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M.V. Temerbayeva^{1*}, L.S. Komardina¹, T.I. Uryumtseva¹, B.K. Diusenalin¹

¹Innovative University of Eurasia, Kazakhstan

* (e-mail: marvik7@yandex.ru)

Development of Physico-chemical and Technological Parameters for the Production of Dairy Products for Sports Nutrition in Pavlodar Region

Abstract

Main problem: The article considers the results of research and design of basic formulations of dairy products for sports nutrition in Pavlodar region. The authors analyzed the problems in the field of development of modern food technologies of a specialized orientation.

Purpose: To develop physical, chemical and technological parameters for the production of dairy products for sports nutrition in Pavlodar region.

Methods: structural-mechanical, physico-chemical, organoleptic.

Results and their significance: Reliable research results have been obtained: the fatty acid composition of goat and cow's milk for the production of a new product has been determined, the physico-chemical and structural-mechanical characteristics of goat and cow's milk (raw materials) have been studied. The authors concluded that in the protein composition of goat's milk in the spring and summer period, there is a slight excess of total protein by 0,27 %, whey and casein proteins by 0,07 % and 0,2 %, respectively, non-protein nitrogenous substances by 0,01 % compared with cow's milk.

A comparative analysis of the physico-chemical composition of the research objects (goat and cow's milk) was carried out and it was concluded that the mass fraction of solids in the milk of Zaanen goats is 12,8 %, respectively, and significantly exceeds the same indicator of cow's milk – 12,41 %. In the milk of Altai and Alpine goat breeds, the mass fraction of solids ranges from 11,85 % to 11,94 %, which is significantly lower than in cow's milk. The study found that the dry matter content in goat's milk is 8,59 %, which is 0,19 % more than the dry matter in cow's milk. There is a greater amount of protein, respectively, by 0,1 %, while the amount of fat is less than in cow's milk, by almost 1 %.

Keywords: physico-chemical parameters, sports nutrition, goat's milk, cow's milk, dry substances, organoleptic parameters, structural and mechanical characteristics

Introduction

In recent years, Kazakhstan has been paying more attention to the creation of sports nutrition products that can have a certain regulatory effect on the body of athletes to achieve high results. The development of dairy production, as well as all agriculture in Kazakhstan is based on the support of various strategic state development programs.

It is known that in recent years there has been a positive trend in our country: according to the Ministry of Sports of the Republic of Kazakhstan, the number of Kazakhstanis who systematically engage in sports has increased from 22,5 % in 2021 to 27 % in 2022. And in accordance with the Concept of development of physical culture and sports of the Republic of Kazakhstan in 2023-2029, the achievement of the level of 50 % according to this indicator [1].

The development and implementation of a development strategy for dairy farming will be able to improve the raw material base of dairy enterprises and increase the degree of use of milk from various farm animals for the production of high-grade dairy products, both for mass and specialized nutrition of the population. Dairy goat breeding, a promising livestock sector, is rapidly developing in Kazakhstan. Therefore, the development of technologies for new types of specialized products for sports nutrition based on goat's milk is an actual direction [2].

Products for sports nutrition are special or functional products, the production industry of which is actively and dynamically developing in the world. Currently, food and drinks intended for athletes of various specializations, widely represented in the Kazakhstani market, mainly imported. To solve the problem of optimal balanced nutrition of athletes, it is necessary to develop and introduce domestic specialized products into production. In the modern market, both in our country and abroad, there is a great demand for sports and fitness products, which so far are represented by a narrow

assortment. Special nutrition is necessary not only for professional athletes, but also for people involved in sports in their free time. It allows you to protect the body from a possible shortage of necessary biologically active substances, as well as increase the activity and effectiveness of sports [3].

A healthy population is a priority for the development of the economy of our country. Over the past few years, interest in a healthy lifestyle has been growing among the population. More and more people spend their free time doing sports. This is facilitated by an increase in the number of sports clubs in Kazakhstan, including Pavlodar region. Sports nutrition is one or more nutrients in concentrated form. The state of the sports nutrition market is closely related to the degree of lifestyle activity and the number of people regularly involved in sports and fitness. In the USA this indicator reached 60%, in Germany – 40 %, in Russia – 58 %, in Kazakhstan – 34 %.

The most developed American market (USA, Canada), it accounts for about 80% of the global market. Another major sports nutrition market is Australia and New Zealand, whose market is saturated with goods from the United States. The next market is European countries, which is far behind the other two markets. In Europe, except Germany, there are no manufacturers capable of competing both in size and in terms of sales with American manufacturers.

Table 1– Geographical distribution of firms

Country	Number of firms
USA	11
Russia	7
Germany	3
Other	7
Total	28

In some countries, to date, a number of sports nutrition products are banned. The USA in the world market of sports nutrition is considered the leader in the production of sports nutrition products. Only a few European manufacturers that are globally recognized are able to compete with American manufacturers. The Kazakhstani sports nutrition market is mostly imported sports nutrition products, mainly products imported from the United States. Currently, food and drinks intended for athletes of various specializations, widely represented in the Kazakhstani market, mainly imported. Out of 35 sports clubs of Pavlodar, according to the results of a telephone survey and further observation, sports nutrition was found only in 6 clubs (table 1).

In Kazakhstan, there are no manufacturers in the sports nutrition industry. The main suppliers are the popular companies of foreign countries. In the first place in popularity, according to the popular American publication, is the Muscle Pharm Corporation from the USA, which has been manufacturing and selling sports nutrition since. The second most popular, according to the Americans who have achieved great results in the production of sports nutrition, is Muscletech. The company's head office is also located in the USA, and sales of drugs under this brand name are successfully carried out worldwide.

The third place in the ranking is occupied by the American company Optimum Nutrition, a subsidiary of the well-known cheese producer, Glanbia. Formed in the distant 1986 by the brothers Tony and Michael Costello, the company presents its customers the widest range of drugs, among which there are a considerable number of world-famous brands. The fourth most popular company is Dymatize Nutrition, which was formed in the USA in 1994 and supplies over 300 supplements and sports nutrition products to all continents. Top Secret Nutrition may continue to rank sports nutrition firms. This company is less popular than the ones presented above, however its preparations and additives allow athletes to achieve great results.

Other companies can continue the global ranking of sports nutrition. Some of them are known to all sports fans, others have recently appeared on the horizon, but have already achieved considerable results. It should be said separately about the drugs sold under the brand name «Arnold Schwarzenegger Series», which offers only seven drugs, whose popularity, thanks to the quality of the goods and the properly organized advertising company, is quite high today. The rating leaders offer a wide range of products, including sportswear, and as for other enterprises and brands that can continue this list, they often produce a limited number of additives, which, nevertheless, have huge demand in the market. In the review of the role of nutrition factors in intense physical exertion of athletes,

scientists noted that currently, food and beverages intended for athletes of various specializations of foreign production are widely represented on the Kazakh market. Thus, the topic of these studies is an actual scientific direction.

Materials and methods

Materials:

- raw goat milk in accordance with GOST 32940-2014;
- raw cow's milk according to GOST 31449-2013;
- BK-Uglich-STBNV bacterial concentrate according to TU 9229-074- 04610209-2003;
- BK-Uglich-TV bacterial concentrate according to TU 9229-074-04610209- 2003;
- BK-Uglich-5A bacterial concentrate according to TU 9229-074-04610209- 2003;
- BK-Uglich-ST bacterial concentrate according to TU 9229-074-04610209- 2003;
- BK-Uglich-TV bacterial concentrate according to TU 9229-074-04610209- 2003.

To conduct experimental studies on a comparative assessment of the milk of goats and cows as raw materials for the production of a new sour-milk product, six groups of animals from the most common goats in the Pavlodar region were formed: Alpine, Gorno-Altai, Saanen breed and Simmental cow.

Methods: structural-mechanical, physico-chemical, organoleptic.

Results

At the Innovative Eurasian University in laboratory conditions did experimental work on a comparative analysis of the protein composition of goat and cow milk and their structural and mechanical characteristics (tables 2–4).

Table 2 – Fatty acid composition of goat and cow milk

Fatty acid	The boundaries of the mass fractions of fatty acids of milk fat, in% of their total			
	Goat's milk (n = 14)		Cow's drinking milk (n=18)	
	Average	Range	Average	Range
Oil	2,0	1,5–2,7	2,78	2,4–3,2
Kapron	2,0	1,8–2,2	1,81	1,5–2,1
Caprylic	2,4	2,0–2,8	1,13	0,9–1,3
Capric	8,5	6,8–10,0	2,55	1,9–3,0
Decenova	0,2	0,0–0,6	0,26	0,2–0,3
Lauric	4,0	2,9–5,1	2,98	2,2–3,6
Myristine	9,8	8,3–11,0	10,16	8,1–11,5
Myristolein	0,2	0,1–0,2	0,86	0,6–1,2
Palmitic	26,6	23,1–31,2	29,00	24,1–33,0
Palmitoleic	0,9	0,4–1,0	1,73	1,4–2,0
Stearin	10,9	7,1–14,2	11,04	8,5–13,5
Oleic	24,2	20,4–28,4	26,32	21,8–30,1
Linoleic	3,3	2,5–4,2	3,23	2,1–4,3
Linolenic	0,7	0,3–1,0	0,61	0,4–0,9
Peanut	0,3	0,1–0,5	0,21	0,2–0,3
Begenova	0,1	0–0,2	0,08	До 0,1
Other	4,0	–	5,27	–
6/8 ratio	0,85	0,68–0,90	1,61	1,50–1,78

Table 3 – Physico-chemical and structural-mechanical characteristics of goat milk

Indicators	Samples of goat milk - raw materials		
	April	May	June
Mass fraction of fat, %	4,17 ± 0,05	3,7 ± 0,05	4,1 ± 0,05
Mass fraction of protein, %	3,29 ± 0,16	3,75 ± 0,14	3,55 ± 0,14
Total nitrogen, %	0,551 ± 0,03	0,588 ± 0,03	0,557 ± 0,03
Non-protein nitrogen, %	0,0337 ± 0,006	0,0436 ± 0,006	0,0414 ± 0,006
Whey proteins, %	0,79 ± 0,03	0,91 ± 0,03	0,85 ± 0,03
Casein proteins, %	2,5 ± 0,04	2,83 ± 0,04	2,69 ± 0,04
Effective viscosity, Pa × s	2 × 10 ⁻³	2,1 × 10 ⁻³	2,1 × 10 ⁻³

Table 4 – Physico-chemical and structural-mechanical characteristics of cow's milk

Indicators	Samples of goat milk - raw materials		
	April	April	April
Mass fraction of fat, %	3,5 ± 0,05	3,5 ± 0,05	3,5 ± 0,05
Mass fraction of protein, %	3,23 ± 0,15	3,35 ± 0,12	3,22 ± 0,11
Total nitrogen, %	0,507 ± 0,03	0,526 ± 0,03	0,505 ± 0,03
Non-protein nitrogen, %	0,0305 ± 0,006	0,0294 ± 0,006	0,0310 ± 0,006
Whey proteins, %	0,77 ± 0,03	0,81 ± 0,03	0,76 ± 0,03
Casein proteins, %	2,43 ± 0,04	2,53 ± 0,04	2,44 ± 0,04
Effective viscosity, Pa × s	1,8 × 10 ⁻³	1,8 × 10 ⁻³	1,8 × 10 ⁻³

The studies were carried out in the spring-summer period (tables 2–4), it follows from the tables that the mass fraction of fat in the spring-summer period in goat milk is on average 0,5 % higher than in cow's milk. This is due to the fact that goat milk fat is presented in the form of small fat globules, which provides a developed surface of the fat phase.

As for the protein composition of goat milk in the spring-summer period, there is a slight excess of the total protein content by 0,27 %, whey and casein proteins by 0,07 % and 0,2 %, respectively, of non-protein nitrogenous substances by 0,01 % compared to cow's milk. The results of the study are presented in Table 5.

Table 5 – The chemical composition of milk of goats of various breeds, in comparison with cow's milk

Milk content	Breed			
	Goats			Cows
	Gorno-Altai	Alpine	Saanensky	Simmentalskaya
Dry matter, %	11,85±0,10	11,94±0,12	12,80±0,15	12,41±0,12
SOMO, %	8,23±0,05	8,63±0,06	8,25±0,06	8,49±0,05
Fat, %	3,61±0,11	3,25±0,15	3,39±0,13	3,90±0,10
Protein, %	2,78±0,05	3,17±0,04	3,35±0,05	3,24±0,05
casein	2,40	2,64	2,56	2,41
whey proteins	0,38	0,53	0,30	0,83
Lactose, %	4,64±0,11	4,62±0,13	4,57±0,15	4,14±0,09

According to the solids content, milk of goats of the Saanen breed can be distinguished. The results of the study are presented in Table 5.

Table 6 – Chemical composition and physico-chemical properties of the object of study

Properties	Chemical composition					Physicochemical properties			
	Dry Islands	Including				Freezing temperature °C	Density	Acidity	
		Fat	Protein	Casein	Protein whey			titer	pH
Cow's milk. Breed «Simmental»	12,5	5,65	2,86	2,41	0,83	-0,529	1027	14	6,67

* Including: SOMO – 7.40, Lactose – 4.3

The mass fraction of solids in the milk of goats of this breed is 12.8 %, respectively, and significantly exceeds the same indicator of cow's milk – 12.41 %. In the milk of goats of the Altai

Altai and Alpine breeds, the mass fraction of solids varies from 11.85 % to 11.94 %, which is significantly lower than in cow's milk.

Table 7 – Chemical composition and physico-chemical properties of the object

Properties	Chemical composition					Physicochemical properties			
	Dry Islands	Including				Freezing temperature ° C	Density Fat	Acidity	
		Fat	Protein	Casein	Protein whey			Protein	Casein
Goat milk. Alpine breed	12,9	4,95	3,30	2,60	0,45	-0,529	1028	33	6,59

* Including: SOMO – 8.65, Lactose – 4,5

Milk was collected in the autumn-winter period at the sampling site and was cleaned with a double filter. All analyzes were carried out in accordance with GOSTs. The chemical composition and physico-chemical properties of the object of study are presented in tables 6 and 7. Organoleptic indicators are presented in table 8.

Analyzing the data from tables 6 and 7, we can conclude that the dry matter in goat's milk is 8.59 %, which is 0.19 % more than the dry matter of cow's milk. A greater amount of protein is observed, respectively, by 0.1 %, while the amount of fat is less than in cow's milk by almost 1 %. The density of goat milk was slightly higher and amounted to 29.26 °T. The titratable acidity of goat's milk is slightly lower than that of cow's milk by 3 °T.

Table 8 – Organoleptic characteristics of the objects of study

Object of study	Name of indicator	Characteristics
Pavlodar region Cow's milk	Appearance and Consistency	Opaque liquid, no precipitate Liquid, homogeneous, not viscous, without protein flakes and clumps of fat.
	Taste and smell	Pure, characteristic of milk, without extraneous smacks and odors
	Color	White, with a slightly yellowish tint, uniform throughout the mass
Object of study	Name of indicator	Characteristics
Pavlodar region Goat milk	Appearance and Consistency	Homogeneous liquid, without precipitation and protein flakes
	Taste and smell	Pure, without extraneous odors and flavors, a weak specific taste of goat milk.
	Color	White with a cream tint.

Discussion

As a result of experimental studies and analysis of the data obtained, a standardized amount of basic raw materials and functional components that form the biological, nutritional and energy values of the new product are established. Since the product is multicomponent, first of all, the total amount of nitrogen, the total protein was determined on an automatic apparatus Kjeldahl AKV-20 (table 9).

Table 9 – The results of the experiments

Sample Name	Defined parameter	Mass concentration	Value $X \pm A, \%$
Sour-milk product for sports nutrition	Total nitrogen	1,25	$1,25 \pm 0,01$
	Total protein	8,01	$8,01 \pm 0,05$

In this work, the experimental material of the amino acid analysis of a prototype fermented milk product for sports nutrition is presented using the «Drop-105» capillary electrophoresis system, the data are presented in table 10.

Table 10 – The results of the experiments of the experimental fermented milk product

Amino acids	The content of amino acids, g / 100 g protein	Ideal protein, g / 100 g protein	Amino acid rate, %
Valine	4,9 ± 0,1	5	98
Isoleucine	5,9 ± 0,2	4	147,5
Leucine	9,9 ± 0,5	7	141,4
Lysine	8,8 ± 0,3	5,5	160
Threonine	4,1 ± 0,3	4	102,5
Methionine	3,6 ± 0,2	3,5	102,8
Tryptophan	2 ± 0,1	1	200
Phenylalanine	11,1 ± 0,5	6	185

Conclusions

The results of such studies allow us to develop technologies for new products and improve the technology of traditional products on a scientific basis. The development of physico-chemical and technological parameters of the production of dairy products for sports nutrition in Pavlodar region is an urgent area. The developed technology provides for the commercialization of the research results obtained by the authors.

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М.В. Темербаева^{1*}, Л.С. Комардина¹, Т.И. Урюмцева¹, Б.К. Дюсеналин¹

¹Инновациялық Еуразия университеті, Қазақстан

Павлодар облысында спорттық тамақтану үшін сүт өнімдерін өндірудің физика-химиялық және технологиялық параметрлерін әзірлеу

Мақала Павлодар облысында спорттық тамақтану үшін сүт өнімдерінің базалық рецептураларын зерттеу және жобалау мәселесіне арналған. Авторлар мамандандырылған бағыттағы заманауи тамақ технологияларын әзірлеу саласындағы мәселелерді талдады. Ешкі мен сиыр сүтін салыстырмалы бағалау бойынша эксперименттік зерттеулер жүргізу үшін спортқа арналған жаңа ашытылған сүт өнімін өндіруге арналған шикізат ретінде Павлодар облысында кең таралған ешкілердің алты тобы құрылды: Альпі, тау-Алтай, саанен тұқымы, сондай-ақ симментальды сиыр тұқымы.

Мақсаты – Павлодар облысында спорттық тамақтану үшін сүт өнімдерін өндірудің физика-химиялық және технологиялық параметрлерін әзірлеу.

Зерттеу барысында құрылымдық-механикалық, физика-химиялық, органолептикалық зерттеу әдістері қолданылды.

Зерттеудің сенімді нәтижелері алынды: жаңа өнімді өндіру үшін ешкі мен сиыр сүтінің май қышқылдық құрамы анықталды, ешкі мен сиыр сүтінің (шикізаттың) физика-химиялық және құрылымдық-механикалық сипаттамалары зерттелді. Авторлар көктемгі-жазғы кезеңде ешкі сүтінің ақуыздық құрамында жалпы ақуыздың 0,27 %-ға, Сарысу және казеин ақуыздарының тиісінше 0,07 %-ға және 0,2 %-ға, ақуыз емес азотты заттардың сиыр сүтімен салыстырғанда 0,01 %-ға шамалы артуы байқалады деген қорытындыға келді.

Зерттеу объектілерінің (ешкі және сиыр сүті) физика-химиялық құрамына салыстырмалы талдау жүргізілді және саанен тұқымды ешкі сүтіндегі құрғақ заттардың массалық үлесі тиісінше 12,8 %-ды құрайды және сиыр сүтінің ұқсас көрсеткішінен – 12,41 %-дан едәуір асады деген қорытынды жасалды. Алтай және альпі ешкілерінің сүтінде қатты заттардың массалық үлесі 11,85 %-дан 11,94 %-ға дейін ауытқиды, бұл сиыр сүтіне қарағанда айтарлықтай төмен. Зерттеу барысында ешкі сүтіндегі құрғақ заттың мөлшері 8,59 % – 8 құрайтыны анықталды, бұл сиыр сүтіндегі құрғақ заттан 0,19 %-ға көп. Ақуыздың көп мөлшері сәйкесінше 0,1 %-ға, ал май мөлшері сиыр сүтіне қарағанда 1 %-ға аз.

Түйінді сөздер: физика-химиялық көрсеткіштер, спорттық тамақтану, ешкі сүті, сиыр сүті, құрғақ заттар, органолептикалық көрсеткіштер, құрылымдық-механикалық сипаттамалар

М.В.Темербаева^{1*}, Л. С. Комардина¹, Т.И. Урюмцева¹, Б.К. Дюсеналин¹

¹Инновационный Евразийский университет, Казахстан

Разработка физико-химических и технологических параметров производства молочной продукции для спортивного питания в Павлодарской области

Статья посвящена вопросу исследования и проектирования базовых рецептур молочных продуктов для спортивного питания в Павлодарской области. Авторами проанализированы проблемы в области разработки современных пищевых технологий специализированной направленности. Для проведения экспериментальных исследований по сравнительной оценке молока коз и коров как сырья для производства нового кисломолочного продукта для спортивного были сформированы шесть групп животных из наиболее распространенных в Павлодарской области коз: альпийской, горно-алтайской, зааненской породы, а также породы симментальской коровы.

Цель – разработать физико-химические и технологические параметры производства молочной продукции для спортивного питания в Павлодарской области.

В ходе исследований использовались структурно-механический, физико-химический, органолептический методы исследований.

Получены достоверные результаты исследований: определен жирнокислотный состав козьего и коровьего молока для производства нового продукта, исследованы физико-химические и структурно-механические характеристики козьего и коровьего молока (сырья). Авторами сделан вывод, что в белковом составе козьего молока в весенне-летний период наблюдается незначительное превышение содержания общего белка на 0,27 %, сывороточного

и казеинового белков на 0,07 % и 0,2 % соответственно, небелковых азотистых веществ на 0,01 % по сравнению с коровьим молоком.

Проведен сравнительный анализ физико-химического состава объектов исследования (козьего и коровьего молока) и сделано заключение, что массовая доля сухих веществ в молоке коз зааненской породы составляет 12,8 % соответственно и значительно превышает аналогичный показатель коровьего молока – 12,41 %. В молоке коз алтайской и альпийской пород массовая доля сухих веществ колеблется от 11,85 % до 11,94 %, что значительно ниже, чем в коровьем молоке. В ходе исследования установлено, что содержание сухого вещества в козьем молоке составляет 8,59 %, что на 0,19 % больше, чем сухого вещества в коровьем молоке. Наблюдается большее количество белка, соответственно, на 0,1 %, в то время как количество жира меньше, чем в коровьем молоке, почти на 1 %.

Ключевые слова: физико-химические показатели, спортивное питание, козье молоко, коровье молоко, сухие вещества, органолептические показатели, структурно-механические характеристики.

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