Айнажан Кайырболатқызы Жумагалиева – Казахский агротехнический исследовательский университет имени С. Сейфуллина, м.т.н. преподаватель Институт инжиниринга и пищевых технологий; e-mail: zhumagalievaaa01@gmail.com. ORCID: https://orcid.org/0009-0008-1063-5161.

Information about the authors

Shynaray Zhaskairat* – Kazakh Agrotechnical Research University named after S. Seifullin, doctoral student of the Institute of Engineering and Food Technology; e-mail: shynarai_92@mail.ru. ORCID: https://orcid.org/0009-0008-2472-4210.

Mohammad Rashedi Ismail Fitry – Senior lector of Department of Food Technology, Faculty of Food Science and Technology, Universiti Putra Malaysia, UPM Serdang, Selangor; e-mail: ismailfitry@upm.edu.my. ORCID: http://orcid.org/0000-0002-2280-5075.

Aidyn Igenbayev – Kazakh Agrotechnical Research University named after S. Seifullin, PhD, associate professor of the Institute of Engineering and Food Technology; e-mail: a.igenbayev@kazatu.edu.kz.ORCID: https://orcid.org/0000-0002-9903-2912.

Ayaulym Mustafayeva – Candidate of Technical Sciences, Senior lecturer of the Department «Technology of Food and Processing Industries», Kazakh Agrotechnical Research University named after S. Seifullin, Astana city, Republic of Kazakhstan; e-mail: ayaulym.mustafa@mail.ru. ORCID: https://orcid.org/0000-0002-9627-7543.

Ainazhan Zhumagaliyeva – Kazakh Agrotechnical Research University named after S.Seifullin, teacher of the Institute of Engineering and Food Technology; e-mail: zhumagalievaaa01@gmail.com. ORCID: https://orcid.org/0009-0008-1063-5161.

Received 30.03.2026
Revised 08.04.2026
Accepted 09.04.2026

https://doi.org/10.53360/2788-7995-2026-2(22)-30

IRSTI: 65.63.33

G.N. Zhakupova, T.Ch. Tultabayeva, A.T. Sagandyk*, A.H. Muldasheva, A.K. Ospanova
Kazakh Agrotechnical Research University named after S. Seifullin,
010000, Kazakhstan, Astana, 62 Zhenis St.
*e-mail: a.sagandyk@kazatu.edu.kz

INVESTIGATION THE TECHNOLOGICAL PARAMETERS OF THE FERMENTATION PROCESS OF A COMBINED DAIRY MIXTURE USING BUTTERMILK CONCENTRATE

Abstract: *The article presents the results of a study on the technological parameters of the fermentation process of a combined dairy mixture using buttermilk concentrate. The relevance of the research is determined by the growing interest in the utilization of secondary dairy resources with high nutritional and biological value, as well as by the need to develop scientifically grounded technologies to produce functional fermented dairy products. The aim of the study was to evaluate the effectiveness of various starter cultures under different fermentation temperature regimes of a combined dairy mixture. The object of the study was a dairy mixture consisting of skimmed cow's milk, goat's milk, and buttermilk. The influence of starter culture composition and fermentation temperature on physicochemical parameters, acidification dynamics, and curd structure formation was investigated. It was established that the combination of mesophilic and thermophilic lactic acid microorganisms significantly affects fermentation intensity, titratable acidity, and structural stability of the product. The results demonstrated that an optimal fermentation temperature promotes the formation of a homogeneous curd with improved physicochemical and sensory characteristics, whereas deviations from optimal conditions lead to structural defects and deterioration of product quality. The results obtained confirm the feasibility of a comprehensive selection of starter cultures and fermentation temperature regimes in the production of fermented dairy products based on combined dairy mixtures using buttermilk concentrate.*

Key words: *combined dairy mixture; buttermilk concentrate; fermentation; physicochemical properties; fermentation temperature; acidification dynamics.*

Introduction

In recent years, the dairy industry has been developing in the direction of creating functional and specialized fermented milk products aimed at increasing nutritional value and expanding the range for various consumer groups.

In the Republic of Kazakhstan, the dairy industry is developing at a steady pace: the production of cow's and goat's milk is increasing every year. In 2024-2025, milk production volumes continued to increase: by the end of 2024, total milk production reached approximately 3.57 million tons, which is 4.4% more than in 2023, with growth provided by both large agricultural enterprises and rural farms. Of note is the 8.1% increase in production at agricultural enterprises to 1.39 million tons of milk [1].

There has been an increase in the number of small and medium-sized enterprises focused on the production of functional and specialized fermented milk products, which creates conditions for diversification of the product range and development of regional production. The processing of secondary milk resources, such as buttermilk, whey, and cream, is also expanding. At the same time, the industry faces problems of seasonal fluctuations in raw materials, insufficient technological equipment of processing enterprises, and limited integration of small producers into large supply chains. In these conditions, the development of scientifically based technologies for fermenting combined milk mixtures is of practical importance, ensuring improved product quality and stability, rational use of resources, and reduced production costs [2, 3].

Attention is paid to alternative types of milk raw materials, including goat milk, which has high digestibility, a balanced fatty acid composition, and reduced allergenicity compared to cow milk. This explains its growing use in the production of therapeutic, preventive, and functional products [4].

At the same time, the technological processing of goat milk is characterized by a number of limitations, including high cost, seasonal variability of physicochemical properties, and instability of the curd structure during fermentation due to low αs1-casein content and specific mineral composition. These characteristics make it difficult to use goat milk on its own in the production of fermented milk products and require the development of combined milk mixtures using affordable and functionally significant components [5].

A promising area is the use of skimmed cow's milk and whey concentrate, which have high protein value and contain phospholipids, lactose, and biologically active substances. Buttermilk, which is produced during the production of butter, is a valuable secondary milk raw material characterized by a high content of whey proteins and containing a unique complex of biologically active substances. It contains approximately 25-40 μg of vitamin A per 100 ml, which helps maintain vision, skin health, and the immune system. Vitamin D is present in an amount of 0.1-0.2 mcg and plays an important role in calcium absorption and bone formation. Vitamin E (0.05-0.1 mg) acts as an antioxidant, protecting cells from damage, and vitamin K (0.5-1 mcg) is involved in blood clotting processes, as well as B_1, B_2, B_6, B_{12}, C, H, choline, etc., as well as minerals and trace elements found in whole milk [6, 7].

These characteristics contribute to the formation of a denser and more homogeneous structure of fermented milk products, as well as improve their organoleptic properties. The use of buttermilk concentrate also allows for an increase in the utilization of dairy industry by-products and a reduction in the cost of finished products [8].

A key stage in the production of fermented milk products based on combined milk mixtures is the fermentation process, which determines the structure, taste, acidity, and microbiological stability of the product. The effectiveness of this process largely depends on the composition and activity of the starter cultures, as well as on the fermentation temperature conditions, which have a direct impact on the rate of acid formation, the growth of lactic acid microorganisms, and the synthesis of metabolites [9, 10].

Despite the existence of studies devoted to individual types of milk raw materials, questions regarding the functioning of starter cultures in combined mixtures based on goat's milk, skimmed cow's milk, and whey concentrate at different temperature regimes remain insufficiently studied. There is a lack of systematic data on the effect of fermentation temperature on acidity formation and curd stability in such systems [11, 12].

The purpose of this study is to analyze the activity of starter cultures depending on the influence of fermentation temperature regimes on a fermented milk product obtained from a combined milk mixture. The study aims to determine the optimal fermentation parameters that ensure the stability of the product's quality and biological value.

Materials and methods

Experimental studies were carried out on the basis of experimental-production shop for processing milk and dairy products and in the scientific laboratory of NAO KazATIU named after Saken Seifullin. Butter, skim milk and goat's milk were used to prepare the combined milk mixture. Pahta for the study was taken from JSC «Astana - Akennym».

In the work, different fermenting cultures and their efficiency at different temperature regimes were investigated. Заквасочные культуры: Lactobacillus acidophilus, Lactobacillus delbrueckii ssp. bulgaricus, Streptococcus thermophilus, Bifidobacterium lactis [10].

Standard analytical methods were used to assess the quality of the raw mixture and the resulting sour milk product

The following methods were used to determine physico-chemical indicators:

1. Determination of acidity using the phenolphthalein indicator GOST 3624-92 Milk and dairy products. Titrimetric methods for determination of acidity» [13].
2. Definition of protein content GOST 25179-2014 Milk and dairy products. Methods for determination of protein mass» [14].
3. Definition of lactose GOST 34304-2017 Milk and dairy products. Method for determining lactose» [15].
4. Definition pH GOST 32892-2014 Milk and dairy products. Method for measuring active acidity» [16].
5. Determination of density GOST P 54758-2011 Milk and milk processing products. Density method» [17].
6. Fat definition GOST 5867-2023 «Fat definition of milk and dairy products»[18].

Results and Discussion

A milk mixture consisting of low-fat cow's milk, goat's milk and butter was chosen for the studies, which has high nutritional and biological value. Non-fat cow's milk is a source of protein and calcium in low fat. Goat milk improves product digestibility, contains easily digestible fats, vitamins and trace elements, and reduces the risk of allergic reactions. Buttermilk enriches the mixture with phospholipids, lecithin, and milk proteins, and helps normalize digestion. Thus, the selected milk mixture is characterized by a balanced chemical composition and combines the valuable nutritional and functional properties of each component. However, for an objective assessment of its quality and technological suitability, it is necessary to conduct a set of laboratory studies [19].

Laboratory analysis of the pulp plays an important role in controlling the quality and safety of the product, as well as in assessing its nutritional value and processing properties.

The physical-chemical analysis of buttermilk such as titrated acidity, fat content, protein, lactose allows to determine product compliance with established standards and to identify possible deviations affecting taste, shelf life and beneficial properties. Physical and chemical parameters of the pulps are shown in table 1.

Table 1 – Physicochemical Properties of Buttermilk

Name of the Parameter	Buttermilk Parameters	
	Separated Buttermilk	GOST 34354-2017
Titratable Acidity, °T	21	19,0 - 40,0
pH	6,47	-
Fat Content, %	0,78	not less than 0,2
Protein Content, %	3.3	not less than 2,6
Density	1028,83	not less than1027
SNF	8,11	not less than 8,0
Total Solids	8,89	-

The studies conducted show that the quality of the pure tested is within the prescribed limits, which confirms the high quality of the product and its compliance with safety and nutritional standards [20].

To produce dairy products with specified parameters, studies were carried out to optimize the technological parameters of the brewing process of the previously selected combined milk mixture based on skim cow's milk 50%, goat's milk 30% and puree 20%).

To determine the potting capacity, the milk mixture was fermented with different probiotic cultures at different temperatures and with different poaching times. As a result of the studies carried out, the optimal conditions for the milk mixture were determined.

Milk mixture containing skimmed cow's milk 50%/ goat's milk 30%/ curd 20% cooked at temperatures of 35, 37, 40°C. Fermented crops were introduced in the amount of 5%. Milk shelling was carried out under the same conditions.

The following samples were used for research and selection of the optimal snack culture:

1 sample – Yoghurt fermented with a starter culture containing *Lactobacillus acidophilus, Lactobacillus delbrueckii ssp. bulgaricus, Streptococcus thermophilus,* and *Bifidobacterium lactis.*

2 sample – Yoghurt fermented with a starter culture containing *Streptococcus thermophilus, Lactobacillus delbrueckii ssp. bulgaricus, Lactobacillus acidophilus, Bifidobacterium lactis, Lactococcus lactis, Lactobacillus acidophilus, Lactobacillus helveticus, Propionibacterium freudenreichii ssp. Shermanii*.

3 sample – Yoghurt fermented with a starter culture containing *Lactococcus lactis, Lactobacillus acidophilus, Lactobacillus helveticus, Propionibacterium freudenreichii ssp. shermanii, Streptococcus thermophilus, Lactobacillus delbrueckii subsp. Bulgaricus.*

The milk mixture was heated to a boiling point of 32 °C, added fermented cultures and leavened at temperatures: 35°C, 37°C, 40°C, in a thermostatic chamber TCS-1PU. Dynamic change of titrated acidity of samples was conducted quarterly.

The data obtained from the fermentation process at a temperature of 35 °C is shown in Figure 1.

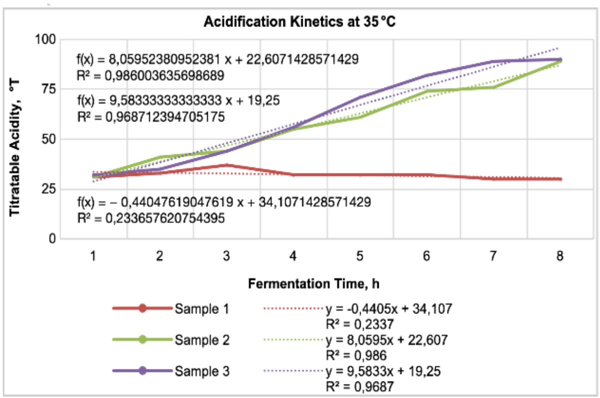

Figure 1 – Acid formation dynamics of samples at 35°C

As the analysis shows, sample 1 had a low accumulation of acidity (up to 37°T after 2 hours), but thickening was already occurring at this stage. Upon further plowing, serum secretion and settling of the clot on the bottom were observed, indicating its fragility and instability. Low acidity combined with low coagulation indicates insufficient fermented activity in the milk mixture. These findings indicate limited technological suitability of the starter culture used in sample 1 for the given raw material formulation, although it may be appropriate for the production of specialized products characterized by mild acidity.

Sample 2 showed a more balanced development of fermentation. By 3-4 o'clock, the acidity reached 55 - 61°T with a reduction in pH to 6.5, and by 6 o'clock a stable clot with sufficient acidity (76°T) formed. By 24 hours, the values reached 89°T at a pH of 5.5, which corresponds to the traditional yogurt parameters. The sensory properties of this sample can be characterized as harmonious, with a moderate acidity and uniform consistency, which makes it suitable for producing yogurts with classic organoleptic characteristics.

Sample 3 showed the highest activity of the fermentation microflora. By 6 o'clock, the acidity was 89°T, indicating rapid and efficient formation of a dense clot. By 24 hours, the acidity had hardly increased (90°T), but the pH dropped significantly to 4.27, indicating deep fermentation. The flavor and texture characteristics of this sample were the highest: the product had a pronounced sour milk note, dense and homogeneous consistency without signs of serum separation. Sensory tests showed that this option was preferred in taste and structure among all the samples studied.

In general, it can be concluded that the starter culture in sample 1 provides low acidity but forms a weak and unstable curd, whereas sample 2 demonstrates balanced characteristics with a classic taste and consistency, which makes it the most promising option for producing yoghurt based on a mixture of cow's milk, goat's milk, and buttermilk.

Thus, shedding at 35 °C in all samples did not show high organoleptic properties.

The results of the studies on the boiling of samples at 37 °C are described in Figure 2.

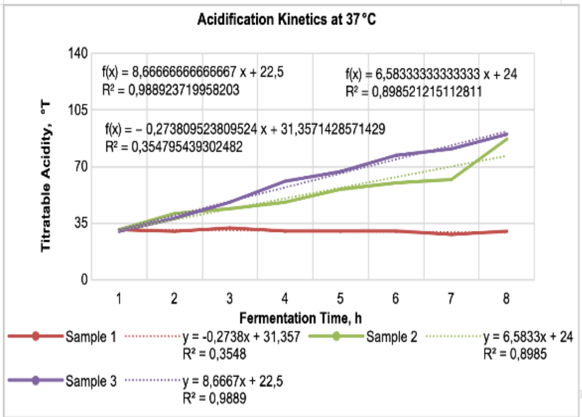

Figure 2 – Dynamics of acid formation of samples at temperature 37°C

The studies show that acid formation in sample 1 at 37°C remained weak. During the first two hours, the acidity remained almost unchanged (31-32 °T) and the pH remained at 6.8. Although the sample formed a clot, its consistency was weak, which was accompanied by serum separation and coagulation. This confirms that the starter culture in sample 1 demonstrates low enzymatic activity in the given milk mixture and does not ensure product stability, even under elevated temperature conditions.

In sample 2 after 1 hour showed an acidity of 41°T at pH 6.1, indicating a more intense development of lactic acid microflora. By 4-6 o'clock the acidity increased to 56-61°T, and the pH dropped to 5.1-5.13, which corresponds to the normal process of coagulation and dense formation. After 24 hours, the acidity reached 87°T at a pH of 4.5, which fully meets the technological requirements for ready-to-use yogurt. The sensory characteristics of this sample can be characterized as balanced, with moderate acidity and homogeneous consistency.

In sample 3 showed the highest activity at 37°C. By 3 hours the acidity was 61°T at pH 5.5, and by 5-6 hours it reached 77-81°T at pH 4.1-3.8, indicating rapid and efficient thickening. After 24 hours, the acidity reached 90°T at pH 4.0, indicating deep acidification. Sensory tests confirmed the high gustatory qualities and thick, homogeneous consistency of this sample, which was recognized as the best among those studied.

These results are due to a combination of factors: combined fermented stock, including thermophilic and mesophilic strains, optimum fermentation temperature and the use of a balanced milk mixture of cow's milk, goat's milk and dross, rich in lactose and milk proteins, which accelerates the growth of lactic acid bacteria and the formation of product structure. In addition, the activity of the strains present in the sourdough ensures the formation of flavor compounds that promote a high sensory evaluation - thick and homogeneous clumps with a pronounced taste.

A similar study was then carried out at 40°C, the results of which are described in Figure 3.

The studies show that acid formation in sample 1 at elevated temperature showed extremely low activity. After 1 hour the pH dropped from 7.6 to 6.5, but the acidity did not increase much (22°T). This indicates the unstable nature of the fermentation: despite some acidification of the medium, a full accumulation of acidity did not occur. Probably at 40°C the culture was heat sensitive and did not provide a stable thickening. This result confirms the low technological suitability of Narine for use in the studied mixture at elevated temperature.

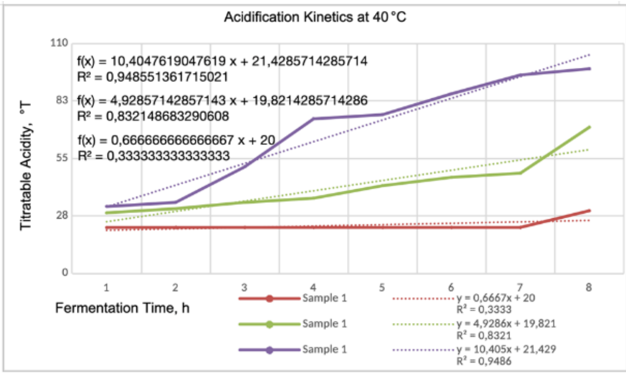

Figure 3 – Acid formation dynamics of samples at 40 °C

In sample 2 its squashing occurred more actively. By 4-5 o'clock the acidity reached 42-46 °T at a pH down to ~ 6.0, and by 6 o'clock – 48 °T at a pH of 5.7, indicating the formation of a lump. By 24 o'clock, the temperature was 70°T at pH 4.2. These values are slightly lower than those at 35 and 37°C, indicating that the excessive temperature increase has slowed down the activity of the fermenting microflora. The product eventually formed a clot, but had less pronounced acidity and less dense consistency compared to conditions at 37°C.

Sample 3 showed the most intense dynamic: by 3 hours, the acidity reached 74°T at pH 5.6 and by 6 hours it was 92°T at pH 4.2, which corresponds to a finished product with pronounced taste and dense consistency. By 24 o'clock the acidity increased to 98°T at pH 4.02, indicating deep fermentation processes. The sensory characteristics of this variant at 40 °C also remained better: dense consistency, no serum separation, harmonious sour-milk taste. However, such high values of acidity (close to 100°T) can lead to an excessive acid note that requires monitoring the duration of fermentation.

According to the conducted studies, it was found that the highest and most stable results were demonstrated by sample 3. In all temperature regimes, the acid accumulation rate ranges from 8.7 to 10.4°T/h and high determinism values (R2 = 0.95-0.99), indicating that the fermentation is stable and well predicted. This confirms that sample 3 provides fast and stable formation of a dense clot. Sample 2 showed a moderate increase in acidity (4.9-8.0 °T/h), with the best results recorded at 35 °C (R2 = 0.986). At 37 °C, the predictability of the process remained high (R2 0.90), but the speed decreased, and at 40 °C both decreased, indicating a slowdown in activity and a less stable pattern of folding. Sample 1 at all temperatures had a minimum acid accumulation rate (- 0.27 to + 0.67 T/h) and low R2 values (0.23-0.35). This reflects the lack of a natural dynamic and the weak activity of the sieve, which explains the formation of an unstable clot and the secretion of the serum.

Thus, the starter culture in sample 1 proved unsuitable for this milk mixture, as it produced unstable curds at all tested temperatures and was characterized by low acid accumulation. The fermentation culture in sample 2 performed most effectively at 37 °C, ensuring a stable fermentation process with the formation of a homogeneous soft curd and typical organoleptic properties of yoghurt. However, the soft curd formed by sample 2 exhibited less pronounced acidity compared to sample 3, making this probiotic culture less promising. The best results were obtained with sample 3 at 37 °C: it provided the most intensive and stable acidification, forming a dense curd with superior sensory characteristics in taste and consistency, which makes it the most promising candidate for producing yoghurt from the tested milk mixture.

Conclusion

The study showed that the quality of the combined milk mixture depends on both the selection of the fermentation culture and the temperature regime. Different fermentations exhibit different activities: some of them form unstable clumps and low acid accumulation, while others provide a homogeneous structure, stable acidification and high organoleptic indicators. Sample 3 proved to be the most promising culture for the production of fermented milk from the milk mixture under study. It ensures intensive and stable milking at an optimum temperature of 37°C. These values demonstrate the high technological efficiency of the leavened cheese and its suitability for producing a quality sour milk product.

The obtained results allow to optimize the technological process of plating, ensuring quality stability, improvement of texture and taste characteristics of the product, as well as form the basis for further improving the formulations of combined sour milk products.

References

1. Анализ молочного рынка Казахстана: современное состояние и тенденции развития / Г.У. Акимбекова и др. // Журнал сельскохозяйственных и экологических наук. – 2024. – Т. 13, № 2. – С. 45-58.
2. Акимбекова Г.У. Приоритетные направления развития агропромышленного комплекса Казахстана / Г.У. Акимбекова, Г.А. Никитина // Проблемы агрорынка. – 2020. – № 4. – С. 13-23. https://doi.org/10.46666/2020-4-2708-9991.01
3. Соболева Т.В. Развитие малого и среднего молочного производства / Т.В. Соболева, Н.В. Козлова // Пищевая промышленность. – 2022. – № 6. – С. 45-52.
4. Goat Milk: A Review of its Nutritional and Therapeutic Potential in Functional Food Development / M.S. Lad, et al // International Journal of Dairy Technology. – 2023. – Vol. 76. – № 3. – P. 445-460.
5. Белов А.П. Козье молоко как компонент комбинированных кисломолочных продуктов / А.П. Белов, М.С. Иванова // Пищевая наука и технологии. – 2020. – № 3. – С. 88-95.
6. Али А.Х. Современные знания о пахте: состав, применение в пищевой промышленности, питательные свойства и польза для здоровья / А.Х. Али // Международный журнал молочных технологий. – 2019. – Т. 72, № 2. – С. 169-182. https://doi.org/10.1111/1471-0307.12572.
7. Yeragi V.S. Effects of Buttermilk on Health / V.S. Yeragi, A.H. Maske // International Journal of Scientific Research and Management (IJSRM). – 2016. – Vol. 4, № 11. – P. 4936-4940. https://doi.org/10.18535/ijsrm/v4i11.13.
8. Кузнецова И.А. Вторичные молочные ресурсы и их использование в производстве кисломолочных продуктов / И.А. Кузнецова, Л.П. Петрова // Пищевая индустрия. – 2020. – № 7. – С. 36-42.
9. Павлова А.В. Сквашивание комбинированных молочных смесей: закваски и температурные режимы / А.В. Павлова, В.Н. Морозов // Пищевая технология. – 2021. – № 5. – С. 52-60.
10. Sensory and Microbiological Quality of Buttermilk Sold in Organized and Unorganized Sectors / S.K. Reddy et al // International Journal of Scientific Research and Engineering Development. – 2024. – Vol. 7, № 1. – P. 47-55. https://doi.org/10.55041/IJSRED2961.
11. Гришина О.А. Влияние ферментации на органолептические и физико-химические свойства кисломолочных продуктов / О.А. Гришина, А.В. Козлов // Молочные технологии. – 2020. – № 3. – С. 18-25.
12. Сергеева Т.П. Комбинированные молочные смеси: проблемы и перспективы исследований / Т.П. Сергеева, Д.Ю. Иванов // Молочные исследования. – 2022. – № 1. – С. 10-16.
13. ГОСТ 3624-92. Молоко и молочные продукты. Титриметрические методы определения кислотности. Введ. 1994–01–01. – Москва: Межгос. совет по стандартизации, метрологии и сертификации; М.: Изд-во стандартов, сор. 1994. – 15 с.
14. ГОСТ 25179-2014. Молоко и молочные продукты. Методы определения массовой доли белка. – Взамен ГОСТ 25179-90; введ. 2015–07–01. – Москва: Межгос. совет по стандартизации, метрологии и сертификации; М.: Изд-во стандартов, сор. 2015. – 15 с.
15. ГОСТ 34304-2017. Молоко и молочные продукты. Метод определения лактозы и галактозы. – Взамен ГОСТ 34304; введ. 2019–01–01. – Москва: Межгос. совет по стандартизации, метрологии и сертификации; М.: Изд-во стандартов, сор. 2017. – 13 с.
16. ГОСТ 32892-2014. Молоко и молочная продукция. Метод измерения активной кислотности. – Введ. 2016–01–01. – Москва: Межгос. совет по стандартизации, метрологии и сертификации; М.: Изд-во стандартов, сор. 2016. – 14 с.
17. ГОСТ Р 54758-2011. Молоко и продукты переработки молока. Метод определения плотности. – Введ. 2012-04-01. – Москва: Стандартинформ, сор. 2011. – 12 с.
18. ГОСТ 5867-2023. Молоко и продукты переработки молока. Метод определения жирности. – Введ. 2024-01-01. – Москва: Стандартинформ, сор. 2023. – 15 с.

19. Dr. Dhrubo Jyoti Sen. Multifaceted nutritional benefits of buttermilk, milk, yoghurt and lassi / Dr. Dhrubo Jyoti Sen, Dr. Pruthviraj K. Chaudhary. // World Journal of Advanced Research in Healthcare. – 2025. – Vol. 9, № 5. – P. 321-332.
20. ГОСТ 34354-2017. Пахта и напитки на её основе. Технические условия. Текст. Взамен ГОСТ 34354; введён в действие с 1 января 2018 г. – М.: Межгосударственный совет по стандартизации, метрологии и сертификации; М.: Издательство стандартов, 2018. – 10 с.

References

1. Analiz molochnogo ry`nka Kazaxstana: sovremennoe sostoyanie i tendencii razvitiya / G.U. Akimbekova i dr. // Zhurnal sel`skoxozyajstvenny`x i e`kologicheskix nauk. – 2024. – T. 13, № 2. – S. 45-58. (In Russian).
2. Akimbekova G.U. Prioritetny`e napravleniya razvitiya agropromy`shlennogo kompleksa Kazaxstana / G.U. Akimbekova, G.A. Nikitina // Problemy` agrory`nka. – 2020. – № 4. – S. 13-23. https://doi.org/10.46666/2020-4-2708-9991.01. (In Russian).
3. Soboleva T.V. Razvitie malogo i srednego molochnogo proizvodstva / T.V. Soboleva, N.V. Kozlova // Pishhevaya promy`shlennost`. – 2022. – № 6. – S. 45-52. (In Russian).
4. Goat Milk: A Review of its Nutritional and Therapeutic Potential in Functional Food Development / M.S. Lad, et al // International Journal of Dairy Technology. – 2023. – Vol. 76. – № 3. – P. 445-460. (In English).
5. Belov A.P. Koz`e moloko kak komponent kombinirovanny`x kislomolochny`x produktov / A.P. Belov, M.S. Ivanova // Pishhevaya nauka i texnologii. – 2020. – № 3. – S. 88-95. (In Russian).
6. Ali A.X. Sovremenny`e znaniya o paxte: sostav, primenenie v pishhevoj promy`shlennosti, pitatel`ny`e svojstva i pol`za dlya zdorov`ya / A.X. Ali // Mezhdunarodny`j zhurnal molochny`x texnologij. – 2019. – T. 72, № 2. – S. 169-182. https://doi.org/10.1111/1471-0307.12572. (In Russian).
7. Yeragi V.S. Effects of Buttermilk on Health / V.S. Yeragi, A.H. Maske // International Journal of Scientific Research and Management (IJSRM). – 2016. – Vol. 4, № 11. – P. 4936-4940. https://doi.org/10.18535/ijsrm/v4i11.13. (In English).
8. Kuzneczova I.A. Vtorichny`e molochny`e resursy` i ix ispol`zovanie v proizvodstve kislomolochny`x produktov / I.A. Kuzneczova, L.P. Petrova // Pishhevaya industriya. – 2020. – № 7. – S. 36-42. (In Russian).
9. Pavlova A.V. Skvashivanie kombinirovanny`x molochny`x smesej: zakvaski i temperaturny`e rezhimy` / A.V. Pavlova, V.N. Morozov // Pishhevaya texnologiya. – 2021. – № 5. – S. 52-60. (In Russian).
10. Sensory and Microbiological Quality of Buttermilk Sold in Organized and Unorganized Sectors / S.K. Reddy et al // International Journal of Scientific Research and Engineering Development. – 2024. – Vol. 7, № 1. – P. 47-55. https://doi.org/10.55041/IJSRED2961. (In English).
11. Grishina O.A. Vliyanie fermentacii na organolepticheskie i fiziko-ximicheskie svojstva kislomolochny`x produktov / O.A. Grishina, A.V. Kozlov // Molochny`e texnologii. – 2020. – № 3. – S. 18-25. (In Russian).
12. Sergeeva T.P. Kombinirovanny`e molochny`e smesi: problemy` i perspektivy` issledovanij / T.P. Sergeeva, D.Yu. Ivanov // Molochny`e issledovaniya. – 2022. – № 1. – S. 10-16. (In Russian).
13. GOST 3624-92. Moloko i molochny`e produkty`. Titrimetricheskie metody` opredeleniya kislotnosti. Vved. 1994–01–01. – Moskva: Mezhgos. sovet po standartizacii, metrologii i sertifikacii; M.: Izd-vo standartov, cop. 1994. – 15 s. (In Russian).
14. GOST 25179-2014. Moloko i molochny`e produkty`. Metody` opredeleniya massovoj doli belka. – Vzamen GOST 25179-90; vved. 2015–07–01. – Moskva: Mezhgos. sovet po standartizacii, metrologii i sertifikacii; M.: Izd-vo standartov, cop. 2015. – 15 s. (In Russian).
15. GOST 34304-2017. Moloko i molochny`e produkty`. Metod opredeleniya laktozy` i galaktozy`. – Vzamen GOST 34304; vved. 2019–01–01. – Moskva: Mezhgos. sovet po standartizacii, metrologii i sertifikacii; M.: Izd-vo standartov, cop. 2017. – 13 s. (In Russian).
16. GOST 32892-2014. Moloko i molochnaya produkciya. Metod izmereniya aktivnoj kislotnosti. – Vved. 2016–01–01. – Moskva: Mezhgos. sovet po standartizacii, metrologii i sertifikacii; M.: Izd-vo standartov, cop. 2016. – 14 s. (In Russian).
17. GOST R 54758-2011. Moloko i produkty` pererabotki moloka. Metod opredeleniya plotnosti. – Vved. 2012-04-01. – Moskva: Standartinform, cop. 2011. – 12 s. (In Russian).

18. GOST 5867-2023. Moloko i produkty` pererabotki moloka. Metod opredeleniya zhirnosti. – Vved. 2024-01-01. – Moskva: Standartinform, cop. 2023. – 15 s. (In Russian).
19. Dr. Dhrubo Jyoti Sen. Multifaceted nutritional benefits of buttermilk, milk, yoghurt and lassi / Dr. Dhrubo Jyoti Sen, Dr. Pruthviraj K. Chaudhary. // World Journal of Advanced Research in Healthcare. – 2025. – Vol. 9, № 5. – P. 321-332. (In English).
20. GOST 34354-2017. Paxta i napitki na eyo osnove. Texnicheskie usloviya. Tekst. Vzamen GOST 34354; vvedyon v dejstvie s 1 yanvarya 2018 g. – M.: Mezhgosudarstvenny`j sovet po standartizacii, metrologii i sertifikacii; M.: Izdatel`stvo standartov, 2018. – 10 s. (In Russian).

Acknowledgements
This work was carried out within the framework of IRN BR24892775: «Development of Technology for Comprehensive and Advanced Processing of Agricultural Raw Materials for the Production of Food Products Ensuring High Quality and Safety of the Final Products».

Г.Н. Жакупова, Т.Ч. Тултабаева, А.Т. Сағандық*, А.Х. Мулдашева, А.К. Оспанова
Казахский агротехнический исследовательский университет имени Сакена Сейфуллина,
010000, Казахстан, г. Астана, пр. Жеңіс, 62
*e-mail: a.sagandyk@kazatu.edu.kz

ИССЛЕДОВАНИЕ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ ПРОЦЕССА СКВАШИВАНИЯ КОМБИНИРОВАННОЙ МОЛОЧНОЙ СМЕСИ С ИСПОЛЬЗОВАНИЕМ КОНЦЕНТРАТА ПАХТЫ

В статье представлены результаты исследования технологических параметров процесса сквашивания комбинированной молочной смеси с использованием концентрата пахты. Актуальность работы обусловлена перспективностью использования вторичных молочных ресурсов, обладающих высокой пищевой и биологической ценностью, а также необходимостью разработки научно обоснованных технологий производства функциональных кисломолочных продуктов. Целью исследования являлась оценка эффективности различных заквасочных культур при разных температурных режимах ферментации комбинированной молочной смеси. В качестве объекта исследования использовалась молочная смесь, включающая обезжиренное коровье молоко, козье молоко и пахту. В ходе исследований изучено влияние состава заквасочных культур и температурных режимов ферментации на физико-химические показатели, процесс кислотообразования и формирование структуры сгустка. Установлено, что сочетание мезофильных и термофильных молочнокислых микроорганизмов оказывает существенное влияние на интенсивность ферментации, титруемую кислотность и стабильность структуры продукта. Показано, что оптимальный температурный режим способствует формированию однородного сгустка с улучшенными органолептическими и физико-химическими характеристиками, тогда как отклонение от оптимальных параметров приводит к нарушению структуры и ухудшению качества продукта. Полученные результаты подтверждают целесообразность комплексного подбора заквасочных культур и температурных режимов при сквашивании комбинированных молочных смесей с использованием концентрата пахты и могут быть использованы при разработке технологий производства новых кисломолочных продуктов.
Ключевые слова: *комбинированная молочная смесь; концентрат пахты; ферментация; физико-химические свойства; температура ферментации; динамика кислотности.*

Г.Н. Жакупова, Т.Ч. Тултабаева, А.Т. Сағандық*, А.Х. Мулдашева, А.К. Оспанова
С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті,
010000, Қазақстан, Астана қ., Жеңіс көшесі, 62.
*e-mail: a.sagandyk@kazatu.edu.kz

МАЙ СУЫН КОНЦЕНТРАТЫН ПАЙДАЛАНА ОТЫРЫП, ҚҰРАМА СҮТ ҚОСПАСЫН АШЫТУ ПРОЦЕСІНІҢ ТЕХНОЛОГИЯЛЫҚ ПАРАМЕТРЛЕРІН ЗЕРТТЕУ

Мақалада май суын концентратын пайдалана отырып, құрама сүт қоспасын ашыту процесінің технологиялық параметрлерін зерттеу нәтижелері ұсынылған. Жұмыстың өзектілігі жоғары тағамдық және биологиялық құндылыққа ие екінші реттік сүт ресурстарын тиімді пайдалану перспективаларымен, сондай-ақ функционалдық қышқыл сүт өнімдерін өндірудің ғылыми негізделген технологияларын әзірлеу қажеттілігімен негізделеді. Зерттеудің мақсаты құрама сүт қоспасын әртүрлі температуралық режимдерде ферментациялау кезінде әртүрлі *ашытқы дақылдарының тиімділігін бағалау болып табылады. Зерттеу нысаны ретінде майсыз сиыр сүті, ешкі сүті және май суын енгізілген сүт қоспасы қолданылды. Зерттеу барысында ашытқы дақылдарының құрамы мен ферментацияның температуралық режимдерінің физика-химиялық көрсеткіштерге, қышқыл түзілу процесіне және ұйытқы құрылымының қалыптасуына әсері қарастырылды. Мезофильді және термофильді сүтқышқылды микроорганизмдердің үйлесуі ферментация қарқындылығына, титрленетін қышқылдыққа және өнім құрылымының тұрақтылығына елеулі әсер ететіні анықталды. Оңтайлы температуралық режим өнімнің органолептикалық және физика-химиялық сипаттамалары жақсартылған біртекті ұйытқы түзілуіне ықпал ететіні көрсетілді, ал оңтайлы параметрлерден ауытқу құрылымның бұзылуына және өнім сапасының төмендеуіне әкеледі. Алынған нәтижелер айран сарысуы концентратын пайдалана отырып, құрама сүт қоспаларын ашыту кезінде ашытқы дақылдары мен температуралық режимдерді кешенді түрде таңдаудың тиімділігін дәлелдейді және жаңа қышқыл сүт өнімдерін өндіру технологияларын әзірлеуде қолданылуы мүмкін.*

Түйін сөздер: *құрама сүт қоспасы; айран сарысуы концентраты; ферментация; физика-химиялық қасиеттер; ферментация температурасы; қышқылдық динамикасы.*

Information about the authors

Tamara Chumanovna Tultabayeva – Doctor of Technical Sciences, Professor, S. Seifullin Kazakh Agrotechnical Research University, Astana, Kazakhstan; e-mail: tamaratultabayrva@gmail.com/ ORCID: https://orcid.org/0000-0003-2483-7406.

Gulmira Nurtaevna Zhakupova – Candidate of Technical Sciences, Professor, Kazakh Agrotechnical Research University named after S. Seifullin, Kazakhstan; e-mail: g.zhakupova@kazatu.edu.kz. ORCID: https://orcid.org/0000-0001-7714-4836.

Asem Talgatovna Sagandyk* – PhD, senior lecturer, S. Seifullin Kazakh Agrotechnical Research University, Astana, Kazakhstan; e-mail: a.sagandyk@kazatu.edu.kz. ORCID: https://orcid.org/0000-0001-5480-933X.

Aknur KhairatovnaM uldasheva – PhD, lecturer, S. Seifullin Kazakh Agrotechnical Research University, Astana, Kazakhstan; e-mail: a.muldasheva@kazatu.edu.kz. ORCID: https://orcid.org/0000-0003-0116-0260 .

Akmaral Kazbekovna Ospanova – Master's student, Kazakh Agrotechnical Research University named after S.Seifullin, Kazakhstan; e-mail: akmaral.ospanova.02@bk.ru. ORCID: https://orcid.org/0009-0007-7696-8738.

Авторлар туралы мәліметтер

Тамара Чумановна Тултабаева – техникалық ғылым докторы, профессор, С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Астана, Казахстан; e-mail: tamaratultabayrva@gmail.com. ORCID: https://orcid.org/0000-0003-2483-7406.

Гульмира Нуртаевна Жакупова – техникалық ғылым кандидаты, профессор, С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Астана, Казахстан; e-mail: g.zhakupova@kazatu.edu.kz. ORCID: https://orcid.org/0000-0001-7714-4836.

Асем Талғатқызы Сағандық – PhD докторы, аға оқытушысы, С.Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Астана, Казахстан; e-mail: a.sagandyk@kazatu.edu.kz. ORCID: https://orcid.org/0000-0001-5480-933X.

Ақнұр Хайратқызы Мулдашева – PhD докторы, оқытушысы, С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Астана, Казахстан; e-mail: a.muldasheva@kazatu.edu.kz. ORCID: https://orcid.org/0000-0003-0116-0260.

Ақмарал Қазбекқызы Оспанова – магистрант, С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Астана, Қазақстан; e-mail: akmaral.ospanova.02@bk.ru. ORCID: https://orcid.org/0009-0007-7696-8738.

Сведения об авторах

Тамара Чумановна Тултабаева – доктор технических наук, профессор, Казахский агротехнический исследовательский университет имени С. Сейфуллина, Астана, Казахстан; e-mail: tamaratultabayrva@gmail.com. ORCID: https://orcid.org/0000-0003-2483-7406.

Гульмира Нуртаевна Жакупова – к.т.н., профессор, Казахский агротехнический исследовательский университет имени С. Сейфуллина, Астана, Казахстан; e-mail: g.zhakupova@kazatu.edu.kz. ORCID: https://orcid.org/0000-0001-7714-4836.

Асем Талгатовна Сағандық – доктор PhD, старший преподаватель, Казахский агротехнический исследовательский университет имени С. Сейфуллина, Астана, Казахстан; e-mail: a.sagandyk@kazatu.edu.kz. ORCID: https://orcid.org/0000-0001-5480-933X.

Акнур Хайратовна Мулдашева – доктор PhD, преподаватель, Казахский агротехнический исследовательский университет имени С. Сейфуллина, Астана, Казахстан; e-mail: a.muldasheva@kazatu.edu.kz. ORCID: https://orcid.org/0000-0003-0116-0260.

Акмарал Казбековна Оспанова – магистрант, Казахский агротехнический исследовательский университет имени С. Сейфуллина, Астана, Казахстан; e-mail: akmaral.ospanova.02@bk.ru. ORCID: https://orcid.org/0009-0007-7696-8738.

Received 30.03.2026
Revised 15.04.2026
Accepted 16.04.2026

https://doi.org/10.53360/2788-7995-2026-2(22)-31

ҒТАХР: 65.59.23

А.С. Камбарова[1*], А.О. Утегенова[1], А. Асылбекова[1], Ж.М. Атамбаева[1], Ш.А. Абжанова[2].
[1]Шәкәрім университеті,
071412, Қазақстан Республикасы, Семей қ., Глинки к-сі 20 А
[2]Алматы технолгиялық университеті,
050012, Қазақстан Республикасы, Алматы қ., Алмалы ауданы, Төле би к-сі, 100
*e-mail.ru: kambarova.80@mail.ru

ЖЫЛҚЫ ЕТІН ТҰЗДАУ ӘДІСІН ЖЕТІЛДІРУ

Аңдатпа: *Мақалада жылқы етін тұздау технологиясын жетілдірудің заманауи тәсілдері қарастырылған. Зерттеу жұмысының негізгі мақсаты – жылқы етінің тағамдық және биологиялық құндылығын арттыру, сондай-ақ сақтау мерзімін ұзарту үшін өсімдік негізіндегі тұздық қоспасы мен шоктық мұздату әдісін қолданудың тиімділігін анықтау болып табылады. Тәжірибелік зерттеу барысында тұздық қоспасының құрамына ас тұзы, ламинария, кептірілген шпинат және сарымсақ енгізілді. Бұл компоненттер ет өнімінің минералдық және биологиялық белсенді заттармен байытылуына ықпал етеді.*

Ет үлгілері -45°C температурада 3 сағат бойы шоктық мұздатудан өткізілді, бұл әдіс өнімнің құрылымын сақтауға және микробиологиялық тұрақтылығын арттыруға мүмкіндік берді. Өсімдік текті тұздық қоспасының әртүрлі мөлшерін (5%, 10%, 15%) қолдану арқылы алынған үлгілердің органолептикалық, құрылымдық және сапалық көрсеткіштері кешенді түрде бағаланды. Зерттеу нәтижелері бойынша 10% тұздық қоспасымен тұздалған жылқы еті дәмі, хош иісі және текстурасы жағынан ең оңтайлы үлгі ретінде анықталды.

Ламинария мен шпинатты қолдану өнімнің минералдық құрамын байытып, әсіресе йод тапшылығы жиі кездесетін өңірлер үшін функционалдық маңызын арттырды. Жалпы алғанда, алынған нәтижелер өсімдік негізіндегі тұздық қоспасы мен шоктық мұздату әдісін үйлестіре қолдану жылқы етінің тағамдық құндылығын сақтай отырып, ұзақ мерзімге дейін сапалы күйде сақтауға мүмкіндік беретін тиімді технология екенін көрсетті.

Түйін сөздер: *жылқы еті, тағамдық құндылық, шоктық мұздату, тұздық қоспасы, шпинат, ламинария, сақтау мерзімі.*

Кіріспе

Қазіргі таңда халықты сапалы әрі ұзақ сақталатын тағам өнімдерімен қамтамасыз ету – тамақ өнеркәсібінің маңызды міндеттерінің бірі. Ет өнімдерінің ішінде жылқы еті – ақуызға, темірге және дәрумендерге бай, майлылығы төмен және сіңімділігі жоғары ет түрі ретінде ерекшеленеді. Алайда еттің сақталу мерзімі мен тағамдық құндылығы уақыт өте келе төмендейді. Сондықтан етті өңдеудің тиімді жолдарын іздеу – өзекті мәселе.

Бұл мақалада жылқы етін тұздау процесінде ламинария мен шпинат қосылған тұздық қоспасын пайдалану арқылы оның тағамдық және биологиялық құндылығын арттыру, сондай-ақ шоктық мұздату әдісімен сақтау мерзімін ұзарту мәселелері қарастырылады.