IJABR

International Journal of Advanced Biotechnology and Research (IJABR)
ISSN 0976-2612, Online ISSN 2278–599X,
Vol-10, Issue-2, 2019, pp241-253
http://www.bipublication.com

Research Article

Development of technology and research on the quality of powdered milk products of specialized purpose

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[Received: 25/01/2019; Accepted: 27/04/2019; Published: 29/04/2019]

ABSTRACT

Milk and dairy products are socially important products in the diets of the population, including risk groups (children, pregnant women, workers of a number of industrial enterprises, etc.). The preservation of milk makes it possible to solve a number of important tasks: to compensate for the winter decrease of milk production, to increase the transportability of raw milk, to provide with dairy products people who do not receive natural milk for geographical, climatic and other reasons; to provide specialized nutrition for people who live in extreme conditions, as well as in remote areas of the country with limited natural milk resources. Powdered milk products with the highest concentration of milk components are included in the state reserve product range, which is also of strategic importance for improving the economic security of the country. During storage, the quality of powdered milk products deteriorates, leading to a decrease in nutritional value, consumer characteristics, and a reduction of shelf life. Improving and preserving the quality of powdered milk products, increasing their shelf life solves the most important social task - providing the population of Russia with high-quality dairy products for both catering and specialized purposes. Currently, the development of scientific principles, techniques and methods for creating technologies of powdered milk products of high storage capacity and nutritional value is relevant. In the present study, the standard and generally accepted methods of research of raw materials and finished products using organoleptic, physico-chemical, microbiological and safety analyses were used. The article presents the results of research on the development of technology of pwdered milk products produced by the sublimation method. The products have a long (up to two years) shelf life due to stabilization by antioxidants, increased nutritional and biological value, due to the replacement of part of milk fat with vegetable fat rich in polyunsaturated fatty acids (PUFAs). The paper presents the results of the calculation of the economic feasibility of introducing new technologies. As a result of the research, resource-saving technologies have been developed for the production of seven types of powdered milk by the method of freeze-drying. The paper attempts to solve the problems of seasonality, shortage of natural milk raw materials, supply of dairy products in remote areas of the country and to special contingent (Russian Army troops, cosmonauts, submariners, tourists, mountain climbers, etc.). In addition, the formulation is cheaper, the cost of powedered milk products is reduced, and an economic effect is obtained, which also has practical value.

Key words: powdered milk, vegetable fats, biological value, antioxidants, specialized nutrition, shelf life, economic efficiency.

INTRODUCTION

Analysis of the existing domestic and foreign literature on the studied problem has shown the relevance of developing the scientific principles, techniques and methods for improving the technology and formation of consumer properties of dairy and milk-containing powdered products for general and specialized purposes with increased storage capacity and nutritional value.

The development of new types of food products, as well as food additives, the improvement of traditional diets should be the main directions of biotechnology in the field of food production.

Full satisfaction of the need for nutrition occurs when human food contains at least 20,000 various ingredients of both vegetable and animal origin. At the same time, it must be said that at present the usual mixed diet of a person contains less than half of the required amount, including minor nutrients. [15, 17, 21]

Recent studies have revealed that the population has reduced the consumption of energy sources, especially among people at risk. However, many people suffer from obesity, as a result of improper metabolism. [12, 16, 19]

Exceptional importance for the nutrition of the population of Russia, as a factor in the health of the nation, is the consumption of milk and dairy products. The problems associated with their production and consumption will never lose their relevance. One of the important tasks is the development of dairy products with extended shelf life; the priority in solving this problem is to improve the quality of raw materials, introduce new technologies and equipment, and improve the production culture. Modern food technologies introduced in the industry should be aimed at improving the quality, increasing safety and increasing the competitiveness of food products, as well as giving them the necessary properties (consumer, functional and dietary). In addition, it is necessary to ensure a streamlined manufacturing process, cost reduction and reduction of expenditures and production losses, taking into account the integrated use of all components of milk. [3, 18]

Memeber of the Russian Academy of Medical Sciences V.A. Tutelyan emphasized that the main factor that violates the structure of nutrition and is more harmful to health than environmental pollution is the violation of the structure of nutrition. As a result, 70% of Russians are deficient in vitamin C, 40% are deficient in β-carotene and vitamin A, and one-third of the country's population suffers from a deficiency in group B vitamins [11, 13].

In the attitude of the population towards health, the ideas that had existed previously (that health can be neglected and investments in it are useless) are gradually disappearing.

Hippocrates' statement that food should become a medicine is still relevant today. The development of the food industry is currently associated with features that require new approaches and schemes that meet the conditions of the modern market. At the same time, it is necessary to take into account such aspects as the number of elderly people, changes in the living conditions of people, and stress loads. Food industry must meet the requirements of the concept of healthy nutrition, strengthening the requirements for the quality and safety of food, scientific achievements, the economic state of the nation, including purchasing power.

Cardiovascular and other diseases of people living in extreme conditions are, among other things, a consequence of the structure of nutrition. The data provided by the World Health Organization proves that the death rate in Russia from cardiovascular diseases (further referred to as CVD) is more than 55%, which is the third place in the world. Thus, mortality from CVD and the structure of nutrition are in close correlation. Prevention and treatment of cardiovascular diseases, as well as the risks that cause them, are possible through the development of specialized foods, including dairy and milk-containing products [9, 10, 15].

Currently, the prevention and treatment of CVD are carried out mainly with pharmacological preparations and imported food additives [4, 7]. The task of developing modern technologies of specialized powdered milk products is extremely relevant.

A comprehensive program to combat CVD is based on the development of new food technologies and formulations, with a content of biologically active components such as mono- and polyunsaturated fatty acids (including the essential ones), vitamins, bifidobacteria, and flavonoids. The prolonged nutritional impact of these components and the resulting reduction of the main risk factors confirm the feasibility of a comprehensive program to combat CVD [1, 14, 21].

Prevention of these diseases through the organization of proper nutrition is also a way to

reduce or prevent CVD. The development of specialized diets is aimed at protecting the body from the influence of harmful environmental conditions, increasing the ability of the organism to adapt to adverse conditions, improving the functioning of the body as a whole, which is essential for nutrition in extreme conditions [22].

A developing direction in the dairy industry for the production of milk-containing products containing vegetable raw materials in the form of milk fat replacers rich in PUFAs, including ω3 and ω6 fatty acids is relevant, because it increases the nutritional value of dairy products and prevents the risk of CVD.

An outstanding biochemist, academician A. A. Pokrovsky made a huge contribution to the development of the ideology of healthy nutrition and food products of various functional purposes.

The world experience and achievements of the Russian science of nutrition are described in the works of V. A. Tutellian, V. D. Spirichev, L. N. Shatnyuk, V. M. Poznyakovsky, Yu. P. Gichev, V. D. Dadali and others.

Due to the need to develop the remote areas of the country, including the Arctic zone of the Russian Federation, , the Program for the Development of the Arctic was approved by the Government of the Russian Federation, see Order No. 366 of April 21, 2014, Moscow "On approval of the state program of the Russian Federation "Socio-economic development of the Arctic zone of the Russian Federation for the period until 2020" [8].

The goal of the Program is to increase the level of socio-economic development of the Arctic zone of the Russian Federation. One of the Program participants is the Ministry of Industry and Trade. In accordance with this Program, food industry experts, including the dairy industry, are tasked with developing new dairy products of increased nutritional value, long shelf lives, with enhanced functional properties and good transportability.

Therefore, the development of scientific principles, techniques and methods for the creation of technologies of powdered milk products of high storage capacity and nutritional value is relevant.

The state program of the Russian Federation "Development of Science and Technology" includes the federal target program "Research and development in priority areas of development of the scientific and technological complex of Russia for 2014-2020," which includes measures for the study and development of Arctic resources [8].

International quality standards are characterized by a set of properties and product characteristics, as well as the ability to satisfy the conditional and expected properties [2, 5].

When forming the quality indicators of the products being designed, the composition and quantity of the ingredients of the product, which should determine the required quality characteristics, are taken into account. Formation of the quality of products consists in the design of the composition and quantity of ingredients, their nutritional, biological and energy value; texture-forming structure; organoleptic, physical and chemical properties; microbiological and safety indicators; expiration dates, etc. The development of new products takes into account the factors that form the quality (raw materials, recipes, technological modes of production) and factors that preserve the quality (types of packaging, storage modes and conditions, transportation, etc.).

The process of formation of consumer characteristics and preservation of the quality of specialized preserved food during long-term storage has not been studied enough and is a complex experimental and theoretical task.

Currently, the market for special ingredients is rich and diverse. As a rule, commercial preparations offered by an enterprise contain various additives of both natural and chemical origin. The most interesting are the natural flavonoid compounds that feature not only antioxidant, but also vitamin activity, the role and importance of which for human nutrition cannot be overestimated.

To stabilize products in storage, the authors of the present article created and tested antioxidant complexes consisting of flavonoid and amino

acid inhibitors in combination with a synergist, vitamin C (ascorbic acid).

One of the requirements for powdered milk products is good transportability. The development of small-sized, disposable, sealed packaging, which can be used for a single-dose meal, has contributed to the use of the products being developed in the diet of people, being in autonomous conditions of existence, and the inclusion of these products in the army survival kits (ASKs), army rations, etc.

The last decades have been expanding the production of milk-containing products, in which milk fat is replaced by various milk fat replacers (MFRs). Replacing a part of milk fat with vegetable raw materials made it possible to create powdered milk with the required qualitative characteristics of the composition of fatty acids and their high biological value.

The use of milk fat replacers has provided an adjustment of the fatty acid composition of the fatty bases of powdered milk products in the right direction to create products of a specialized purpose.

Thus, when developing powdered milk for general and specialized purposes, the following indicators were provided:

- improved organoleptic characteristics;
- increased storage term and nutritional value;
- balanced fatty acid composition.

The purpose of research: to establish the possibility and develop the technological process of production of powdered milk products in freeze-dried form, of increased nutritional and biological value, suitable for long-term storage for general and specialized purposes.

To achieve this goal, the following tasks were solved:

- analysis of technical literature on the establishment of the possibility of developing and obtaining powdered milk products for specialized nutrition in areas with limited natural raw milk resources;
- establishing the possibility of extending the shelf life of dry products by introducing of antioxidants into the formulation and technology;
- adjustment of fatty acid composition in order to replace part of milk fat with vegetable fats rich in PUFAs;
- conducting a comprehensive assessment of the quality and nutritional value of new products and the establishment of their shelf life;
- development of technology and recipes of powdered milk products produced by the method of freeze-drying;
- calculation of the economic feasibility of the production of new types of preserves.

MATERIALS AND METHODS

In the process of developing new technologies of powdered milk products of increased nutritional and biological value and stability in long-term storage, the operations of emulsifying vegetable fatty additive and developing a normalized milk-vegetable mixture using the substitute of milk fat SMF «Ecolact» were introduced in the technological schemes of production.

The result of comprehensive studies on the replacement of part of milk fat with its substitutes are recommendations on the combined use of milk fat and «Soyuz 53» MFR, which makes it possible to ensure the ω-6 / ω-3 ratio within 6/1.

When using the «Ecolact» milk fat replacer in products, the ω6 / ω3 ratio is provided as 7/1. Based on the results of the determination of organoleptic indicators of dairy-vegetable mixtures, it is suggested to use «Ecolact 1443» MFR in the recipes for the production of powdered milk products. This composition of vegetable fats, in addition, contains a protein supplement that promotes the effective emulsification of milk-vegetable mixtures.

In order to stabilize the fatty phase of powdered milk products during long-term storage, antioxidant complexes consisting of antioxidants of flavonoid (dihydroquercetin, or DHQ) and amino acid (cysteine) nature are recommended in combination with synergist vitamin C before the drying operation.

The amount of DHQ introduced into the mixture DHQ is calculated by the following formula:

$$K = \frac{F \cdot M \cdot A}{100 \cdot 100},$$

where K is the amount of antioxidant, kg;
F - fat content of the mixture, %;
M - the amount of milk mixture, kg;
A - the percentage of DHQ to the fatty phase of the mixture,%;
Mass fraction of the introduction of DHQ and vitamin C is at 0.2% of the fat per milk formula.
The calculated mass of dihydroquercetin (DHQ) is dissolved in ethyl alcohol with a mass fraction of 96% alcohol and a temperature of (58 ± 2) ° C. The ratio of the volume of alcohol to the mass of the DQC is 10: 1.
Vitamin C is dissolved at a ratio of volume of distilled water to the weight of synergist as 20: 1.
The antioxidant solution is added to the mixture in small portions with constant stirring prior to the operation of freeze-drying.
To enrich the powdered milk products with bifidobacteria, the BB-12 starter culture was used, containing Bifidobacterium lactis with the number of viable cells in 1 g ranging from $5 \cdot 10^{10}$ to $5 \cdot 10^{11}$.
The drying of the products was carried out by a gentle method of sublimation, using a LZ-45.27 freeze dryer from Czechia to a residual moisture content of not more than 4%.
Compared to heat drying at high temperatures, freeze drying is characterized by the elimination of moisture by sublimation, i.e. transition from solid to gaseous state at minus (40-20) ° C.
Such a drying process preserves all the beneficial properties of the product (vitamins, beneficial microflora, bifidobacteria, nutritional and biological value) with little or no change and extends the shelf life of the dried products.
The produced preserved products are packaged under vacuum in an inert gas atmosphere in (150 ± 5) g plastic composite bags based on aluminum foil.
The recombination of powdered milk products is carried out under stirring with hot drinking water at a temperature of 55-60 ° C for 20 minutes with a ratio of water and product 2.5: 1.0 (250 g H2O + 100 g of product).
The developed group of dry milk and milk-containing products is produced mainly according to the same basic technological scheme, but each product under development has its own specific production conditions.

RESULTS AND ITS DISCUSSION

High-fat dry cream with antioxidant in capsules refers to dry high-fat milk preserved food obtained by drying the pasteurized, condensed and homogenized cream, stabilized by antioxidants and packed in gelatin capsules. The product is intended for specialized nutrition in autonomous conditions of existence. The technological process of production of dry high-fat cream with antioxidant in capsules is carried out in the following sequence (Figure 1).
Pasteurized at a temperature of (96 ± 2) ° C, the milk mixture is concentrated in vacuum evaporation plants until the dry matter content reaches (50 ± 5)%. To reduce the free fat content in the finished product, the mixture is homogenized at a pressure of 5-6 MPa and a temperature corresponding to the temperature of the mixture in the last vessel of the vacuum apparatus.

Figure 1 - Technological block diagram of the production of dry high fat cream in edible gelatin capsules

In order to increase the stability of dry high-fat cream in storage, the antioxidant dihydroquercetin is added to the thickened homogenized mixture before drying, in an amount of 0.02% to the fat content of the product and a synergist (ascorbic acid) in the amount of 0.02% to the fat content.
The condensed mixture with a temperature of (45 ± 5) ° C is sent to a spray type drying unit (preheated to air temperature of 110 ° C) and dried at air temperature of 160-180 ° C in a drying tower to a residual moisture content in the product not exceeding 4%. Upon leaving the drying tower, the dry high-fat cream is sifted on a shaking sieve with a cell size of not more than 5 × 5 mm. After sifting, the product is cooled to ambient air temperature in the pneumatic conveying system.
When drying by the sublimation method, the condensed mixture is cooled at the outlet of the vacuum apparatus, spread on the trays of the freeze-dryer, frozen and dried to a final moisture

content of not more than 4%. Then the product is packaged in gelatin capsules weighing (5 ± 0.2) g.

The gelatin mixture, prepared in accordance with the developed recipe, is heated to 60 ° C and vacuumed for 2 hours at a discharge of 86.6 kPA, then it is subjected to heat treatment at a temperature of 108-110 ° C for 20 minutes. Gelatin mixture recipe (g): water - 85; glycerin - 12.5; gelatin 25.

The capsules are dried in the apparatus for the manufacture and drying of gelatin capsules at a temperature of (40 ± 1) ° C for 40-50 minutes. Capsules are densely filled with (5 ± 0.02) g of dry high fat cream at.

Dry high-fat cream with antioxidant in capsules is packed by 10 pieces in a special metallized film based on aluminum foil, under vacuum. Dry high-fat cream with antioxidant in gelatin capsules is used as an additive to the dinner dishes that make up the menu of specialized diets.

Gelatin capsules with dry high-fat cream dissolve in hot dishes at 60 ° C in 3 minutes in liquid dishes, in 5 minutes in cereals and purees, increasing their nutritional value and taste properties.

Organoleptic characteristics of dry high-fat cream are presented in Table 1.

Table 1 : Evaluation of the organoleptic characteristics of dry high-fat cream

Texture	Taste
Dry powder with the presence of easily crumbling lumps	Pure, slightly sweet, typical of high-fat dry cream, without other flavors and odors

Indicators of the nutritional value of dry high-fat cream are presented in Table 2.

Table 2 : The composition and nutritional value of dry high fat cream (100 g)

Product name	Mass fraction, %			Vitamins, mg				Energy value, kJ / kcal
	proteins	fats	carbohydrates	A	D	E	C	
Dry high fat cream	8.0	75.0	10.3	1.2	0.06	4.3	18.0	3138 750

Dry high-fat milk-containing product refers to powdered milk-containing products obtained by drying a cream-vegetable mixture normalized by fat, followed by thickening, homogenization, adding antioxidant and drying by spraying or by sublimation.

Dry high-fat milk-containing product of high nutritional and biological value, suitable for long-term storage, is intended for general and specialized nutrition.

The technological process of the production of dry high-fat milk-containing product is carried out in the following sequence (Figure 2).

Figure 2 - Technological block diagram of the production of dry high-fat milk-containing product

Preparation of the milk-vegetable mixture is carried out as follows: «Ecolact» MFR of pasty consistency is added to skimmed milk with a temperature of (50 ± 5) ° C. The milk- vegetable mixture is emulsified for (20 ± 5) minutes at a temperature of (50 ± 5) ° C, then it is normalized, pasteurized at a temperature of (95 ± 2) ° C and condensed up to 45% of dry substances on a "Wiegand" vacuum evaporator of continuous operation with a water evaporation rate of of 8,000kg/h, and then homogenized at a temperature of (55 ± 5) ° C and P = 7-10 MPa. Antioxidants, consisting of antioxidant complexes of flavonoid and amino acid nature with an ascorbic acid synergist: DHQ+ vitamin C (0.02% and 0.02% to fat content, respectively); cysteine + vitamin C (0.2% and 0.02% to fat content, respectively), are introduced in a condensed mixture. Drying is carried out by spraying or sublimation to a residual amount of moisture not more than 4%. The finished product is packaged in bags of (150 ± 5) g and sealed in vacuum.

Organoleptic characteristics of dry high-fat milk-containing product are presented in Table 3.

Table 3 : Organoleptic characteristics of dry high-fat milk-containing product

Texture	Taste
Dry powder with lumps crumbled with little effort	Pure, slightly sweet, characteristic of a dry high-fat dairy product, without other tastes and odors

The nutritional and energy value of dry high-fat milk-containing product is presented in Table 4.

Table 4 : Nutritional and energy value of dry high-fat milk-containing product (100 g)

Product name	Mass fraction, %			Vitamins, mg				Energy value, KJ / kcal
	proteins	fats	carbohydrates	A	D	E	C	
Dry high fat milk-containing product	6.5	75.0	14.3	2.4	0.12	5.4	18.2	3164 755

Dry sour cream is a dry milk-containing product, produced from cream normalized by fat and "Ecolact" MFR, with pasteurization at a temperature of (84 - 87) ° C, stabilization with antioxidants, starting and fermentation with complex ferment and sublimation drying.

Dry sour cream product is eaten after dissolving in hot water at a temperature of 60 ° C for 20 minutes.

The technological process of production of dry sour cream is carried out in the following sequence (Figure 3).

Skimmed milk is fed into the tank and mixed with a milk fat replacer of a buttery texture. The mixture is emulsified for (15 ± 5) minutes at a temperature of (55 ± 5) ° C; then the calculated amount of cream with fat content of 25% is introduced to normalize the mixture. The resulting mixture is subjected to additional mixing for 5-10 minutes. Milk-vegetable mixture is normalized, if necessary.

Homogenization of the normalized milk- vegetable mixture is carried out at a temperature of (60 ± 5) ° C and P = 9-10 MPa, then the mixture is pasteurized at a temperature of (90 ± 1) ° C and a maturation of 5 s. To increase stability, antioxidants consisting of antioxidant complexes of flavonoid and amino acid nature (DHQand cysteine) in composition with ascorbic acid are added to the prepared mixture. The mixture is fermented at a temperature of (32 ± 2) ° C with complex starter lactic acid and bifidobacteria.

The end of the fermentation is identified by the increase of titrated acidity in the mixture. Souring is complete when titrated acidity reaches (95 ± 5) ° T. The duration of the process is 12-15 hours. The product is cooled to a temperature of (6 ± 2) ° C and sent for maturation within 6-7 hours.

The finished sour cream is spread on the trays of the freeze-dryer, frozen and dried to a final moisture content of not more than 4%. Then it is packaged and labeled.

Figure 3 - Technological block diagram of the production of dry sour cream product

Organoleptic characteristics of dry sour cream product are presented in Table 5.

Table 5 : Characteristics of dry sour cream product

Indicator	Characteristics of the dry product	Characteristics of the recombined product
Taste and smell	Pure, Fermented Milk	
Consistency	Powder, homogeneous in composition with particles of various shapes and lumps, crumbling at a slight mechanical action	Thick, homogeneous, with a slight viscosity, and the presence of separate air bubbles. Low flour texture is allowed
Colour	White with a slight creamy tint, with no visible unevenness in color	

Mass fractions characterizing the nutritional value of the product are shown in table 6.

Table 6 : Nutritional value of dry sour cream product (100 g)

Product name	Mass fraction,%			Vitamins, mg				Energy value, kJ / kcal
	proteins	fats	carbohydrates	A	D	E	C	
Dry sour cream product	20.0	60.0	10.3	1.4	0.08	5.4	16.8	3151 750

The quality of any food product is characterized by its nutritional, biological and energy value. Nutritional value in general characterizes the ability of products to meet the needs of the body in nutrients and biologically active substances.

The characteristics of the food and energy value of the developed products are presented in Table 7.

Table 7 : Composition and energy value of new types of powdered milk products

Content	Powdered milk products		
	dry high-fat cream	dry high-fat milk-containing product	dry sour cream product
Mass fraction of fat,%	75.0	75.0	60.0
Mass fraction of protein,%	8.0	6.5	20.0
Mass fraction of carbohydrates,%	10.3	14.3	10.3
Mass fraction of mineral substances,%	2.7	2.3	5.7
Energy value, kJ / kcal	3138 750	3164 755	3151 534

Fractional composition of lipids of new types of powdered milk products is presented in Table 8.

Table 8 : Fractional composition of lipids of new types of powdered milk products

Fractional composition of lipids	Content, % of total fatty acids		
	dry high-fat milk-containing product	dry sour cream product	balanced fat
Saturated	64.25	53.91	30.0
Unsaturated, incl. - MUFA - PUFA	35.75 25.64 10.11	46.09 34.03 12.06	70.0 60.0 10.0
The ratio of ω-6: ω-3	8:1	5:1	5÷10:1

As can be seen from Table 8, the introduction of vegetable fats into the composition of products made it possible to significantly increase the content of unsaturated fatty acids in powdered milk-containing products, in particular PUFA, and to reduce the amount of saturated fatty acids, which increased the nutritional value of the products being developed and allowed to obtain the required ω6: ω3 ratio as 5 ÷ 10: 1.

The vitamin composition of powdered milk and milk-containing products is presented in Table 9.

Table 9 : Vitamin composition of powdered milk-based products

Product name	Vitamins, mg / 100 g			
	A retinol	D calciferon	E tocopherol	C ascorbic acid
Dry high fat cream	1.20±0.10	0.060±0.001	4.30±0.12	18.20±0.62
Dry high fat milk-containing product	2.40±0.10	0.120±0.001	5.50±0.13	18.00±0.61
Dry sour cream	0.900±0.100	0.020±0.001	4.20±0.11	10.20±0.60
Dry sour cream product	1.100±0.100	0.020±0.001	4.40±0.14	16.04±0.71

According to the data in Table 9, it can be concluded that powdered milk-containing products have a higher content of fat-soluble vitamins of groups A, D, and E, and ascorbic acid (due to the enrichment of new products with vitamin C as a synergist of oxidative processes).

To assess the biological value (BV) of new types of powdered milk products, their amino acid composition was determined, the amino acid score of essential amino acids was calculated with respect to the ideal FAO / WHO protein.

The calculation of the amino acid score was made after the determination of the amino acids in the test product according to the following formula:

$$A = \frac{X1 \times 100}{X2} A = \frac{X1 \times 100}{X2},$$

where A – score of investigated amino acid, %

X_1 – amino acid content in 1 g of product,

X_2 – amino acid content per gram of protein taken as ideal.

The results of studies of amino acid composition (Table 10) indicate that powdered milk products have sufficient biological value of essential amino acids. The exceptions are amino acids that limit the biological value, such as methionine, cysteine, etc.

Table 10 : Amino acid composition and score of new types of powdered milk products

Essential Amino Acid	Ideal FAO / WHO protein mg / g protein	Powdered milk products					
		dry high fat cream		dry sour cream product		dry high fat milk-containing product	
		mg / g protein	score, %	mg / g protein	score, %	mg / g protein	score, %
Valin	50.0	32.0	64	47.65	95	11.14	29
Isoleucine	40.0	26.5	66	37.12	92	12.84	33
Leucine	70.0	58.2	83	61.51	88	22.91	32
Lysine	55.0	42.4	78	55.43	100	14.21	15
Methionine + cystine	35.0	3.5	7.3	3.62	10	8.1	23
Threonine	40.0	29.7	74	33.48	83	11.39	18
Tryptophan	10.0	trace amount	-	trace amount	-	3.64	36
Phenylalanine + + tyrosine	60.0	48.2	80	53.48	89	24.53	41

The dominant in powdered milk-based products are: valine, leucine, lysine, phenylalanine + tyrosine.

For the calculation of the biological value of proteins of powdered milk-based products, a coefficient called ASDC was used, calculated by the formula:

$$ASDC = 100 - BV,$$

where ASDC - Amino Acid Score Difference Coefficient.

The coefficient of differences in amino acid score is calculated as the sum of the differences in amino acid scores for an essential acid as compared to one of the most deficient.

Using this method of calculation it is possible to confirm the increase in the biological value of high-fat products. The maximum biological value is established in dry high-fat milk-containing and dry sour cream products.

The results of the calculation of the usefulness of proteins for different types of developed products are shown in Table 11.

Table 11: The biological value of proteins of powdered milk products

Indicators	Powdered milk products		
	dry high fat cream	dry high-fat milk-containing product	dry sour cream product
Amino Acid Difference Ratio	55.7	41.5	40.15
Biological value, %	44.3	58.5	59.85

The degree of compliance of the new products with the requirements of healthy nutrition in accordance with its balance is presented in Table 12.

Table 12: Compliance of powdered milk products with balanced nutrition formula

Food substances	Need (g / day) *	Compliance of powdered milk products with balanced nutrition formula, %
Proteins	90	5 - 50
Fats	90	20 - 80
Vitamin E (tocopherol)	2-6	9 - 85
Vitamin D (calciferol)	10.0	1.5 - 10.0
Vitamin A (Retinol)	1.75	3.0 - 25.0
Vitamin C (ascorbic acid)	70.0	6.0 - 30.0
Vitamin B1 (thiamine)	1.75	9.0-10.0
Vitamin B2 (riboflavin)	2.25	9.5-10.5

* according to MR (MP) 2.3.1 1915-04 [6]

New powdered milk products are characterized by a high degree of compliance with the balanced nutrition formula for the main food substances.

Given that the vitamin composition of powdered milk and milk-containing products has a high content of vitamins E, A, D, groups B and C, the consumption of 100 g of these products per day provides the body with vitamin B1 from 9 to 10%, B2 from 9.5 up to 10.5%, vitamin A from 3.0 to 25.0%; vitamin D from 1.5 to 10.0%; vitamin C from 6.0 to 30.0%. The data presented in Table 12 confirm that new types of powdered products, both dairy and milk-containing, are characterized by a fairly high percentage of compliance with the balanced nutrition formula, and are recommended for both general and specialized nutrition as functional products for the prevention of cardiovascular and other diseases.

The calculation of economic indicators characterizing the feasibility of the production of powdered milk products was made on the basis of the developed formulations, the cost of the main and auxiliary raw materials, materials, packaging, production costs, etc. of the dairy enterprise LLC «VNIMI-Sibir» as of the time of the production inspection of the technological process.

The economic feasibility of the production of products with partial replacement of milk fat with vegetable fat was proved when comparing the cost and calculating the planned cost of products made from milk and milk-containing products.

Among the developed powdered milk products, the dry sour cream product is the highest in terms of cost, since this type of milk-containing product is high-fat, is produced by an expensive method of freeze-drying and, in addition, is fermented and requires technological processes of starting, fermentation and maturation of the mixture.

Given this fact, the costs of powdered milk and milk-containing products were compared on the example of powdered milk high-fat fermented products: dry sour cream and dry sour cream product.

The calculation of the cost of raw materials and auxiliary materials in the production of powdered fermented milk is presented in Table 13.

Table 13: Cost of the main raw materials and auxiliary materials in the production of dry sour cream and dry sour cream product (per 1000 kg)

Raw material and materials	Cost per kg, rouble	Dry sour cream		Dry sour cream product	
		consumption, kg	Cost, rouble	consumption, kg	Cost, rouble
Cow cream	71.4	2547.2	181968.0	1269.8	90791.3
Low calcium coprecipitate	150.3	110.8	16650.5	110.8	16650.5
Skimmed milk	15.3	1110.2	16982.7	1110.2	16982.7
Starter for sour cream	83.5	197.1	16450.3	197.1	16450.3

Vitamin C	3961.8	1.284	5087	1.284	5087
Quercetin	97952	0.096	9403.4	-	-
Ethanol	220.2	0.96	211.4	0.96	211.4
Milk Fat Replacer	60.2	-	-	317.0	19091.7
DHQ	120000	-	-	0.096	11520
Total	-	-	246753.3	-	176784.9

From Table 13 it follows that when comparing the cost of formulations (raw materials and basic materials) of dry sour cream and dry sour cream product, the economic feasibility of the production of milk-containing products is obvious, where part of the expensive dairy fat is replaced with cheaper vegetable fat.

More objectively, production expenses are characterized by the cost of products, which includes the total expenses of production (material consumption, labor intensity, energy intensity, overhead costs, etc.). The calculation of the cost and selling price of fermented milk product with and without vegetable fats is presented in Table 14.

Table 14 : Cost of dry sour cream and dry sour cream product

Costing	Cost per kg, rouble	
	dry sour cream	dry sour cream product
Main raw material	246753,30	176784,90
Auxiliary raw materials	149,3	138,20
Packaging materials	468.0	4680.0
Salary costs	2639.18	2639.18
Production costs	1038.9	1038.9
Power consumption	108584.9	108584.9
Social Security Fund	650.00	650.00
Depreciation	1073.86	1037.86
Production expenses	365568.44	187031.14
Administrative costs	680.45	686.43
Marketing costs	850.87	850.87
Production self cost	367099.76	188568.49
Selling price (including profit)	422164.73	405422.25
Value Added Tax	42216.5	40542.2
Package selling price (150 ± 5) g	69.66	66.89

According to the calculations presented in Table 14, the wholesale selling price of 1 package of dry sour cream is 69.66 roubles and 1 package of dry sour cream product is 66.89 rubles, which indicates the feasibility of introducing the developed resource-saving technologies.

Nutrition in the entire history of human existence has always been and remains the most significant factor exerting a direct and permanent influence on people's state of health. It is food in accordance with the biological laws of nature that affects the indicators of working ability and life expectancy: about 80% of all diseases are somehow related to nutrition.

Human health may deteriorate due to both nutritional deficiencies and excessive nutrition (excessive consumption of salt, sugar, animal fats and saturated fatty acids, and, consequently, "empty" calories).

Solving these problems by theoretical substantiation and carrying out numerous experimental studies, the authors of the paper have developed a number of formulations and technologies of dairy products for general and specialized nutrition.

In concluding part of this work presents new technologies of powdered milk products produced both from whole milk and fermented milk using vegetable raw materials, milk fat

replacers stabilized by antioxidant complexes, packaged in a disposable sealed package.

Due to using functional ingredients, new technological methods of production, and various types of packaging, a group of powdered milk and milk-containing products of improved quality and extended shelf life for general and specialized purposes has been developed.

Technical documentation kits have been developed and approved for the new range of powdered milk products.

All types of powdered milk products have been tested in the production conditions of the operating dairy enterprise LLC «VNIMI – Siberia» (Omsk).

CONCLUSION

Thus, a new group of powdered milk and milk-containing products with high nutritional and biological value, suitable for long-term storage for specialized purposes, has been created:

- use of vegetable fats rich in essential fatty acids, antioxidants of flavonoid nature, having P-vitamin activity, ascorbic acid, amino acids in the production of powdered milk provides the possibility of obtaining products with high nutritional and biological value not only in a fresh form, but also suitable for long-term (up to two years) storage.
- it has been established that powdered milk products have a high indicator of the biological value of essential amino acids in comparison with the ideal protein. Leastin, lysine, and threonine are dominant in dry high fat cream; in a dry cream product, the main components are valine, isoleucine, and threonine; in dry high-fat milk-containing product, these are leucine, lysine, and tryptophan.
- partial replacement of milk fat with vegetable fat ("Ecolact" MFR) increased the content of UFA, especially PUFA, while reducing the content of saturated fatty acids. Powdered milk-containing products correlate well with the balanced nutrition formula for the main ingredients of the composition. The ratio ω6: ω3 is 5 ÷ 10: 1.

Production of new types of powdered products expands the range of competitive products with improved organoleptic characteristics, increased nutritional value and durability in long-term storage, meeting modern requirements for healthy nutrition, taking into account their safety, balanced and relatively high content of vital substances of protein and lipid nature, vitamins, and minerals.

Resource-saving technologies for the production of new products are carried out on standard equipment and can be implemented at the processing enterprises of the dairy industry without special costs for the conversion of production capacity. Most of the developed products are recommended for production at the enterprises of the dairy industry of the Siberian region. The novelty of technology is reflected in four patents of the Russian Federation and the inventor's certificate. The economic effect from the introduction of new technologies is more than 30%.

REFERENCES

1. Abaturova, N. A. Basic principles for the development of combined products of directional action / N. A. Abaturova, K. K. Kusmanov, T. N. Khaustova // Storage and processing of agricultural raw materials. - 1998. - № 8. - p. 39-40.
2. GOST R ISO 9000-2001. Quality management systems. The main provisions and vocabulary.
3. Krasheninin, P.F. Dairy products for therapeutic and preventive nutrition of children and adults, enriched with bifidogenic factors: a review. inform / P.F. Krasheninin, V.N. Sergeev, E.G. Shcherbakova [et al.]. - M.: AgroNIIEMMP, - 1995. - 47 p.
4. Lizko, N. N. Products of the XXI century. Analysis of the situation and market development prospects / N. N. Lizko, S. A. Andriyanov // Moloch. prom-st. - 2001. - № 6. - p. 26-27.
5. Majurnikova, L. A. Formation of quality and merchandising characteristics of soft drinks for therapeutic and prophylactic purposes:

dis. ... Dr. Techn. Sciences: 05.18.15. - Kemerovo, 2001. - 388 p.

6. Methodical recommendations MR 2.3.1.1915-04. Recommended levels of consumption of food and biologically active substances. - M.: Ministry of Health of Russia, 2004.
7. Nesterova, A. V. Therapeutic nutrition in cardiovascular diseases / A. V. Nesterova // - M.: Publishing House Veche. - 2005. - 124 p.
8. The program of the development of the Arctic "On the approval of the state program of the Russian Federation "Social and economic development of the Arctic zone of the Russian Federation for the period up to 2020. "/ Resolution of the Government of the Russian Federation No. 366 of April 21, 2014, Moscow
9. Spirichev, B. V. Food fortification with micronutrients - a reliable way to correct nutrition and health / B. V. Spirichev, L. N. Shatnyuk // Modern priorities of nutrition, food industry and trade: collection of articles. scientific tr. - M., - Kemerovo. 2006. p. 76-78.
10. Technical regulations of the Customs Union "On the safety of milk and dairy products" (TR CU 033/2013). Adopted 9.10.2013, the number 67.
11. Tutelyan V. A. Micronutrients in the nutrition of healthy and sick people / V. A. Tutelyan, B. P. Sukhanov, V. B. Spirichev, V. A. Kudasheva. - M .: Kolos, 2002. - 424 p.
12. Williams, K. The link between healthy consumption of protein, carbohydrates and fat / K. Williams, T. Sanders // Nutrition. - 2000. - № 3. - p. 54-57.
13. Federal Law "On the sanitary and epidemiological welfare of the population." - M.: INFRA, - M., 2002.
14. Shatnyuk, L.N. Enrichment of dairy products with micronutrients / L.N. Shatnyuk // Food industry. - 2001. - № 9. - p. 49-51.
15 Shenderov, B. A. Medical microbial ecology and functional nutrition / B. A. Shenderov. - M.: Grant, 2001. - 288 p.
16. Azeredo Henriette M.C. Nanocomposites for food packaging applications / Henriette M.C. Azeredo // Food Res. Int. – 2009. – Vol. 42. – № 9. – P. 1240-1253.
17. Banks, W. The physical properties of milk fats of different chemical compositions / W. Banks, J. L. Clapperton, E. Morag // Journal of the Society of Dair Technology 29. – 2000. –P. 86-90.
18. BORISOVA G.V., BESSONOVA O.V. ,HISTIDINE BIOTRANSFORMATION MEDIATED BY L-HISTIDINE-AMMONIA-LYASE, T. 1 №2. - 2013. - P. 37-41
19. Ivkova I.A., Scrjabina O.V., Ryabkova D.S., Pilyaeva A.S., Diener J.A. Development of resource-saving technologies in the production of flour confectionery products/ I.A. Ivkova, O.V. Scrjabina, D.S. Ryabkova, A.S. Pilyaeva, J.A. Diener. // Journal of fundamental and Applied Sciences. - 2018. - № 10 (4 S) 1082-1098
20. Kosenchuk O.V., Aleshchenko V.V., Stukach V.F., Zinich A.V., Leushkina V.V. STUDY OF THE PROBLEMS OF SUSTAINABLE DEVELOPMENT OF RURAL TERRITORIES- T.13. № 6. 2016. -P.2391-2407
21. McCance and Widdowson's. The Composition of Foods : Sixth summary edition. Food Standards Agency. – Cambridge: Royal Society of Chemistry. 2002. – 450 p.
22. Milner, J. A. Functional foods and health: a US perspective / J. A. Milner // British J. Nutpition. – 2002. – № 2. – P. 151-158.
23. Siedell, J. C. Obesity in Europe, prevalence and public health implications / J. C. Siedell // Geneva. – 1992. – P. 23-29.