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**Development of technology for meat products using protein hydrolysates
from collagen-containing raw materials of the poultry processing industry**
ANNOTATION

for the dissertation of Dinara Akimova Akimbayevna
for the degree of Doctor of Philosophy (PhD)
in the specialty 8D07201 – "Technology of food products"

The relevance of the work. The development of modern technologies for deep and complex processing of collagen-containing raw materials in the poultry processing industry solves the problem of rational use of secondary raw materials. Work in the field of obtaining and researching the functional properties of bioactive protein hydrolysates is currently relevant in the global scientific community. The composition of food products has a positive biological effect in the human body - hydrolysates have the ability to slow down the development of osteoarthritis and lower blood pressure, improve skin condition and slow down the aging process. Taking into account the predominance of imported protein additives in the Kazakhstani market, work in the field of production of protein hydrolysates and other protein components is particularly relevant and corresponds to the direction of state policy.

The work was carried out within the framework of the scientific and technical program BR10764970 "Development of high-tech technologies for deep processing of agricultural raw materials in order to expand the range and yield of finished products per unit of raw materials, as well as reduce the share of waste in production" budget program 267 "Increasing the availability of knowledge and scientific research" subprogram 101 "Program-targeted financing of scientific research and events" of the Ministry of Agriculture of the Republic of Kazakhstan for 2021-2023.

The purpose of the dissertation work is to develop a method for obtaining protein hydrolysates through deep processing of collagen-containing raw materials from the poultry processing industry with justification for further use in the production of meat products.

In accordance with the goal, the following tasks were set:

1. Investigation of the chemical composition and properties of chicken legs to justify their use as raw materials for the production of protein hydrolysates.
2. Application of mechanical and biotechnological methods for processing collagen-containing raw materials, followed by the production of dry protein hydrolysates and analysis of their qualitative characteristics.
3. Research of nutritional value, functional and technological properties and safety of protein hydrolysates.
4. Development and substantiation of technologies for the use of protein hydrolysates in meat products with an assessment of the quality of finished products.
5. Testing of the developed technologies in production conditions.

Objects of research: collagen-containing raw materials of the poultry processing industry - poultry by-products (chicken legs); protein hydrolysates obtained on the basis of processed by-products; sausage products and pate with the

addition of protein hydrolysates.

Research methods. Theoretical and experimental studies were conducted according to the set scientific objectives. Experimental research includes physico-chemical methods, organoleptic methods, histological and microbiological methods, biotechnological methods, and technological experiments. The research results were processed using statistical analysis and mathematical optimization methods.

The scientific novelty of the work. The parameters of modification of collagen-containing raw materials in the poultry processing industry for the production of protein hydrolysates and use as a prescription component of meat products have been scientifically substantiated and experimentally confirmed. Optimal parameters of biotechnological processing of collagen-containing raw materials using subsurface serum and the proteolytic enzyme preparation Enzi Mix -U, followed by fermentation with the preparation Collagenase, have been determined. This method contributes to the effective purification of raw materials from ballast impurities and the targeted destruction of connective tissue proteins, which results in the production of collagen hydrolysate with high functional and technological properties. It has been established that the enzymatic effect of the drug Collagenase, obtained from the *Streptomyces lavendulae* strain, on chilled and frozen raw materials ensures maximum collagen destruction with minimal protein loss. Based on experimental data, the optimal level of administration of protein hydrolysates instead of the main raw materials in the formulations of meat products is substantiated, experimental values of physico-chemical, amino acid, fatty acid compositions, safety indicators, and histological characteristics of the developed meat products are obtained.

The author's personal contribution includes substantiation of the purpose and objectives of the research, organization and implementation of scientific and practical research, creation of technology and formulation of new products with further industrial testing.

The main provisions submitted for defense:

- technology for the production of protein hydrolysates from collagen-containing raw materials of the poultry processing industry (chicken legs);
- practical aspects of the use of protein hydrolysates from collagen-containing raw materials of the poultry processing industry (chicken legs) in the production of poultry meat paste and boiled sausage;
- the results of a comprehensive assessment of the quality and safety of poultry meat paste and boiled sausage with the addition of protein hydrolysates.

The practical value of the work.

The practical value of the work is as follows:

- **a technology has been developed for the production of protein hydrolysate by fermentation of poultry by-products, which contributes to the involvement of nutritionally low-value by-products of broiler chickens and brood hens in food production;**
- **industrial testing of canned meat technology was carried out at the Kazakh Scientific Research Institute of Processing and Food Industry**

LLP and the introduction of sausage production technology with the introduction of protein hydrolysates of collagen-containing poultry raw materials at the enterprise of IP Tyumenbayeva Zh.Kh. Semey;

– drafts of technical documentation have been developed for the production of boiled sausage containing protein hydrolysate (ARTICLES 10130-002-28032361-2023), for the production of poultry meat paste (Articles 130840007973-001-2024) using protein and mineral additives.

The technical novelty of the developed solutions is confirmed by utility model patents of the Republic of Kazakhstan No. 9446 "Method for obtaining protein hydrolysate from raw materials of animal origin" dated 08/09/2024, No. 9667 "Method for obtaining protein hydrolysate from chicken legs" dated 10/11/2024, No. 8146 "Method for obtaining poultry meat paste" dated 06/09/2023.

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Approbation of the work. The main results of the work were reported at international scientific and practical conferences.: "The state and prospects of industrial and innovative development of the agro-industrial complex of the Republic of Kazakhstan" (Semey, October 21, 2022), "Continuity in science is the basis for sustainable development of agricultural science and production" (Almaty, April 20-21, 2023).

Publications. 15 scientific papers have been published on the topic of the dissertation, including: 4 articles in journals included in the Scopus database and having a non-zero impact factor; 2 articles in journals 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 in the materials of international scientific and practical conferences. 3 utility model patents of the Republic of Kazakhstan were obtained: No. 8146 "Method of obtaining poultry meat paste" dated 06/09/2023, No. 9446 "Method of obtaining protein hydrolysate from animal raw materials" dated 08/09/2024, No. 9667 "Method of obtaining protein hydrolysate from chicken legs" dated 10/11/2024.

The volume and structure of the dissertation. The dissertation work consists of an introduction, a review of scientific, technical and patent literature, experimental research methods, a discussion of the results obtained, conclusions, and a list of sources used, including 185 titles. The work is presented on 141 pages of computer text, contains 38 tables, 23 figures and 15 appendices.

Assessment of the completeness of the solution of the tasks. The data obtained correspond to the purpose of the thesis and allow us to conclude that all the tasks were successfully completed as follows:

1. Chemical composition study showed that chicken legs contain 17.1% protein, 65.9% moisture, 12.9% fat and 4% ash. It was revealed that in terms of radiological safety and the content of toxic elements, chicken legs comply with the requirements of regulatory documents.

2. A method for obtaining collagen hydrolysates from chicken legs has been developed, which includes an integrated approach to processing raw materials. Pre-cleansing and multi-stage grinding of chicken legs can significantly increase the availability of collagen for subsequent extraction. Enzymatic treatment in several stages using Enzi-mix U preparations, subcutaneous serum and Collagenase promotes the breakdown of protein molecules and optimizes the extraction of both protein and mineral components. Freeze-drying of the resulting liquid fraction and grinding of the dried solid residue provide two products: a water-soluble protein hydrolysate and a protein-mineral additive.

3. By chemical composition, protein hydrolysate contains 59.1% protein, 4.32% ash, 7.5% moisture. The results of the amino acid analysis showed a high content of glycine (18.7 g/100g), oxyproline (6.45 g/100g), alanine (6.25 g/100g), arginine (5.09 g/100g), glutamic acid (4.98 g/100g) and proline (3.99 g/100g). The protein-mineral supplement contains 53.64% ash, 28.5% protein (including 3.609% oxyproline) and 5.3% moisture. One-dimensional electrophoresis analysis showed the presence of distinct protein fractions with molecular weights of 130 kDa, 95 kDa and 34 kDa, which indicates the presence of peptides of medium molecular weight, high quality of the hydrolysate and its functional applicability. The presence of low molecular weight fractions (20-40 kDa) indicates the presence of peptides with increased digestibility. The mineral composition of the protein hydrolysate contains sodium (463.13 mg/100g), magnesium (351.89 mg/100g), zinc (20.31 mg/100g) and iron (6.97 mg/100g). The content of calcium was 0.77 mg/100g, copper 0.73 mg/100g, phosphorus 0.474 mg/100g. The results of studying the functional and technological properties of protein hydrolysate showed that the moisture binding capacity of the hydrolysate in cold water was 580%, and in hot water — 716%. The gelling capacity of the protein hydrolysate was 460% in cold water and 620% in hot water. The fat emulsifying ability of the hydrolysate is shown in a ratio of 1:7:7, which makes it a valuable ingredient for products with specified functional and technological characteristics.

4. The formulation and technology of boiled sausage "START" has been developed with the addition of protein hydrolysate with a significant improvement in nutritional value and organoleptic characteristics such as taste, texture and aroma due to increased moisture binding capacity. The sausage contains 13.9% protein, 17.2% fat, 66.8% moisture and 2.1% ash, has a high yield and demonstrates a juicy, homogeneous structure. The amino acid composition of the boiled sausage "START" is not inferior to the control version, while the content of amino acids such as arginine, phenylalanine, methionine, proline and serine significantly exceeds that in the control sample, especially proline, which increased by more than 2.3 times. The technology and formulation of poultry meat paste with a protein and mineral supplement have been developed. Pate with protein and mineral supplement

contains protein 19.53 g/100g, fat 16.4 g/100g, carbohydrates 10.13 g/100g, ash 1.67 g/100g. In a test sample of pate with the addition of a protein-mineral supplement, the content of glutamic acid (by 18 mg/100g), glycine (by 313 mg/100g), alanine (18 mg/100g), tyrosine (16 mg/100g), lysine (46 mg/100g) and proline (265 mg/100g). The paste contains minerals such as calcium (56 mg/100g) and iron (12.7 mg/100g). The processed products comply with food safety standards, and the content of toxic elements, antibiotics, and pesticides has not been detected. Of the radionuclides, the amount of caesium and strontium is significantly lower than the MPC.

5. Industrial testing of canned meat technology was carried out at the Kazakh Scientific Research Institute of Processing and Food Industry LLP and the introduction of sausage production technology with the introduction of protein hydrolysates of collagen-containing poultry raw materials at the enterprise of IP Tyumenbayeva Zh.Kh. Semey. Replacing meat raw materials with a protein-mineral additive in the paste reduces the cost of basic raw materials, which will lead to an additional profit of 6,928 tenge per 100 kg of finished product. As a result, the profitability of products increases from 15% to 25%, which indicates a 10% increase in profitability. Draft technical documentation for the production of poultry meat paste (ST. 130840007973-001-2024) using protein and mineral additives, draft technical documentation for the production of boiled sausage with protein hydrolysate (ST. 10130-002-28032361-2023) have been developed. The production cost of 1 kg of protein hydrolysate is 1,367 tenge. The cost of 1 kg of protein hydrolysate is 1684.1 tenge, the cost of 1 kg of mineral residue is 560.7 tenge.