«Integrated assessment of food safety in the production of cheese with plant components»

ANNOTATION

for the dissertation of Kyrykbayeva Shynar Turarbekovna
for the degree of Doctor of Philosophy (PhD) in the educational program
8D07202 – «Food safety»

The relevance of the work. In the Message of the President of the Republic of Kazakhstan K.K. Tokayev to the people of Kazakhstan for 2025, special attention is paid to the development of the agro-industrial complex, while emphasizing the importance of producing safe and high-quality products for domestic and foreign markets. In order to give additional impetus to this industry, the government has been implementing a set of reforms in recent years. A number of large-scale projects aimed at deep processing of agricultural products are currently underway.

Within the framework of the «Auyl – El Besigi» project, work continues to provide rural settlements with the necessary social and engineering infrastructure. These activities will be brought to an appropriate level in accordance with the system of regional standards. The policy of development of the agro-industrial complex is focused on the transition from a raw-material model of agriculture to an industrial model aimed at creating added value in the regions. This approach supports the development of vertically integrated value chains, covering not only production, but also storage, logistics and processing. This makes it possible to create a steady demand for agricultural products within the regions, stimulate local investment and promote employment growth in agricultural territories.

The Concept for the development of the agro-industrial complex, which provides for the sustainable development of the regions until 2030, pays special attention to the modernization of the agro-industrial complex as a key sector of the economy. The priority areas identified are increasing the productivity of agricultural land, diversifying production with an emphasis on highly profitable and processed products, as well as the development of intensive animal husbandry. For this purpose, it is planned to introduce innovative agricultural technologies, strengthen the infrastructure of the agro-industrial complex, including water conservation and storage systems, veterinary and phytosanitary safety, as well as digitalization of production processes.

The regional policy will take into account the peculiarities of the resource, production and export potential of each region, contributing to their balanced development. This will not only ensure food independence and competitiveness in foreign markets, but also stimulate the economic development of the Territories by integrating value chains and attracting investments.

The Concept of development of the agro-industrial complex of the Republic of Kazakhstan for 2021-2030 defines efficient production, food security and conservation of natural resources as the main principles. The National Project for 2021-2025 pays special attention to the processing of agricultural products, as well as the safety of raw materials and finished food products.

Providing the population with high-quality dairy products is one of the key tasks facing producers and the entire dairy processing industry. The expansion of the dairy market and the increase in the range are accompanied by increased competition. To ensure competitiveness, enterprises need to produce high-quality and safe products made from raw materials that meet organoleptic, physico-chemical, microbiological and sanitary-hygienic requirements. At the same time, the finished products must meet all quality and safety requirements, since this is directly related to the reputation of the enterprise, as well as to the health and life of consumers. One of the effective ways to solve this problem is to implement an integrated quality management system in accordance with the international standards ISO 9001 and ISO 22000. The integrated application of international standards makes it possible to harmonize technological and managerial processes, ensure continuous quality improvement, reduce risks, use resources efficiently and increase customer satisfaction. It should be noted that a significant part of milk processing enterprises belongs to small-scale enterprises, the share of which has increased significantly over the past 15-20 years. At the same time, the products of such enterprises are often criticized by consumers and regulatory authorities in terms of quality and safety.

In this regard, the introduction of an international HACCP is considered as a key stage in improving production processes and ensuring product quality. The HACCP system allows you to identify potential risks in the production of brined cheese, as well as identify critical points to be monitored and managed. This, in turn, helps to prevent possible threats to consumer health and ensure that products comply with international food safety standards. Thus, the introduction of the HACCP system into the production of pickled cheeses is an urgent and significant scientific task aimed at ensuring product quality and safety, as well as increasing the competitiveness of enterprises in the food market.

The problems of ensuring the safety and quality of food products are widely reflected in the works of domestic and foreign scientists, including James M. Jay, Martin J. Lessner, N.B. Gavrilova, E.V. N. Mitaseva, Z. K. Basati, U. O. Tungyshbaeva, M. K. Alimardanova, A. K. Kakimov, J.K. Kakimova, D. B. Kurmangalieva, S. N. Kuzeubaeva et al.

The dissertation work was carried out within the framework of the scientific program BR24992914 "Integrated biotechnological solutions for the production of products with increased added value aimed at the valorization of lignocellulose by-products", implemented under program 217 "Development of Science", subprogram 101 "Program-targeted financing of subjects of scientific and (or) scientific and technical activities", funded by the Ministry of Science and higher education of the Republic of Kazakhstan.

The purpose of the dissertation work.

Comprehensive assessment and ensuring of food safety in the production of cheese with the addition of a vegetable component.

Research objectives:

1. Evaluate the quality and safety of dairy and vegetable raw materials used in cheese production.

2. To study the effect of the vegetable component on the quality and safety of cheese in order to ensure that the products comply with the requirements of current standards.

3. Identify potential risks at each stage of the production process when assessing the food safety of cheese production with the addition of a vegetable component.

4. To scientifically substantiate a control system based on the principles of HACCP in the production of cheese with a vegetable component by identifying critical control points and developing risk mitigation measures at each stage of the technological process.

5. To develop recommendations for ensuring food safety in the production of cheese with the addition of a vegetable component.

The review of scientific and technical literature analyzes current issues of ensuring the quality and safety of dairy and vegetable raw materials, as well as scientific papers devoted to the preservation and improvement of the quality of cheeses.

Research methods. During the experimental studies, generally accepted complex and standard methods of analysis were used, including physico-chemical, microbiological, structural-mechanical and organoleptic methods.

The results of the study and their analysis. The paper presents the results of determining the suitability of milk for cheese making, evaluating hops safety indicators, experimental production and research of pickled soft cheese "Damdi" with the addition of a vegetable component, measuring the structural and mechanical properties of cheese, studying its physico-chemical parameters. Studies have been conducted using drinking water used for the preparation of brine, as well as water enriched with molecular hydrogen. Based on the data obtained, the product production technology has been developed.

Ensuring food safety. Comprehensive studies of pickled soft cheese "Damdi" with the addition of a vegetable component have been conducted. Critical control points have been identified to improve product quality based on the HACCP system. The **appendices** contain test reports, an act of industrial approbation of pickled soft cheese "Damdi" with the addition of a vegetable component, as well as regulatory and technical documentation.

The scientific novelty of the dissertation work. For the first time in scientific practice, the use of the Humulus lupulus plant growing in the floodplains of the Irtysh River in the Semey region in cheese production has been substantiated and its effect on food safety indicators has been proven.

The practical significance of the work. Based on the results of the research conducted for pickled soft cheese "Damdi" with the addition of a vegetable component in the Kalikanuli farm (Semey, Abai region), regulatory and technical documentation ST 050741587145-10-2025 was developed and approved, as well as production testing of the technology for making this cheese.

Personal contribution of the author. The author has carried out all theoretical and experimental studies, processed and analyzed the results obtained, formulated the purpose and objectives of the study, as well as carried out the

practical implementation of pilot production samples and the implementation of research results.

Approbation of the research.

The main provisions and results of the dissertation research have been published and discussed in scientific journals of the Republic of Kazakhstan and abroad, including:

in the *Bulletin of Almaty Technological University*:

- the article "The Effectiveness of Using Common Hop in the Production of Fermented Milk Products";

in the *Bulletin of Shakarim University of Semey*:

- "Investigation of the Possibility of Using Hop Extract in Cheese Production";
- "Examination of Brined Soft Cheese with Added Plant Component";
- "Study of the Rheological Properties of Soft Brined Cheese with a Plant Component";
- in the proceedings of the international conference *Science without Borders – 2021* (United Kingdom) — the article "The Use of Common Hop in Food Production.
- Potravinarstvo Slovak Journal of Food Sciences. «The study of nutritional value and microbiological characteristics of brine cheese with vegetable additive», (Slovak 2023 – February);
- and in the journal CyTA – Journal of Food — the article "Evaluation of Antimicrobial Efficacy and Shelf Life of Natural Hop Extract in Cheese Production", published in a scientific journal with an impact factor above zero.

Publications. The results of the dissertation are reflected in 9 scientific publications, including: 4 articles published in journals included in the list of publications recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan; 2 articles in foreign scientific journals indexed in the Scopus database and having an impact factor above zero (respectively, the 44th and 67th percentiles); 1 article published in the proceedings of an international scientific and practical conference; 2 patents of the Republic of Kazakhstan for a utility model were obtained: (21) 2022/1009.2 No. 7819 and (21) 2024/0170.2 № 9180.

The structure and scope of the dissertation. The thesis is presented on 109 pages of computer text and consists of an introduction, a review of scientific and technical literature and patent research, a section on experimental research methods, a discussion of the results, summary and conclusions, a list of sources used, including 116 titles, as well as 27 tables, 24 figures and appendices.

Assessment of the completeness of the solution of the tasks.

The obtained data correspond to the aim of the dissertation and allow us to conclude that all the set objectives have been successfully achieved:

1. According to the proposed safety indicators, the cow's milk used in cheese production complied with the requirements of the Technical Regulation of the Customs Union TR CU 033/2013 "On the Safety of Milk and Dairy Products." During storage, milk from the "Aisha Dairy Products" enterprise of the

“Kalikhanuly” farm demonstrated lower microbiological indicators (TAMC — total aerobic mesophilic microorganisms count) compared to samples from other farms.

The conducted studies proved that the use of hop (*Humulus lupulus*) in cheese production enhances the nutritional value and safety of the product. The presence of tannins (3.8%), vitamins (A, D_3, C, β-carotene), and mineral elements (Ca – 1300 mg/kg, Mg – 460 mg/kg, K – 2360 mg/kg, Zn – 25 mg/kg, Fe – 330 mg/kg) strengthens the functional properties of cheese. The concentrations of heavy metals (Pb – 1.0 mg/kg, Cr – 4.5 mg/kg, Ni – 2.7 mg/kg, Cu – 3.8 mg/kg) did not exceed permissible limits, confirming product safety.

2. The results of the studies demonstrated that the addition of a plant component to brined soft “Dämdi” cheese reduces the risk of development of pathogens such as *Salmonella spp.* and *Staphylococcus aureus*. Furthermore, hop contributes to extending the shelf life of the product by inhibiting the growth of yeasts and molds in brine. The antioxidant components of hop help stabilize the organoleptic properties of cheese. As a result, brined soft “Damdi” cheese with a plant component is microbiologically safer and more storage-stable.

3. The main technological risks in the production of cheese with plant components were identified, and their impact on product quality and safety was assessed. According to the “decision tree” method, three main Critical Control Points (CCPs) were determined in accordance with HACCP principles and ISO 22000 requirements.

4. In accordance with the first principle of the HACCP system, a hazard analysis was conducted across the entire technological chain of production of brined soft “Dämdi” cheese with a plant component. The hazard analysis was performed in compliance with ST RK 1179-2003, identifying potential hazards and three CCPs: milk reception and initial quality control; addition of enzyme, starter culture, and plant extract; storage of the finished product.

5. Control of raw milk quality, purity of the hop additive, pasteurization regime, and storage conditions were designated as Critical Control Points (CCPs). These measures made it possible to prevent biological, chemical, and physical hazards. During milk reception, each batch was tested for pH, total aerobic mesophilic microorganisms (TAMC), and antibiotic residues, and only certified raw materials were used. During the addition of starter cultures, enzymes, and plant extract, sterility and technological temperature conditions were strictly maintained. The finished cheese was packaged in hermetically sealed containers, labeled, and stored at t=4 ± 8C under regulated warehouse conditions for up to 30–40 days. During this period, product safety, taste, and consistency were required to be preserved, while container integrity and temperature conditions were continuously monitored.