ANNOTATION

of the dissertation work by Kostanova Anel Talgatovna on the topic:

«Development of technology for the complex use of secondary raw materials of horse in the production of delicatessen meat product»

submitted for the degree of Doctor of Philosophy (PhD)

in the educational program 8D07201 – «Food Technology»

Relevance of the dissertation work. Modern state priorities of the Republic of Kazakhstan in the field of agro-industrial development are aimed at improving the efficiency of agricultural raw material processing, reducing technological losses, and introducing innovative technologies into the food industry. In his Address to the People of Kazakhstan entitled "The Economic Course of a Fair Kazakhstan," President of the Republic of Kazakhstan Kassym-Jomart Tokayev emphasized the need to develop deep processing of agricultural products, including meat, and to increase the share of processed products in the agro-industrial complex to 70%.

Kazakhstan is one of the largest meat producers in Central Asia and possesses significant export potential. The development of the meat industry is of great importance for ensuring national food security, enhancing the competitiveness of the agro-industrial sector, and promoting the rational use of agricultural resources.

According to the World Health Organization, unbalanced nutrition is one of the major risk factors for the development of non-communicable diseases. Therefore, providing the population with wholesome and safe food products is considered an essential condition for protecting public health and strengthening national food security.

Particular importance is currently attached to the rational utilization of secondary raw materials generated by the meat industry. By-products of slaughter, including intestinal raw materials, represent an additional source of complete proteins, fats, and biologically active compounds. The development of resource-saving technologies for their processing makes it possible to increase raw material utilization rates, reduce waste generation, and expand the range of meat products with enhanced nutritional value.

The present dissertation research was carried out within the framework of the Concept for the Development of the Agro-Industrial Complex of the Republic of Kazakhstan for 2021–2030 (Resolution of the Government of the Republic of Kazakhstan No. 960 dated December 30, 2021).

1. Research Objects. The research objects included horse intestinal raw material «Qarta» used as a natural casing. High-grade trimmed horse meat complying with the requirements of ST RK 1099–2002 was used as the main meat raw material. In addition, fat from the intestinal raw material «Qarta», prepared in accordance with ST RK 1303–2015, was used as a functional component of the minced meat formulation. Buckwheat groats were used as a plant-based ingredient to enrich the product; they were incorporated into the formulation to enhance the nutritional and

biological value as well as to improve the functional and technological properties of the minced meat.

2. The aim of the dissertation work. The objective of the study was to develop a scientifically substantiated technology for the integrated utilization of secondary horse raw materials and a plant component in the production of a meat product with enhanced nutritional value.

To achieve this objective, the following tasks were set:

– to substantiate the feasibility of the integrated use of secondary horse raw materials based on an analytical review of scientific literature;

– to justify and select a novel method for processing secondary horse intestinal raw material «Qarta» as a natural casing for the production of a delicatessen meat product;

– to substantiate and select plant components and to study their effect on the quality indicators of meat products;

– to develop an optimal formulation of the meat product with the addition of buckwheat groats using mathematical modeling methods;

– to conduct a comprehensive assessment of the nutritional, biological, and energy value of the developed delicatessen meat product, including amino acid and fatty acid composition, as well as physicochemical, microbiological, structural-mechanical, and sensory characteristics;

– to calculate the economic efficiency of the developed technology;

– to carry out industrial approbation of the developed delicatessen meat product followed by the preparation of regulatory and technical documentation.

3. Research methods and methodology. Standard methods regulated by GOST (State Standards) and ST RK (Standards of the Republic of Kazakhstan) were used to determine acidity, mass fraction of fat, protein, moisture, and microbiological indicators (GOST 9959–2015, GOST 23042-2015, GOST 10444.15–94, etc.), as well as biochemical methods for analyzing amino acid and fatty acid composition.

Experimental studies were carried out in the scientific laboratories of the NCJSC «S.Seifullin Kazakh Agrotechnical Research University», the research laboratory for food quality and safety assessment of JSC «Almaty Technological University», and the testing laboratory of LLP «NutriTEST».

Standard AOAC methods were used to assess nutritional value, along with modern research approaches including organoleptic, physicochemical, biochemical, and microbiological analyses.

Statistical processing of the results was performed using Microsoft Excel and Statistica software packages, applying methods of variation statistics, analysis of variance (ANOVA), and mathematical modeling to construct regression relationships and optimize technological parameters.

4. Scientific novelty of the research.

– a new method for the combined treatment of horse intestinal raw material «Qarta» has been proposed and experimentally validated. The method is based on

the sequential application of citric acid and ultrasonic treatment in an ultrasonic bath, providing targeted modification of its structural-mechanical and microbiological characteristics when used as a natural casing for a delicatessen meat product;

– it was established that the optimal combination of processing parameters – soaking in a 1% citric acid solution followed by ultrasonic treatment in a bath at a frequency of 35 kHz, power of 200 W, and duration of 5 minutes – provides a pronounced synergistic effect. This effect is manifested in the reduction of total microbial contamination to 1.63 log CFU/g and its stabilization at no higher than 3.24 log CFU/g by the 13th day of storage at 4°C, as well as in improved mechanical properties of the casings: tensile strength – 5.7 MPa, relative elongation – 58%;

– it has been proven that the developed processing method increases elasticity by 12–15%, as well as the plasticity and technological stability of the intestinal raw material, ensuring its microbiological safety and expanding the possibilities of its practical use as a natural casing for a delicatessen meat product. At the same time, citric acid partially reduces the specific odor and flavor characteristic of intestinal raw materials;

– a scientifically substantiated formulation and technology of a delicatessen meat product based on the integrated use of secondary horse raw materials and buckwheat groats have been developed. It was established that the optimal component ratio (10% intestinal fat and 10% buckwheat groats) ensures an increase in water-holding capacity up to 63.1%, a reduction in heat treatment losses to 11.3%, an increase in finished product yield by 12%, and an extension of shelf life due to the antioxidant properties of the plant component.

5. Application Field: The developed technology for the production of delicatessen meat products using secondary horse by-products can be implemented at meat processing enterprises. The research results are aimed at expanding the product range and improving its nutritional and biological value.

6. Practical value of the dissertation work. The results of the dissertation research were implemented and reproduced under industrial conditions at LLP «Auyl-Damu 2009», as well as in the experimental meat processing workshop of the Educational Program «Food Science».

Based on the research outcomes, positive results of the formal examination were obtained for the invention patent applications №2024/1092.1 «Method for Processing Collagen-Containing Raw Materials» and №2025/0309.1 «Method for Producing a Delicatessen Meat Product in a Natural Horse Casing with a Plant Additive».

An organizational standard – ST LLP «Auyl-Damu 2009» 002–2025 – has been developed and approved, which makes it possible to recommend the technology of the delicatessen meat product «Argymaq» for industrial implementation at meat processing enterprises.

7. Personal Contribution of the author. A review of the available literature over the past ten years on the selected topic; formulation of the research goal and objectives; theoretical and experimental studies conducted under laboratory and industrial conditions, including during an international internship; processing and analysis of the obtained data; conducting pilot industrial trials and practical implementation of the results; development of regulatory documentation; and preparation and publication of scientific papers.

8. Work Approbation. All obtained data were verified in accredited laboratories, and the developed technologies were tested under industrial conditions. The key results of the dissertation research were presented and discussed in the form of reports at international scientific and practical conferences. The research materials were published in the proceedings of the following international conferences: «Astana Biotech 2024» dedicated to the 30th anniversary of the National Center for Biotechnology LLP (Astana); «Science and Innovations: News, Problems and Achievements» (KazConf Media Conference, Karaganda); Proceedings of the 11th International Scientific Conference «Modern Scientific Technology» (September 11–12, 2025, Stockholm, Sweden); Proceedings of the 11th International Scientific Conference «Modern Scientific Method» (September 25–26, 2025, Vienna, Austria); and Proceedings of the 11th International Scientific Conference «Academics and Science Reviews Materials» (October 9–10, 2025, Helsinki, Finland).

9. Publications. The results of the dissertation research are reflected in 12 scientific publications, including 3 articles published in journals recommended by the Committee for Quality Assurance in Higher Education and Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan; 1 article published in a journal indexed in the international scientometric databases Web of Science and Scopus with a non-zero impact factor; and 8 publications presented in the proceedings of international scientific and practical conferences.

10. Structure and scope of the dissertation. The dissertation research includes an introduction, an analytical review of scientific, technical and patent literature, a description of the methodology and experimental research program, analysis and discussion of the obtained results, conclusions, and a list of references comprising 201 sources. The main body of the dissertation is presented on 216 pages of typescript and contains 52 tables, 30 figures, and 6 appendices, ensuring the completeness and clarity of the presented material.

11. Conclusions of the dissertation:

- based on an analytical review of the scientific literature, it was established that the involvement of secondary horse meat resources in processing makes it possible to increase the utilization rate of slaughter raw materials from 78–80% to 92–94% and reduce waste volume by 15–18%, which meets modern requirements for resource-saving and low-waste technologies in the meat industry.
- a method for the combined treatment of horse intestinal raw material «Qarta» as a natural casing was substantiated and developed, including the sequential

application of a 1% citric acid solution and ultrasonic treatment (35 kHz, 200 W, 5 min). It was found that this method reduces the total viable microbial count from 4.5–5.5 to 2.5–3.0 log CFU/g (by 68–72%), stabilizes the pH from 6.1 to 5.3, and decreases the intensity of oxidative processes (TBARS after 180 days: 0.6–0.8 mg MDA/kg versus 2.5 mg/kg in the control) while maintaining casing strength (8.5 N/cm) and elasticity (elongation 55%).

- the selection of the plant component buckwheat groats was substantiated, and its effect on the quality of meat products was studied. It was established that its inclusion at 10% increases the water-holding capacity of the mince from 56.2% to 63.1%, reduces cooking losses from 13.5% to 11.3%, and increases the average sensory score from 4.55 to 4.88, confirming the pronounced functional and technological effect of the additive.

- an optimal formulation of the delicatessen meat product «Argymaq» was developed, including 60% horse meat, 20% intestinal raw material «Qarta», 10% intestinal fat, and 10% buckwheat groats. This composition ensures the maximum yield of the finished product 95.6% (versus 92.0% in the control), minimal technological losses, and optimal structural and mechanical characteristics, including a reduction in shear force from 39.5 to 31.0 N/cm².

- a comprehensive study of the nutritional, biological, and energy value of the developed delicatessen meat product «Argymaq» was conducted. An increase in protein content from 17.2 to 19.5 g/100 g and a decrease in energy value from 289 to 275 kcal/100 g were established, along with an improved amino acid profile due to higher lysine and methionine levels and increased polyunsaturated fatty acids. Levels of heavy metals (Pb – 0.028; Cd – 0.007; Hg – <0.001; As – 0.004 mg/kg) and radionuclides (Cs-137 – 4.6; Sr-90 – 2.4 Bq/kg) were significantly below the limits of TR CU 021/2011, confirming the sanitary safety of the product.

- the economic efficiency of the technology for producing the delicatessen meat product «Argymaq» was evaluated. The use of secondary horse intestinal raw materials and a plant component reduced the production cost compared to the control sample. The production cost of sample 2 was 3341 KZT/kg, while in the control sample it was 3633 KZT/kg. The profitability level reached 34.7%, confirming the feasibility of using the developed technology in the production of meat delicacy products.

- pilot testing of the developed delicatessen meat product «Argymaq» was carried out under technological processing conditions at LLP «Auyl-Damu 2009». Reproducibility of technological modes, stability of product quality indicators, and microbiological safety were confirmed. The organizational standard ST LLP «Auyl-Damu 2009» 002–2025 was developed and approved, and regulatory and technical documentation materials were prepared, allowing the developed technology to be recommended for industrial implementation at meat processing enterprises.