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QUALITY ESTIMATION OF FROZEN DESSERTS WITH POLYFUNCTIONAL COMPOSITION

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Abstract:*The article analyzes the structure of consumption of animal and plant origin food products. The characteristic of milk-protein concentrates is being looked at for the purpose of their use in the technology of frozen desserts. The relevance of the development of new frozen desserts with poly-functional composition is substantiated. The technological process of production of poly-functional ingredients soy-containing protein component and protein-herbal semi-finished product is being dealt with. Formulations of frozen desserts with proteins of various origins were developed on the basis of a complex analysis of organoleptic indicators and physico-chemical characteristics. The aim of the work is to evaluate the quality of frozen desserts with poly-functional composition. The object of research is the technology of frozen desserts.It is proved that by using the graph-mathematical method it is possible to predict the quality of frozen desserts with soy-containing protein component in the range of 40...50% and protein-herbal semi-finished products at the level of 20...25%. An analysis of the amino acid composition of frozen desserts has confirmed that the introduction of protein components of different origins in formulation will lead to high biological value products.*

Keywords*: low-fat cottage cheese, soy-containing protein component, protein-herbal semi-finished product, frozen dessert, graph-mathematical method.*

1. Introduction.

In recent years, the structure of food consumption has changed dramatically. The results of dynamic observations of actual nutrition of the adult and infant population, as well as data from the State Statistics Committee of Ukraine, show a decrease in the consumption of animal products, as well as vegetable oils, fruits and vegetables. This tendency is caused by a decrease in social accessibility and an appropriate quality assortment. Most people consume cheap products with a low biological value, but a high energy content of the diet [1].

As a result of the reduction in the consumption of dairy products, the population is poorly provided with full protein, easily digestible calcium and phosphorus. In the diet of the people, the consumption of animal proteins decreased from 110 g / day (in 1990) to 78 g / day (2015) [1].

Actual questions arise in terms of adequate nutrition, with reduced content of fats, sugars and high content of complete proteins. Scientific and practical interest lay on the development and implementation of technologies of frozen desserts using milk and protein concentrates, which will reduce the cost of raw materials and lead to the production of high nutritional value food.

The raw materials for the aforementioned products are cottage cheese, soy-containing protein component and protein-herbal

semi-finished product and other traditional ingredients.

Cottage cheese is characterized by high digestibility. The main feature of cottage cheese is the high content in proteins (10... 18%), most of which is casein. The protein composition of cottage cheese contains all the essential amino acids, which determine the biological value of the product. The object of research is the technology of frozen desserts [2].

Soy protein - the main component of soy-containing protein concentrate, 88...95% is represented by a water-soluble fraction, which includes soluble globulins (60...81%), albumins (8...25%) and difficult soluble globulins (3...7%). Soybean proteins contain the necessary set of essential amino acids, which are almost identical in quality to animal protein [3,4].

The introduction of protein-herbal semi-finished products into a frozen dessert will allow the finished product being enriched by whey proteins, thus providing the daily intake of main nutrients.

An objective indicator for assessing the quality of frozen desserts is a complex analysis of organoleptic and physico-chemical characteristics.

Thus, the development of a complex assessment combining the above mentioned indicators of frozen desserts with poly-functional composition, will allow the obtainingof a product with a balanced composition and of guaranteed quality.

The main tasks of this scientific work are:

- to use the graph-mathematical method in order to establish a ratio between the milk base and protein components in the formulation of frozen desserts with poly-functional composition;
- to study the biological values of model samples of frozen desserts with poly-functional composition.

The purpose of the articleis to evaluate the quality of frozen desserts with poly-functional composition, using the graph-mathematical method.

2. Materials and methods

For the soy-containing protein component the following were used soy protein concentrate, dried skim milk, drinking water, DVS starter (*Lactococcuslactis* subsp. *Lactis*, *Lactococcuslactis* subsp. *Cremoris*, *Lactococcuslactis* subsp. *lactisbiovar. diacetylactis*). The technological process was carried out in the following sequence:

The recipe components (soy protein concentrate and skimmed milk powder) are taken into consideration in terms of quantity and quality, weighed, sifted and restored at the temperatures of 35...40 °C. For better dissolution, the resulting mixture can be maintained for 30... 40 minutes. In order to isolate the insoluble particles of dry components, the mixture is subjected to filtration. After that, the resulting mixture is pasteurized at the temperature of 76...78 °C and cooled to a temperature of inoculation of the mixture, which occurs by the starter culture at a temperature of 30...34 °C. The incubation of the mixture takes place during 6...8 hours. After that, there occurs the process of whey extraction and self-pressing and pressing of the resulted protein base (soy-containing protein component) [3,5].

The indicators of the soy-containing protein component are shown in Table 1 [3,6].

To obtain protein-herbal semi-finished products as a coagulant, the ground part of sorrel Rumex [7] was used during the thermos-acid precipitation of milk proteins at a temperature of 96...98 ° C.

Table 1

Indicators of soy-containing protein component

Indicator	Characteristic
Taste and smell	Sour milk, with a slight vegetable flavor
Structure and consistency	Homogeneous, tender, creamy
Color	White with a grayish tinge
Titrated acidity, ºT	174...180
Active acidity, pH	4.2...4.3
Mass fraction of moisture,%	74...76

According to the literature data, the water content in the leaves of Rumex is (90...92)%, protein 1.5%, total carbohydrates (3.0... 5.3)%, fiber 1%. Minerals are fixed at (mg%): Na (15), K (500), Ca (47), Mg (85), P (90), Fe (2,0), vitamins, in (mg%): C (43...81), B1 (0.19), B2 (0.1), PP (0.3), β-carotene (2.5). The amount of oxalic acid is determined - 360 mg%, which will allow the use of this type of plant material as a coagulant [8,9].

The obtained protein-herbal semi-finished product had the following qualitative parameters: the mass fraction of moisture - (64 ± 2)%, titrated acidity (80 ± 1) ° T, color - light pistachio, not uniform, consistency - mild, slightly broken on slices, to a degree tight, taste - milk-protein, cheesy, without foreign smells, with a slight herbal flavor. The parametric scheme of production of protein-herbal semi-finished products is shown in Figure 1.

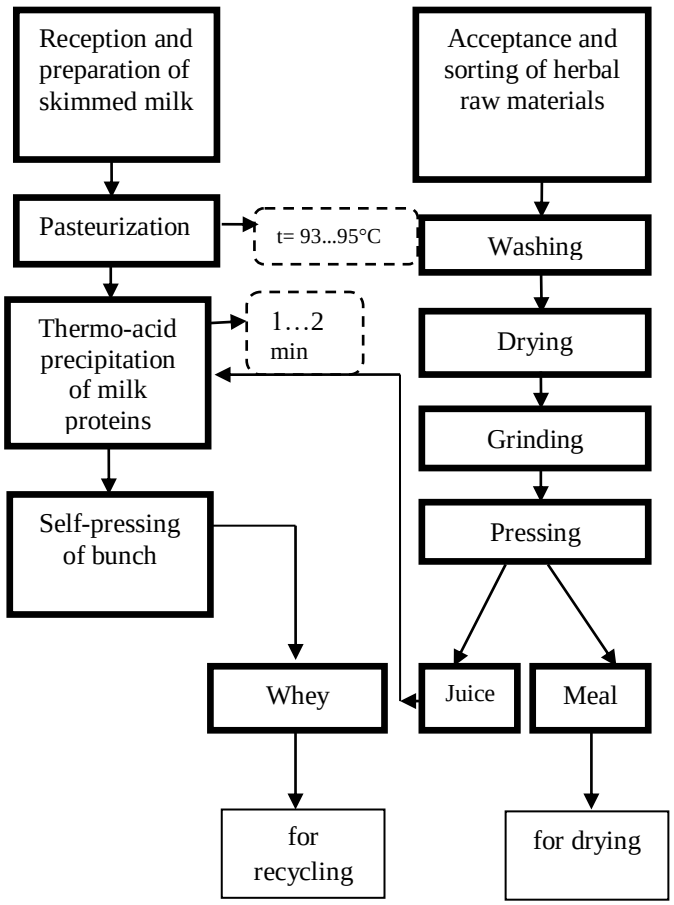

Fig. 1. Parameter scheme of production of protein-herbal semi-finished products

The determination of physico-chemical and organoleptic indicators of frozen desserts was carried out according to generally accepted methods [10].

Amino acid composition of frozen desserts – by ion-exchange liquid-column chromatography on automatic analyzer of amino acids T339.

The coefficient of difference of amino acid fast (KDAF) and biological value of protein (BV) was determined by the method M.P. Chernikov [4]. It is based on the postulate that the assimilation of EAA is limited to limiting content amino acids that is, the KDAF is the average arithmetic excess of the EAA amino acid accelerator as compared to the smallest limit of limiting amino acids. KDAF are found by the formula:

$$KDAF = (\Sigma DAF) / n, \quad (2.2)$$

where KDAF - coefficient of difference of an amino acid,%;

DAF is the difference in the amino acid rate for each NAC compared with the amino acid soon limiting amino acids, %;

n - the number of amino acids.

The smaller the value of KDAF is, the more fully used by EAA for the needs of biosynthesis. So, the biological value of the protein is calculated by the formula:

$$BV = 100 - KDAF, \quad (2.3)$$

where BV - biological value of protein,%.

The graph-mathematical method is the determination of the optimal value (point of intersection) of complex indicators by graphic representation of the simultaneous influence of two variables, which are reflected on parallel axes of the ordinate on a function, which is reflected on the axis ofabscise.

The complex indicator of organoleptic evaluation was calculated using the equations below:

$$K_a = M_t \frac{C_a}{C_b} + M_{con} \frac{Con_a}{Con_b} + M_{col} \frac{Col_a}{Col_b},$$

where M_t=0.4;M_{con},=0.3; M_{col}=0.3 – coefficients of weight of the corresponding group of indicators: taste and smell, structure and consistency, colour and appearance;

C_a, Con_a, Col_a – absolute values of the corresponding group of indicators: taste and smell, structure and consistency, colour and appearance;

C_b, Con_b, Col_b – basic values of the corresponding group of indicators: taste and smell, structure and consistency, colour and appearance.

The complex index of physical and chemical characteristics was calculated by the equations given below:

$$K_{p-c} = M_{def} \frac{Def_a}{Def_b} + M_r \frac{R_a}{R_b} + M_a \frac{A_a}{A_b},$$

whereM_a=0.4;M_{def},=0.3; M_r=0.3 – coefficients of weighting of the corresponding group of indicators: acidity, defeat, resistance to melting;

Def_a, R_a, A_a – Defb, Rb, Ab - absolute values of the corresponding group of indicators: loss, resistance to melting, acidity;

Def_b, R_b, A_b – basic values of the corresponding group of indicators: loss, resistance to melting, acidity.

3. Results and discussion

At the Department of Milk and Dairy Products Technology of the National University of Food Technologies, there were developed formulations of frozen desserts with the use of low-fat cottage cheese, soy-containing protein component and protein-herbal semi-finished product as a protein enrichment agent [3, 5, 6]. At the first stage, organoleptic and physico-chemical parameters of freshly prepared samples of frozen desserts with poly-functional components were determined. The results are shown in the Tables 2 and 3.

For an objective assessment of the quality of frozen desserts in a laboratory, a 30-point system was developed that included

the following groups of indicators: taste and smell – 15, structure and consistency – 10, colour – 5.

When defects of quality of frozen desserts were detected, a decrease in the maximum predicted score for a certain number of points was made. Frozen dessert with an estimate below 24 points - is discarded.

Table 2

Organoleptic indicators of frozen desserts with poly-functional components

Indicator	Characteristics of a frozen dessert		
	with low-fat cottage cheese	with soy-containing protein component	with protein-herbal semi-finished product
Taste andsmell	Pure, delicious sour-milk taste, without foreign flavors and odors	A pleasant sour-milk taste with a slight flavor of soy, without foreign smells	Pure, delicious sour-milk taste with a light herbal flavor, without foreign smells
Structureandconsistency	Homogeneous throughout the mass, delicate creamy		
Color	White	White, with a grayish tinge	Lightpistachio

Table 3

Physico-chemical indicators of frozen desserts with poly-functional components

Indicator	Indicator rate for frozen dessert		
	with low-fat cottage cheese	with soy-containing protein component	with protein-herbal semi-finished product
Mass fraction,%, not less: fat / sugar / dry matter	3.5/14.0/29.5	3.5/14.0/29.5	3.5/14.0/30.5
Acidity, ° T	84	80	85
Active acidity, pH	6.1	6.2	6.15
Defeat,%	54	51	52
Resistancetomelting, min	52	55	43

For the objective assessment of the influence of organoleptic and physico-chemical indicators on the consumer properties of the product, a general integrated quality index is used.

The assessment of the quality of products by the complex indicator was conducted on the following scale: 0.9...1 - rating "excellent", 0.8...0.89 - score "good", 0.7...0.79 - the score "satisfactory".

The value of a complex indicator of organoleptic evaluation and physical and chemical indices of experimental samples of frozen desserts are shown in the Table 4.

Table 4

Complex index of organoleptic and physico-chemical evaluation of frozen desserts

Indicator	Sample of frozen dessert		
	with low-fat cottage cheese (control)	with soy-containing protein component	with protein-herbal semi-finished product
Organoleptic evaluation	1.0	0.935	0.957
Physico-chemical indicators	1.0	0.942	0.95

The rational mass contribution of the protein component in the formulations of frozen dessert was determined by the graph-mathematical method [11], by assessing the optimal ratio - the milk basis: the protein component, taking into account the complex interaction of the indicators of organoleptic evaluationK_o and physico-chemical characteristicsK_{p-c} (Figure 2).

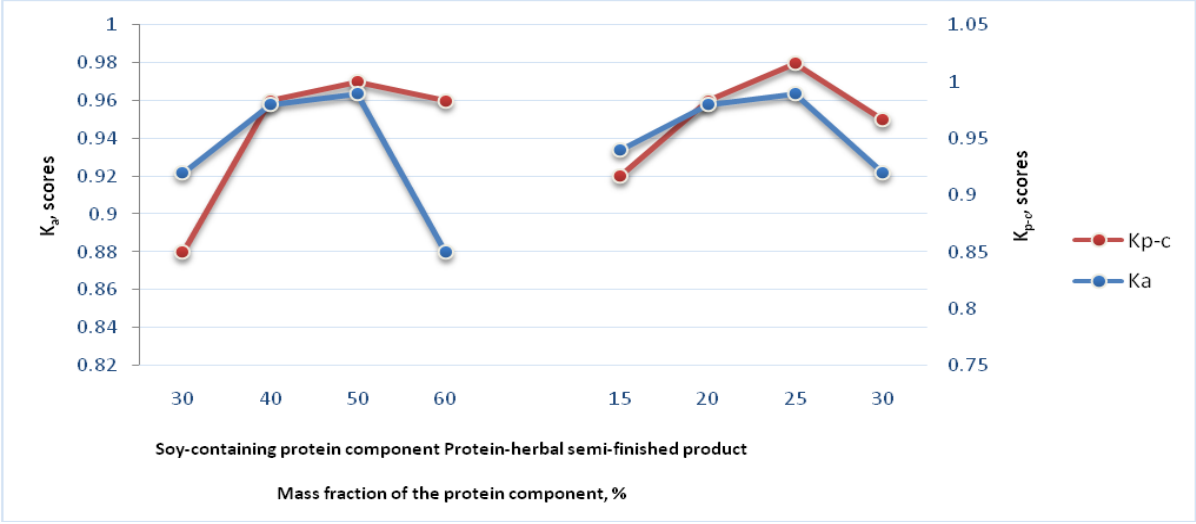

Fig. 2. Graph-mathematical method of determining the mass fraction of the introduction of protein components

As can be seen from the chart below, the optimum mass fraction of making soy-containing protein component was of-40...50%, protein-herbal semi-finished product - 20... 25%.

The technology of production of frozen desserts with poly-functional composition was carried out in three stages: the preparation of a normalized mixture (scheduled parameters: a mass fraction of fat – 3.5%, a skimmed milk residue - 12%, sugar - 14%) and protein component, mixing of the normalized milk base and protein component. The mixing of milk and protein basis is assumed with the following ratio of components:

- with use of low-fat cottage cheese - milk basis: cottage cheese, low-fat cheese, as (50... 60): (40...50);
- with use of a soy-containing ingredient-milk basis: soy-containing component, as (50...60): (40...50);
- with use of protein-herbal semi-finished products - milk basis: protein-herbal semi-finished product, as (75... 80): (20...25).

The restriction of the amount of addition of protein components is due to an increase in acidity up to 100 ° T and specific organoleptic characteristics due to the taste of the incorporated protein ingredients.

It is advisable to mix the milk base with the protein component directly before the freezing of the mixture, which ensures the addition of a homogeneous mixture to the freezer, without increasing the titratable acidity.

To study the biological value of the developed frozen dairy dessert, its amino acid composition was determined. The following samples were studied: frozen dessert with cottage cheese (control) and desserts with soy-containing component and protein-herbal semi-finished products. To assess the degree of using protein, the coefficient of difference between amino acid rate (CDAF) and biological value of protein (BV) was calculated. The difference between the amino acid rates of the essential amino acids of the experimental samples is shown in Figure 3.

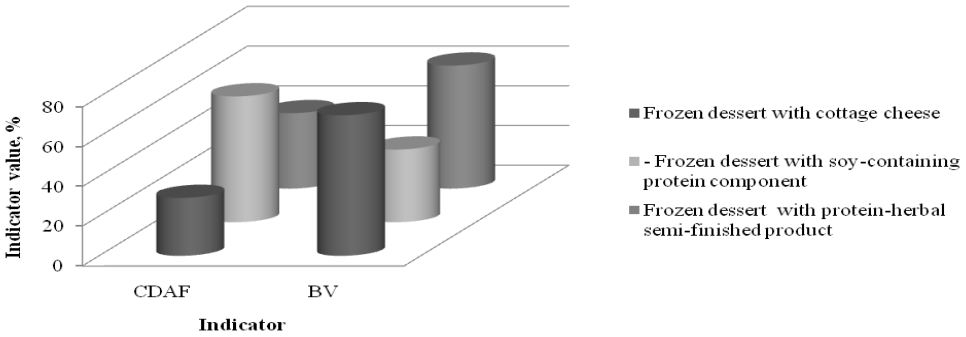

Fig. 3. Difference between the amino acid AF of the essential amino acids of the experimental samples

As can be seen from Figure 3 the maximum surplus, characteristic for frozen desserts with cottage cheese and protein-herbal semi-finished product, provides leucine, and a sample of frozen dessert with soy-containing protein component - threonine. The smaller the value of CDAF is, the more fully used by EAA for the needs of biosynthesis. The indicators of biological value (CDAF and BV) are shown in Figure 4.

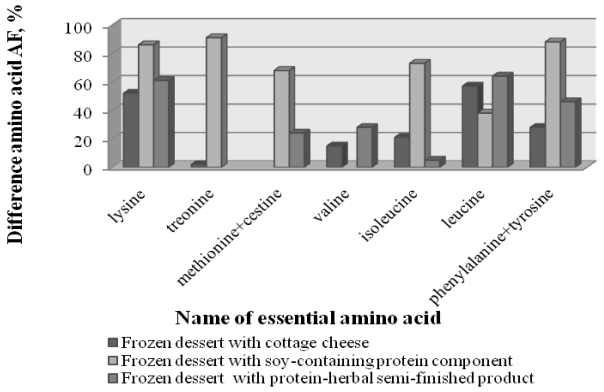

Fig.4. Indicators of biological value of experimental samples

The given biological values indicate that the introduction into the formulation of a frozen dessert of protein-herbal semi-finished products will result in a product whose biological value is 62%, which is practically close to the control sample - 71%.

4. Conclusions

1. By using the graph-mathematical method, it was established that the mass fraction of protein component in formulations of frozen milk desserts varies in the range of 40...50% (with soy-containing protein component), 20…25% (with protein-herbal semi-finished product), providing the optimal ratio of organoleptic and physico-chemical parameters of experimental samples.
2. An analysis of the amino acid composition of frozen desserts has shown that the incorporation of protein components into the formulation will provide the product with a biological value of 37% (for a protein containing protein soya) and 62% (for protein-herbal semi-finished products), respectively.

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