

MURATBAYEV ALIBEK MANARBEKOVICH

**PRACTICAL ASPECTS OF ENSURING THE SAFETY OF FOOD
PRODUCTS PRODUCED WITH THE USE OF INCAPSULATED
BIOLOGICALLY ACTIVE ADDITIVES**

ANNOTATION

PhD thesis - doctoral student Muratbayev Alibek
Manarbekovich for the degree of Doctor of Philosophy (PhD)
in the specialty 6D073500 – «Food Safety»

Actuality. The President of the Republic of Kazakhstan Kassym-Jomart Tokayev in his Address to the people of Kazakhstan «Kazakhstan in a new reality: time for action» in 2020 noted «The most important task facing Kazakhstan is the full disclosure of its industrial potential. Despite the successes in this area, we have not yet managed to realize the full potential of the domestic market. About two thirds of processed goods are imported from abroad. To ensure the strategic self-sufficiency of the national economy, it is necessary to urgently start developing new food products».

In accordance with the State Program for the Development of Healthcare of the Republic of Kazakhstan «Densaulyk» for 2020-2025, one of the measures for the development of intersectoral interaction is strengthening the health of the population of the Republic of Kazakhstan.

Encapsulated biologically active additives (BAA) obtained from medicinal plants can be used for diseases of all organs and systems. The use of encapsulated BAA of immunomodulatory action in the production of a fermented milk drink for functional purposes is relevant.

The purpose of the dissertation is to ensure food safety of the production of a fermented milk drink produced with the use of encapsulated biologically active additives with immunomodulatory effects from medicinal plants.

To achieve this goal, the following tasks were solved:

1. Based on the literature review, determine medicinal herbs for BAA and materials for encapsulation, the use and safety of in the production of fermented milk products;
2. Research and develop a method for encapsulating BAA from medicinal herbs;
3. To develop a technology for a fermented milk drink with an encapsulated dietary supplement with an immunomodulatory effect. Investigate indicators of physical, chemical, organoleptic and food safety;
4. Conduct a hazard analysis and determine critical control points (CCP) for the production of a fermented milk drink with encapsulated BAA;
5. Ensure quality and food safety in the production of the product by identifying risks using HACCP (Hazard Analysis and Critical Control Points).

Develop a map of quality assurance and safety of raw materials and finished products during production.

6. Develop normative and technical documentation and test the technology for the production of a fermented milk drink. Determine the economic indicators of the cost in the production of a fermented milk drink.

The main content of the work. The dissertation consists of an introduction, five chapters, in which all the problems posed, a list of references and applications are consistently solved.

Introduction. Contains the relevance and novelty of the research, the purpose and objectives of the research are given.

In the review of scientific and technical literature, the current state of the issue is considered in detail. The state and prospects of ensuring the safety of food products based on BAA have been studied, and medicinal plants with an immunomodulatory effect for obtaining BAA have been studied. The use and safety of BAA in the production of fermented milk products have been studied.

Research methods. In the 2nd chapter, the characteristics of the research are presented, the scheme of the experiments is given. The laboratories of the departments «Food technology and biotechnology» and «Technological equipment and mechanical engineering» of the NJSC «Shakarim University of Semey»; the basis of the peasant farm «Kalikhanuly» of Semey; Semey branch of Kazakh Research Institute of Processing and Food Industry LLP; LLP Semey branch of JSC «National Center for Expertise and Certification»; Research Institute of Biotechnology at Kemerovo State University, Kemerovo, RF were involved in the implementation of experimental studies of the work.

Theoretical and experimental part. In the 3rd chapter, on the basis of experimental studies, the choice of materials used for encapsulation is substantiated, the choice of the optimal concentration of alginate 1% and chitosan in the quality of an extra-enriching covering. A technology has been developed for obtaining a tincture from a composition of medicinal plants from Echinacea and Leuzea in an optimal ratio of 1:1, and the organoleptic, physicochemical indicators in the obtained tincture have been investigated. It was established that the encapsulated BAA in the algal medium SIF (pH 7.2) begin to dissolve in 60 minutes and in 120 minutes completely dissolve in the model medium of the intestinal tract, which evidences that alginate capsules coated with chitosan provide the delivery of BAA to the intestinal department, where they are capable of providing a high efficiency.

In the 4th chapter, according to the results of experimental studies, it was concluded that the introduction of encapsulated BAA into a dairy product is unacceptably physically modified. In terms of organoleptic and structural-mechanical characteristics, the optimal dose of encapsulated BAA is 8%.

The technology and recipe for milk-based products with encapsulated BAA have been developed. The organoleptic, physicochemical, microbiological indices of the irradiated product have been studied.

In the 5th chapter, an analysis was carried out using the Quality Function Deployment method (QFD) of a milk product with encapsulated BAA. The

analysis of the technological scheme of production was carried out, all possible risks were indicated, with a division into biological, chemical and physical. Risk analysis was carried out and 13 CCPs were identified. Monitoring actions and corrective actions are proposed for cases when the parameters of the CCP are outside the permissible limits. The HACCP control card was developed for the production of the fermented milk drink «Densaulyk». Approved normative and technical documentation for the product. The economic efficiency of the production of dairy products with encapsulated BAA has been calculated.

The appendix contains test reports, acts of industrial approbation and implementation of the technology of a fermented milk drink with encapsulated BAA, regulatory and technical documentation and patents for a useful model.

Scientific novelty. The scientific novelty of the project is the development of a method for encapsulating BAA of immunomodulatory action. Based on the studies carried out, biopolymers were selected and a method for encapsulation was selected; encapsulated BAA were obtained on an encapsulation plant, the novelty of which is confirmed by a patent for a useful model of RK No. 5236, «Equipment for the production of encapsulated BAA»; a technology for obtaining an extract from a composition of medicinal plants has been developed, the novelty of which is confirmed by a patent for a useful model of the Republic of Kazakhstan No. 4936 «A method for obtaining a composite extract from echinacea purpurea and leuzea»; the technology of a fermented milk drink with encapsulated BAA has been developed, the novelty of which is confirmed by a patent for a useful model of the Republic of Kazakhstan No. 4932 «A method for producing a fermented milk drink with encapsulated BAA». To ensure the safety of a fermented milk drink with encapsulated BAA, a control card based on HACCP has been developed.

Practical value of the work. On the basis of the research, the normative and technical documentation for the fermented milk drink with encapsulated BAA «Densaulyk» ST NJSC «Shakarim University of Semey» 3992 1917 27 001-2021 was approved. Industrial approbation of the developed technology was carried out in the dairy manufactory of the «Kalikanuly» peasant farm (Semey). Production approbation of the equipment was carried out in the Semey branch of the Kazakh Research Institute of Processing and Food Industry LLP.

Communication of the work with research projects.

The dissertation work was carried out within the framework of a scientific grant funded by the Ministry of Education and Science of the Republic of Kazakhstan in the priority direction «Rational use of natural resources, processing of raw materials and products», the enterprise «Technologies of deep processing of raw materials and products» on the topic «Scientific and practical substantiation of the use of encapsulated synbiotic drugs with immunostimulating activity, in the production of milk products» (2015-2017, state registration number 0115PK01199) and «Development of a biosensor for the determination of highly cumulative xenobiotics in milk and dairy products based on regional monitoring of food safety» (2021-2023, state registration number 0115PK01199).

The personal contribution of the author is included in the preparation of tasks, in the conduct of experimental research, in the analysis and communication of the results of the experiments, in the formulation of conclusions.

Appraisal of work. The main research results are discussed at the Republic and international conferences: «Materials of the XIII International scientific and practical Conference Trends of modern science» (Sheffield, England, 2018); «Actual problems of technology and technology for milk processing» (Barnaul, 2018); «Innovations in Food Biotechnology: Proceedings of the International Symposium» (Kemerovo, 2018); «VII International Scientific and Technical Conference» «Kazakhstan - Cold 2017» (Almaty, 2017); «Materials of the international scientific-practical conference, actual problems of food production: state and development prospects, dedicated to the 75th anniversary, Doctor of Technical Sciences, Professor E.T. Tuleuov».(Semey, 2017).

Publications. Based on the results of scientific research, 20 scientific works were published, of which 3 articles in journals included in the international base Scopus, 5 articles in journals recommended by the Committee for Control in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 2 articles in the materials of International conferences, 2 articles in the materials of the International Conference of Far Abroad, 2 articles in other scientific publications of the Republic of Kazakhstan, 1 monograph, 1 analytical review; 4 patents.

Protection positions:

- the process of encapsulating BAA;
- ensuring safety based on the principles of HACCP;
- technology of production of dairy products with encapsulated BAA.

Structure and volume of the dissertation. The dissertation consists of an introduction, a review of the literature, an experimental part, a connection, a list of used sources and applications. The work is laid out on 123 typewritten pages, includes 213 literary sources, 21 tables, 33 figures and 18 appendices.

Assessment of the completeness of solutions to the tasks. The data obtained allow us to consider that all the tasks in the dissertation work have been completed and the goal of the dissertation has been achieved.

In the conclusion of the dissertation, the author presents the main conclusions and results:

1. Analysis of information sources made it possible to determine medicinal herbs for obtaining BAA: echinacea and leuzea. Encapsulation materials are sodium alginate and pectin.

2. On the basis of experimental studies, the choice of materials used for encapsulation is substantiated, the optimal concentration of alginate is 1%. For the purpose of providing additional protection, chitosan was used. The optimal method for the production of capsules has been established - the spray method. An experimental device for obtaining capsules has been developed and manufactured, confirmed by the patent of the Republic of Kazakhstan for utility model No. 5236 dated 07/30/2020. The analysis of the obtained data made it possible to verify the

parameters of the encapsulation process, as a result of which capsules of the required size (1×10^{-3} m) were obtained.

3. According to the results of the research of organic and structural-mechanical performance indicators, the optimal dose of 8% of the external energy sources was set. A dietary supplement with an immunomodulatory effect from medicinal plants was obtained, confirmed by the patent of the Republic of Kazakhstan for a useful model No. 4936 dated 05.15.2020. Developed technology and recipe for fermented milk product with encapsulated BAA, confirmed by the patent of the Republic of Kazakhstan for useful model No. 4932 dated 05.15.2020 «Method for producing a fermented milk drink with encapsulated BAA». Organoleptic, physical and chemical indicators and indicators of food safety of the resulting product have been studied.

4. Hazardous factors and CCP in the production of fermented milk drink with encapsulated BAA have been determined. In the technological process of the production of a fermented milk drink, 13 CCPs have been identified.

5. A map of quality control and safety of raw materials and finished products in the production of a fermented milk drink with encapsulated BAA has been developed. Monitoring systems and corrective actions have been identified to eliminate or reduce hazardous factors to an acceptable level.

6. Developed regulatory and technical documentation (ST 3992 1917 27 001-2021). Industrial approbation of the technology of milk products with encapsulated BAA was carried out in the dairy manufacture on the basis of the peasant farm «Kalikanuly» (Semey), testing of the equipment - in the Semey branch of the Kazakh Research Institute of Processing and Food Industry LLP. The calculation of the economic indicators of the production of a new product has been carried out. The cost price of a fermented milk drink with encapsulated BAA «Densaulyk», per 1 liter of the product - 450 tenge.