

ANNOTATION

**of the dissertation by Tuleuov Assylan Mukhambetovich on the topic
«Veterinary-sanitary assessment of the quality and food safety of narrow-clawed crayfish in the water bodies of the West Kazakhstan region»
submitted for the degree of Doctor of Philosophy (PhD) in the specialty
6D120200 – «Veterinary Sanitation»**

Relevance of the research topic. Hydrobionts represent a crucial source of protein for humans. Among aquatic animals, crustaceans are distinguished by their high nutritional value and constitute a significant part of the diet in many countries (Japan, USA, Italy, etc.). Crayfish meat is rich in proteins, beneficial fats, vitamins, and microelements, making it a valuable delicacy product.

In the freshwater bodies of Kazakhstan, among invertebrates, only river crayfish hold nutritional significance. Among them, the narrow-clawed crayfish (*Pontastacus leptodactylus*) is of particular commercial and ecological importance. Natural populations of this species are widely distributed in the rivers, lakes, and water systems of the West Kazakhstan region. However, until now, under Kazakhstan conditions, no comprehensive studies have been conducted on the nutritional value of crayfish, the ecological factors affecting their quality, and food safety indicators.

The current veterinary and sanitary examination rules assess crayfish quality only based on organoleptic indicators. This approach does not provide complete and comprehensive information and is insufficient for determining the food safety of raw crayfish material. Furthermore, the common practice of delivering live crayfish to consumers involves keeping them in flow-through basins without feeding for several days. This may affect their physiological condition and food quality, yet no scientifically grounded research in this direction has been conducted in Kazakhstan.

Therefore, a comprehensive study of the veterinary and sanitary quality indicators of the narrow-clawed crayfish harvested in the water bodies of the West Kazakhstan region, assessment of its food safety, and scientific substantiation of the safety of keeping them alive – represents a current and urgent scientific and practical issue.

The purpose of the dissertation research was to conduct a comprehensive assessment of the veterinary and sanitary quality and food safety of the narrow-clawed crayfish inhabiting the main water bodies of the West Kazakhstan region, as well as to study the effect of holding live marketable crayfish in a basin with flow-through water supply on their nutritional value indicators.

Research objectives. In accordance with the objective of the dissertation, the following tasks were set:

1. To conduct hydrochemical studies of the habitat of the narrow-clawed crayfish and to assess the morphometric indicators of crayfish inhabiting locally significant water bodies;

2. To study the organoleptic, physico-chemical, and microbiological indicators of narrow-clawed crayfish immediately after capture from water bodies and during holding in a flow-through basin;
3. To determine the nutritional value of crayfish meat, including its amino acid, fatty acid, vitamin, and mineral composition;
4. To conduct studies on the levels of heavy metals and radionuclides in crayfish meat;
5. To perform a veterinary and sanitary assessment of crayfish meat quality.

Materials and research methods.

The research material comprised narrow-clawed crayfish harvested from the water bodies of the West Kazakhstan region (water bodies of the Ural-Kushum system, the Kamys-Samara system of water bodies, and the QOS OZEN reception basin assigned to Individual Entrepreneur "Albetiyarov" in Uralsk).

In the study areas, water samples for hydrochemical and toxicological (toxicological) analyses were collected from the surface layer using a bathometer, in accordance with State Standard GOST RK 51592-2003. The obtained samples were analyzed in the accredited testing laboratories of LLP "Oral-Zher" and the West Kazakhstan branch of JSC "National Center for Expertise and Certification." For data analysis, hydrochemical standards established for fishery water bodies were applied. The dissolved oxygen content in water was measured on-site at the beginning of the water body using SAMARA-2 and Mark-302M water analyzers, and pH was measured with a Mark-911 pH meter. Water transparency was determined using a Secchi disk.

Sampling and preparation of samples for toxicological analysis were carried out considering sample preservation conditions and in accordance with the requirements of testing laboratories. The obtained samples were analyzed using spectrometric methods in the accredited testing laboratories of the West Kazakhstan Regional Branch of the RSE "Republican Veterinary Laboratory" of the Committee for Veterinary Control and Supervision of the Ministry of Agriculture of the Republic of Kazakhstan, and the West Kazakhstan branch of JSC "National Center for Expertise and Certification." Permissible limit levels of toxicants in biological objects were assessed in accordance with current technical regulations.

A comparative analysis of the nutritional value and chemical composition of crayfish captured from natural water bodies and those held in a basin was conducted. The research was carried out at the laboratory of LLP "Nutritest."

The main provisions for defense:

1. An analysis of the hydrochemical composition of locally significant fishery water bodies in the West Kazakhstan region was conducted, and the stock status and morphometric indicators of the narrow-clawed crayfish were assessed;
2. The nutritional value and chemical composition of narrow-clawed crayfish harvested from different water systems were studied, and differences between the systems were comparatively assessed;

3. The levels of heavy metals and radionuclides (Cd, Pb, Cs-137, Sr-90) in crayfish meat were determined, and their compliance with sanitary requirements was investigated;

4. Based on the obtained results, a comprehensive veterinary and sanitary assessment of the quality of the narrow-clawed crayfish was provided..

Description of the main results of the study.

The water quality of the studied fishery water bodies was found to be favorable and safe for crayfish habitation. The reaction of the aquatic environment was neutral or slightly alkaline (pH 7.11–8.31), and the dissolved oxygen content was at a normal level, above 6.30 mg/dm³. The highest mineralization was recorded in Lake Saryshyganak during the summer season – 1731 mg/dm³, while the lowest concentration was observed in the Pyatimar reservoir at 353 mg/dm³.

The length of harvested crayfish ranged from 7 to 15 cm, with individuals of 11–12 cm in length and an average weight of 43–63 g being the most common. As in other natural habitats within the same water bodies, males predominated in the studied crayfish populations. The average proportion of females to males in the studied population was equal to a 2:3 ratio. Between 2018 and 2025, the crayfish catch quota increased approximately 2.1 times.

Keeping narrow-clawed crayfish alive in a special flow-through basin for 8–10 days without feeding did not significantly affect their meat quality. During storage, after 10 days, the color of the crayfish muscle changed from pinkish to a grayish hue; however, the consistency of the meat remained well preserved, and its taste qualities did not deteriorate. The pH of the muscle tissue was at the level of 6.76–6.81 (neutral), ammonia and hydrogen sulfide were not detected (reactions negative), the peroxidase reaction was positive (an indicator of freshness), and no protein breakdown products were found. Reductase test results also indicated that the quality of crayfish meat remained unchanged for up to 10 days of live storage.

The protein content in crayfish meat ranged from 15.78% to 16.07%, while fat content varied between 0.84% and 0.98%. Meat moisture content was 81.59–82.05%.

Eighteen amino acids (including all essential amino acids) were identified in crayfish muscle. In research group 1, the share of essential amino acids in crayfish meat protein constituted 6.9% of the total amino acid content; in groups 2 and 3, it was 7.2% and 7.0%, respectively. The balance coefficient of the amino acid composition was 0.8.

Among fatty acids, oleic acid (C18:1) accounted for the major share at 34–38%. Linoleic acid (C18:2, ω6) was present at a level of 11–12%; it is one of the essential fatty acids not synthesized by the human body. Eicosapentaenoic acid from the omega-3 group was found in significant amounts at 5.6–6.3%, and arachidonic acid at 5.7–5.9%.

Regarding minerals, the highest shares were contributed by potassium (274–298 mg/100 g) and phosphorus (236–253 mg/100 g). These elements play an important role in regulating water-salt balance and the formation of bone tissues in the body. Sodium content was 93–106 mg/100 g, calcium – 49–57 mg/100 g,

magnesium – 20–29 mg/100 g. Iron was determined within the range of 1.5–1.9 mg/100 g.

In the muscle tissue of the studied crayfish, among fat-soluble vitamins, the highest content was that of tocopherol – 2.70%, while the lowest indicator was for vitamin A at 0.014%. Overall, in all research groups, vitamin E and vitamin PP (niacin) predominated in the vitamin composition.

Among toxic elements, in terms of cadmium content, the most environmentally clean were crayfish from the Malyi Uzen River (0.0028 mcg/kg), while the highest content (0.024 mcg/kg) was found in crayfish from Lake Saryshyanak. The highest lead content (0.17 mcg/kg) was found in crayfish from the Kushum River, while the lowest (0.035 mcg/kg) was determined in crayfish meat from Lake Saryshyanak. Furthermore, the ¹³⁷Cs content in crayfish meat from Lake Saryshyanak was 28.4 Bq/kg, while ⁹⁰Sr, conversely, had the lowest indicator among the studied water bodies – 0.5 Bq/kg. In terms of ¹³⁷Cs content, crayfish from the Bolshoi Uzen River ranked second – 21.4 Bq/kg. While crayfish from the Kushum and Malyi Uzen Rivers had similar ¹³⁷Cs levels (10.5 and 12.2 Bq/kg, respectively), the ⁹⁰Sr content in crayfish from the Malyi Uzen River was distinguished by the highest indicator.

To reduce injury during crayfish harvesting, the use of improved crayfish trap-catchers is recommended (patent No. 5164). As an additional method for crayfish cultivation in the natural environment, there is potential for introducing the method of manual rearing in shallow lakes (patent No. 5189).

Justification of the novelty and importance of the results obtained.

For the first time, a comprehensive assessment of the veterinary and sanitary condition of the narrow-clawed crayfish in the water bodies of the West Kazakhstan region was conducted. Levels of heavy metals and radionuclides were determined, and nutritional value was thoroughly characterized. For the first time, the preservation of food quality during crayfish storage in flow-through basins was scientifically substantiated. These data enable the development of crayfish farming, ensure food safety, and enhance export potential.

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Compliance with research programs.

The study was conducted within the framework of the Scientific and Technical Program BR21882122 “Sustainable Development of Natural-Economic and Socio-Economic Systems of the West Kazakhstan Region in the Context of Green Growth: Comprehensive Analysis, Concept, Forecast Assessments and Scenarios” (block: fish resources) for 2023-2025, as well as within the Program-Targeted Funding of the Ministry of Agriculture of the Republic of Kazakhstan under the Scientific and Technical Program BR10764944 “Development of Methods for Analytical Control and Monitoring of Food Safety,” under the task “Development of Test Systems for Monitoring the Safety of Livestock Products,”

within the project “Monitoring of Veterinary and Sanitary Safety of Fish and Fish Products in the West Kazakhstan Region” for 2021-2023.

Description of the doctoral student's contribution to the preparation of each publication.

All results and conclusions presented in the dissertation work were obtained with the direct participation of the doctoral student, in accordance with the individual scientific research plan. The doctoral student mastered all research methods, actively participated in discussing the obtained results, in the preparation and drafting of scientific articles for domestic and foreign publications, and in their publication.

A total of 10 scientific works were published on the dissertation topic, including 2 articles in peer-reviewed journals indexed in the Scopus database, 4 articles in journals recommended by the Science and Higher Education Quality Assurance Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan and 4 articles in the proceedings of international scientific-practical conferences. Three patents for utility models were obtained.

Scope and structure of the dissertation.

The dissertation is a computer-typed text comprising 122 pages and consists of a table of contents, introduction, literature review, research materials and methods, research results, analysis of research results, conclusion, practical recommendations, and appendices. It includes a list of 210 references, and is illustrated with 25 tables, 3 appendices, and 19 figures.