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DEVELOPMENT OF THE TECHNOLOGY OF DRINKING YOGURT WITH ENCAPSULATED PROBIOTIC CULTURES

ANNOTATION

on the thesis of PhD-student Jumazhanova Madina
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Actuality. In the message of the Republic of Kazakhstan First President N.A. Nazarbayev's dated January 10, 2018 «New Development Opportunities under the Fourth Industrial Revolution» set the task of producing organic food. For this purpose, the Ministry of Health and Social Development has developed a draft state health program «Densaulyk» for 2016-2019, where the main objective is to improve the health of the population of the Republic of Kazakhstan. In accordance with the program for the development of the country's agro-industrial complex «Agribusiness 2020», one of the indicators of the macroeconomic and social impact of the program is to ensure the domestic market for basic food products at the level of 80%. The dairy industry, which provides the population with basic foodstuffs, is one of the most important sectors of the country's agro-industrial complex.

The leading role in solving the problem of providing the domestic market of the Republic of Kazakhstan with organic food products belongs to the dairy industry, which supplies the population with food products of general and special purpose. Dairy products are products of daily demand that provide the body with vital substances. Over the past decade, there have been clear changes in understanding the role of food in promoting human health. The first frontier of scientific research has gone from the main role of food as a source of energy and substances that form the body, to a more subtle effect of food biologically active components on human health. In industrialized countries, there is an increase in consumer interest in the active role of food in the well-being and prolongation of life, as well as in preventing the development of various diseases. As a result, a new term «functional nutrition» was proposed. By definition, functional food is part of the daily diet and has been shown to provide health benefits and reduce the risk of chronic diseases in addition to generally accepted nutritional effects.

This is due to the fact that the design of functional food products, biochemical reactions and psychosocial behavior of a person through the normalization of their microecological status is one of the priorities of the modern food industry.

A special role in functional nutrition is given to functional dairy products, such as sour milk products, in which the presence of living probiotic cells is mandatory. However, nowadays, numerous studies show that a significant proportion of probiotic cells lose their activity due to the death of microorganisms during storage of products, as well as during passage through the gastrointestinal tract. The reasons for this are low pH values of the stomach, the effect of hydrochloric acid and gastric acid pepsin, etc. The most promising direction for solving this problem is the use of a particular case of the bacterial cells immobilization process - encapsulation.

In this regard, the use of probiotic encapsulation methods for capsules and their use in the technology of sour milk products for functional purposes is relevant.

The object of the study: probiotics (*Propionibacterium asidirrorioici*, *Propionibacterium fréudenreichii*, *Propionibacterium thoenii*), polymers (amidated pectin, sodium alginate, gelatin), encapsulated probiotic, energy yogurt with encapsuots.

The purpose and objectives of the study. The purpose of the thesis is, based on theoretical and experimental studies, to develop a technology for the production of drinking yogurt with encapsulated probiotics for functional nutrition.

In accordance with the purpose, the following tasks were formulated:

1. To investigate and justify the choice of materials used for encapsulation.
2. Investigate and justify the choice of probiotics for encapsulation.
3. Investigate the viability of encapsulated probiotics in a simulated gastrointestinal tract.
4. Investigate the storage capacity of encapsulated probiotics.
5. Develop technology for drinking yogurt with encapsulated probiotics and explore its nutritional and biological value.
6. Investigate the shelf life of drinking yogurt with encapsulated probiotics.
7. Develop and approve normative technical documentation for drinking yogurt with encapsulated probiotics.

The main content of the work. All these tasks are set for all tasks, references and applications. Introduction. Keep relevance and novelty of research.

The review of scientific and technical literature discusses the current state of the issue. The role of probiotics for human health and the problem of their delivery to the small intestine in a viable state have been studied in detail. Data is provided on materials and methods used in the encapsulation of probiotics. The literature review has been completed in full using new sources.

Research Methods. The 2nd chapter presents the characteristics of the research, provides a diagram of the experiments. Experimental studies were carried out with a 5-fold repetition. When performing dissertation works, a set of generally accepted and standard research methods is used in accordance with the regulatory documentation of the Republic of Kazakhstan. During the experiments, the following methods were used: research using a plant and electron microscope, chemical and microbiological research methods. Processing of experimental data was carried out using the program Microsoft Excel.

The experiments were carried out on the basis of the Shakarim State University in the laboratories of the department «Technology of food and processing industries», «Standardization and Biotechnology», in the regional testing engineering laboratory «Scientific Center for Radioecological Research» of the Shakarim State University of Semey.

Theoretical and experimental part. In the 3rd chapter, based on experimental data, the choice of materials and probiotics used for encapsulation was justified. The process of probiotic encapsulation in an alginate-gelatin capsule was studied in detail, and the viability of encapsulated probiotics in a model medium simulating the gastrointestinal tract was studied. The results of studies on the storage capacity of encapsulated probiotics were given.

The 4th chapter presents the technology and composition of drinking yogurt with encapsulated probiotics, the amino acid and fatty acid composition of yogurt, the results of determining microbiological and safety indicators. The shelf life of drinking yogurt was determined. The production technology of drinking yogurt with encapsulated probiotics was tested in the «Kalikanuly» farm. The normative and technical documentation for drinking yogurt with encapsulated probiotics was developed and approved (ST RGP at PHV 3992 1917 27 001-2019).

Chapter 5 presents the calculation of the economic performance of drinking yogurt with encapsulated probiotics.

The appendix presents the test report, acts of industrial testing and implementation of the technology of drinking yogurt with encapsulated probiotics, regulatory and technical documentation and a utility model patent.

Scientific novelty. The technology and composition of the drinking yogurt with encapsulated probiotics were developed.

Based on the studies, biopolymers and probiotics for encapsulation were selected; studied the viability of probiotic cells and the release of *Propionibacterium freudenreichii* probiotics from alginate - gelatin capsules in a model medium simulating the gastrointestinal tract; the necessity of using the process of encapsulating probiotics with the aim of its further using in the production of drinking yogurt was proved; investigated the storage capacity of encapsulated probiotics and drinking yogurt with encapsulated probiotics. Based on the obtained data, the technology of drinking yogurt with encapsulated probiotics was developed, the novelty of which was confirmed by the patent for utility model of the Republic of Kazakhstan No. 4286 «Method for the production of yogurt with encapsulated probiotic cultures» (2019 / 0508.2, 06/04/2019).

Field of application: research results can be used in the conditions of large and small milk processing enterprises, in mini-shops of public catering, for research purposes.

The practical value of the work. A technology was developed for producing drinking yogurt with encapsulated probiotics. Based on experimental studies, normative and technical documentation was developed and approved (ST RGP at PHV 3992 1917 27 001-2019). Industrial testing of the developed technology was carried out in the farm «Kalikanuly» (Semey).

A certain part of the 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», to the initiative «Technologies for the advanced processing of raw materials and products» on the topic «Scientific and practical justification for the using of encapsulated synbiotic preparations with immunostimulating activity in the production of dairy products» (2015-2017, state registration number 0115RK01199).

The personal contribution of the autor lies in theoretical and experimental research and processing of the results; in conducting pilot tests and practical implementation of the results.

Testing the results. The main research results were discussed at the International and Republican conferences: International Journal of Innovative Technologies and Engineering Surveys (IJITEE) (India, Bhopal, 2019); XV modern scientific-practical conference «The scientific industry of the European continent - 2019» (Prague, 2019); «Actual problems of machinery and technologies for milk processing», a collection of scientific papers dedicated to the 60th anniversary of the department of SibNIIS FGBNU FANTSA (Barnaul, 2018); All-Russian scientific-practical conference with international participation «The State and Prospects of the Development of the Best Available Technologies of Specialized Food Products», dedicated to the 60th anniversary of the end of the Omsk Agricultural Institute, academician of the Russian Academy of Sciences, Doctor of Technical Sciences, Professor A. Khramtsova (Omsk, 2019); «Food innovations and biotechnologies» of the VII International scientific conference of students, graduate students and young scientists (Kemerovo, 2019); Kazakhstan-Cold 2017 (Almaty, 2017); «Kazakhstan - Cold 2019» (Almaty, 2019).

Publications. According to the results of scientific research, 19 scientific papers were published, of which 5 articles were published in materials of international conferences, incl. 2 articles in the materials of the International Conference of far abroad countries, 2 articles in journals included in the international Scopus base, 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, 1 monograph. There is also patent No. 4286 for a utility model, «Method for the production of yogurt with encapsulated probiotic cultures»; patent No. 3202 for the utility model «Installation for the production of encapsulated products».

The main findings:

- The process of encapsulating probiotics and its viability in a model environment that simulates the gastrointestinal tract;
- technology for the production of drinking yogurt with encapsulated probiotics.

The structure and scope of the dissertation. The dissertation consists of introduction, literature review, experimental part, conclusion, list of used sources and applications. The work is presented on 158 pages, includes 22 tables, 26 figures and 11 applications.

Assessment of the completeness of the solutions to the tasks. The data obtained allow us to assume that all the tasks in the thesis are completed and the goal of the dissertation is achieved.

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

1. The search for information data allowed to conclude that research related to the creation of functional food products, developed on the basis of natural food raw materials, with the inclusion of encapsulated probiotics, is a promising direction. Scientists assign a special role in functional nutrition to fermented milk products with probiotics, which have a more pronounced functional effect on the human body, due to the complex action of probiotics.

2. On the basis of experimental studies, the choice of materials used for encapsulation is justified, the optimal concentration of alginate and gelatin in the ratio 1:1 is selected. To obtain the capsules, the extrusion method of encapsulation was used.

3. It was found that the number of viable cells of *Propionibacterium* strains in the model environment simulating the stomach (pH 2.0) decreased by about 2.5-5%, which proves the sensitivity of these probiotics to the acidic environment. The choice of *P. freudenreichii* strain for encapsulation is explained by the fact that, unlike other strains, they are able to produce a number of useful compounds-nutraceuticals, while showing low growth needs.

4. It was found that encapsulated *P. freudenreichii* probiotics in the model medium of the small intestine SIF (pH 7.2) are released after 30 minutes of incubation, which indicates that the alginate-gelatin capsule contributes to the delivery of the probiotic to the small intestine, where they are able to provide a successful therapeutic effect.

5. The guaranteed shelf life of capsules not subjected to freeze – drying – 14 days, capsules after freeze-drying-70 days at a temperature of $4\pm 2^{\circ}\text{C}$.

6. The technology of drinking yogurt with encapsulated probiotics was developed. The nutritional and biological value of the finished product was investigated. The analysis of the data testifies to the high nutritional and biological value of drinking yogurt with encapsulated probiotics.

7. The process of storage of drinking yogurt with encapsulated probiotics was investigated and the shelf life of drinking yogurt with encapsulated probiotics was established - no more than 5 days at a temperature of $4\pm 2^{\circ}\text{C}$.

8. Normative and technical documentation for drinking yogurt with encapsulated probiotics was developed and approved. Industrial approbation of drinking yogurt technology with encapsulated probiotics was carried out in the farm «Kalikanuly» Semey. The calculation of economic indicators of the new product was carried out, the cost of drinking yogurt was-500 g of the product - 304,16 tenge.