for raw protein cream. This scheme includes the preparation of prescripted components, whipped egg-white with sugar and addition of citric acid. To make cream with glucose, the technological scheme of custard egg-white cream was used. The syrup of glucose and maltose treacle was brewed and introduced (T ~ 90˚C) in egg-white foam during whipping. According to the recommended storage rules of creams by the Ukrainian standard [14] the shelf life of products decorated with raw egg-white creams is 12 hours, with custard cream –is 5 days at a temperature of 6 ± 2 ºC.

The following microbial indicators were monitored [14]: the quantity of mesophilic aerobic and facultative anaerobic microorganisms (qMAFAnM), yeasts and molds, the quantity of spore-forming bacteria (SFB), and pathogens, including Salmonella and S. aureus in number of conventional units (NCU) per 1 g. The number of spore-forming bacteria is not provided by standards for cakes and pastries in Ukraine. But, from the literature data, it is known that the high number of SFB in raw materials and finished goods may contain enough pathogenic bacteria Bacillius cereus, which is dangerous for human health [15-17]. The analysis of samples was carried out within 5 days of storage at temperatures of 6 ± 2 ºC.

The microbial determination was made 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

The results of microbial analysis are given in the table 1. The analysis of tabular data allows determining the new egg-white creams recipes with reduced sugars as safe for human health during their use (within 5 days). The microbial content of all the tested parameters does not exceed required limits. Pathogenic bacteria such as S. aureus and Salmonella were not found. This indicates that the complex of polysaccharides introduced to the system of egg-white creams has the ability of water binding. This ability allows reducing water activity, thereby preventing growth of microbial activity.

The analysis of colony morphotypes isolated from the egg-white creams shows that all the samples have several common types of microorganisms' colonies. During storage the ratios of colonies changed.

Common for all the egg-white cream samples were bacterial colonies such as white with irregular edges, round glow yellow, round white and round colorless. The main part of all colonies was coccoid. Cells of these colonies were placed singly or in clusters. They were represented by aerobic and facultative anaerobic bacteria. The correlation and changes of colonies during storage are given in figure 1.

Table 1.

Microbial indicators of egg-white creams

Indicator	Normative by Ukrainian standard (DSTU)	Time of storage, days	Cream		
			with sucrose	with fructose	with glucose
qMAFAnM, NCU in 1 g, not more than	$1.0x10^4$	–	2×10^2	1×10^2	3×10^2
		1	2×10^2	2×10^2	4×10^2
		2	3×10^2	2×10^2	5×10^2
		3	3×10^2	2×10^2	5×10^2
		4	2×10^3	1×10^3	3×10^3
		5	3×10^3	2×10^3	5×10^3
S. aureus in 1 g	Not allowed	1-6	Not found		
Salmonella in 25 g	Not allowed	1-6	Not found		
Mold funghi, NCU in 1 g, not more than	100	1	Not found		
		2	<5	<5	<5
		3	<10	<10	<10
		4	<10	<10	<10
		5	<15	<15	<15
Yeasts, NCU in 1 g, not more than	50	1-2	Not found		
		3	<5	<5	<5
		4	<10	<10	<10
		5	<10	<10	<10
SFB, NCU in 1g	Not standardized	–	1×10^2	1×10^2	1×10^2
		1	2×10^2	1×10^2	2×10^2
		2	3×10^2	3×10^2	4×10^2
		3	4×10^2	3×10^2	4×10^2
		4	5×10^2	4×10^2	5×10^2
		5	5×10^2	4×10^2	6×10^2

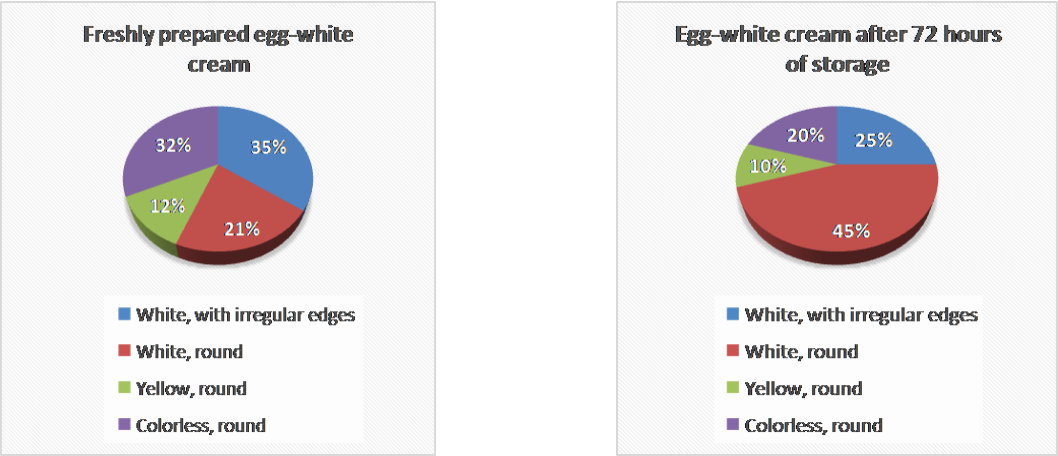

Fig. 1. Correlation of morphotypes of egg-white creams during storage

In samples of freshly made egg-white creams predominate clear round colonies of medium size (32%). During storage of the samples, the number of white round colonies of medium size (45%) increases. This is due to the ability of microorganisms of absorbing nutrients from the product and interspecific competition for nutrients.

The development of microorganisms and the rate of their growth depend on different factors such as product's composition, its properties and production environment. First of all, the growth rate determines the presence of moisture available to microorganisms. With decreasing of humidity, the intensity of the reproduction of microorganisms decreases. After reaching sthe pecified moisture, the growth of humidity content stops. The research results on how the humidity content changes in samples are given in figure 2.

The analysis of moisture changes during storage (figure 2) shows that the samples with sucrose and glucose behave identically. On the 4th night they retain the moisture content at the initial data. After 4 days of storage the samples begin to lose humidity due to desorption, so this indicator begins to decrease. On the contrary, the cream with fructose shows the ability of raising humidity. It is connected with high hydrophilic abilities of fructose. The sample starts to absorb water even when φ is about 45 ... 50%.

The pH indicator is also one of the most important factors that affect the activity of microorganisms. All the microorganisms grow well at pH 6.0-8.0. However, with a pH below 4.5 only certain types of bacteria are able to develop, including fungi and yeasts. Pathogenic bacteria at a pH below 4.5 do not reproduce. Also at increased pH, such as above 9.0, many bacteria stop their growth.

The diagram (figure 3) shows that the pH values of cream samples are optimal for the growth of microorganisms. This is another factor that reduces the activity of microorganisms. During storage the pH remains virtually unchanged, but the samples of sucrose and glucose have the trend of increasing the values. The pH value of cream with fructose decreases. The reduction of the pH values can be explained by higher moisture content in sample of fructose. It is a consequence of some higher activity of complex enzymatic of egg-white and amino acids accumulation. But even after 8 days pH does not reach the optimal values for microorganisms.

However, total acidity changes for all the samples with the same regularity (table 2).

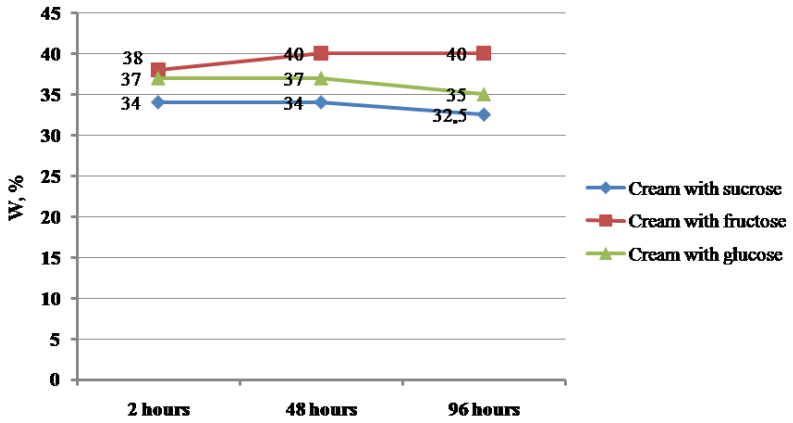

Fig. 2. Changes of humidity of egg-white creams with reduced sugar

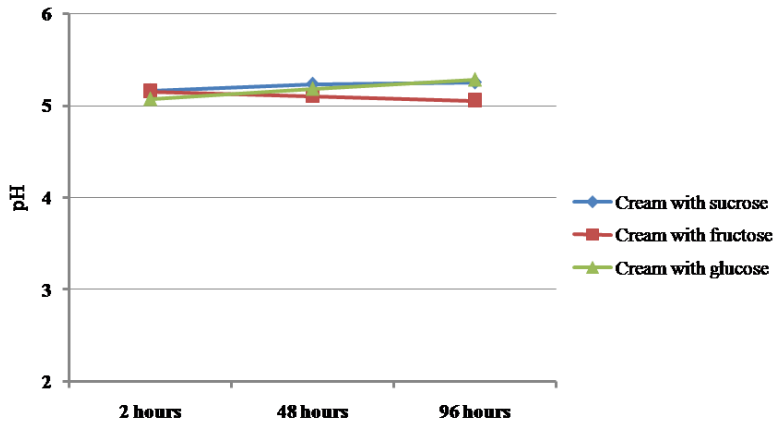

Fig. 3. Changes of pH of egg-white creams with reduced sugar

Table 2.

Changes of the total acidity of egg-white creams with reduced sugar

Egg-white cream	Total acidity					
	freshly prepared		on 4th day		on 8th day	
	degrees	% solids	degrees	% solids	degrees	% solids
with sucrose	4.2	6.36	4.9	7.42	4.7	6.96
with fructose	4.5	7.26	4.5	7.5	4.3	7.17
with glucose	4.3	6.83	4.7	7.46	3.6	5.54

In the first period of storage up to 4 days there is an increase of total acidity. It is explained by the accumulation of active acid-reacting compounds as a result of enzymatic hydrolysis of proteins.

In the second period of storage the process slows down. This happens due to a decrease of moisture content. Some substances are able of breaking down into simpler compounds and as a result the total acidity rate decreases.

The most significant decrease in terms of the tendency of accumulating acid-reacting compounds is observed for the sample with glucose.

It is connected with the start of its crystallization and therefore with the negative impact on the growth of microorganisms.

4. Conclusions

Regardless of the type of sugar in the recipe of egg-white creams all the microbial indicators correspond to the state standard.

The microflora activity does not increase during storage. This is achieved as a result of the polysaccharide complex introduction and presence of sugar as preserving agents. Binding water and reducing its activity in the product inhibit the growth of microorganisms.

At the same time, the pH of samples changes slightly during storage time. The active development of microflora prevents the changes of pH of creams that are out of bounds for optimal activity of bacteria, fungi and yeasts.

Creams produced by new recipes are safe and can be used in technology of cakes and pastries production.

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