DOI: 10.11134/btp.2.2026.8

UDC 637.146 Original Article

BIOTECHNOLOGICAL APPROACHES TO PRODUCING OF A COMBINED FERMENTED MILK DRINK

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ABSTRACT

The article presents the results of research on the development of a fermented dairy product with a plant-based additive, using goat's milk. The study was conducted at the Department of Food Biotechnology of Almaty Technological University, as well as in the Laboratory of Biotechnology of Specialised Products and Bioactive Supplements at the Kazakh Academy of Nutrition.

For the preparation of the fermented dairy products, a starter culture comprising pure strains of *Lactobacillus bulgaricus* B6, *Streptococcus thermophilus* TA 45, and *Lactobacillus acidophilus* in a ratio of 1:5:1 was used. The starter was added while the mixture was being stirred, with continuous mixing for 15 minutes. The milk was fermented until a milk-protein curd was formed, with an acidity of (78 ± 3) °T and pH = 4.70 ± 0.02, over a period of 5 to 6 hours. The resulting curd was then cooled to 20–25 °C over 30 minutes and subsequently stirred for 3–5 minutes.

The starter culture used contains probiotics, which help extend the shelf life of the product and inhibit the growth of yeasts and moulds. *Lactobacillus bulgaricus* synthesises a specific enzyme, peptidoglycan hydrolase, responsible for hydrolysing peptidoglycan. *Streptococcus thermophilus* contributes to a high viscosity, promoting the formation of a firm curd and desirable consistency. *Lactobacillus acidophilus* helps restore healthy intestinal microflora by suppressing the growth of harmful bacteria through the production of antimicrobial compounds.

When pumpkin juice with pulp was added to the milk mixture, fermentation led to more than a tenfold increase in lactic acid bacteria. This represents a significant advantage, as lactic acid bacteria in combined fermented dairy products improve digestion by breaking down lactose and proteins, suppress pathogenic microflora, strengthen immunity, and enhance calcium absorption. The protein content of the fermented products increased by over 3% compared with the control sample, due to the formation of a denser protein gel structure resulting from interactions between milk proteins, pumpkin pectins, and minerals. This enrichment enhances the nutritional value of the product.

***Key words*:** global food issues, goat milk, fermented milk product, starter culture, probiotics, plant additives, pumpkin juice with pulp, functional products.

INTRODUCTION

In an increasingly globalised and interconnected world, the eradication of hunger is a prerequisite for international peace and security. The challenge of providing sustainable food for an expected population of 9 billion people by 2050 can be met, among other things, by attempting to preserve and utilise greater diversity in food production and agricultural systems, both in terms of crops and varieties within each crop [1, 2]. Currently, the world's population obtains most of its calories from a small number of crops, with only about 30 species accounting for 95% of the world's food energy [3].

The nutrition structure of the population of Kazakhstan has changed significantly in recent years: the consumption of animal products, which are the main source of fat and protein, has significantly decreased. There is a global trend associated with the creation of products that improve health and prevent various diseases (anemia, diabetes mellitus, coronary heart disease, etc.). Irrational nutrition leads to an increase in the incidence of dysbiosis, diabetes, gastroenterological diseases in different age groups of the population [4, p. 67], which suggests the need to develop products that positively affect the restoration of human intestinal microflora [5, p. 10732; 6].

There is a worldwide demand for goat milk products. Goat breeding is a traditionally and historically rooted area of animal husbandry in Kazakhstan. Goats are able to more effectively use such low-productive lands as deserts and semi-deserts, small-contour unproductive areas in forest and forest-steppe zones, as well as various ravines, foothill and mountain pastures. Goat milk is more similar in structure to human breast milk, so there is a tendency in the world to use goat milk instead of cow's milk for the production of products not only baby food, but also mass consumption [7-9].

Goat milk contains more conjugated linoleic acids, which play an important role in stimulating immunity. The average size of fat balls of cow's milk is 21.2-31.2 microns, goat - only 2 microns. The ratio of β-casein/ α s1-casein (70 %/30%) in goat milk proteins is similar to human breast milk, which leads to greater digestibility compared to cow's milk due to the higher sensitivity of β-casein to protease enzymes. Due to the presence of β -casein in the main fraction of milk, goat milk forms a soft clot that is easily digested in the human stomach. [10, p. 14-16; 11, p. 1219, p. 1229].

For the production of fermented milk products, it is advisable to use special types of lactic acid bacteria, including *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. These bacteria mutually stimulate each other and compensate for each other's metabolism. The combination of these microorganisms ensures a product with a fermented milk aroma and a delicate, pleasant taste [12].

Streptococcus thermophilus is a soft-fermenting thermophilic culture with a high degree of viscosity, which promotes the formation of a good curd. *Streptococcus thermophilus* promotes digestion, alleviates symptoms of lactose intolerance

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and maintains intestinal microflora balance, producing lactic acid and exopolysaccharides, which promote milk fermentation and the formation of the desired product texture. Viscous strains of thermophilic streptococcus produce exopolysaccharides, which impart viscosity and an ideal consistency for yoghurts.

Lactobacillus bulgaricus is beneficial to health due to its effect on the digestive and immune systems. It inhibits the growth of pathogenic microorganisms, improves digestion and nutrient absorption, and maintains normal pH levels in the intestines and female reproductive organs. Consuming foods containing Bulgarian bacillus can lower cholesterol levels and strengthen the immune system.

The Bulgarian bacillus actively synthesizes extracellular polysaccharides, which are part of casein micelles and contribute to their stability, helping to keep them dispersed in milk, improving consistency and preventing syneresis.

Lactobacillus acidophilus has a beneficial effect on intestinal health, strengthens the immune system, improves digestion and lactose absorption.

Milk, as a raw material for fermented milk products, is the most important source of natural biologically active ingredients. Farm animal milk contains proteins, fats, carbohydrates, which determine the nutritional value of milk. Biological value is determined by the level of vitamins, macro- and microelements, polyunsaturated fatty acids (PUFA), immune factors. Most of the published works are related to the search for bioactive peptides in cow's milk samples, some of them are devoted to studies of sheep or goat's milk [13, p. 137].

The choice of plant filler for the fermented milk product was determined on the basis of quality indicators in accordance with the vitamin and mineral composition, allowing to obtain a final product with high nutritional and biological value, enriched with biologically active substances, dietary fibre and pectin substances, affordable and inexpensive [14].

There was first developed the concept of functional foods in 1980, which initiated and approved the development of products that were used to improve the health of older adults in Japan [15, p. 13]. Functional foods included beneficial food components (dietary fiber, carotenoids, phenolic acids, fatty acids, plant sterols, flavonoids, polyols, soy protein, pre- and probiotics, phytoestrogens, vitamins, and minerals) [16, p. 62].

Combination products can be used to treat and prevent a number of diseases, since they can be an additional agent to drug therapy. Thus, biologically active components contained in products of plant origin are represented by a different class of compounds: vitamins, macro- and microelements, dietary fibers, which have a beneficial effect on the state of health and quality of life [17, p. 51-56]. Of particular interest are bioflavonoids, the sources of which are fruits, berries, vegetables, among which lemons, fresh cranberries, chokeberries, hawthorn, redcurrants, blackcurrants, raspberries, rose hips should be distinguished; dried oregano, grapefruit, oranges, artichoke [18, p. 135]. Bioflavonoids have antiallergic, antioxidant, antibacterial and anti-inflammatory effects [19, p. 130].

Many fruits and berries are rich in antioxidants, participate in neutralizing free radicals, prevent cell damage, weaken the course of severe non-communicable diseases, and properly maintain health [20, p. 129-131]. The main requirements for plant-based fillers are safety, minimal side effects, effectiveness, high bioavailability, and lower cost compared to synthetic drugs. One such crop is pumpkin, whose pulp is rich in valuable nutrients that are beneficial to health and have antioxidant properties.

Pumpkin (*Cucurbita spp*.) is one of the most underrated and underutilised food and medicinal plants. Their production is hampered by a lack of genetically improved seeds. It is an extraordinary vegetable that can be used as a medicine as well as a nutritious, multifunctional food product. The skin and flesh of pumpkins contain essential minerals and phytochemicals (β-carotene, total flavonoids and total phenols) that can help fight ageing and strengthen the immune system [21-24]. In particular, pumpkin seeds are rich in zinc, and in the context of the COVID-19 pandemic, scientists are fully aware of the oxidative and mediating effects of zinc, which stimulates enzymes in the body. Inexpensive powders made from pumpkin components can be used in the food and pharmaceutical industries as a source of functional ingredients and nutraceuticals [25].

Pumpkin consumption can be used to increase vitamin A intake, strengthen the diet and diversify complementary foods (CF) by including animal products [26]. As shown by recent studies on the use of fibre to modify glycaemic response and, consequently, treat diabetes, these phytochemicals have a direct impact on the nutritional value of food, which has been confirmed by the use of pumpkin derivatives to treat diabetes in Asia.

Vegetable juices are a structured fluid that set the body's cells up for a harmonious existence. As is known from the literature, pumpkin is 90% structured water. Pumpkin juice also contains a lot of carotene and vitamins A, K, B and E, there is ascorbic acid. Zinc salts, mineral salts, as well as proteins and fats are present. A particularly unique component of pumpkin juice is vitamin K, which is not found in almost any other vegetables. It also normalizes blood clotting [27-29].

However, the most valuable thing in pumpkin juice is pectin, which helps to reduce blood cholesterol, improve peripheral blood circulation and normalize intestinal motility. It cleans living organisms of many harmful substances, including radioactive elements, toxins and pesticides. Pumpkin juice can promote the growth and development of beneficial microorganisms in infant formula because it contains prebiotics (fiber), vitamins, and antioxidants [30-33].

The aim of the study is to develop biotechnological approaches to the creation of combined dairy products based on goat's milk.

MATERIALS AND METHODS

For the study goat milk was used for the study from the Almaty region, that was pasteurized at (85-87) °C without holding time.

A combination of *Lactobacillus acidophilus*, *Streptococcus salivarius subspecies termophilius* T*45* (Danisco, Germany) and *Lactobacillus delbruki subspecies bulgaricus B6* (University of Food Technologies, Plovdiv, Bulgaria) strains was used as starter culture.

Pumpkin varieties adapted to the local climate are success-

DOI: 10.11134/btp.2.2026.8

fully grown in the Almaty region. These include the butternut squash varieties with their rich, sweet flesh, which were used in this study.

When creating multicomponent dairy products, the microbiological contamination of plant materials should be taken into account. Based on this, the purpose of the studies at the next stage was to study the safety of a fermented milk drink with and without the introduction of a vegetable component. Samples were analyzed for microbiological parameters: NMAaFAM (number of mesophilic aerobic and facultative anaerobic microorganisms), BECG (bacteria of the Escherichia coli group).

We used selective medium MRS (Merck KGaA, Germany), the main feature of which is a low pH (<5.4) and a high concentration of acetate ions, which is an inhibitor of many microorganisms. The count of lactic acid bacteria in dairy product samples was determined according to GOST 10444.15-94. The limiting dilution method was used, followed by calculation of the most probable count of lactic acid microorganisms. The identification of the isolated bacteria as belonging to the genus *Lactobacillus bulgaricus* was determined according to GOST 10444.11-89 «Food Products. « The culture from each dilution was inoculated with at least two 0.1 cm³ volumes onto the agar surface and incubated for 2-3 days at 37°C under anaerobic conditions using anaerobic cylinders and gas generator units (Merck KGaA, Germany). *Streptococcus thermophilus* was identified by culturing on selective M17 media supplemented with lactose (for improved growth). The cultures were incubated at 37-45°C for 24-48 hours under anaerobic conditions. Under a microscope, *S. thermophilus* appears as gram-positive spherical cells arranged in chains or pairs.

The determination of the dry matter content in milk and SOMO was carried out in accordance with GOST 3626. The principle of the method for determining the dry matter content in milk is based on drying a sample of the product under investigation at a constant temperature. Required materials and equipment: a glass beaker containing 20–30 g of thoroughly washed and calcined sand, a drying oven, a desiccator, and a water bath. Samples are weighed after drying until the difference between two consecutive weighings is equal to or less than 0.001 g.

The fat content of the samples was determined according to **GOST 5867–90** using a centrifuge operating at 1000 rpm and butyrometers for samples with a measurement range of 0–6% and a scale division of 0.1%. Materials and reagents required to perform the work: 10 ml of sulfuric acid, 1 ml of isoamyl alcohol. The butyrometer reading corresponds to the grams of fat per 100 ml of sample. Ten small scale divisions correspond to 1 g of fat.

The protein content was determined in accordance with GOST 23327–98 “Milk and dairy products. Methods for protein determination” using the Kjeldahl method. This method is based on the conversion of amino acid nitrogen into ammonia through mineralization, followed by its quantitative determination and subsequent conversion to protein content. Main materials and equipment: automatic coulometric titrator (or distillation apparatus), magnetic stirrer, mercury thermometer, sulphuric acid, sodium hydroxide, catalyst (copper sulphate/potassium sulphate).

The lactose content was determined according to the standard method adopted for milk and dairy products in accordance with GOST 3628–78. The following equipment is required for the analysis: a balance, a centrifuge, a photocolorimeter (or burettes), a water bath, flasks, pipettes, and the following reagents: Fehling’s solution, zinc acetate, ferric chloride, iodine, sodium thiosulphate, acetic acid, and sodium hydroxide. The method is based on the oxidation of reducing sugars (lactose and glucose), which contain an aldehyde group, by iodine in an alkaline medium. The mass fraction of sugars was determined from the difference between the amount of iodine initially added and the amount of iodine remaining after the reaction, which was quantified by titration with sodium thiosulfate.

The titratable acidity of fermented milk beverages was determined according to the standard method adopted for milk and liquid dairy products in accordance with GOST 3624–92.

Main materials and equipment: laboratory balances; burettes with a capacity of 25 or 50 cm³; pipettes with a capacity of 10, 20 or 25 cm³; conical flasks (Erlenmeyer flasks) with a capacity of 100 or 250 cm³; measuring cylinders with a capacity of 25, 50 or 100 cm³; sodium hydroxide (NaOH) or potassium hydroxide (KOH) 0.1 N; 1% phenolphthalein alcohol solution (indicator); distilled water; cobalt sulphate, potassium dichromate (for preparing the colour standard).

Active acidity was determined by the electrometric method using a pH meter in accordance with GOST 26781–85. The measurement method is based on determining the hydrogen ion activity in milk using a potentiometric method. Equipment, glassware, consumables and measuring instruments: a potentiometric analyser (pH meter) for monitoring the pH of milk and dairy products in accordance with GOST 19881-74; Class 4 laboratory balances; laboratory thermometer; thermostat or water bath for maintaining the sample temperature; magnetic stirrer (recommended for rapid mixing of the sample); 50–100 cm³ beakers; pipettes: 10–20 cm³ capacity.

The energy value of the samples was determined in accordance with GOST 31981-2013 (Yoghurts. General technical specifications).

Phosphatase in milk was determined using a method based on the hydrolysis of phenolphthalein sodium phosphate by phosphatase, in accordance with GOST 3623-73. The method is based on the ability of the enzyme phosphatase to hydrolyse the disodium salt of phenylphosphoric acid, resulting in the formation of phenol. The amount of phenol formed is directly proportional to the activity of the phosphatase. Measurements were carried out in triplicate.

RESULTS

The composition of fermented milk products includes whole pasteurized milk, plant filler (pumpkin juice with pulp) in the amount of 5%, starter culture composition of lactic acid bacteria, *Lactobacillus bulgaricus*, *Streptococcus thermophilus* and *Lactobacillus acidophilus* in a ratio of 1:5:1.

The production of fermented milk products from goat milk was carried out in accordance with the technological scheme presented in Figure 1.

The technological scheme for producing pumpkin juice with pulp is presented in accordance with Figure 1.

DOI: 10.11134/btp.2.2026.8

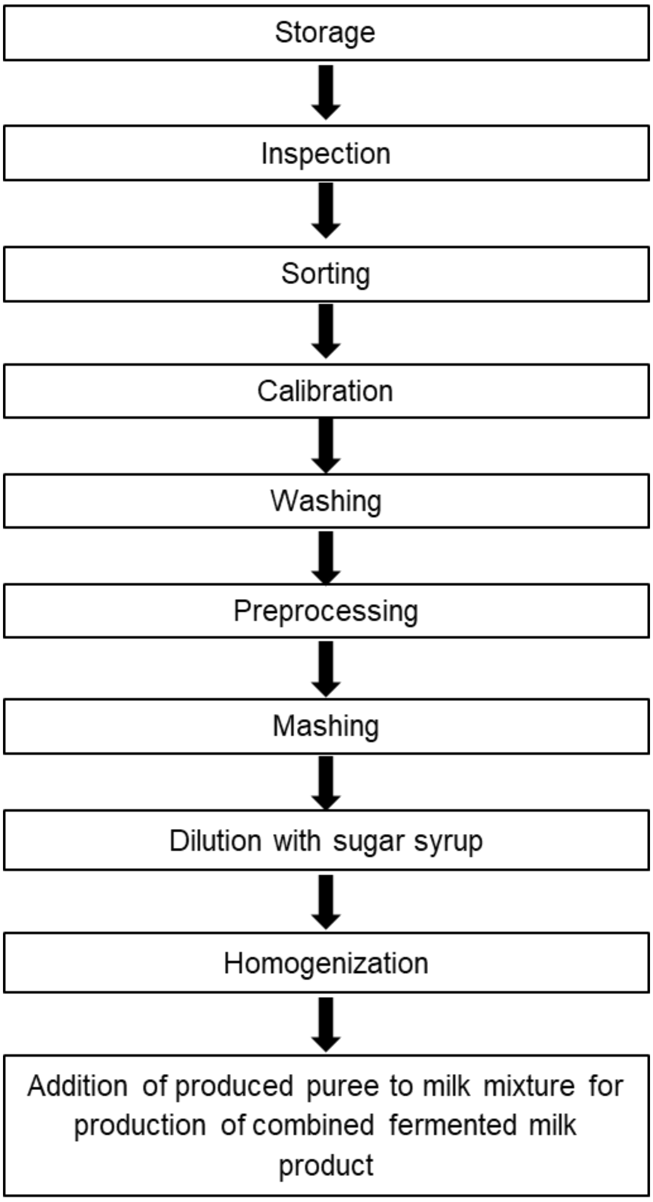

Figure 1 – Pumpkin juice production flow chart

Storage. Pumpkin is stored in accordance with the requirements established by the standard.

Inspection. Pumpkin is inspected and peduncles are removed.

Sorting and calibration. Then the fruits and berries are sorted by quality, while selecting all substandard (rotten, pest-affected, unripe and overripe fruits) and related impurities. Then calibration is performed.

Washing. After calibration pumpkin is loaded into bath where it is locked at continuous bubbling of compressed air. After the lock, the pumpkin is thoroughly washed with clean running water until the impurities are completely removed.

Preprocessing. After washing, the pumpkin is peeled. Pumpkin is cut, cleaned from seeds and fibrous part, and then milled.

Mashing pumpkin to produce puree. The produced mass is strained through special sieves 1.5-2 mm or filters to separate coarse particles and produce a homogeneous pulp puree.

Dilution with sugar syrup. To obtain pumpkin juice with pulp, the resulting puree is diluted with sugar syrup.

Addition of produced puree to milk mixture for production of combined fermented milk product. Pumpkin juice in an amount of 7% is added to the milk mixture at a temperature of (39 ± 2) 0S, mixed and then, in accordance with the stages of the developed technological process, a fermented milk drink is obtained from goat milk with a phyto-filler.

The next stage of work was the production of a fermented milk product based on goat milk. Preparation of fermented milk product with phyto-fillers complies with the flow chart

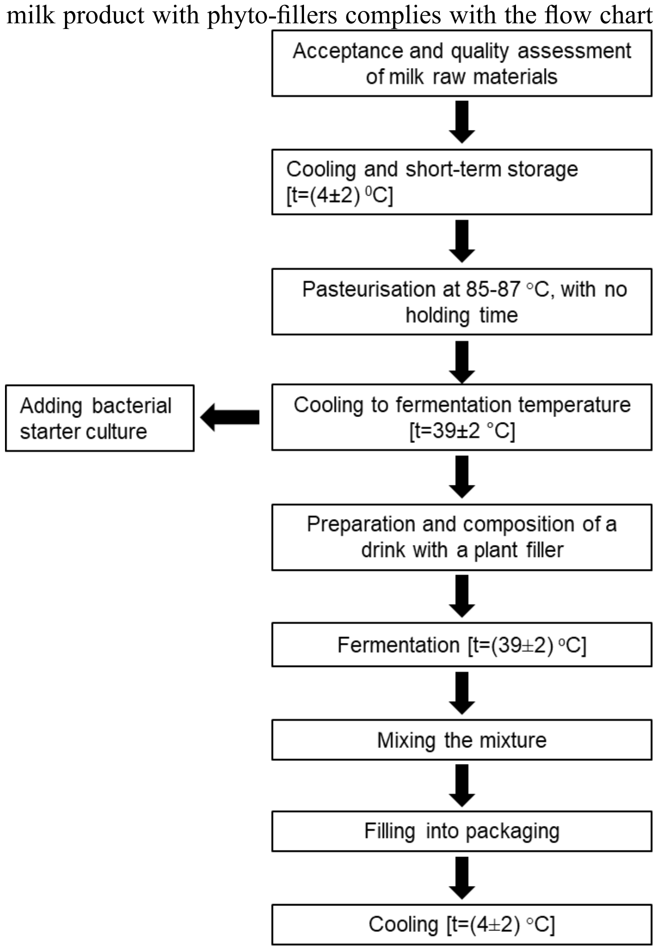

Figure 2 – Fermented milk production flow chart

below (Figure 2).

Acceptance and quality assessment of raw materials. Goat milk is accepted according to the quantity and quality established by the standard. Upon arrival at the enterprise, milk must have a temperature of at least 10 °C.

Cooling and short-term storage. Milk is cooled and stored at a temperature of (6±2) °C.

Pasteurisation. Milk was pasteurised at a temperature of 85-87 °C without holding time.

Cooling to fermentation temperature. The milk mixture was then cooled to fermentation temperature (39±2) °C.

Addition of bacterial starter culture. The culture was added to the milk mixture and the milk was stirred with the starter culture.

Preparation of plant additive. Plant raw materials were prepared using established technology.

DOI: 10.11134/btp.2.2026.8

Preparation of a beverage with a plant supplement (pumpkin juice with pulp). After pasteurisation, the prepared supplement was added to the milk mixture at a temperature of (39±2) °C in an amount of 7% and stirred.

Fermentation. The milk was fermented in tanks for fermented milk drinks with a cooled jacket, equipped with special stirrers to ensure uniform and thorough mixing of the milk with the starter culture. To avoid foaming, which affects the separation of whey, the mixture for fermentation is fed through the lower nozzle.

The milk was fermented with lactic acid starter culture consisting of pure cultures of *Lactobacillus bulgaricus B6* and *Streptococcus thermophilus TA 45* and *Lactobacillus acidophilus* in a ratio of 1:5:1. The starter culture was added with the mixer running, and stirring was carried out for 15 minutes.

The milk was fermented until a milk-protein clot was formed with an acidity of (78±3)°T, pH=(4.70±0.02) and the fermentation lasted from 5 to 6 hours.

Mixing. After fermentation, the curd was cooled to a temperature of 20-25 °C for 30 minutes, then stirred for 3-5 minutes.

Bottling and packaging. Fermented milk drinks were packaged in plastic bottles with a capacity of 200-250 cm³.

Cooling. The packaged product was sent to a cold room for cooling and maturation to a temperature of 2-4 °C. After that, the technological process was considered complete, and the drink was ready for sale.

The microbiological indicators of goat milk-based fermented milk drinks are presented in Tables 1-2. Sample names: beverage No. 1 – fermented milk beverage based on goat milk; beverage No. 2 – fermented milk beverage based on goat milk with pumpkin juice.

Cultures were grown in sterile goat's milk. Cell titers were determined; the data are presented in Table 1.

Table 1 – Growth of probiotic strains

Culture	Cell count in CFU/cm³ (g)
Lactobacillus bulgaricus B6	$\geq 1x10^7$
Streptococcus thermophilus	$\geq 1x10^9$
Lactobacillus acidophilus	$\geq 1x10^6$

The data presented in Table 1 show the number of microorganisms grown at an inoculum dose of 5%.

The influence of pumpkin juice with pulp concentration on the organoleptic properties of fermented dairy beverage samples was evaluated. In the experimental samples, the plant-based additive was added in amounts ranging from 3% to 9%, with increments of 2%. The experimental data on the effect of the plant additive on the organoleptic properties of the samples are presented in Figure 3.

According to the data presented in Figure 3, varying the addition of pumpkin juice with pulp from 1% to 9%, in increments of 2%, led to an optimal result in terms of organoleptic properties at a 7% addition. Increasing the dose to 9% resulted in excessive sweetness and an undesirable aftertaste. The 7% dose of the plant-based additive was found to be optimal, as it provided a subtle aroma of the additive along with a pleasant fermented dairy flavour with a mild hint of the plant ingredient. It was determined that the dose of the added plant-based additive did not significantly affect the overall taste of the fermented dairy product samples.

In the next stage, microbiological analyses of the fermented dairy beverages were conducted, as presented in Table 2. The fermented dairy beverages (drinks) were designated as follows: Drink No. 1 – control sample; Drink No. 2 – fermented dairy beverage (drink) with a 7% addition of the plant-based additive (pumpkin juice).

As can be seen from the data in Table 2, neither *Escherichia coli* nor mould was detected in the fermented goat's milk drinks. The data in the table show that the number of lactic acid bacteria increased more than tenfold during fermentation.

Based on the results of the studies, it can be concluded that adding pumpkin juice with pulp to milk in an amount of up to 7% does not worsen the bacterial contamination of the finished product.

The further goal of our research was to study the physicochemical indicators of fermented milk drinks based on goat milk.

The physicochemical characteristics of goat milk-based fermented milk drinks are presented in Table 3.

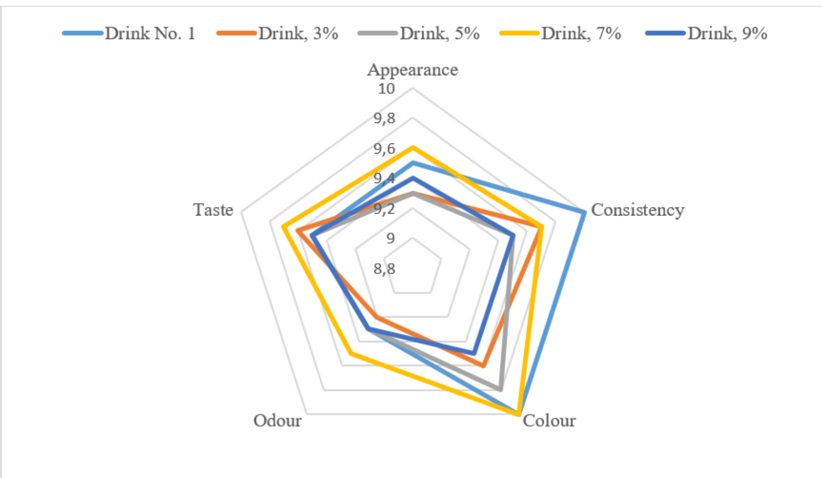

Figure 3 – Organoleptic characteristics of fermented dairy beverage samples

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Table 2 – Microbiological indicators of fermented milk drinks from goat's milk

Name of indicators, units of measurement	Standard for ND	Drink No. 1	Drink No. 2
Lactic acid microorganisms, not less than	$1*10^7$	$3,0*10^7$	$3,5*10^8$
Bacteria of ECG (coliforms) in 0.1 g	not permitted	not detected	not detected
Mould, CFU/cm3 (g), not more than	50	not detected	not detected

Table 3 – Physicochemical indicators of goat milk-based fermented milk drinks

№	Indicators, g/100g	Drink No. 1	Drink No. 2
1	Mass fraction of dry matter	$13,08±0,25^{**}$	$13,54±0,24^{**}$
2	Mass fraction of fat	$4,27±0,03^{*}$	$4,28±0,02^{*}$
3	Mass fraction of protein	$4,20±0,05^{**}$	$4,35±0,05^{**}$
4	Carbohydrates	$3,81±0,02^{*}$	$4,32±0,03^{*}$
5	Titratable acidity, ^{O}T	77±2 °T	80±2 °T
6	Active acidity, pH	4,58±0,05	4,57±0,05
7	Energy value of 100 g of milk, kcal	$69,73±0,47^{*}$	$72,13±0,51^{*}$
8	Energy value of 100 g of milk, kJ	291,94	297,8
9	Phosphatase	Not detected	
The results are based on the calculation of the average standard error $^{*}p≤0,01$, $^{**}p≤0,05$			

The analysis results shown in Table 3 indicate that the protein content in the fermented milk products increased by more than 3% compared with the control sample. The carbohydrate content has increased by approximately 13%, including glucose, fructose and sucrose, which are abundant in pumpkin juice. It should be noted that there are no significant differences between the samples of fermented milk products: the protein, fat and dry matter content in fermented milk products remains within the limits specified in the regulatory documentation.

The absence of phosphatase indicates that the pasteurisation process for producing fermented milk products has been carried out correctly.

CONCLUSIONS

Fermented milk products, particularly yoghurt, remain a key substrate for probiotic bacteria: as the range of new fermented milk products and drinks with improved organoleptic properties expands, their popularity among consumers is growing.

As a result of the experiment, a fermented milk drink was prepared from goat's milk with the addition of a plant-based ingredient (pumpkin juice with pulp).

A comparison with the literature shows that our organoleptic assessment results not only align with current understanding of promising functional drinks, but also expand existing knowledge by incorporating a specific plant component — pumpkin juice with pulp — into the context of fermented milk products. Similar approaches to the development of fermented fruit juice-based beverages have been employed by various authors. For example, Dikmetaş et al. [36] demonstrated the possibility of fermenting apple, orange, kiwi and dragon fruit juices using water kefir grains, which led to significant changes in the microbiological composition and phenolic profile without the formation of undesirable by-products.

Research by other authors into the formulation of blends of various fruit and vegetable juices with dairy ingredients shows that combined plant-based drinks are capable of maintaining high viability of probiotic cultures and delivering the desired organoleptic characteristics, which is consistent with our findings regarding the optimal addition of 7% pumpkin purée [37]. This study, as well as research by other authors, confirms that fruit and vegetable drinks can serve as a suitable medium for fermentation and for improving organoleptic and physicochemical properties. This also highlights the importance of selecting the optimal content of added ingredients to achieve a balanced taste and aroma without excessive sweetness or off-flavours.

Thus, it can be concluded that the addition of pumpkin juice to goat's milk significantly enhances the nutritional value of the fermented milk drinks produced from it.

AUTHOR CONTRIBUTIONS

Nadirova S.A. was responsible for defining the research topic and objectives, developing the formulation of the combined product (the ratio of milk and plant-based components), designing the production process flowchart, and drafting and formatting the main text of the manuscript in accordance with the journal's requirements.

Students Kazi Arailym, Zosimov Vadim and Zhanbolat Gaziza were directly involved in conducting the experimental studies (examination of physicochemical and microbiological parameters).

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DOI: 10.11134/btp.2.2026.8

ӘОЖ 637.146

АРАЛАС СҮТ СУСЫН ЖАСАУДЫҢ БИОТЕХНОЛОГИЯЛЫҚ ТӘСІЛДЕРІ

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АННОТАЦИЯ

Мақалада ешкі сүті негізінде өсімдік қосымшасы бар қышқыл сүт өнімін әзірлеу жөніндегі зерттеулер нәтижелері ұсынылған. Зерттеулер Алматы Технологиялық Университетінің «Азық-түлік биотехнологиясы» кафедрасында және Қазақстан Тамақтану Академиясының Арнайы өнімдер мен биологиялық белсенді қоспалар биотехнологиясы лабораториясында жүргізілді. Қышқыл сүт өнімдерін дайындауда *Lactobacillus bulgaricus* В6, *Streptococcus thermophilus* ТА 45 және *Lactobacillus acidophilus* таза мәдениеттерінен тұратын 1:5:1 қатынасындағы стартер қолданылды. Стартер қоспаға араластырғыш қосылған кезде енгізіліп, 15 минут бойы араластырылады. Сүт сүт-белокты ірімшікке айналғанша қышытылып, қышқылдығы (78 ± 3) °Т, pH = 4,70 ± 0,02 болған кезде 5–6 сағатқа дейін ферменттелді. Алынған ірімшік 30 минут ішінде 20–25 °C температураға дейін салқындатылады, содан кейін 3–5 минут бойы араластырылады. Зерттеуде қолданылған стартер құрамында пробиотиктер бар, бұл өнімнің сақтау мерзімін ұзартуға және соңғы өнімде ашытқы мен көксаңырауқұлақтардың өсуіне жол бермеуге мүмкіндік береді. *Lactobacillus bulgaricus* пептидогликанды гидролиздейтін арнайы фермент – пептидогликангидролаз синтездейді. *Streptococcus thermophilus* жоғары тұтқырлыққа ие болып, тығыз ірімшік пен дұрыс консистенция қалыптастыруға ықпал етеді. *Lactobacillus acidophilus* ішек микрофлорасын қалпына келтіріп, зиянды бактериялардың дамуын антибиотиктік заттар шығару арқылы тежейді. Сүт қоспасына асқабақ шырыны мен ұнтағын қосқанда ферментация нәтижесінде сүт қышқыл бактерияларының саны он есе артты. Бұл артықшылық болып табылады, себебі қоспалы қышқыл сүт өнімдеріндегі сүт қышқыл бактериялары қорыту процесін жақсартып, лактоза мен ақуыздарды ыдыратады, патогенді микрофлораны тежейді, иммунитетті күшейтеді және кальцийдің сіңуін арттырады. Қышқыл сүт өнімдеріндегі ақуыз мөлшері бақылау үлгісіне қарағанда 3%-дан астам өсті, бұл сүт ақуыздарының асқабақ пектині мен минералдарымен әрекеттесу нәтижесінде тығыз гель құрылымының пайда болуымен байланысты. Бұл өнімді қоректік қасиеті жоғары, пайдалы етеді.

Түйінді сөздер: жаһандық азық-түлік мәселелері, ешкі сүті, ашытылған сүт, ашытқы, пробиотиктер, өсімдік қоспалары, целлюлоза қосылған асқабақ шырыны, функционалды тағамдар.

УДК 637.146

БИОТЕХНОЛОГИЧЕСКИЕ ПОДХОДЫ К СОЗДАНИЮ КОМБИНИРОВАННОГО КИСЛОМОЛОЧНОГО НАПИТКА

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АННОТАЦИЯ

В статье представлены результаты исследований по разработке кисломолочного продукта с растительным наполнителем на основе козьего молока. Исследования проведены на кафедре «Пищевая биотехнология» Алматинского Технологического Университета, а также в лаборатории биотехнологии специализированных продуктов и биологически активных добавок Казахской академии питания. При приготовлении кисломолочных продуктов использовали закваску, состоящую из чистых культур *Lactobacillus bulgaricus B6, Streptococcus thermophilus* ТА *45* и *Lactobacillus acidophilus* в соотношении 1:5:1. Закваску вносили при включенной мешалке, перемешивание осуществляли в течение 15 мин. Молоко сквашивали до образования молочно-белкового сгустка кислотностью (78±3)°Т, pH=(4,70±0,02), продолжительность сквашивания – от 5 до 6 часов. Полученный сгусток охлаждали до температуры 20-25 °С в течение 30 мин, затем перемешивали в течение 3-5 минут. Используемая в работе закваска состоит из пробиотиков, что способствует продлению сроков хранения и не позволяет расти дрожжам и плесени в конечном продукте. *Lactobacillus bulgaricus* синтезирует специфический фермент пептидогликангидролазу, ответственного за гидролиз пептидогликана. *Streptococcus thermophilus* обладает высокой степенью вязкости, что способствует образованию хорошего сгустка и консистенции. Ацидофильная палочка восстанавливает здоровую микрофлору кишечника, подавляя развитие вредных бактерий за счет выделения антибиотиков. При использовании сока тыквы с мякотью в качестве добавки в молочную смесь, в результате ферментации, количество молочнокислых бактерий увеличилось более чем в десять раз, что является преимуществом данной разработки, т.к. молочнокислые бактерии в комбинированных кисломолочных продуктах улучшают пищеварение, расщепляя лактозу и белки, подавляют патогенную микрофлору, укрепляют иммунитет и повышают усвоение кальция. Содержание белка в кисломолочных продуктах увеличилось более чем на 3% по

DOI: 10.11134/btp.2.2026.8

сравнению с контрольным образцом благодаря созданию более плотной белковой структуры (геля) за счет взаимодействия молочных белков с пектинами и минералами тыквы. Это обогащает продукт, повышая его пищевую ценность.

Ключевые слова: глобальные продовольственные проблемы, козье молоко, кисломолочный продукт, закваска, пробиотики, растительные добавки, тыквенный сок с мякотью, функциональные продукты.