

Program name: BR10764998 “Development of technologies using new strains of beneficial microorganisms, enzymes, nutrients and other kits in the production of special dietary food products”

Relevance: In the last decade, the health status of the population has been characterized by negative trends: morbidity and mortality due to cardiovascular diseases and cancer have increased, and the problem of insufficiency of vitamins and micronutrients (iodine, iron, etc.) is acute.

The nutritional structure of Kazakhstanis is characterized by a continuing decline in the consumption of the most biologically valuable products, such as milk and dairy products, fruits, vegetables, eggs, fish, meat, and vegetable oil. In actual nutrition, there is an imbalance in proteins, fats and carbohydrates, a deficiency of complete proteins, polyunsaturated fatty acids, vitamins, microelements with excess consumption of carbohydrates.

Among the various groups of food products used by the population of our country at present, from the point of view of the possibility of creating new products of increased nutritional value, dietary functional products are of great interest. These products can be considered as the optimal form of food product, which should be used to enrich the diet of any person with all essential nutrients, as well as biologically active substances that have a beneficial effect on the functional state, metabolism and immunoresistance of the body.

One of the important areas of work of domestic enterprises and firms to expand their product range is the development of new dietary products enriched with essential nutrients, as well as biologically active additives (nutraceuticals). This applies to both mass consumption products, the purpose of which is to most fully satisfy the body’s needs for essential macro- and micronutrients, and special dietary products with a given chemical composition, which have therapeutic and prophylactic properties, for certain populations and people in extreme conditions .

The program is aimed at implementing the “Strategy “Kazakhstan-2050”: a new political course of the established state”, the Message of the President of the Republic of Kazakhstan N. Nazarbayev dated October 5, 2018 “Growing the welfare of Kazakhstanis: increasing incomes and quality of life” and other strategic and program documents.

Solving the objectives of the Program will allow the agricultural sector of the Republic of Kazakhstan to become a highly profitable sector of the economy, ensuring food and environmental security, development of export potential, and will lead to the development of small farming; will increase the volume of agricultural products produced in value terms; will increase the country's GDP, as well as tax revenues to the budget; will strengthen the position of domestic producers of quality food products in the domestic and foreign markets.

Target: Development of innovative technologies for processing and storage of crop and livestock products

Expected results:

Upon completion of the program:

A technology for functional food products made from sheep and goat milk will be developed.

Technologies for instant food products for functional purposes will be developed.

Technologies for combined fermented milk protein products with long shelf life will be developed.

Technologies for lactose-free curd raw materials and bifidoyogurt will be developed.

Technologies for the production of food products with increased nutritional value and long shelf life using nutrients and nanocarboxylates (microelements) will be developed.

Technologies for preventive drinks will be developed.

Resource-saving technologies for economy-class dairy products made from whey (whey cheese, refreshing and tonic drinks) will be developed.

New food products with a reduced content of trans fats based on animal and plant raw materials will be developed.

Technologies for gerodietetic meat products enriched with biologically active ingredients from secondary meat raw materials will be developed.

3 seminars and round tables will be held, 14 articles will be published in peer-reviewed foreign scientific publications with a non-zero impact factor, 2 articles in peer-reviewed foreign scientific publications indexed in the Science Citation Index Expanded database of the Web of Science and (or) having a percentile on CiteScore in Scopus database at least 30 (thirty), 32 publications in foreign and domestic publications recommended by KOKSON, 1 monograph in a Kazakh publishing house, 6 patent applications submitted to the Kazakh Patent Office, 1 application for an EAEU patent, of which at least 2 patents were received for an invention.

2 pilot industrial testing will be carried out, calculations of the economic efficiency of new technologies will be carried out.

14 master's students and 9 PhD doctoral students will be involved, and it is also planned to improve the qualifications of young scientists in leading foreign scientific centers of at least 3 people per year.

Results obtained in 2021:

- a technology for producing goat and sheep milk coagulant has been developed;

- a technology has been developed for the production of lactobacilli *Lactobacillus lactis* and *Lactobacillus bulgaricus*, *Streptococcus thermophiles* for use as starter cultures in technologies for producing cheese and probiotic products from goat and sheep milk;

- a technology for producing bifidobacteria *Bifidobacterium bifidum* and *Bifidobacterium breve* has been developed for use in technologies for producing probiotic products and goat and sheep milk;

- the production of enzyme preparations and starter cultures was organized at the National Center of Biotechnology with a production capacity of up to 200 grams of enzyme preparation, 10 kg of starter preparations per month;
- functional low-lactose products (bifido curd and bifidoyogurt) have been developed that have characteristic product characteristics and probiotic activity;
- 10 lactic acid bacteria were isolated, after studying the maximum viability index among the isolated isolates, 4 isolates were taken to study further biological characteristics. The indicator of viable cells corresponded to 10⁷ CFU/ml;
- a recipe for a preventative drink enriched with mineral supplements, vitamins and prebiotics has been developed: starting culture (consortium): Lactobacillus casei Y1, Lactobacillus brevis 4 LB B-RKM 0610, Lactobacillus paracasei Y2; pectin; prebiotic component inulin; vitamin-mineral premix (vitamins A, C, B1, B2, trace elements iodine); natural milk;
- recipe for a drink based on whey, enriched with vitamin and prebiotic: starting culture (consortium): Lactobacillus casei Y1, Lactobacillus brevis 4 LB B-RKM 0610, Lactobacillus paracasei Y2; prebiotic component inulin; vitamin C; whey;
- a technology has been developed for the production of a meat product with a low content of trans isomers using plant raw materials (oleogel 10%);
- a technological scheme for the production of protein hydrolyzate from wool by-products has been proposed. Based on the conducted research, a technological scheme for the production of boiled sausages enriched with biologically active ingredients from secondary meat raw materials has been proposed.

Results obtained in 2022:

- a recipe and technology for preparing soft cheese and semi-hard cheese from goat and sheep milk has been developed.
- optimal cooling and steaming modes have been established, taking into account minimizing energy consumption for various grains and legumes, porridge extrusion modes have been optimized.
- a recipe and technological drying modes for combined fermented milk protein products with herbal additives have been developed;
- optimal modes for the drying process of combined fermented milk protein products with herbal additives using microwave energy were obtained;
- 2 technologies for manufacturing lactose-free products have been developed;
- 4 complexes of microelements (nanocarboxylates) were obtained; a technology for obtaining special additives (nutrients) and complex microelements using nanotechnology from local raw materials has been developed, 1 pilot batch of a special additive has been produced; 4 recipes have been developed enriched flour mixtures for bakery products;
- an assessment was made of the effect of using preventive drinks enriched with probiotic LAB, vitamins and minerals and prebiotics on laboratory animals;
- developed a recipe and technological scheme for the production of whey full-time drinks, which allows you to increase the biological value of the

product by including biologically active components in the structure, such as serviceberry and sea buckthorn juice; a consortium of microorganisms, lactic acid bacteria, has been developed, and a technology for soft whey cheese has been developed. An experimental batch of soft cheese was received;

- recipes have been developed for semi-smoked sausages containing 10% oleogels based on sunflower oil and beeswax and containing 7% oleogels of a composite mixture based on sunflower oil, monoglyceride and wax; Ra technology and 1 recommendation have been developed for the production of a meat product with a low content of trans isomers using raw materials of animal and plant origin;

- a technological scheme for obtaining protein hydrolyzate from wool by-products has been developed and proposed; a recipe has been developed for prototypes of boiled sausage for gerodietetic purposes with the addition of protein hydrolyzate and a plant component – purslane in an amount of 1%; Pilot testing of the production of gerodietetic meat products enriched with biologically active ingredients from secondary meat raw materials was carried out at the meat processing complex of MPK Rakhmet LLP (Ekibastuz).

Results obtained in 2023:

- from various sources - domestic cow, goat, sheep, camel and mare milk, kumiss, sauerkraut, fermented milk products, homemade cheese - 17 isolates of lactic acid bacteria were obtained. Using microbiological methods, pure cultures of these isolates were obtained, which, based on cultural and morphological characteristics, were assigned to the genus *Lactobacillus*, *Lactococcus* and *Enterococcus*;

- as a result of molecular genetic and proteomic identification, it was established that the isolated strains are: *Lactobacillus plantarum*, *Lactococcus lactis*, *Lactobacillus brevis*, *Leuconostoc lactis*, *Lactobacillus rhamnosus*, *Lactobacillus paracasei*, *Lactobacillus harbiensis*, *Lactobacillus fermentum*, *Lactobacillus curvatus*, *Enterococcus faecium*, *Lactobacillus delbrueckii*. Determined that in 11 samples of domestic dairy and fermented milk products, four different strains of lactobacilli, namely *L. plantarum*, *L. brevis*, *L. rhamnosus* and *Lactococcus lactis*, predominated;

- to study the phenotypic properties of lactobacilli, biochemical studies were carried out: the ability of each strain to ferment lactose and the ability to produce lactic acid was studied. The study of the biological properties of isolated strains of the genus *Lactobacillus* allowed us to establish that all studied strains exhibit a high ability to ferment lactose. It was found that *L. plantarum* VGM1, *L. plantarum* VS2 and *L. rhamnosus* VK1, isolated from goat milk, sauerkraut and koumiss, respectively, showed higher fermentation activity and, accordingly, produced more lactic acid than others;

- studies of probiotic potential made it possible to establish the survival rate of each strain under simulated conditions of the gastrointestinal tract and its ability to compete with pathogenic microorganisms. Of the 17 strains studied, 16 withstood a 3-hour incubation of gastric juice with a pH of 3.0, and 8 of the 17 strains withstood a 3-hour incubation with a pH of 2.0. A study of the resistance of

strains to bile shock showed that 4 strains showed good survival under simulated conditions with the addition of trypsin and 1.8% bile salts. When testing antagonistic abilities towards opportunistic microflora, 4 strains out of 17 showed the best results. Based on the data received it was found that of all isolates, three strains *Lactobacillus plantarum* VGM1, *Lactobacillus plantarum* VS2 and *Lactobacillus rhamnosus* VK1, isolated from goat milk, sauerkraut and kumiss, accordingly, have the greatest probiotic properties;

- cultivation technology has been developed and freeze-dried strains have been obtained *Lactobacillus rhamnosus* VK1, *Lactobacillus delbrueskii* NU1, *Lactobacillus plantarum* VGM1, *Lactobacillus plantarum* VS2 and *Streptococcus thermophilus* STBody, which have prospects for use as starter and probiotic cultures;

- using strains *Streptococcus thermophilus* STBody, *Lactobacillus rhamnosus* VK1, *Lactobacillus delbrueskii* NU1 probiotic yogurt is obtained from sheep's milk. The technology includes homogenization, normalization of milk by fat, degassing, pasteurization and enrichment with probiotic bifidobacteria *Bifidobacterium bifidum*, *Bifidobacterium breve*;

- using strains *Lactobacillus rhamnosus* VK1, *Lactobacillus delbrueskii* NU1 and *Streptococcus thermophilus* STBody probiotic yogurt was obtained from goat milk. The technology for producing yogurt from goat milk includes normalization of goat milk, adding goat milk powder to increase the amount of solids, homogenization and degassing of milk, fermentation and enrichment with probiotic cultures of bifidobacteria and lactic acid bacteria *Lactobacillus plantarum* VGM1, *Lactobacillus plantarum* VS2, incubation to increase acidity and cooling yogurt;

- technologies for producing probiotic yoghurts from sheep and goat milk have been developed;

- on the basis of the NJSC "Kazakh Agrotechnical Research University named after S. Seifullin" a mini-factory was created for the processing of sheep and goat milk and for the production of fermented milk products and cheeses from sheep and goat milk;

- as a result of the research, 7 recipes for instant porridge concentrates on a milk basis for functional purposes were developed, of which 5 recipes are based on milk (cow's milk powder and freeze-dried mare's milk), the remaining 2 recipes are based on vegetable milk (freeze-dried oat milk);

- based on the research conducted, 2 technologies of milk-based cereal concentrates (cow's, mare's milk, freeze-dried oat milk) for quick preparation and functional purposes have been developed. The developed technology makes it possible to obtain high-quality, nutritious, valuable instant cereal concentrates based on flattened and extruded grains and legumes with the addition of vegetable and dairy raw materials;

- studies were conducted to determine the nutritional and energy value of 7 recipes for instant porridge concentrates. As a result of the research, it was found that functionally significant formulations, which contain, unlike others, the

maximum amount of vitamins A, C and β -carotene and minerals, such as Ca, Fe and Zn, have high energy and nutritional value;

- as a result of the study, the temperature and shelf life of instant porridge concentrates were determined; it was found that storing the developed recipes for instant porridge concentrates at a temperature of +20-25°C, with a shelf life of up to 4 months, is acceptable, since the porridges contain herbal additives that lose its basic properties after more than 4 months;

- 1 draft standard for food concentrates “Instant milk-based porridge for functional purposes” was developed;

- established, that in terms of protein content, the developed dairy products are classified as high-protein products, and the water activity indicator confirms that they are products with low humidity and a long shelf life;

- The patterns of formation of the rheological properties of protein products with herbal additives established in the work make it possible to predict the quality of products, excluding the shortcomings of the organoleptic assessment of the consistency indicator;

- it has been established that microwave drying in a vacuum can reduce the drying time of a protein product by 4 times and reduce specific energy consumption by 3 times compared to traditional types of drying. For example, to reach the final moisture content of a protein product of 14.9% (dry basis) it took 8 hours for freeze drying, approximately 3 days for air drying, and 33 minutes for MDF;

- a draft standard and technical specifications for the production of fermented milk protein product for long-term storage have been developed;

- analysis of the taxonomic structure at the genus level showed an increase in the relative abundance of the group Eubacterium ruminantium, Ruminococcus, Romboutsia, an undefined taxon at the genus level, Prevotella. At the same time, the abundance of Lactobacillus, a taxon identified as the human gut metagenome, group Lachnospiraceae NK4A136, Helicobacter, decreased. In the general structure, after taking the product under study, there was an enrichment in taxa of the phylum Firmicutes and a depletion in taxa of Bacteroidota;

- 16S rRNA gene sequencing revealed a selective increase in potentially beneficial bacterial genera such as Prevotella, Lachnospiraceae, Rikenellaceae and Bifidobacterium in rats consuming fermented camel milk compared to controls. Notably, the Bifidobacterium genus showed one of the highest growth rates, indicating that the camel milk product stimulated the growth of this well-established probiotic organism. At the same time, the number of genera such as Prevotella_9 decreased significantly with the advent of fermented milk products;

- consumption of lactose-free yogurt led to a change in the microbiome that differed in 13% of unique operational taxonomic units, while 7.3 and 5.4% were shared with the initial microbiome and the microbiota in the group consuming lactose-free cottage cheese. Whereas the original group contained 1.7%, and those consuming lactose-free cottage cheese – 1.1% of unique taxonomic units;

- Functionality analysis showed that levels of vitamin H biosynthesis and bacterial fatty acid biosynthesis and elongation were enriched in the animal model

following dietary intervention. At the same time, lipopolysaccharide metabolism decreased. The combination of these two factors suggests that consumption of lactose-free yogurt enhances absorption of the vitamin in the lower colon, since lipopolysaccharide is known to inhibit colonic biotin uptake by reducing membrane expression of the sodium-dependent multivitamin transporter. Also, a decrease in the modules of antibiotic resistance and pathogenetic signature was revealed. Whereas, functional metagenomic prediction of metabolic capabilities in the curd consumption group identified several metabolic pathways enriched in fermented camel milk, including pyruvate fermentation, naphthoate biosynthesis, and vitamin B6 metabolism. Correlation analysis revealed a connection between taxonomic and functional shifts in the microbiome. For example, increased abundance of bifidobacteria is closely correlated with enrichment of the pyruvate and vitamin B6 pathways. In contrast, reductions in *Bacteroides* were negatively correlated with the same pathways associated with camel milk;

- research results show that after 4 months there is a decrease and stabilization of the acid number of fat in stored flour mixtures. After 6 months of storage, there is a slight increase in the acid number of fat in all samples of flour mixtures stored for storage. However, even such an increase in the acid number of the fat did not bring it to its original values, which allows us to judge the good quality of the samples;

- flour mixtures enriched with nanocarboxylates and fine grain bran powders comply with the requirements of the regulatory document for wheat flour, which establishes the shelf life of wheat flour, according to which the shelf life of flour begins only when the acid number of fat in the flour reaches 80 mg KOH;

- 4 experimental batches of enriched flour mixtures and 4 experimental batches of bakery products made from them were received. According to the developed recipe, laboratory baking of 4 types of hearth bread with nanocarboxylates and fine bran from wheat, oats, buckwheat and lentils and a control sample without additives was carried out;

- production testing of the technology for the production of bakery products was carried out using 4 recipes of flour mixtures enriched with complex microelements and fine powders from grain and legume bran;

- 4 recommendations and 4 technical specifications for new enriched mixtures have been developed. The developed technical specifications apply to a flour mixture with fine powder of buckwheat, oat, wheat and lentil bran with nanocarboxylates, produced from wheat grain harvested for food purposes, intended for the preparation of composite mixtures for the production of bakery products with increased nutritional and biological value;

- formulations of preventive drinks have been developed: a preventive drink based on natural milk and a preventive drink based on whey, enriched with probiotic lactic acid probiotic bacteria *Lactobacillus casei* 1A, *Lactobacillus paracasei* 2A, *Lactobacillus brevis* 4 LB, prebiotic inulin, vitamin and mineral premix (vitamins A, B1, B2, C and potassium iodide);

- laboratory and technical regulations for the prophylactic drink have been prepared. The acute toxicity and allergenic properties of two prophylactic drinks

were assessed. Based on the results of studies of the acute toxicity of preventive drinks on outbred laboratory mice of the CD-1 line, according to the generally accepted hygienic classification, both preventive drinks belong to hazard class 4 - low-hazard substances. In the tests studied, the conjunctival test and the method of skin applications did not show allergenic properties in preventive drinks;

- laboratory tests have been carried out to optimize the recipe with the inclusion of a sweetener and preservative. Laboratory and pilot-industrial tests were carried out production of preventive drinks;

- it was found that cheese samples contain complete proteins containing all essential amino acids: valine, isoleucine, leucine, lysine, methionine, threonine, tryptophan and phenylalanine. The largest amount shows the content of leucine + isoleucine in both samples - 1739.130 mg/100g and 1568.437 mg/100g, respectively. The next highest content is proline - 1369.565 mg/100g and 1235.294 mg/100g, respectively. The total amount of amino acids in both cheese samples was satisfactory, ranging from 985 mg/100g to 516 mg/100g, respectively. The lowest content shows glycine 253 mg/100g and 259 mg/100g of product, respectively;

- a technological scheme for the production of soft whey cheese with the addition of condensed cheese whey has been developed. Recommendations have been developed for the production of cheese and drinks from whey. The economic efficiency of the technology for the production of whey drinks and cheese was calculated;

- It was found that when pork fat is partially replaced with 7% and 10% oleogel, there is a decrease mass fraction of fat by 1.46 and 1.61%, respectively. Partial replacement of pork fat with oleogel, in general, did not worsen the organoleptic characteristics, however, according to the tasters' assessments the most preferred sample was the one with 7% oleogel;

- There is a decrease in the SFA content from 40.89% in the control sausage to 26.37% with 7% substitution for oleogel and to 25.27% with 10%. The ratio of PUFAs to MUFAs has increased. The TIFA content in the control sample was 2.48%, in the test sample with 7% oleogel replacement - 0.43%, in the sample with 10% - 0.41%, which indicates a decrease in TIFA in the samples of semi-smoked sausages by 75% and 85% respectively;

- technological regulations have been developed for the production of food products with a reduced content of trans fats. Pilot testing of the production of food products with a reduced content of trans fats was carried out. Regulatory and technical documentation has been developed (standard of the organization "Semi-smoked sausages with reduced trans fat content "AGRARKA");

- A technology has been developed for producing meat products for gerodietary nutrition with the addition of protein hydrolyzate in an amount of 5% by weight of unsalted meat raw materials. As a result of the research, the positive effect of purslane and protein hydrolyzate on the developed products has been scientifically substantiated. Applications for utility models have been submitted.

- a draft standard for the organization for the production of meat products for gerodietary nutrition has been developed;

- an analytical review has been prepared and a recommendation has been developed for the use of gerodietetic meat products. Based on the analytical review, we can conclude about the relevance and feasibility of developing gerodietetic products based on the biopotential of secondary resources of animal origin. This will replenish the existing range of gerontological products with functional and enriched products, balanced in chemical composition and adequate to the needs of the elderly body, as well as solve the problem of waste-free, comprehensive processing of secondary raw materials from meat processing industries. A monograph has been published.

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List of publications and patents published within the framework of this project: (with links to them):

Based on the results of studies conducted in the period 2021-2023, the following were published:

In 2021:

In domestic and foreign journals recommended by KOKSON:

1. Kozhakhmetov S.S., Mukhanbetzhanov N., Kushugulova A.R. Modulation of intestinal microbiota in diabetic patients. Eurasian Journal of Applied Biotechnology. No2,2021.-P.49-61

Published articles in peer-reviewed scientific journals indexed in Web of Science and/or Scopus:

1. Samat Kozhakhmetov, Dmitriy Babenko, Saniya Kozhakhmetov, Altynay Tuyakova, Madiyar Nurgaziyev, Ayaulym Nurgozhina, Nurislam Muhanbetganov, Laura Chulenbayeva, Shynggys Sergazy, Alexander Gulyayev, Baimakhan Tanabayev, Timur Saliev, Almagul Kushugulova. Gut modulation of dysbiosis induced by dextran sulfate sodium. Volume 42, August 2021, 101167 <https://doi.org/10.1016/j.fbio.2021.101167>.

In 2022:

In domestic and foreign journals recommended by KOKSON:

1. Tultabayeva T.Ch., Zhumanova U.T., Tultabayev M.Ch., Shoman A.K. Research of qualitative indicators of mare's milk in farms of Almaty region. The Journal of Almaty Technological University. 2022 No3. p.87-94. <https://doi.org/10.48184/2304-568X-2022-3-87-94>

2. Igenbaev A.K., Amirkhanov Sh.A., Ospankulova G.Kh., Temirova I.Zh., Aldieva A.B. Trans may kuramy tomendetilgen zhartylay ystalgan shuzhykka arналган turaman physics-chemistry korsetkishteri Almaty technology university khabarshysy. 2022. No3. Almaty, B.103-107 <https://doi.org/10.48184/2304-568X-2022-3-102-107>.

3. Zhakupova G.N., Alimardanova M.K., Nurtaeva A.B., Sagandyk A.T., Erbolat T.E. Improving the technology of cheeses based on whey. Bulletin of Almaty Technological University. Almaty. 2022. No3. P.40-45. <https://doi.org/10.48184/2304-568X-2022-3-40-45>

4. Muratkhani M., Bulashev B.K., Ospankulova G.Kh., Toimbaeva D.B., Kamanova S.G., Murat L.A., Ermekov E.E., Saduakhasova S.A. Study of the chemical composition of freeze-dried berries for the enrichment of instant cereals. Bulletin of Almaty Technological University. Almaty. 2022. No3. 201-207. <https://doi.org/10.48184/2304-568X-2022-3-201-207>

5. Tokysheva G.M., Kakimov M.M., Mashanova N.S., Makangali K.K. Ekinshilik et shikizatynyts biologiyalyk belsendi ingredientrimen byyytylgan gerodietikalyk et onimderin zhasau tekhnologiyasy slaughterhouse zertteuler. Bulletin of Almaty Technological University. 2022 No3. Art.137-144. <https://doi.org/10.48184/2304-568X-2022-3-137-144>

6. Tokysheva G.M., Kakimov M.M., Tultabaeva T.Ch., Mashanova N.S., Makangali K.K. Development of technology for obtaining protein hydrolyzate from by-products of category II. Bulletin of Almaty Technological University. 2022;(3):144-150. <https://doi.org/10.48184/2304-568X-2022-3-144-150>

7. Akishev Zh.D., Tursunbekova A.E. Khasenov B.B. Milk-clotting activity of recombinant camel chymosin // Vestnik KazNU. Biological series. Volume 90 No1. 2022. pp. 39-49. doi:10.26577/eb.2022.v90.i1.04

8. Kiribaeva A., Silaev D., Abdullaeva A., Ramankulov E., Khasenov B. Study of the biochemical characteristics of glycosylated recombinant xylanase //

Eurasian Journal of Applied Biotechnology, 2022. No. 1. P.24-32 doi: 10.11134/btp.1.2022.3.

9. Kiribayeva AK, Silayev DV, Tursunbekova AE, Ramankulov YM, Khassenov B. Cloning, purification and study of the biochemical properties of α -amylase from *Bacillus licheniformis* T5 strain // Science Bulletin of the S. Seifullin Kazakh Agrotechnical University (interdisciplinary) , 2022, No. 1(112) pp. 181-189. doi: 10.51452/kazatu.2022.1(112).942.

10. Bissenova G.N., Abitaeva G.K., Tuyakova A.K., Sarmurzina Z.S. The main biological properties of lactic acid bacteria promising in the production of fermented milk products for prophylactic purposes // Bulletin of L.N. ENU. Gumilyov. Series Biological Sciences. – 2022. - No. 1 (138) – P. 57-75. DOI: 10.32523/2616-7034-2022-138-1-57-75.

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1. Utility model patent RK No. 7607 for the utility model “Method for producing soft cheese.” Zhakupova G.N., Tultabaeva T.Ch., Nurtaeva A.B., Kalemshariv B., Kundyzaeva N.D., Kakimov M.M., Tynybaeva I.K., Sagandyk A.T. Published November 25, 2022.

2. Utility model patent of the Republic of Kazakhstan No7743 (01/20/2023) Method for preparing a fermented milk drink (Application No2022/0737.2 dated 08/27/2022). Abitaeva G.K., Sarmurzina Z.S., Bisenova G.N., received 01/20/2023.

3. Application for Patent RK No2022/0584.1 dated September 29, 2022. Method for producing milk-clotting enzyme based on recombinant goat chymosin. Akishev Zh.D., Abdullaeva A.N., Kiribaeva A.K., Aktaeva S.A., Khasenov B.B., Ramankulov E.M.

4. Deposit certificate of the microorganism strain (association). Tynybaeva I.K., Zhakupova G.N., Tultabaeva T.Ch., Nurtaeva A.B., Sagandyk A.T., Sarmurzina Z.S. Approved: . 09/23/2022

5. Positive decision dated 08/28/23. on the issuance of a patent for a utility model “Method for the production of dry cheese with herbal additives”, No. 2023/0762.2.

6. Patent Application No.2023/0655.2 Method for producing protein hydrolysate from beef, horse, and lamb wool by-products. Tultabaeva T.Ch., Uzakov Ya.M., Mashanova N.S., Tokysheva G.M., Begaly M.N., Aiken D.K., Makangali K.K.

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2 pilot industrial testing were carried out, calculations of the economic efficiency of new technologies were carried out.

14 master's students and 9 PhD doctoral students were involved, 3 employees took advanced training courses in leading foreign scientific centers.