

Review Article

DEVELOPMENT OF SPECIALIZED FOOD PRODUCTS FOR NUTRITION OF SPORTSMEN

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Abstract

The article is based on the relevance of the development and production of specialized food products for nutrition of athletes, aimed at solving the problem of maintaining the appropriate physical condition of the population engaged in sports, fitness in a healthy lifestyle. As a result of theoretical and experimental researches the scientific concept of creation of fermented specialized food products on a dairy basis for sports nutrition is formulated, the structural and logistic scheme of realization of scientific and methodical principles of creation of these technologies is developed. Biotechnologies and recipes of specialized food products for sports nutrition have been developed. The biological and energetic value of diets with the use of specialized foodstuffs is determined. For practical realization of results of analytical and experimental researches normative and technical documentation for manufacture of new products which have been tested in industrial conditions of the operating enterprises of milk branch are developed. The technologies of all products are highly appreciated by consumers who are effectively engaged in sports and fitness.

Keywords: Products for Sportsmen, Methodological Approach, Specialized Nutrition, Probiotics, Antioxidants, Scientific and Methodological Principles.

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INTRODUCTION

Under current conditions, there is a growing population trend towards a healthy lifestyle. Not only professional sportsmen, but also amateurs, as well as visitors of fitness clubs are interested in specialized nutrition, which includes sports nutrition [1, 2]. For athletes, the requirements for essential nutrients differ markedly from those of non-athletes. This is primarily due to the fact that energy costs in most sports are 3-6 times higher than those for moderately active people. The daily energy costs of athletes during intensive training and competition days usually reach 5000-6000 kcal, and in some cases (tournament games, ski races, marathon run, etc.) they exceed 10 000 kcal per day [3].

The following components are to be included in sports food products:

- Dicarboxylic amino acids - primarily glutamic and asparagic acids. They are very easy to digest, being an excellent building material for muscles.
- Multivitamins. Athletes are in great need of increased doses of vitamins during intensive training.
- Products containing protein concentrates.
- Gainers are products containing a mixture of protein concentrates and carbohydrates. They provide an athlete with these two most important compounds for muscle growth.
- L-carnitine-based fats. L-carnitine promotes the breakdown of fat in muscle tissues, providing it with additional energy, which in turn increases the duration of training.

- Other fat-burning supplements are not as effective as L-carnitine and have a more moderate effect.
- Additives with a directed regenerating effect - they are based on different types of substances such as glucosamine or chondroitin, which protect the joints from damage, or nitrogen oxide, which accelerates the healing of muscle and ligament injuries [4, 5].

To date, there are many methods to develop sports nutrition products, in particular specialized sports nutrition products for athletes [6-8]. The aforesaid allows considering as actual the chosen direction on development and manufacture of specialized food products for athletes' nutrition, directed on the decision of a problem of maintenance of a corresponding physical condition of the population engaged in sports, fitness within a healthy way of life.

The aim of the work is to substantiate, develop and test an innovative methodological approach to the creation of specialized foods with general health-improving properties intended for the population engaged in sports, fitness and experiencing increased physical activity.

MATERIALS AND METHODS

As objects of research were used:

- Cow's milk according to GOST 31449-2013 [9];
- Goat milk in accordance with GOST 32940-2014 [10];

- Association of probiotic cultures of lactic acid bacteria *Lactobacillus acidophilus*, *Streptococcus thermophilus* and *Bifidobacterium bifidum*, *Bifidobacterium longum*;
- Biopolymers: gelatine and pectin from the current regulatory documentation.

Experimental repetition is five times. The results have been statistically analyzed using correlation and regression analysis methods and Math CAD-14 Professional software packages.

Measurements of chemical, microbiological, organoleptic indicators were performed using standard methods and modern devices: Rapid N Cube analyzer (Germany), "PROTEAN II" electrophoresis cell of analytical analyzer AAA-339 (Czech Republic), high-performance liquid chromatograph by Gibson (France), "Crystallux 4000M" chromatograph (Russia) and others [11].

RESULTS AND DISCUSSION

In the basis of formation of methodology for achievement of the stated purpose of the research the achievements of the science of nutrition - nutriology, which take into account the current state of physiological needs of the human body depending on its age, activity peculiarities, state of health and other factors. In particular, a healthy diet consists of the regime and conditions of food consumption, its component composition and physical state that promotes the assimilation of substances consumed by the human body [12].

As a result of theoretical and experimental research the scientific concept of fermented specialized food products development on the milk base was formulated, which includes the sequence of their development and management by regulating the biochemical and microbiological changes in the component composition of the milk base with its subsequent enrichment with functional and technically necessary ingredients for sports nutrition.

The methodology of fermented specialized food products creation is based on the following scientific and methodological principles:

- Realization of the process of fermentation of milk and milk compound base should be carried out through the use of bacterial concentrates based on the combination of probiotic cultures immobilized in gel biopolymers;
- Quality and safety of fermented specialized food products should be ensured by using natural sources of animal and plant raw materials and modern methods of its treatment - membrane, thermal, physical and chemical, etc.;
- Formation of functional and special properties of fermented specialized food products is carried out due to scientific justification and optimization of ingredients with the use of mathematical modeling methods that correlate fatty acid, and/or protein-carbohydrate, and/or vitamin and mineral composition, as well as biological, food, energy value of new products targeted for the population with increased physical activity during sports or fitness activities;
- Technological schemes of fermented specialized foods production are designed taking into account the full complex use of components of the main (basic) animal raw materials - milk and its products;
- Determination of shelf life of fermented specialized foods and their prolongation should be implemented using modern functional and technical ingredients, including food fibers and antioxidants of natural origin [13, 14].

The creation of specialized food products is based on the above scientific and methodological principles and scientifically based standard requirements to the following product characteristics [15]:

- Organoleptic characteristics;

- Microbiological indicators;
- Safety parameters;
- Functional properties;
- Chemical composition, balance of the main components;
- Correction of fatty acid, protein-carbohydrate composition.
- Technically necessary ingredients.

The structural and logistic scheme for realization of the scientific and methodical principles of fermented specialized food products for sports nutrition is shown in Figure 1.

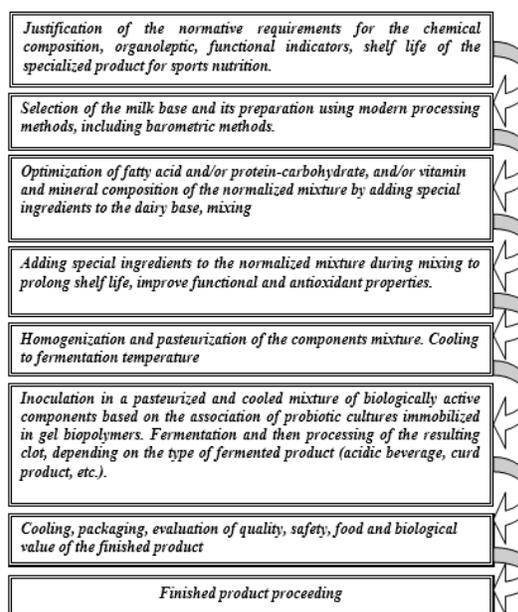


Figure 1: Structural and logistic scheme of implementation of scientific and methodological principles of fermented specialized food products for sports nutrition

Considering the above mentioned, the type of the main milk raw material and technological operations to prepare it for processing are specified, including lactose hydrolysis to reduce its quantity, whey hydrolysis to produce whey hydrolyzate with increased amount of essential amino acids, ultrafiltration of cow's or goat's whole milk or skimmed milk to increase protein concentration in milk base, etc.

The main technological operation of specialized food production is the fermentation process. The purpose of fermentation is not only to change the physical state of milk protein, but also to enrich specialized fermented dairy products with probiotic microflora. To achieve this goal, a biologically active component was developed on the basis of associations of starter cultures (probiotic), immobilized in the gel biopolymers of plant and animal origin, which contribute to the increase of product assimilation, as well as the preservation of the volume of viable cells of probiotic cultures in accordance with the requirements of GOST R 55577-2013 "Specialized and functional food products. Information about Distinctive Signs and Efficiency" not only during the whole shelf life of the product, but also when entering the gastrointestinal tract of the human, novelty of which is patented [16]. Also, on the basis of mathematical modeling of experimental data set, the main thermodynamic parameters of fermentation process by the above mentioned biologically active component were established.

An important factor in the creation of specialized food products is to determine the type and quantity of specialized and technically necessary ingredients, including prebiotics, stabilizers, components that increase muscle mass, and the

ability to achieve high sports results, as well as food and biological value of new products.

In order to implement the results of analytical and experimental research in practice, packages of normative and technical documentation were developed for the production of new food products for athletes, which were tested in the industrial conditions of existing milk industry enterprises (Table 1).

On the basis of the results of development of biotechnologies and recipes of specialized food products for sports nutrition, the main indicators, on which diets with the use of specialized food products, biological and energetic value were determined.

The amino acid composition of proteins from fermented foods for athletes' nutrition is given in Table 2. Nutritional and energy value of the products is presented in Table 3.

All products are enriched with probiotic microflora in quantity - lactic acid bacteria not less than $1 \cdot 10^8$ CFU/g and bifidobacteria not less than $1 \cdot 10^7$ CFU/g, propionic acid bacteria not less than $1 \cdot 10^7$ CFU/g.

The data presented in Tables 2 and 3 are used to compile athletes' diets based on the energy value of specialized foods. The range of new products was developed based on the findings of a study of the needs of different age groups, work and physical activity.

Table 1: Innovative technologies of food products for athletes

Food products for athletes	Official document	Authors
Biologically active components (BAC) based on associations of starter (probiotic) cultures immobilized in gel biopolymers	STO 00417591-032-2019	N.L. Chernopolskaya
Bioproduct for nutrition of sportsmen.	STO 23818594-007-2013	E.I. Petrova N.B. Gavrilova, N.L. Chernopolskaya
Protein and carbohydrate fermented milk product "Sport"	STO 78805029-035-2015	I.E. Trofimov, N.B. Gavrilova, N.L. Chernopolskaya
Special Purpose Bioproduct	STO 71063300-011-2019	N.L. Chernopolskaya N.B. Gavrilova
Protein Milk bioproduct	STO 56438524-021-2019	N.L. Chernopolskaya N.B. Gavrilova
Products for sportsmen nutrition "Olympia"	STO 01475277-042-2012	M.B. Rebezov
Soft cheese " Altaiskaya kozochka " based on goat and cow's milk	STO 44988-260-001-2016	E.M. Shchetinina

Table 2: Amino acid composition of proteins from fermented foods for athletes' nutrition

Amino acid	Mass content, mg/100 g of product				
	Protein-carbohydrate product "Sportivnyi"	Athlete nutrition bioproduct	Specialty athletes nutrition product	Protein bioproduct ProteinMilk	Soft cheese " Altaiskaya kozochka " based on goat and cow's milk
Essential	3798.0	2107.49	2350.0	8914.50	8462.26
valine	670.0	271.22	321.0	1048.08	1350.40
isoleucine	590.0	337.32	368.0	1250.40	1750.00

leucine	820.0	473.50	519.0	2106.12	1100.20
lysine	483.0	321.04	357.0	1400.28	1460.24
methionine	370.0	187.60	196.0	493.94	590.20
threonine	384.0	244.21	267.0	1283.34	1020.41
tryptophan	86.0	90.00	99.0	274.92	230.52
phenylalanine	395.0	182.60	223.0	1057.92	960.29
Non-essential	3880.0	2395.54	2010.0	11520.90	12043.22
alanine	170.0	160.36	161.0	537.48	490.13
arginine	185.0	59.53	67.0	607.14	610.24
asparagic acid	634.0	226.60	222.0	1329.84	1260.50
histidine	245.0	101.25	113.0	490.02	540.77
glycine	98.0	86.81	92.0	515.28	700.24
glutamic acid	1330.0	400.02	336.0	3796.62	3990.60
proline	550.0	302.62	201.0	2051.40	2310.60
serine	330.0	465.30	311.0	1090.74	1110.29
tyrosine	282.0	113.35	116.0	922.50	860.26
cystine	56.0	479.70	391.0	284.88	170.09
Total	7678.0	4503.03	4360.0	20480.40	20505.48

Table 3 - Nutritional and energy value of fermented products for athletes' nutrition

Name of product	Mass content, %			Energy value	
	fat	protein	carbohydrate	kCal	kJ
Protein-carbohydrate product "Sportivnyi"	0.07	7.7	9.7	118.4	494.90
Athlete nutrition bioproduct	2.50	4.5	16.5	106.5	446.23
Specialty athletes nutrition product	4.10	4.10	16.65	119.9	520.36
Protein bioproduct ProteinMilk	7.11	31.02	5.01	208.1	870.73
Soft cheese " Altaiskaya kozochka " based on goat and cow's milk	20.0	20.5	-	248	1037.88

CONCLUSION

On the basis of complex analytical work on research of scientifically-practical achievements of Russian and foreign scientists it has been established that one of the most important directions of development and production of specialized food products are food products for the population systematically engaged in physical exercises, fitness, amateur and professional sports. The scientific and experimental substantiation of biotechnology of specialized products for sportsmen nutrition is based on the main tendencies contributing to the development of domestic sport, achievement of high sports results and preservation of sportsmen's health, among which the most significant is ensuring the resistance of sportsmen's organism to stress situations by organizing a rational diet that provides an adequate supply of energy, biologically active substances and antioxidants. The technologies of all products were tested in the conditions of operating enterprises and were highly appreciated by consumers who are effectively engaged in sports and fitness.

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