https://doi.org/10.53360/2788-7995-2026-3(23)-37

IRSTI: 62.13.99

BY 4.0
Check for updates

F.G. Sagymbek[1], Z.A. Kozhakhmetova[1], T.B. Abdigaliyeva[2]*
[1]Kazakh National Agrarian Research University,
050010, Republic of Kazakhstan, Almaty, Abay ave., 8
[2]Almaty Technological University,
050012, Republic of Kazakhstan, Almaty, Tole bi st.,100
*e-mail: tolkyn_07.1987@mail.ru

DEVELOPMENT OF A TECHNOLOGY FOR PRODUCING DRY BIOPRODUCTS FOR THE FOOD INDUSTRY WITH PRESERVATION OF STRAIN FUNCTIONAL ACTIVITY

Annotation: *The article presents a technology for creating a dry probiotic bioproduct using Lactobacillus paracasei-010K and Torulopsis sphaerica-105k strains, ensuring the preservation of their survival and functional characteristics. The main object of the study was the probiotic strain Lactobacillus paracasei-010K, obtained from koumiss and having a pronounced inhibitory effect. Two formulations have been developed for this method: a monoculture and a bacterial-fungal mixture using hydrolyzed milk as a substrate for cultivation. Freeze drying was carried out according to a programmed sequence, including freezing, freeze drying, and subsequent drying steps. Survival was estimated by counting the number of colony-forming units on the plates.*

After freeze-drying, the viability of Lactobacillus paracasei-010K cells was 88.6% in the monoculture and 91.9% in the bacterial-fungal population; for yeast element T. sphaerica – 105K reached 91.3%. The overall viability of the strains remained at 88-92%, while their inhibitory effect on the test cultures of Escherichia coli, Salmonella Dublin and Bacillus subtilis decreased by no more than 10-12%. The aggregate demonstrated a slightly more pronounced inhibitory effect compared to the monoculture, which indicates the synergistic effect of the yeast component.

The developed technology makes it possible to obtain homogeneous dry biological products with high functional characteristics and potential storage stability, demonstrating their prospects for use in the food industry.

Key words: *probiotics, lyophilization, dry bioproduct, Lactobacillus paracasei, Thorulopsis, viability, functional activity, microbes.*

Introduction

In the context of the rapid development of the food industry and the functional food market, there is a growing demand for stable probiotic cultures capable of maintaining their viability and functional activity during storage and transportation [1]. Dry bacterial preparations are widely used in the production of fermented milk drinks, starter cultures, biologically active additives and other functional food products. Their effectiveness depends on maintaining a high concentration of viable cells, antagonistic activity, and technological stability [2].

Lyophilization is considered to be the most effective method of obtaining dry probiotic preparations. This method is based on removing moisture from a frozen product by sublimation under vacuum conditions [3]. Lyophilization minimizes damage to cell membranes and enzymatic systems, ensuring the preservation of the metabolic activity of microorganisms [4]. Unlike spray drying, which involves exposure to high temperatures, lyophilization provides milder conditions for dehydration and allows you to obtain drugs with an extended shelf life.

Despite its high efficiency, the lyophilization process is technologically complex and energy-intensive, requiring optimization of the parameters of freezing, vacuuming and secondary drying [5].

©F.G. Sagymbek, Z.A. Kozhakhmetova, T.B. Abdigaliyeva, 2026

The composition and concentration of the protective environment (lyoprotectors) have a significant effect on cell survival, as they can form a stabilizing matrix around cellular structures and reduce the damaging effect of ice crystals [6]. Commonly used ingredients include skimmed milk, sugar, peptone hydrolysates, and other stabilizers.

Thus, the development of a technically optimized protocol for the lyophilization of probiotic cultures, including the selection of an effective protective environment, remains an urgent task in modern food engineering and biotechnology. Of particular interest is the creation of dry probiotic compositions based on a consortium of lactic acid bacteria and yeast intended for use in the production of functional foods.

The purpose of this study was to develop a technology for the production of dry bioproducts based on *Lactobacillus paracasei – 010K* and *Torulopsis sphaerica – 105k* using lyophilization while maintaining their viability and functional activity.

Unlike existing approaches, the proposed technology is aimed at optimizing both the lyophilization parameters and the composition of the protective medium for the bacterial-yeast consortium. While traditional methods often use monocultures and standard cryoprotectors, the present study presents a combined system that increases cell survival and maintains functional activity. Compared to previously presented technologies, the developed method provides higher viability (up to 91-92%) and improved antagonistic properties after drying.

The scientific novelty of the study lies in the development of an integrated lyophilization technology combining optimized temperature-vacuum drying parameters with a bacterial-yeast consortium based on Lactobacillus paracasei-010K and Torulopsis sphaerica-105k cultivated in hydrolyzed milk. Unlike conventional approaches focused on bacterial monocultures, the proposed system demonstrated enhanced cell survival (88-92%) and better preservation of antagonistic activity after drying. The study also provides experimental evidence of the synergistic effect of the yeast component on the stability of probiotic cultures during lyophilization. The available literature contains limited information regarding the application of this specific bacterial-yeast consortium under optimized lyophilization conditions.

Materials and methods

The probiotic strain *Lactobacillus paracasei-010K* isolated from koumiss was used as the main object of the study. The strain was characterized by stable cultural properties and pronounced antagonistic activity. *Lactobacillus paracasei-010K* was deposited and stored in the RSE at the Republican Collection of Microorganisms of the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan under the number B-RKM 1009.

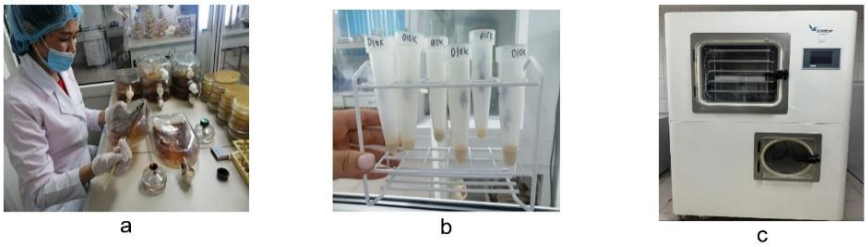
Two variants of the composition were prepared for the development of the dry bioproduct technology. Sample № 1 consisted of a monoculture of *L. paracasei-010K* with the addition of skimmed milk in a ratio of 1:1. Sample № 2 included a consortium of *L. paracasei-010K* and *T. sphaerica-105k* in a ratio of 1:0.5, with the addition of skimmed milk in a ratio of 1:1 relative to the volume of the cell suspension.

Skimmed milk has been used as a protective medium due to its well-proven cryo- and lyoprotective properties. It contains proteins (mainly casein) and lactose, which form a stabilizing matrix around microbial cells during freezing and subsequent drying. This matrix reduces mechanical damage caused by the formation of ice crystals and protects cell membranes from dehydration. The choice of skimmed milk is also confirmed by previous studies demonstrating its effectiveness in maintaining the viability of probiotic microorganisms during lyophilization. Hydrolyzed skimmed milk is generally characterized by the presence of milk proteins (mainly casein-derived peptides), lactose and mineral components. The selection of this medium was based on its availability, food-grade safety, and previously reported effectiveness in preserving probiotic microorganisms during freeze-drying.

For lyophilization, 24-hour cultures of microorganisms were grown in an enriched nutrient medium at a temperature of 37±2 °C until a concentration of 10^8-10^{10} CFU/ml was reached (Fig. 1a). The culture liquid was centrifuged at 2000 rpm for 10 minutes to concentrate the cellular biomass (Fig. 1b). The resulting precipitate was resuspended in a protective medium until a homogeneous suspension was obtained. The ratio of biomass to the protective environment was 1:1.

Lyophilization was performed in a Lyobeta-4 PS chamber apparatus using standard 2R vials (Fig. 1b). The sample volume in each vial was 0.5 ml. The technological cycle included the stages of freezing, primary (sublimation) and secondary (desorption) drying. The process was carried out

in automatic mode with programmatically adjustable temperature and vacuum parameters. The lyophilization parameters are shown in Table 1.



a b c

Figure 1 – Inoculation of Lactobacillus paracasei 010K into liquid medium (a), biomass obtained after centrifugation (b), and the LyoBeta lyophilizer used for biomass drying (c)

Table 1 – Lyophilization Parameters

Process Stage	Temperature, °C	Pressure, Pa	Duration
Freezing	–50	–	7 h
Primary drying	–30	300	7 h
Primary drying	–30	500	3 h
Secondary drying	40	–	7 h
Secondary drying	37	–	6,5 h

The parameters were monitored at all stages of the technological cycle. This lyophilization regime was chosen as a compromise between the intensity of moisture removal and minimizing damage to cellular structures. The number of viable cells before and after lyophilization was determined by seeding on nutrient media. Under sterile conditions, 0.1 ml of suspension of the appropriate dilution was applied to the surface of the solid nutrient medium and incubated at a temperature of 37±2 °C. After incubation, colony-forming units were counted.

All experiments were carried out in triplicate (n=3). The results are presented as averages ± standard deviation (SD). Statistical analysis was performed using the Student's t-test. The differences were considered statistically significant at p≤0.05.

The effectiveness of the developed lyophilization regimen was evaluated based on the survival rate calculated according to the formula (1):

$$S = \frac{N_1}{N_0} \times 100\% \quad (1)$$

where, N0 is the concentration of viable cells before lyophilization, N1 is the concentration of cells after the completion of the process.

Results and Discussion

In the first stage of the study, cell viability was assessed after the completion of the sublimation drying process. Based on the obtained data, the survival rate was calculated. The results of the quantitative evaluation are presented in Table 2.

Table 2 – Effect of lyophilization on the viability and functional activity of the strains

Sample	Parameter	Before Lyophilization	After Lyophilization
№ 1 (monoculture)	*L. paracasei,* CFU/ml	3.5±0.2	3.1±0.1
Inhibition zone, mm	*Salmonella dublin*	12.2±0.1	11.0±0.2
	Escherichia coli	15.3±0.1	13.8±0.2*
	Bacillus subtilis	11.2±0.1	10.0±0.2
	Contamination	not detected	not detected
№ 2 (bacterial-yeast consortium)	*L. paracasei,* CFU/ml	3.8±0.1	3.4±0.1
	T. sphaerica, CFU/ml	4.7±0,2	4.2±0.2
Inhibition zone, mm	*Salmonella dublin*	12.8±0.2	11.5±0.2*
	Escherichia coli	16.0±0.2*	14.2±0.2*
	Bacillus subtilis	12.0±0.2	10.7±0.2*
	Contamination	not detected	not detected
*-p≤0,05			

For the L. paracasei-010K strain, the number of cells in the monoculture decreased from 3.5 to 3.1×10 CFU/ml. A similar decrease was observed in the consortium, from 3.7 to 3.4×10 CFU/ml. For the yeast component *T. sphaerica-105k* concentration decreased from 4.6 to 4.2×10 CFU/ml. This decrease can be explained by the physiological stress resulting from water crystallization, osmotic fluctuations, and cell dehydration. However, the magnitude of these losses is within acceptable technological limits and does not significantly affect the functional properties of crops.

An important indicator of the effectiveness of the developed technology is the preservation of the antagonistic activity of the strains after lyophilization [7]. The antagonistic activity of *Lactobacillus paracasei-010K* was evaluated before and after lyophilization against test cultures of *Escherichia coli, Salmonella Dublin* and *Bacillus subtilis*. Pronounced inhibition zones were observed in the monoculture: 15.3±0,1 mm before and 13.8±0,2 mm after for *E. coli* ($p<0,05$), 12.2±0.1 mm before and 11.0±0.2 mm after for *S. dublin* and 11.2±0.1 mm before and 10.0±0.2 mm after for *B. subtilis*. Bacterial-yeast Consortium (*L. paracasei-010K* and *T. sphaerica-105k*) showed slightly higher antagonistic activity after lyophilization (14.2±0.2 mm for E. coli, 11.5±0.2 mm for *S. dublin*, and 10.7±0.2 mm for *B. subtilis* ($p<0,05$), indicating a synergistic effect of the yeast components. After lyophilization, the viability of the strains remained at the level of 88-92% (Fig. 2), while the inhibition zones decreased by no more than 10-12%, which confirmed the preservation of the functional potential of probiotic cultures. The absence of polluting microorganisms in all series of experiments confirms the microbiological purity of the preparations obtained and the correct organization of the technological process.

In sample № 1, the absolute death of *L. paracasei-010K* was 0.4×10 CFU/ml, which led to an estimated survival rate of 88.6%. In sample №2 for the same strain, the decrease in the number of cells was 0.3×10 CFU/ml, which corresponds to a survival rate of 91.9%. For the yeast component *T. sphaerica-105K* in the consortium lost 0.4×10 CFU/ml with a survival rate of 91.3%.

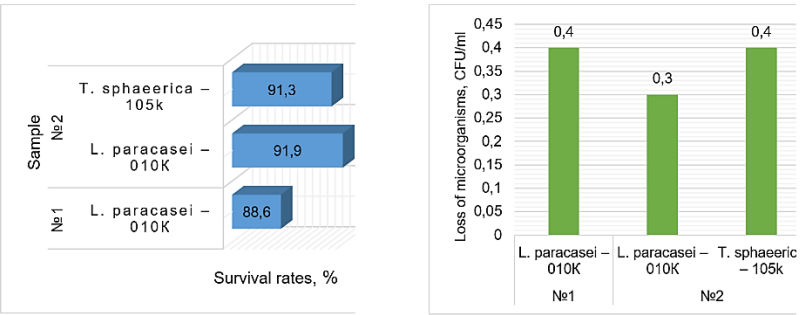


Figure 2 – Survival rates and cell loss of microorganisms after lyophilization

The scheme of the lyophilization process is shown in Figure 3. In all variants, the decrease in the number of cells after freeze drying did not exceed 12%, which indicates the high resistance of the studied cultures to low-temperature exposure and dehydration stress.

The developed technological scheme for the production of a dry biological product is based on the principles of gentle stabilization of cellular structures and is aimed at maximizing the viability and functional activity of *Lactobacillus paracasei-010K* and *Torulopsis sphaerica-105k* strains. The results of this study demonstrate that the proposed lyophilization regimen provides a high level of preservation of the viability of probiotic strains. According to Ge et al. (2024) lyophilization is one of the most effective strategies for stabilizing probiotics by minimizing thermal stress compared to other drying methods [8].

Other authors also note that the effectiveness of maintaining cell viability largely depends on the use of protective agents capable of forming a vitreous matrix and limiting the formation of intracellular ice. In particular, studies on the lyophilization of *L. casei* have shown that choosing a culture medium with an optimal ratio of components can increase cell survival to 80-90% or higher. At the same time, a higher concentration of protective substances in the environment does not always correlate with a higher survival rate, which emphasizes the importance of optimizing the composition of the lyoprotector [9].



Figure 3 – Schematic representation of the technological process for obtaining lyophilized biopreparations and the final dry bioproducts

Similar conclusions have been drawn in studies on the freezing and lyophilization of lactic acid cultures for the production of starter culture, where the preservation of cells in a dry state depends not only on the parameters of the thermal regime, but also on factors such as the rate of freezing, the concentration of solute and the structure of the protective environment [10]. It should also be noted that the preservation of the antagonistic activity of microbial cultures after lyophilization indicates the preservation of the functional ability of probiotics, which is an important criterion for the effectiveness of their use. For example, studies on the storage of cultures of lactococci and lactobacilli have shown that microbiological and biochemical properties, including the ability to suppress pathogenic microorganisms, can be maintained for a long time under appropriate drying and storage conditions [11].

A comparison of the results obtained with the literature data indicates that the developed lyophilization regime has good technological representativeness and can be adapted for the industrial production of dry probiotic preparations. At the same time, optimization of the protective medium and temperature-vacuum parameters may significantly influence the survival rate of different strains. These differences are associated with the specific characteristics of microbial cells, including cell surface structure, metabolic activity, and the ability to synthesize exopolysaccharides, which together determine resistance to dehydration stress. Similar observations have been reported in studies on probiotic lyophilization [12].

Compared with previously published studies, where the survival rate of probiotic microorganisms after lyophilization typically ranges from 70% to 85%, the results obtained in this work demonstrate a higher level of cell preservation. This improvement can be attributed to the combined optimization of temperature-vacuum parameters and the selected protective medium.

In addition, the use of a bacterial-yeast consortium contributed to enhanced stability of the system. The presence of the yeast component likely provided additional protection to bacterial cells during dehydration, resulting in higher survival rates and better preservation of antagonistic activity. This suggests the existence of synergistic interactions between the components of the consortium. These findings indicate that the proposed technology has advantages over conventional approaches and can be considered a promising method for the production of stable dry probiotic preparations for the food industry.

One limitation of the present study is the absence of residual moisture determination in the obtained lyophilized preparations. Residual moisture is an important quality parameter affecting storage stability and viability of probiotic products. Therefore, future studies will include residual moisture analysis together with long-term storage stability assessment to provide a more comprehensive characterization of the developed bioproducts.

However, further studies are required to evaluate the long-term stability (shelf-life) of the developed bioproducts under different storage conditions. This will allow a more complete assessment of their practical applicability in the food industry.

Conclusion

The study showed that the proposed lyophilization regimen provides high viability and functional activity of *Lactobacillus paracasei-010K* and *Torulopsis sphaerica-105k* strains. The decrease in the number of viable cells after lyophilization ranged from 8 to 12%, which confirms the

effectiveness of the selected temperature and vacuum parameters and the protective environment. The preservation of activity after lyophilization indicates the stability of the functional properties of probiotic cultures. The results of this study confirm that the developed technology can be applied to the production of stable dry biological products with high viability and preserved functional activity. Evaluation of long-term storage stability requires additional studies under different storage conditions.

References

1. The International Scientific Association of Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of postbiotics / S. Salminen et al // Nat. Rev. Gastroenterol. Hepatol. – 2021. – Vol. 18. – P. 649-667. https://doi.org/10.1038/s41575-021-00440-6.
2. Lactic acid bacteria in Asian fermented foods and their beneficial roles in human health / H. Doo et al // Food Sci. Biotechnol. – 2024. – Vol. 33. – P. 2021-2033. https://doi.org/10.1007/s10068-024-01634-9.
3. Polysaccharides as carriers of polyphenols: Comparison of freeze-drying and spray-drying as encapsulation techniques / I. Buljeta et al // Molecules. – 2022. – Vol. 27. – Art. 5069. https://doi.org/10.3390/molecules27165069.
4. Preservation of biomaterials and cells by freeze-drying: Change of paradigm / A. Merivaara et al // J. Control. Release. – 2021. – Vol. 336. – P. 480-498. https://doi.org/10.1016/j.jconrel.2021.06.042.
5. Blynskaya E.V. Technological approaches to improving the process lyophilization of protein and peptide drugs / E.V. Blynskaya, S.V. Tishkov, K.V. Alekseev // Russian journal of biotherapy. – 2017. – Vol. 16. – №. 1. – P. 6-11. https://doi.org/10.17650/1726-9784-2017-16-1-6-11. (In Russian).
6. Yavnikov N.V. The effect of various cryoprotective components on the survival of probiotic microorganisms after freeze drying / N.V. Yavnikov // International Bulletin of Veterinary Medicine. – 2022. - № 1. – P. 69-73. https://doi.org/10.52419/issn2072-2419.2022.1.69. (In Russian).
7. Development of stable freeze-dried functional ingredients containing wild-type probiotic strains / P. Prapa et al. // Applied Sciences. – 2023. – Vol. 13, № 1. – Art. 630. https://doi.org/10.3390/app13010630.
8. Research progress on improving the freeze-drying resistance of probiotics: A review / S. Ge et al // Trends in Food Science & Technology. – 2024. – Vol. 147. – Art. 104425. https://doi.org/10.1016/j.tifs.2024.104425.
9. Improvement of the lyophilization survival rate of Lactobacillus casei via regulation of its surface substances / S. Cui et al // Foods. – 2022. – Vol. 11, № 21. – Art. 3468. https://doi.org/10.3390/foods11213468.
10. Sitnikova P.B. Prospects for the production of whipped frozen fruit desserts with natural sugars / P.B. Sitnikova, A.A. Tvorogova, V.A. Naumov // Food Processing Industry. – 2025. – № 5. – P. 8-12.
11. Ovcharova E.S. Freeze-drying, storage time and conditions influence on the adhesive activity and biochemical properties of lactobacilli / E.S. Ovcharova, A.F. Novikova, D.V. Maslov // Proceedings of the Kuban State Agrarian University. – 2025. – № 117. – P. 314-319. https://doi.org/10.21515/1999-1703-117-314-319. (In Russian).
12. Sadguruprasad LT. Statistical modelling for optimized lyophilization of Lactobacillus acidophilus strains for improved viability and stability using response surface methodology / LT. Sadguruprasad, M. Basavaraj // AMB Express. – 2018. – Vol. 8. – Art. 129. https://doi.org/10.1186/s13568-018-0659-3.

Acknowledgment

The authors express their sincere gratitude to the Research Laboratory «Microbiocenosis and Probiotic Engineering» of the Kazakh National Agrarian Research University for their support in conducting experiments, providing equipment, and assisting with microbiological analyses.

Ф.Ғ. Сағымбек[1], З.А. Кожахметова[1], Т.Б. Абдигалиева[2]*

[1]Казахский национальный аграрный исследовательский университет,
050010, Республика Казахстан, г. Алматы, пр. Абая, 8

[2]Алматинский технологический университет, 050012, Республика Казахстан, г. Алматы, ул. Толе би, 100

*e-mail: tolkyn_07.1987@mail.ru

РАЗРАБОТКА ТЕХНОЛОГИИ ПОЛУЧЕНИЯ СУХОГО БИОПРЕПАРАТА ДЛЯ ПИЩЕВОЙ ПРОМЫШЛЕННОСТИ С СОХРАНЕНИЕМ ФУНКЦИОНАЛЬНОЙ АКТИВНОСТИ ШТАММОВ

В статье представлена технология получения сухого пробиотического биопрепарата на основе штаммов Lactobacillus paracasei-010K и Torulopsis sphaerica-105k с сохранением их жизнеспособности и функциональной активности. В качестве основного объекта исследования использовали пробиотический штамм Lactobacillus paracasei-010K, выделенный из кумыса и обладающий выраженной антагонистической активностью. Для разработки технологии были сформированы два варианта композиций: монокультура и бактериально-дрожжевой консорциум; в качестве питательной среды применялось гидролизованное молоко. Лиофилизацию проводили по запрограммированному циклу, включающему стадии замораживания, сублимационной сушки и вторичного высушивания. Оценку жизнеспособности осуществляли методом посева с подсчётом колониеобразующих единиц.

После лиофилизации сохранность клеток Lactobacillus paracasei-010K составила 88.6 % в монокультуре и 91.9 % в составе бактериально-дрожжевого консорциума; для дрожжевого компонента T. Sphaerica-105k показатель достиг 91.3 %. Жизнеспособность штаммов сохранялась на уровне 88-92 %, а антагонистическая активность в отношении тест-культур Escherichia coli, Salmonella Dublin и Bacillus subtilis уменьшилась не более чем на 10-12 %, при этом консорциум демонстрировал несколько более высокие показатели по сравнению с монокультурой, что свидетельствует о синергетическом эффекте дрожжевого компонента.

Разработанная технология обеспечивает получение стабильных сухих биопрепаратов с высокой функциональной активностью и потенциалом к длительному хранению, что определяет перспективность их применения в пищевой промышленности.

***Ключевые слова:** пробиотики, лиофилизация, сухой биопрепарат, Lactobacillus paracasei, Torulopsis, жизнеспособность, функциональная активность, микроорганизмы.*

Ф.Ғ. Сағымбек[1], З.А. Кожахметова[1], Т.Б. Абдигалиева[2]*
[1]Қазақ ұлттық аграрлық зерттеу университеті,
050010, Қазақстан Республикасы, Алматы қ., Абай даңғ., 8
[2]Алматы технологиялық университеті,
050012, Қазақстан Республикасы, Алматы қ., Төле би к., 100
*e-mail: tolkyn_07.1987@mail.ru

ШТАММДАРДЫҢ ФУНКЦИОНАЛДЫҚ БЕЛСЕНДІЛІГІН САҚТАЙ ОТЫРЫП ТАМАҚ ӨНЕРКӘСІБІНЕ АРНАЛҒАН БИОПРЕПАРАТ АЛУ ТЕХНОЛОГИЯСЫН ӘЗІРЛЕУ

Мақалада Lactobacillus paracasei-010K және Torulopsis sphaerica-105K штамдары негізінде олардың тіршілік қабілеті мен функционалдық белсенділігін сақтай отырып құрғақ пробиотикалық биопрепарат алу технологиясы ұсынылған. Зерттеудің негізгі нысаны Lactobacillus paracasei-010K штаммы қымыздан бөлініп алынған және айқын антагонистік белсенділікке ие. Технологияны әзірлеу үшін екі композициялық нұсқа жасалды: монокультура және бактерия-саңырауқұлақ консорциумы және қоректік орта ретінде гидролизделген сүт қолданылды. Лиофилизация алдын ала бағдарламаланған жүйе бойынша жүргізілді, оған мұздату, сублимациялық кептіру және екінші (десорбциялық) кептіру кезеңдері кірді. Тіршілік қабілетін бағалау колония түзетін бірліктерді санау әдісімен жасалды.

Лиофилизациядан кейін Lactobacillus paracasei-010K клеткаларының сақталу деңгейі монокультурада 88.6 %, ал бактерия-саңырауқұлақ консорциумында 91.9 % болды; T. sphaerica-105K ашытқы компонентінде көрсеткіш 91.3 % жетті. Штаммдардың тіршілік қабілеті 88-92 % деңгейінде сақталды, ал Escherichia coli, Salmonella Dublin және Bacillus subtilis тест-дақылдарына қарсы антагонистік белсенділіктің төмендеуі 10-12 %-дан аспады. Сонымен бірге, консорциум монокультураға қарағанда сәл жоғары көрсеткіштер көрсетті, бұл ашытқылық компоненттің синергетикалық әсерін көрсетеді.

Дайындалған технология жоғары функционалдық белсенділікке ие тұрақты құрғақ биопрепараттарды алуға мүмкіндік береді және олардың ұзақ мерзімді сақтауға әлеуеті бар және бұл олардың азық-түлік өнеркәсібінде қолдану болашағын айқындайды.

***Түйін сөздер:** пробиотиктер, лиофилизация, құрғақ биопрепарат, Lactobacillus paracasei, Torulopsis, тіршілік қабілеті, функционалдық белсенділік, микроағзалар.*

Information about the authors

Fatima Sagymbek – PhD, Senior Lecturer of the Department of «Zooengineering and Biotechnology», Kazakh National Agrarian Research University, Republic of Kazakhstan, Almaty; e-mail: fakosya.ru@mail.ru. ORCID: https://orcid.org/0000-0001-9925-8527.

Zubaira Kozhakhmetova – Candidate of Biological Sciences, Senior Lecturer at the Department of «Microbiology, Virology and Immunology», Kazakh National Agrarian Research University, Republic of Kazakhstan, Almaty; e-mail: zubajra043@gmail.com. ORCID: https://orcid.org/0009-0002-0103-0247.

Tolkyn Abdigaliyeva* – PhD, associate professor of the Department «Applied Biotechnology»; Almaty Technological University, Almaty, Kazakhstan, Republic of Kazakhstan, Almaty; e-mail: tolkyn_07.1987@mail.ru. ORCID: https://orcid.org/0000-0002-1404-8852.

Сведения об авторах

Фатима Сағымбек – PhD, старший преподаватель кафедры «Зооинженерия и биотехнология», Казахский национальный аграрный исследовательский университет, Республика Казахстан, г. Алматы; e-mail: fakosya.ru@mail.ru. ORCID: https://orcid.org/0000-0001-9925-8527.

Зубайра Қожахметова – кандидат биологических наук, старший преподаватель кафедры «Микробиология, вирусология и иммунология», Казахский национальный аграрный исследовательский университет, Республика Казахстан, г. Алматы; e-mail: zubajra043@gmail.com. ORCID: https://orcid.org/0009-0002-0103-0247.

Толкын Абдигалиева* – PhD, ассоциированный профессор кафедры «Прикладная биотехнология»; Алматинский технологический университет, Алматы, Казахстан; e-mail: tolkyn_07.1987@mail.ru. ORCID: https://orcid.org/0000-0002-1404-8852.

Авторлар туралы мәліметтер

Фатима Сағымбек – PhD, Қазақ ұлттық аграрлық зерттеу университеті, «Зооинженерия және биотехнология» кафедрасының аға оқытушысы, Қазақстан Республикасы, Алматы қаласы; e-mail: fakosya.ru@mail.ru. ORCID: https://orcid.org/0000-0001-9925-8527.

Зубайра Қожахметова – б.ғ.к., Қазақ ұлттық аграрлық зерттеу университеті, «Микробиология, вирусология және иммунология» кафедрасының аға оқытушысы, Қазақстан Республикасы, Алматы қаласы; e-mail: zubajra043@gmail.com. ORCID: https://orcid.org/0009-0002-0103-0247.

Толкын Абдигалиева* – PhD, Алматы технологиялық университеті, «Қолданбалы биотехнология» кафедрасының қауымдастырылған профессоры, Алматы, Қазақстан; e-mail: tolkyn_07.1987@mail.ru. ORCID: https://orcid.org/0000-0002-1404-8852.

Received 30.03.2026
Revised 13.05.2026
Accepted 11.06.2026

https://doi.org/10.53360/2788-7995-2026-3(23)-38

ҒТАХР: 65.35.33

CC BY 4.0
Check for updates

Ж.С. Набиева, А.Н. Жаханова, А.А. Кулаипбекова*, Э.К. Асембаева, Ш.А. Абжанова
Алматы технологиялық университеті
050012, Қазақстан Республикасы, Алматы қаласы, Төле би көшесі, 100
*e-mail: ak04erke22@mail.ru

ДОЛАНА ЖАПЫРАҒЫ СЫҒЫНДЫСЫМЕН БАЙЫТЫЛҒАН ЖЕМІС-КӨКӨНІС ПАСТИЛАСЫНЫҢ САПАЛЫҚ КӨРСЕТКІШТЕРІН БАҒАЛАУ

Аңдатпа: *Бұл мақалада алма, асқабақ және қызылшадан жасалған пастилаларға долана жапырағының сығындысын (Crataegus almaatensis) қосудың өнім сапасына әсерін кешенді бағалауға талдау жүргізілді. Тәжірибе барысында сығындымен байытылған пастила үлгілерінің органолептикалық сипаттамалары, дәрумендер мөлшері, антиоксиданттық белсенділігі және микробиологиялық қауіпсіздігі анықталды.*

Дегустациялық талдау нәтижесі 3% долана жапырағының сығындысы бар пастилалар дәмі, жағымды хош иісі және сыртқы түрі бойынша ең жоғары бағаға ие болды. Сонымен қатар, бұл үлгілерде аскорбин қышқылының мөлшерінің жоғарылауы байқалды: алма-асқабақ негізіндегі пастиладағы С дәруменінің концентрациясы 38,06 мг/100 г-нан 62,97 мг/100 г-ға дейін, ал алма-қызылша негізіндегі пастилада 22,61 мг/100 г-нан 29,98 мг/100 г-ға дейін жоғарылады.

Микробиологиялық зерттеулер пастила үлгілерінің барлық дайын өнімдердің қолданыстағы санитарлық-гигиеналық стандарттарға сәйкес келетінін растады. Талдау жүргізілген үлгілерде

©Ж.С. Набиева, А.Н. Жаханова, А.А. Кулаипбекова, Э.К. Асембаева, Ш.А. Абжанова, 2026