

ICE-CREAM WITH FUNCTIONAL PROPERTIES AS A MEANS OF COMMERCIAL NETWORKS ASSORTMENT EXTENSION AND POPULATION FEEDING IMPROVING

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Abstract

Developing public trend of healthy lifestyle popularity stimulates the growth of demand for functional products. Trading networks are interested in expanding the relevant segments of their product range. The purpose of the study is to develop a formula and processing of ice cream with adaptogenic functional properties.

Foresight on volumes of the functional products market is formed applying methods of constructing and analyzing dynamic series. Organoleptic evaluation of functional ice cream is carried out by the descriptive method (qualitative) and by the profile analysis method (quantitative). Nutritional value is estimated through the use of physicochemical methods: total protein content - by applying Kjeldahl method; amino acid composition - by ion-exchange chromatography; vitamin content - by high-performance liquid chromatography, fluorescent method; the content of mineral substances - by the method of flame photometry. In order to preserve the nutrient composition of spirulina, the method of sublimation drying is used.

The average annual growth of Ukraine functional products domestic market volume is forecasted to amount 5% in the next three years. For the retail chains functional products range expansion, a recipe and technology for the production of milk-based ice-cream (milk) using spirulina (*Spirulina* Turp.) and extract of stevia leaves, as a sugar substitute, which have a total volume of 6%, is developed. The use of the indicated concentration of components enriches the formulation of ice cream with a full protein in the amount of 7 g per 100 g of product, flavonoids, unsaturated fatty acids, min

erals (potassium, calcium, phosphorus, iron, sodium, magnesium, silicon, zinc, copper, selenium, chromium, etc.), vitamins C, A, E of B complex.

The efficiency of using the sublimation drying method in the functional purpose ice cream production is experimentally proved. A new type of ice cream is a product with high biological value due to the adding of spirulina and stevia plant material into its composition. Developed optimal concentration of additives provides a high nutritional value - digestibility, a mass fraction of nutrients and biologically active substances, organoleptic and physiological value. The estimated cost of ice cream confirms its price competitiveness in the functional products segment.

Key words: Functional products, Assortment, Trade networks, Healthy lifestyle, Nutritional value.

1. Introduction

It is generally accepted that the health status of the population in the country is directly dependent on the degree of balance and nutritional value of the diet. The low level of incomes of people from post-Soviet countries leads to the predominant consumption of cheap products containing a large amount of carbohydrates and trans-fats. Such products are one of the main reasons for the increase in the number of cardiovascular diseases in Ukraine, which, according to the Ministry of Health of Ukraine, causes 66% of deaths [1].

Low purchasing power and nutrition habits are recognized as one of the main determinants of the demographic crisis. In Ukraine, the average life expectancy is 68.3 years. Comparing with the countries of the European Union it is 75.4 years. The average life expectancy of Ukrainian women is 8 years less than in the European Union countries, and the average life expectancy of men is less than 12 years. The demographic problem has gained public recognition and has become the subject of many government programs which unfortunately focus on the elimination of the effects of unfavorable living conditions in Ukraine [2].

But, according to the authors, the post-industrial society, which exists within the information economy, is endowed with greater scope for freedom and self-regulation. Due to free circulation and access to information, individual and mass consciousness formulates strategies for self-preservation in today's difficult conditions of existence much faster than a complicated and slow-moving state bureaucratic management system.

Information technology has provided unlimited access to information. In the last ten years in the mass consciousness a trend of popularity and prestige of a healthy lifestyle is being formed under the influence of blatant facts about the quality of life and the health of Ukrainians, determined by the instinct of self-preservation. One of the components of this trend is the interest of an increasing number of people in a nutritious food. The research of opinion of buyers of large network supermarkets in Ukraine shows that in 2017 the number of buyers who were willing to spend money on the purchase of functional products has increased by 16.8% compared to 2014.

Functional products with improved nutritional properties on the basis of enrichment supplements, aim to promote the: full development of children and adolescents, rapid recovery and maintenance of optimal functional characteristics of all physiological systems of the human body in conditions of severe physical labor, stress, recovery after diseases, functional support of the body in different age and physiological conditions.

The main feature of product belonging to a functional type according to the provisions of the Scientific Concepts of Functional Foods in Europe is the demonstrable physiological effect, which manifests itself positively on the functional state of the physiological systems of the human body by preventing or eliminating the present nutritional deficiencies in the human body. The consequence of the use of functional products should be the preservation and improvement of human health [3].

Under the conditions that have developed on the market of functional products, trading networks are

interested in expanding the relevant segments of their range. The purpose of the study is to develop a formulation and technology for the production of ice cream with adaptogen functional properties.

2. Materials and Methods

Foresight on volumes of the functional products market is formed applying methods of constructing and analyzing dynamic series.

Organoleptic evaluation of functional ice cream is carried out by the descriptive method (qualitative) and by the profile analysis method (quantitative).

Nutritional value is estimated through the use of physicochemical methods: total protein content - by applying Kjeldahl method; amino acid composition - by ion-exchange chromatography; vitamin content - by high-performance liquid chromatography, fluorescent method; the content of mineral substances - by the method of flame photometry.

In order to preserve the nutrient composition of spirulina, the method of sublimation drying is used.

3. Results and Discussion

3.1 Dynamics of the market for functional products

Today functional foods and drinks are the fastest growing segment of the food industry in the world market. According to a study by Euromonitor International, the global market for health products, including functional, hypoallergenic, organic, was estimated at € 770 million in 2017 [4].

According to Leatherhead Food International, Japan traditionally owns almost 40% of the world market for functional products, with the United States accounting for about 30%, and the share of five European countries (Great Britain, Spain, Italy, France and Germany) is over 28%. Britain has become the largest European market for functional products, matching France. According to Leatherhead Food International, the market of European five countries for the next three years may grow by 27.6%.

The segment of healthy products in the countries of BRIC is actively growing. Thus, in 2011, the segment of healthy food in China was estimated at 8.5 billion euro, in Brazil - 3 billion euro. According to Euromonitor, the health and wellness market in the world market by 2018 will grow by 7.5% per year, while the segment of conventional beverages will increase by 6.75% per year. In this case, the segment of healthy beverages will reach almost 308 billion euro, compared with approximately 385 billion euro for ordinary beverages [3].

Euromonitor believes that the most promising markets for functional products and drinks are such countries with fast-paced economies as the: USA, Mexico, Venezuela, Argentina, Indonesia, the United Kingdom, India, Canada, Germany, Australia, Columbia, South Korea, France, Italy and Saudi Arabia. Dairy and bakery products dominate the world market of functional products, totaling over 70%.

Despite the fact that the global market for functional products is increasing, the growth rate has slowed over the last few years. However, health remains the main driving force behind marketing strategies for promoting food and drink in many parts of the world.

The share of functional food products segment in the Ukrainian food market was determined by calculating the corresponding share in the assortment of supermarkets of all-Ukrainian trading networks "Auchan", "Silpo" and "ATB". According to the results of observations and calculations, it was found that the share of functional products during 2010 - 2015 in the food market was 0.9 - 1%. But in the last two years this share has grown by 0.2%. The annual figures for the volume of the segment of functional products were determined on the basis of the summarized information of the State Statistics Service of Ukraine about the volumes of retail commodity turnover in the consumer product segment, which was 7.8 billion euro in 2017 [5]. The dynamics of the relevant indicators is shown in Figure 1.

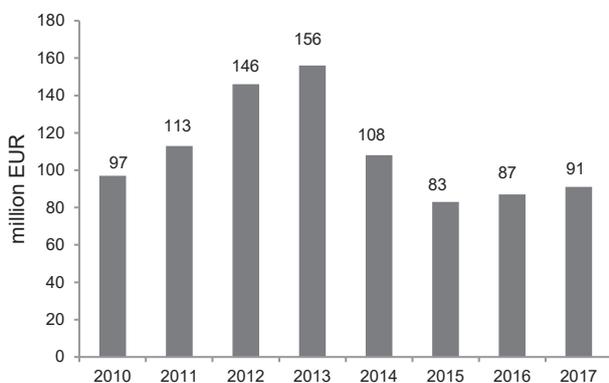


Figure 1. Market volume of functional products in Ukraine

Taking into account the presence of a trend towards increasing demand for functional products and a general stabilization of the socio-economic situation, it is possible to predict the growth of volumes of the corresponding segment at the level of 5% annually.

The structure of the range of functional food products was studied on the basis of an analysis of the range of supermarkets belonging to the networks "Auchan", "Silpo" and "ATB". The first place in volume of sales (42% of the total volume) is occupied by diet sour-milk products, namely, drinking yoghurt. The second largest

market share belongs to cereals and flakes with vitamin, mineral and protein enrichment additives (27% of the total volume). The third largest market share belongs to vitamin and energy drinks (19% of the total), which, due to their low cost, tangible physiological effect and massive advertising company in the media, have become very popular among young people. The fourth place is the bakery and pasta products (12% of the total volume). Thanks to the technological simplicity of creating new recipes and products with a variety of enrichment additives, this segment develops at an accelerated pace.

3.2 Determination of the internal composition of the functional product

The level of development of modern technologies allows to organize production of goods with specified properties in a short time. These properties are provided to food products, depending on the technical and economic problems facing the manufacturer. The "engine" of the innovation process, including in the area of production of innovative food products, is a demand.

The constantly expanding technological opportunities have led to the emergence in the market of goods with a variety of properties, characteristics, functional orientation, differentiated by quality and consumer properties. Among the essentially new products are food products that have adaptogen functional properties, the ability to adjust the functional parameters of the human body.

The popularity of a healthy lifestyle determines several areas of modern market trends of ice cream. Ukrainian consumer has become more focused on the issue of the naturalness of this product and carefully analyze the list of the ingredients. The most commonly consumed one is ice cream with simple recipes, which does not contain synthetic additives, dyes or artificial flavors. Manufacturers are expanding the range of ice cream with various additives (vitaminized, iodized, with probiotic additives, bio ice cream, etc.), as well as with reduced fat and sugar content [6].

Despite the fact that the proportion of ice cream with an enriched composition is increasing, it is still not significant, and the range of low biological value kinds of ice cream dominate. That is why today problem is the search for promising sources of non-traditional raw materials, the development of methods for its processing and use in the production of ice cream, as well as the study of the biological value of new products and the specifics of their effects on the human body [6].

The task is solved by the fact that a new type of functional ice-cream using spirulina (*Spirulina Turp.*) and extract of stevia leaves is created taking into account the principles of nutrition - the components of the

product do not dramatically affect the level of glucose in the blood of people. In addition, the product is enriched with high-grade amino acid composition of protein and unsaturated fatty acids. Creating a new type of ice cream is based on the following methods of food combinatorics:

- Elimination or reduction of content - the exclusion from the composition of the product of simple carbohydrates, namely sugar, which creates an additional burden on the liver and can lead to its fatty degeneration, as well as contributes to the deposition of fats and creates favorable conditions for the development of pathogenic microorganisms in the intestine, which complicates the synthesis lactic acid, which possesses bacteriostatic properties;
- Enrichment - the addition of: food fibers, amino acids, polyunsaturated fatty acids, etc. micronutrients contained in raw materials;
- Replacement - instead of sugar, a similar ingredient with more useful property, an extract of the stevia leaves, is introduced, since the stevioside and rebaudioside glycosides do not affect the level of sugar in the blood.

The main principles of food combinatorics used in the creation of ice cream include the following [7]:

- The principle of food safety: Raw materials and additives used in the development of ice cream allowed for sale in domestic trading networks and passed appropriate sanitary and epidemiological control;
- Principle of compatibility: The possibility of interaction of ingredients included in the recipes of ice cream is excluded. The determined combination of components and methods of technological processing provide maximum safety in the production, storage, as well as high digestibility of the body
- The principle of giving advantages and equivalence of control: Raw components used in the development of ice cream are only of natural origin
- The principle of final control: Development process evaluates the raw materials components to obtain the product with the planned functional characteristics
- Principle of exclusion: Process of developing a new type of ice cream used the existing regulatory documentation on the raw material components of the product. Ice cream with a similar composition does not exist.

In accordance with the current regulatory documentation, namely, DSTU 4733: 2003 [8]: "Ice cream: milk, creamy or sundae. General technical conditions", ice cream is classified according to the fat content as follows:

- Milk - with a fat content of 0.5 to 7.5%;
- Creamy - with a fat content from 8.0 to 11.5%;

- Sundae - with a fat content of 12.0 to 20.0%.

As a prototype, for a new type, milk ice cream with 3.5% fat content was selected. A distinctive feature of milk ice cream is the significant content of simple carbohydrates - sucrose - in the amount of 15.5 g per 100 g of product. The content of proteins is set at 3.7 g per 100 g. Nutrient composition is also represented by: mineral substances (sodium, potassium, calcium, magnesium, phosphorus, iron), vitamins A, C, b-carotene, B₁, B₂ [9].

In order to exclude simple carbohydrates from the composition of milk ice cream and giving it a sweet taste, an extract of stevia leaves was added. The sweetness of the stevia extract exceeds 300 - 400 times the sugar's caused by eight glycosides: stevioside, rebaudioside A, rebaudioside C, D, E and F and dulcicoloside A. Stevioside and rebavoidsioside A are the main and most widespread of these components. The final product - leaf extract - is obtained as a result of the application of water extraction, purification and spray drying [10]. The peculiarity of this component is that, unlike sugar, stevic glycosides practically do not decompose on glucose. It gives the plant huge prophylactic and therapeutic properties: the fight against overweight, diabetes care, prevention of heart disease. The complex of trace elements entering the plant has: antimicrobial properties, choleric, anti-inflammatory effect and is an antifungal agent [11].

In order to increase the total protein content, the improvement of the amino acid and fatty acid composition of the ice cream recipes was introduced *Spirulina* Turp.

Spirulina is a kind of freshwater algae, spiral shape and blue-green colour. Biomass of spirulina is low caloric, the nutrients, necessary for the normal functioning of the human body in modern environmental conditions, contain about: 2,000 vitamins, minerals, amino acids, enzymes, essential polyunsaturated fatty acids, food fibers, and more than 100 extremely important for humans biologically active substances. Carbohydrates make up 15 - 25%, predominantly easily digestible, preventing hypoglycemia (rhamnose, glycogen, etc.), as well as specific inulin polysaccharides capable of activating human monocytes and macrophages, increase the synthesis of β -interleukin RNA and tumor necrosis factor. Proteins of their biological value are not inferior to the proteins of meat, soybeans and eggs, rich in enzymes and reaching the content of 58 - 70%. Phycocyanin, shifted in spirulina, slows the development of malignant tumors, has immunomodulatory properties, activates lymphocytosis, and participates in the synthesis of most enzymes. β -linolenic acid promotes the formation of prostaglandin, vitamin E stimulates the immune system, regulates the activity of enzymes; sulfuric acid cefalotin - antigen in the fight against AIDS; cholinesterase, mannitol, enzymes of polyosine

- counteract radiation damage of cells; oxyddismutase is capable of absorbing free radicals [12]. Results of the study of the chemical composition of spirulina are given in Table 1.

According to its chemical composition, spirulina surpasses all known components of nutrition, it is quickly and easily digested, increases digestibility of food by 25 - 30%, is a universal systemic bioprotector and

Table 1. Chemical composition of spirulina

Indicator	Share
Carbohydrates, g per 100	20.3
Nutrition fibers, g per 100	3.6
Fat, total, g per 100	7.72
Saturated fatty acids	2.65
Mono-unsaturated fatty acids, g per 100	0.68
Polyunsaturated fatty acids, g per 100	2.08
Proteins, g per 100	58
Amino acids, g per 100	
Arginine	4.15
Valine	3.51
Histidine	1.08
Isoleucine	3.21
Leucine	4.95
Lysine	3.03
Methionine	1.15
Threonine	2.97
Tryptophan	0.93
Phenylalanine	2.78
Aspartic acid	5.79
Alanine	4.51
Glycine	3.1
Glutamic acid	8.39
Proline	2.38
Tyrosine	3
Cysteine	2.58
Serine	0.66
Vitamins, mg per 100 g	
A	29
E	5
K	25.5
C	10.1
Thiamin	2.38
Riboflavin	3.67
Pantothenic acid	3.48
Pyridoxine	0.36
Folic acid	0.094
Mineral substances, mg per 100 g	
By	1363
Ca	120
Mg	195
Na	1048
P	118
Fe	28.5
Mn	1.9
Cu	6.1
Se	0.007
Zn	0.002

biocorrector. The chemical substances of the spirulina cells are balanced, they are found in an easily soluble and digestible organism of the mucoprotein shell, which promotes the widespread use of algae.

3.3 Testing of the developed recipes and technological regimes

The technological process of producing a new type of ice cream includes the following operations:

- Mixing of ingredients;
- Filtration;
- Pasteurization;
- Homogenization;
- Cooling (to a temperature of 2 - 6 0C);
- Maturation of the mixture (at a temperature of 4 - 6 0C);
- Milling;
- Formation;
- Quenching (at temperatures from -25 to -40 0C).

The preparation of a new type of milk ice cream experimentally determined the concentration of new ingredients in the recipes, calculated by the method of arbitrary selection [13]. To obtain pleasant, original organoleptic properties, an optimal concentration of stevia extract was determined - 0.05%. Replacing sugar with the extract of stevia leads to a decrease in the mass fraction of dry matter, which affects the quality of ice cream (resistance to melting, sluggishness). Adding to the ice cream component of the protein spirulina makes it possible to raise the quality of ice cream. The additive in the form of spirulina was added in the amount of 5.95% (Table 2).

Table 2. Recipe for a new type of ice cream

Raw Material	Mass	Including			
		Fat	Dry fat free milk residue	Dry substances	Sugar Extractor
Milk (fat content 3.2%, DFMR 8.1%)	80	2.56	6.4	9.04	-
Cream (fat content 40%, DFMR 4.8%)	3.1	1.24	0.15	1.41	-
Dry skimmed milk (DS 93%)	4.149	-	-	3.86	-
Stevia extract (DS 96%)	0.05	0.45	-	0.048	0.05
Spirulina (DS 18%)	5.95	-	-	1.071	-
Potato starch (80% DS)	1.5	-	-	1.2	-
Vanillin	0.001	-	-	0.001	-
Drinking water	5.25	-	-		-
Total (g)	100.0	4.25	6.55	16.63	0.05

Legend: DFMR - Dry fat free milk residue; DS - dry substances.

In order to preserve the nutrient composition of spirulina, the method of sublimation drying is used. The main advantage and distinctive feature of sublimation drying is that the process proceeds at a minus temperature. The dried product is pre-frozen, and the removal of moisture is due to sublimation which means the phase transition from a solid state to a vaporous omitting liquid. Due to the low-temperature conditions of sublimation dehydration, the initial properties of the product are not only preserved (biologically active substances, initial odor, taste, colour), but are also improved due to the concentration of the most valuable components [14]. After drying, the algae was ground to a powder with a particle size of 15 - 150 μm and was added to other raw ingredients. Subsequent production operations were carried out in accordance with the above technological scheme.

3.4 Physico-chemical and organoleptic characteristics of the final functional product

To determine the qualitative characteristics of the finished milk ice cream, the conformity with the current regulatory documentation on the territory of Ukraine was established - DSTU 4733: 2003 [8]. Within this standard, organoleptic and physico-chemical parameters are monitored. The consumer properties of the new ice cream were studied according to the organoleptic parameters according to the developed 5-point scale (Table 3).

Table 3. Estimation of organoleptic properties of ice cream

Indicator	Result
Taste and smell	4.8
Structure and consistency	4.9
Colour	5
Appearance	4.9

On the basis of the obtained data on the organoleptic evaluation of ice cream, a prophylogram of organoleptic properties was constructed (Figure 2).

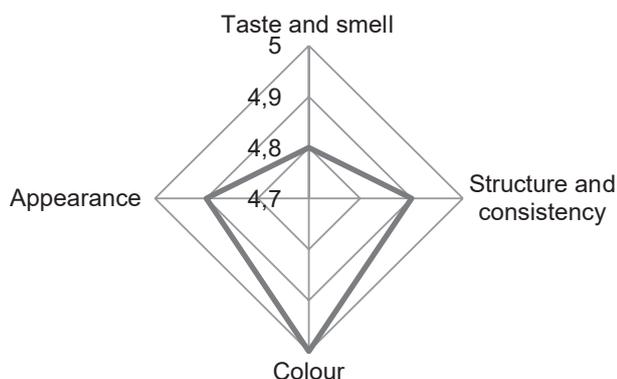


Figure 2. Prophylogram of organoleptic properties of a new type of milk ice cream

According to the data shown in Figure 2, it can be concluded that the new type of ice cream has high organoleptic characteristics.

Data of physical and chemical parameters of milk ice cream with the addition of stevia and spirulina extract were within the established limits for milk ice cream.

Compared to the prototype, a new kind of ice cream has an improved composition due to the replacement of sugar and the addition of protein-containing spirulina, which has not only improved the qualitative characteristics but also has increased the biological value. The total amount of protein, in comparison with the prototype, has increased almost 2 times - up to 7 g per 100 g. The total content of minerals and vitamins has increased significantly. The comparative chemical composition of the prototype and a new type of ice cream is presented in Table 4.

Table 4. Comparative chemical composition of the prototype and a new type of ice cream

Indicator	Prototype of milk ice cream	Ice cream with extract of stevia and spirulina
Carbohydrates, g per 100	21.3	7.7
Lactose	5.8	6.5
Sucrose	15.5	-
Total fat, g per 100	3.5	4.25
Proteins, g per 100	3.7	7
Vitamins, mg per 100 g		
A	0.02	1.75
E	0.1	0.41
K		1.52
C	0.4	1.06
Thiamine	0.03	0.18
Riboflavin	0.16	0.4
Pantothenic acid		0.2
Pyridoxine		0.02
Folate		0.006
Mineral substances, mg per 100 g		
K	148	250.2
Ca	136	162.6
Mg	17	31.03
Na	51	120.64
P	101	122.44
Fe	0.1	1.81
Mn		0.11
Cu		0.36
Se		0.0004
Zn		0.0001

Among the range of functional products that are sold in domestic retail chains, milk ice cream with extract of stevia and spirulina plant material can be sold at a price of 0.48 to 0.54 euros, which confirms its price competitiveness.

4. Conclusions

- The efficiency of using the sublimation drying method in the functional purpose ice cream production is experimentally proved.
- A new type of ice cream is a product with high biological value due to the adding of spirulina and stevia plant material into its composition. Developed optimal concentration of additives provides a high nutritional value - digestibility, a mass fraction of nutrients and biologically active substances, organoleptic and physiological value.
- The estimated cost of ice cream confirms its price competitiveness in the functional products segment.

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