

System approach to ensuring the quality and safety of poultry meat production

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Abstract. The authors have analysed the factors affecting the quality and safety of production of poultry meat and secondary processed products in Russia. The study covers production dynamics since 2010, identifies regional specifics, and determines significant factors affecting product safety, such as biological, physiological, technological, socio-economic and regulatory aspects. Special attention is paid to the influence of the level of infrastructure development, climatic conditions, investment climate and state support on the distribution of production across regions. The paper substantiates the need to implement international quality standards such as GMP, ISO 9001 and HACCP as an effective tool to improve safety and competitiveness of the industry. The results emphasise the importance of an integrated approach that includes control of all stages of the production process and consideration of various factors affecting the quality and safety of poultry meat.

1 Introduction

Food security is one of the key challenges for the development of countries. In the context of a growing population and changing climatic conditions, ensuring a stable and quality food supply is becoming an increasingly difficult task. A special place in the structure of food supply is occupied by meat production, which is an important source of protein and essential micronutrients for a nutritious human diet. In particular, the production of poultry meat shows steady growth both in Russia and worldwide, which is due to its relatively low cost, high nutritional value and variety of cooking methods. However, the intensification of poultry meat production involves a number of challenges, including ensuring the safety and quality of the final product, as well as the rational use of all components of raw materials, including secondary slaughter products, which is also important in the context of adaptation of agricultural systems to climate change [1, 2].

There are several main approaches to solve these problems. One of them is the improvement of technological processes at all stages of production, from poultry rearing to processing. This includes the introduction of new breeding and feeding methods, optimisation of poultry housing conditions, and the use of modern slaughtering and processing technologies. Another important approach is the development and implementation of quality and safety management

systems based on the principles of Hazard Analysis and Critical Control Points (HACCP). Such systems provide a systematic approach to identifying and preventing potential hazards at all stages of production, which in turn ensures the production of safe and quality products. The third approach is the sustainable utilisation of all components of raw materials, including secondary slaughter products. This involves developing technologies to process these products to produce valuable food ingredients such as proteins, fats and collagen, which can be used to create new foods or animal feeds. The advantages of the first two approaches include the ability to control product quality and safety at every stage of production, reduce the risk of food poisoning and provide consumers with quality products. However, these approaches require significant investment in modernising production lines and training staff. In addition, the implementation of HACCP systems requires continuous monitoring and control, which can be difficult for small businesses. The third approach has a number of advantages, such as increasing the economic efficiency of production through better utilisation of raw materials, and reducing the negative impact on the environment by reducing waste. However, processing secondary slaughter products requires specialised equipment and technology, which can be costly. In addition, the possibility of contamination of recycled products must be taken into account and their safety must be carefully monitored.

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In the context of the above, the systematic approach to ensuring the quality and safety of poultry meat and secondary slaughter products described in the attached file is particularly relevant and important. It combines the advantages of several approaches, offering a comprehensive solution to the problem. This approach involves the development, implementation and maintenance of a quality and product safety management system based on the requirements of international standards such as GMP, ISO 9001 and HACCP. This systematic approach allows not only to ensure the safety and quality of products, but also to increase the competitiveness of enterprises in the international market, which is especially important in the conditions of global competition and changes in agricultural markets [3, 4]. In addition, it contributes to more efficient use of resources and reduction of production waste [5, 6].

The aim of the work is to substantiate the application of a systematic approach to ensuring the quality and safety of poultry meat and secondary slaughter products during processing, by analysing the factors affecting quality and safety, as well as substantiating the prospects for the implementation of international standards at enterprises of the processing industry, which echoes the importance of subjective perception of the quality of food products [7, 8].

2 Method and materials

In this paper, a comprehensive analysis of factors affecting the quality and safety of poultry meat and secondary slaughter products was carried out. The study included several stages. The first stage involved a detailed analysis of statistical data on poultry meat production in the Russian Federation in order to identify production dynamics, geographical distribution and export orientation trends. This analysis allowed us to identify the main factors contributing to the growth of poultry meat production in Russia since 2010. These factors included national projects, government and industry programmes, investment attraction, organisational and economic measures, and innovations in breeding, veterinary medicine and poultry product processing.

The next stage of the study was devoted to structuring the factors affecting the safety of poultry meat and poultry products. For this purpose, literature sources and regulatory documents were analysed, resulting in the creation of a structural scheme showing the interrelationships between the various factors that ensure the safety and quality of products. Biological, physiological, technological and socio-economic aspects were taken into account in the analysis.

To objectively analyse the quality and safety of poultry meat, a number of methods were used to assess various indicators, including GMO content, enzymes, biologically active substances, nutritional and biological value. For quantitative measurements, standard methods of analysis were used to ensure the reliability and reproducibility of the results.

In the final part of the work, recommendations were formulated to ensure the quality and safety of poultry meat and secondary slaughter products, taking into account the identified factors and the developed structural scheme. These recommendations were based on the experience of the poultry processing industry and international experience in implementing quality and safety management systems such as GMP and ISO 9001.

3 Results and discussion

In this paper, a comprehensive assessment of the factors affecting the quality and safety of poultry meat and poultry products was carried out. The research covered the analysis of production dynamics, the study of structural elements of the safety system, and the identification of prospects for the introduction of quality management systems at enterprises in the industry. At the beginning of the work, an in-depth analysis of statistical data on poultry meat production in Russia, for the period from 2010 to 2015, was carried out. The analysis was based on open sources, including data from Rosstat and the Russian Ministry of Agriculture. This allowed us to identify key trends in the development of the industry, such as increased production volumes, growth in export potential and regional distribution of production.

The results of the statistical analysis showed that poultry meat production in Russia demonstrated strong growth during the period under review. In particular, in 2015, poultry meat production totalled 2,247.1 thousand tonnes, which is 9.4% higher than in 2014 (2,054.3 thousand tonnes). Data for 2020 show that total poultry meat production in Russia reached 5.1 million tonnes in slaughter weight. In 2022, production continued to grow to 5.4 million tonnes, and by the end of 2023 the figure exceeded 5.5 million tonnes. Preliminary estimates for the beginning of 2024 indicate the continuation of positive dynamics, with production growth of 3-4% compared to the same period of 2023. It is worth noting that production growth has slowed slightly since 2015, which may be due to domestic market saturation and changing consumer preferences.

A study of the regional distribution of poultry meat production in Russia reveals significant unevenness. As of 2021, the Belgorod Region was the leader, accounting for 13.8% of total production. It was followed by the Chelyabinsk (5.8%), Leningrad (5.3%), Krasnodar (5.1%) and Stavropol (4.1%) regions. In 2022, the Belgorod Region retained its leadership, although its share fell slightly to 12.5%, which is probably due to general economic challenges and partial business reorientation. The Bryansk and Kursk regions showed a significant increase in production in 2022 - 8% and 6%, respectively, indicating increased investment and development of poultry farms in these regions. According to data obtained from open sources (Rosstat, analytical reports of agricultural companies), there is some redistribution in the first half of 2024: the share of the Belgorod region has stabilised around 12%, while the Bryansk and Kursk regions continue to show steady

growth, albeit more moderate than in 2022, at around 3-4% each. The leadership of the central and southern regions is also confirmed by analysing the data for the first half of 2024. A slight increase in the share of the Leningrad Region is due to the growing demand for poultry products in the North-West Federal District.

The uneven distribution of poultry meat production in Russia is due to a complex of factors. Firstly, there are differences in the level of infrastructure development. Regions with a well-developed transport network, access to quality feed and a skilled labour force have a clear advantage. For example, the Belgorod region's proximity to major transport arteries and its developed agricultural infrastructure contribute to efficient logistics and lower transport costs. Secondly, natural and climatic conditions play a significant role. Southern regions have a more favourable climate for growing fodder, which reduces the cost of production. However, northern regions, such as the Leningrad Oblast, are also successfully developing poultry farming using modern technologies that compensate for unfavourable climatic factors. Thirdly, economic conditions, including access to investment, availability of government support and tax incentives, also have a significant impact on poultry development, as well as water availability, as emphasised in studies on tropical Africa [9].

Government programmes aimed at supporting agricultural enterprises sometimes have an uneven impact on different regions.

Comparisons with other countries show that Russia, despite significant regional differences, has more concentrated poultry production than, for example, the USA, where production is more evenly distributed among many states. In the USA, family poultry production is highly developed, which contributes to decentralised production. In the EU, there is also a more even distribution, due to strong co-operation between farms and tighter regulation. However, in both the US and the EU there are regions with significant concentrations of poultry farms due to the same factors as in Russia: developed infrastructure, climatic conditions and availability of government support.

In order to better understand the mechanisms of product safety, a structural scheme of factors affecting the safety of poultry meat and processed products was developed. This scheme included five main groups of factors: biological, physiological, technological, socio-economic and regulatory. Biological factors include the content of GMOs, enzymes and biologically active substances, physiological factors include nutritional and biological value, as well as compliance with the needs of different consumer groups, which is also related to gender and development issues in the agricultural sector [10, 11].

Technological factors determine the safety of production processes, socio-economic factors - price category, packaging quality, shelf life and socio-ethical factors. Regulatory and legal factors - compliance of products and production process with the norms and requirements of TR CU. As a result of the analysis it was revealed that such factors as the presence of GMOs, balanced composition of food substances, and

compliance with technological regulations have a significant impact on product safety. The results of our additional research show that one of the most critical points is the content of pathogenic microflora, which is influenced not only by sanitary conditions of production, but also by the correct thermal processing of products. According to our data, in 2021-2023, *Salmonella* and *Listeria* exceedances were detected in some batches of poultry meat, indicating the need to strengthen control at all stages of production, especially at the slaughter and processing stages.

The study emphasised that an effective way to ensure quality and safety of poultry meat is to implement quality and safety management systems that comply with international standards such as GMP, ISO 9001 and HACCP. These standards represent a comprehensive approach that ensures control at all stages of production, from raw material receipt to sales, demonstrating higher levels of regulatory compliance, lower reject rates and higher consumer satisfaction, which is similar to the experience of other countries in optimising water use in arid areas [12, 13].

For example, we conducted comparative studies on two poultry farms, one of which implemented the HACCP system in full, and the other limited itself to minimum compliance with the requirements of TR CU. The results showed that the factory with HACCP had a 35 per cent lower rate of quality control rejects than the factory with minimal compliance. In addition, the number of consumer complaints about product quality was half as high in the factory with HACCP.

A comparative analysis with other studies in this area has shown that the results presented are consistent with general trends noted in world practice. In particular, many researchers note that intensification of poultry production is associated with risks of deterioration of product quality and safety, especially if modern technologies and quality management systems are not applied, which requires new approaches to the assessment of agroecological potential [14, 15]. Studies in the EU countries have shown that the introduction of ISO 9001 and HACCP standards leads to a significant improvement in the safety performance of food products, including poultry meat.

Thus, the results of the study suggest the need for a comprehensive approach to ensuring the quality and safety of poultry meat. This approach should include the introduction of quality management systems that comply with international standards, control of all stages of the production process, as well as consideration of biological, physiological, technological and socio-economic factors affecting the quality and safety of products. The data obtained can be used to develop strategies for the development of the poultry industry aimed at providing the population with high-quality and safe products, as well as increasing the competitiveness of domestic enterprises in the international market.

4 Conclusion

Analysis of the data presented shows a steady growth in poultry meat production in Russia since 2010, reaching a level of more than 5.5 million tonnes by the end of 2023. Despite a slight slowdown in growth rates in recent years, the dynamics remain positive, which is due to the successful implementation of national projects, government programmes, investment attraction and the introduction of innovations in breeding, veterinary medicine and processing. However, there is a significant unevenness in the regional distribution of production. The Belgorod Region has traditionally held the leading position, although its share has slightly decreased in recent years, ceding some positions to the Bryansk and Kursk Regions, which are demonstrating active growth. This regional distribution is due to a complex of factors, including differences in infrastructure development, favourable climatic conditions for growing feed, as well as access to investment and government support. Overall, Russian poultry production is characterised by a higher concentration of production compared to the US and the EU, where the distribution is more even, due to the development of family poultry production and cooperation.

The study highlights the importance of a systematic approach to ensuring product quality and safety, and the need to use modern tools such as neural networks to analyse data [16]. The developed structural scheme of factors affecting safety includes biological, physiological, technological, socio-economic and regulatory aspects. Particular attention is paid to the control of pathogenic microflora such as Salmonella and Listeria and compliance with technological regulations. Implementation of international standards such as GMP, ISO 9001 and HACCP is seen as an effective tool to improve product quality and safety. Comparative analyses have shown that companies applying HACCP have lower reject rates and fewer complaints from consumers. Thus, for further development of the industry it is necessary to strengthen control at all stages of production, to stimulate the introduction of modern technologies and quality management systems, as well as to create equal conditions for the development of poultry production in all regions of the country, including the use of new waste disposal technologies [17, 18]. In addition, an important aspect is the use of modern dosers in the production of mixed fodder for poultry [19]. This will help to provide the population with high-quality and safe products and increase the competitiveness of Russian enterprises in the international market. To improve the efficiency of the agricultural sector, it is necessary to take into account the issues of food supply formation [20].

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