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**DEVELOPMENT OF TECHNOLOGY OF SEMI-HARD GOAT
CHEESE AND ENSURING ITS FOOD SAFETY**

ANNOTATION

on the thesis of PhD-student Kapshakbayeva Zarina for the degree of Doctor
of Philosophy (PhD) in specialty
6D073500 - Food Safety

Actuality. The main task of the State Program for the Development of the Agro-Industrial Complex of the Republic of Kazakhstan 2017-2021, carried out in the framework of the Message of First President of the Republic of Kazakhstan dated January 10, 2018 «New Development Opportunities in the Conditions of the Fourth Industrial Revolution», is to ensure food safety and develop export potential. Providing food safety is achieved by creating conditions for the development of the agro-industrial complex, the physical accessibility of food in the Republic of Kazakhstan, as well as the economic availability of safe food for the country's population in an adequate volume and assortment.

The current stage of the dairy industry development in Kazakhstan, despite the difficult situation in the economy and changes in the international situation, is characterized by the development of new approaches that can provide quality growth in the sectors of agro-industrial production.

High food quality and safety is currently one of the essential prerequisites for the preservation of food independence of Kazakhstan and the most important task of the state policy in the field of healthy nutrition.

Of particular relevance at present, both in the country as a whole and in a single region among urban and rural populations, is the consumption of natural dairy products. Competitive advantage, in terms of product quality, of agricultural producers is the use of natural milk.

Production of goat cheese has high perspectives. Goat cheese is characterized by distinctive organoleptic and biological features compared to traditional cheeses.

This trend, first of all, is aimed at ensuring the nutritional safety of the population, especially the group that suffers from intolerance to cow's milk, since goat's milk has hypoallergic features.

Despite the fact that the production of cheese in Kazakhstan is poorly established and the republic remains import-dependent for cheese, the culture of cheese consumption among the population is growing. When Kazakhstan joins the WTO, the most important task is the production of dairy products, primarily cheese, which is of high quality, safety, with the prospect of exporting into foreign countries. These are, first of all, semi-hard cheeses with high organoleptic characteristics.

Today, there is increasing demand for high-quality cheeses of the European assortment. For this reason, experts of Kazakhstan enterprises in the cheese-making industry are actively studying the experience of European enterprises,

exploring new types of bio-objects, enzyme preparations, acquiring modern high-tech equipment to develop and introduce new types of cheeses to increase the brand of the enterprise in domestic and foreign market.

All of the above allows us to consider it is relevant to conduct comprehensive study of quality indicators of goat milk and the development of cheese technology from goat milk of foreign brands.

The object of the study: goat milk, enzyme preparations of animal and microbial origin, semi-hard cheese «Otan» from goat milk.

The purpose of the study. The purpose of this work is to study the quality and food safety of goat milk for the production of semi-hard cheese.

To achieve this purpose, the following **tasks** were formulated and successively solved:

1. To justify the choice of cheese analogue, which provides high levels of food safety, and to determine critical control point (CCP) in its production using the HACCP system.

2. To investigate the physico-chemical composition of goat milk from the North-Eastern region of Kazakhstan that meet the requirements of food safety.

3. To determine the milk-clotting activity of enzyme preparations of animal and microbial origin. Based on a mathematical analysis to determine the optimal dose of enzyme preparations and calcium chloride for coagulation of goat milk and to obtain a good quality milk clot. To study the relaxation characteristics of cheese and to test the methodology for determining the relaxation of cheese using an experimental device.

4. To investigate organoleptic, physico-chemical, microbiological and safety indicators, nutritional and energy value of the product. To set the storage terms.

5. To develop semi-hard cheese technology, providing high safety indicators in its production, using the principles of HACCP. To ensure quality and food safety in the production of semi-hard goat cheese through risk identification using the HACCP, FMEA, FTA systems. To develop a map of metrological support for the quality and safety of raw materials and finished products in the production of semi-hard cheese.

6. To develop scientific and technical documentation and to test the production technology at the enterprise of the dairy industry of the Republic of Kazakhstan. To determine the economic indicators of cost in the production of semi-hard goat cheese.

The main content of the work. The dissertation consists of introduction, five chapters, in which all the tasks set are successively solved, list of references and appendix.

The review of scientific and technical literature discusses the current problems of food safety in the Republic of Kazakhstan; issues of ensuring and improving the quality of cheeses through the introduction of the HACCP system, which will minimize the appearance of microbiological risks, thereby contributing to the production of a product of guaranteed quality.

Research methods. The second chapter presents the characteristics of the research, provides a diagram of the experiments. Experimental studies were carried

out with a 5-fold repetition. The obtained experimental data were processed using the method of mathematical statistics. When performing the dissertation, a set of generally accepted and standard research methods was used. The study of the coagulability of goat milk and the ultimate strength of the clot was carried out on original devices developed at SibRIC. Structural and mechanical properties, namely the relaxation characteristics of the cheese mass, were studied on a SibRIC relaxometer. Physico-chemical and biological parameters of raw materials and the finished product were determined using modern analytical instruments (Kapel-105M, capillary electrophoresis, Shimadzu LC-Prominence high-performance liquid chromatograph, and Milkoscan FT 120 milk analyzer).

Theoretical and experimental part. The 3rd chapter of the dissertation presents the qualitative characteristics of goat milk of the North-Eastern region of Kazakhstan, the results and results of coagulation of goat milk with enzymatic preparations of animal and microbial origin. The tensile strength of milk clots and the relaxation characteristics of semi-hard cheese, produced by coagulation of an animal and microbial enzyme, were also investigated. Based on the data obtained, the choice of the enzyme was substantiated and the optimal dose for the production of semi-hard goat cheese was determined.

The 4th chapter presents the production technology of semi-hard cheese from goat milk «Otan», the amino acid and fatty acid composition of the cheese, the results of determining microbiological and safety indicators. The storage term of semi-hard cheese was determined. The «Otan» cheese production technology was tested in the «REGTime» farm. Regulatory and technical documentation for semi-hard cheese was developed and approved (ST CF 050741587145-07-2019). The cost of cheese was calculated, which amounted to 2640 tg/kg. Metrological support map for the technological process, quality and safety control of raw materials, materials and finished product of semi-hard cheese «Otan» from goat milk was developed.

Chapter 5 is devoted to ensuring food safety in the production of semi-hard goat cheese, through the application and implementation of the principles of HACCP, FMEA and FTA analyzes. Critical control points and risks of semi-hard cheese «Otan» production were identified.

The appendix contains method of relaxation of cheese mass, drawings of graphic differentiation of curves of coagulation of goat milk, test reports, a map of metrological support for cheese production, acts of industrial approbation and implementation of semi-hard cheese «Otan» technology, regulatory and technical documentation and the patent for utility model.

Scientific novelty. The scientific novelty of the work is to study the quality and food safety of goat milk from the North-Eastern region of the Republic of Kazakhstan for the production of semi-hard cheese of guaranteed quality. The process of coagulation and tensile strength of goat milk clot with enzyme preparations of animal and microbial origin were studied using original SibRIC experimental instruments. Together with SibRIC, a methodology for determining the relaxation characteristics of semi-hard cheese has been developed and tested by directly measuring the compressive stress in the sample with a special strain gauge

sensor. Physicochemical, microbiological and safety indicators, nutritional and energy values were studied, and the maximum storage periods at various temperatures that ensure quality and food safety of semi-hard cheese were determined. Based on the data obtained, for the first time in Kazakhstan, a technology for semi-hard goat cheese was developed, the novelty of which was confirmed by utility model patent of the Republic of Kazakhstan (2018/0487.2, 03.07.2018), and FMEA and FTA analysis system was used to identify risks in the production of semi-hard cheese from goat milk.

Field of application: the results of the research can be used in cheese-making enterprises and public catering enterprises.

Practical value of the work. Based on the studies, the regulatory and technical documentation for semi-hard cheese «Otan» ST CF 050741587145-07-2019 was approved. The industrial testing of semi-hard cheese technology was carried out in the farm «REGTime" (the village Konstantinovka, Pavlodar region). A map of metrological support for the technological process, quality and safety control of raw materials, materials and finished product of semi-hard cheese «Otan» from goat milk was developed.

The personal contribution of the author lies in the formulation of the scientific goal and objectives of the study, in conducting theoretical and experimental research and processing the results; in conducting pilot tests and practical implementation of the results.

Testing the results. The results of the dissertation research were the subject of discussion and reports at conferences and forums of various levels, including international scientific and practical conferences: II Interregional Scientific and Practical Conference «From Bioproducts to Bioeconomy», April 12-13, 2018, Barnaul, XV International Scientific and Practical Conference «Food, Ecology, Quality» Krasnoobsk, June 27-29, 2018; 21st International Scientific and Practical Conference dedicated to the memory of Vasily Matveevich Gorbatov «Innovation and technological development of food industry — trends, strategies, challenges», Moscow, December 6, 2018; Collection of scientific papers dedicated to the 60th anniversary of the SibRIC department of the Federal State Budget Scientific Institution of the Federal Agency for Science and Technology «Actual problems of milk processing equipment and technologies», Issue 14, Barnaul 2018; VII International Scientific and Practical Conference «International Trends in Science and Technology», Warsaw, Poland, November, 2018; Science, XIII International Scientific and Practical Conference «Science, Research, Development», Berlin, January, 2019.

Publications. On the topic of dissertation work 14 scientific papers were published including: 4 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 article included in the Scopus database; 6 materials of international scientific and practical conferences, including 2 foreign articles, 2 articles in other scientific journals of the Republic of Kazakhstan and far abroad, 1 patent for utility model of the Republic of Kazakhstan 2018/0487.2, 03.07.2018.

Structure and scope of the dissertation. The thesis consists of introduction, main part, conclusion, list of references and appendixes. The main text is 114 pages, contains 39 tables, 24 figures, 174 literary sources, including 32 foreign and 6 applications.

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

Development of recommendations and baseline data for specific use of the results. The results of the research can be used in research and in production of semi-hard cheese from goat's milk. The joint use of the HACCP and FMEA and FTA analysis system allows to identify production risks and nonconformities and prevent them before they actually occur.

Conclusions of the thesis. In the conclusion of the dissertation the author presents the main conclusions and results:

1 Based on the analysis of scientific literature and patent information the choice of cheese analog (Halloumi) was justified. CCPs in the basic technology of Halloumi cheese for specification of technological parameters of development of domestic semi-hard cheese from goat milk were defined.

2 The quality and food safety of goat milk of the North-Eastern region of the Republic of Kazakhstan was studied. The average annual mass fraction of fat and protein of goat milk, which amounted to 5,42 % and 3,56 % respectively, was revealed.

3 On the basis of mathematical analysis of experimental data, the optimal dose of enzyme preparations FP SG-50 and FP «Renin» in the amount of 2,5 g/100 l and a dose of calcium chloride 30 g/100 l, providing the desired quality of milk clot was defined. It was found that as a result of coagulation with an enzyme preparation SG-50, the yield of the product was higher by 11,4% and the strength of the milk clot was higher by 16,27% than in the coagulation of FP «Renin». It was revealed that a sample of cheese produced by coagulation of FP SG-50 has better relaxing features than a sample of cheese obtained by fermentation of FP «Renin». The relaxation coefficient (C_R) of the cheese mass for freshly processed and cheese after defrostration during the development by coagulation of FP SG-50 and «Renin» was $C_R = 110,552/101,625$ N/s and $C_R = 93,709/89,91$ N/s respectively. Together with SibRIC the determining method of the cheese mass relaxation was developed.

4 The biological value of cheese was determined: the mass concentration of amino acids - 30149,89 mg/100 g, including essential - 12677,94 mg/100 g; saturated fatty acids - 67,968 %, monounsaturated - 27,647 % and polyunsaturated - 4,367 %. The energy value of the product constituted 1435 kJ/343 kcal.

The maximum shelf life of the developed cheese was determined: at $t=0-2^\circ\text{C}$ - 33 days; at $t=3-5^\circ\text{C}$ - 29 days and at $t=6-8^\circ\text{C}$ - 24 days. For defrosted cheese, the shelf life was: at $t=0-2^\circ\text{C}$ - 31 days; at $t=3-5^\circ\text{C}$ -27 days and at $t=6-8^\circ\text{C}$ -21 days.

5 In the technological process of cheese production 7 CCPs were revealed: milk acceptance, pasteurization, coagulation, boiling, salting, formation, and storage. Critical limits and systems of monitoring and corrective actions for

elimination or reduction of the dangerous factor to the accepted level are defined. The Risk Limit Number (RLN=66) was determined for the production of semi-hard cheese. The map of metrological support of technological process, quality control and safety of raw materials, materials and finished products of semi-hard cheese «Otan» from goat milk was developed.

6 Normative and technical documentation was developed, industrial approbation of technology of semi-hard cheese from goat's milk was carried out at CF «REGTime» of Pavlodar region. The calculations of the economic indicators of the new product were carried out; the cost of cheese constituted 2640 tg/kg, and 200 g. product – 528 tenge, respectively.