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Assessment of the Microbiological Safety of Broiler Meat

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ABSTRACT

Microbiological safety is a relevant issue concerning food quality and public health. In this study, we examined modern methods for assessing microbiological risks associated with contamination of broiler meat by the pathogenic microorganisms Campylobacter and Salmonella. Our study is based on an analysis of laboratory research assessing factors affecting the microbiological purity of products, including conditions of cultivation, slaughter, and subsequent processing. Special attention is paid to novel methods of control, including antimicrobial packaging materials and modified atmosphere packaging. A comprehensive approach can reduce contamination risks through improved sanitary conditions in meat production facilities and new technologies. Our suggestions, aimed at optimizing processes to improve broiler meat quality, are relevant in the context of globalization and increasing food quality requirements.

Keywords: *Foodborne pathogens, Poultry production systems, Risk-based food safety, Hygienic design, Cold chain management, Pathogen control technologies*

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INTRODUCTION

The microbiological safety of broiler meat is a priority concern for the food industry because its infection with harmful microorganisms poses a significant danger to human health. As poultry meat becomes more affordable and nutritious, cases of food poisoning caused by *Campylobacter* and *Salmonella* have increased.

In the context of globalization and expanding international trade, food safety requirements are becoming increasingly stringent, searching for effective methods to control microbiological risks more urgent than ever. Nauta *et al.* (2012) note that in the European Union, the development of risk-based microbiological criteria for *Campylobacter* in broiler meat has led to a 20%-30% reduction in the incidence of campylobacteriosis. Their research highlights the need to establish rigorous standards at all stages of production.

Calvo-Fernandez *et al.* (2025) indicate that cooling and modified atmosphere packaging technologies significantly reduce contamination levels, especially in intensive production settings. This confirms that technological innovations play an important role in ensuring product safety.

Safitri and Van Asselt (2024) note differences in microbiological risks between intensive and extensive poultry production systems. The authors show that, despite their high productivity, intensive systems are likely to face contamination problems because of high poultry stocking density (Safitri & Van Asselt, 2024). They underscore the need to adapt control methods to production conditions.

Rauber Kleinübing *et al.* (2025) investigate antimicrobial cryogels based on corn starch with clove essential oil to combat resistant strains of *C. jejuni*. The authors' results show these materials' effectiveness as absorbent pads in meat packaging (Rauber Kleinübing *et al.*, 2025). This work addresses the problem, opens a path for developing new technologies, and highlights strict regulatory requirements as a key factor in improving microbiological safety.

MATERIALS AND METHODS

We conducted the study at a poultry farm specializing in broiler meat production. To assess microbiological safety, we selected meat samples at various stages of the production cycle: after slaughter, cooling, and packaging. 150 samples were analyzed, of which 50 were taken from an intensive production system and 100 from a system using a modified atmosphere.

The samples were subjected to microbiological analysis for *Campylobacter* and *Salmonella* presence, using standard culture methods and PCR diagnostics. To evaluate the effectiveness of antimicrobial packaging materials, we used cryogels containing clove essential oil, developed based on the methodology described by Rauber Kleinübing *et al.* (2025).

Data processing was conducted using a statistical package that allowed us to determine the level of significance of the differences between the groups regarding the level of contamination. The sanitation standards within the production site were closely monitored, considering the water quality utilized in the processing of carcasses and the equipment used within the site. We identified critical control points in accordance with the recommendations of Trevisani *et al.* (2024), which allowed us to evaluate how technological processes affect the microbiological purity of the products.

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RESULTS AND DISCUSSION

We studied the microbiological safety of broiler meat to identify key factors influencing contamination with the pathogenic microorganisms *Campylobacter* and *Salmonella* and to assess the effectiveness of modern control technologies. Microbiological analysis showed that *Campylobacter* contamination in samples from the intensive production system was 32%. This is significantly higher than in samples packaged in a modified atmosphere, where this indicator decreased to 15%.

We detected *Salmonella* contamination in 8% of samples from the intensive farming system and in 3% of samples from the modified atmosphere system. This underscores the importance of using technologies that reduce microbial load. **Table 1** shows the distribution of pathogens by production system for a more detailed analysis of contamination levels.

Table 1. Level of contamination with pathogenic microorganisms in broiler meat samples.

Production system	Sample number	*Campylobacter* (%)	*Salmonella* (%)	Total contamination (%)
Intensive	50	32	8	40
Modified atmosphere	100	15	3	18

Table 1 shows that a modified atmosphere significantly reduces the microbiological burden. Our statistical analysis using Student's t-test revealed significant differences ($P < 0.05$) between groups, confirming the influence of packaging technologies on product safety.

These methods are important steps in improving broiler meat quality, particularly in intensive production systems. We evaluated the effectiveness of antimicrobial packaging materials, such as corn starch-based cryogels with clove essential oil, developed using the methodology described by Rauber Kleinübing *et al.* (2025).

In samples packaged with these materials, *Campylobacter* decreased by 10% compared with the control group with standard polymer packaging. We observed the most pronounced effect during storage; after 7 days at 4°C, microbial load decreased by 24% compared with the control.

These results highlight the potential of antimicrobial materials to extend shelf life and improve product safety. **Table 2** illustrates microbial load dynamics and reflects changes in contamination during storage.

Table 2. Dynamics of *Campylobacter* contamination levels in broiler meat during storage.

Packaging type	Initial level (%)	Day 3 (%)	Day 7 (%)	Decrease in 7 days (%)
Standard	15	14	12	20
Antimicrobial cryogels	15	11	9	40

In our study, antimicrobial cryogels showed a more pronounced reduction in microbial burden than standard packaging. This is especially important when products are transported to distant locations, such as the Krasnodar region (Russia), where new packaging technologies can optimize logistics, reduce delivery times, and minimize spoilage. For perishable crop products, digital coordination has also been proposed to improve traceability and reduce logistical losses (Logachev & Fomin, 2026).

This approach improves product safety and prevents economic losses. By observing sanitary conditions within the production facility, we noted that insufficient equipment cleaning raises the risk of cross-contamination by 12%.

Analysis of water samples used for carcass rinsing showed that 5% contained *Campylobacter*, indicating the need to exercise strict water quality control. These findings support adherence to sanitary standards, as Trevisani *et al.* (2024) emphasized in their research on risk-based meat safety management systems (RB-MSAS). Implementing these systems enables optimal cleaning and disinfection practices, which reduce contamination by 8% during the slaughtering phase.

To analyze the impact of sanitary conditions in depth, we conducted a Hazard Analysis and Critical Control Points (HACCP) assessment. HACCP helped us identify the stages most susceptible to risk. The carcass cooling area proved most vulnerable because high humidity promoted microbial growth. Additional disinfection measures, including ozonated water, reduced *Salmonella* by 5% at this stage. These results underscore the necessity for a comprehensive approach that incorporates technological and organizational measures. We also examined how microbiological safety depends on poultry farming conditions.

Samples from the intensive production system (20 birds/m^2 stocking density) showed higher contamination than the reduced-density system (15 birds/m^2); higher density contributes to pathogen dissemination. Applying biosecurity measures, such as regular disinfection of poultry housing, reduced *Campylobacter* levels by 7% in samples from the slaughter stage.

Table 3 shows contamination levels by growing conditions to assess biosecurity's impact on microbiological purity.

Table 3. Influence of growing conditions on contamination levels in broiler meat.

Growing conditions	Stocking density, birds/m^2	*Campylobacter*, %	*Salmonella*, %	Total contamination, %
Intensive system	20	32	8	40
Reduced density and biosafety	15	25	3	28

Table 3 shows that decreased stocking density, combined with increased biosafety measures, significantly improves product microbiological purity. This confirms the importance of optimizing poultry farming conditions, especially relevant considering growing requirements for food safety in the international market.

We assessed the impact of storage temperature on microbiological stability. Samples stored at 0 °C showed a 15% decrease in *Campylobacter* after 5 days compared with samples stored at 4 °C. These findings clearly indicate the importance of strictly adhering to temperature-control protocols. Despite slight temperature deviations, the antimicrobial cryogels helped maintain result stability, making this technology promising for logistics.

Although antimicrobial packaging materials increased packaging costs by 10%, the 20% reduction in product spoilage losses offset the additional expenses. Investments in novel technologies improve product safety and support economic efficiency.

A comprehensive approach that combines modified atmosphere packaging, antimicrobial packaging materials, and strict observance of sanitary conditions greatly reduces the microbiological load on broiler meat (Kubatbekov *et al.*, 2022; Dzhancharova *et al.*, 2023a; 2023b; Filonova *et al.*, 2024). Our research emphasizes the need to integrate technological and organizational measures to assure product safety. Optimizing cooling-stage procedures and implementing poultry farming biosecurity measures show a synergistic effect, reducing overall contamination by 22%.

We confirmed that modified atmosphere significantly reduces broiler meat's microbiological load, consistent with Calvo-Fernandez *et al.* (2025). As Safitri and van Asselt (2024) note, this is especially important in intensive production systems, where high poultry density increases risk.

As Rauber Kleinübing *et al.* (2025) note, antimicrobial packaging materials, such as clove essence oil containing cryogels, offer broader pathogen-control potential. Preparations from Alnus glutinosa leaves have also shown in vitro activity against a Salmonella test strain (Bazargaliyeva *et al*., 2026). In this context, risk management approaches, including the RB-MSAS proposed by Trevisani *et al.* (2024), are important considerations.

These systems enable identification of critical control points where process optimization is possible throughout all stages of production. Stringent sanitary control reduces cross-contamination, which is especially important in high-volume production. These technologies' effectiveness depends on their proper application.

According to Nauta *et al.* (2012), insufficient standardization of microbiological criteria causes evaluation results to vary. The TRiMiCri model, developed by Seliwiorstow *et al.* (2016), improves risk-assessment accuracy, which is especially important for large farms.

The economic side of implementing innovative technologies is also worth considering. Dzhancharova *et al.* (2024) emphasize that investments in environmentally friendly and safe technologies improve product quality and strengthen competitiveness in the international market. In our case, investments in antimicrobial packaging materials pay off by reducing spoilage losses.

Employee training and changes in production techniques are prerequisites for implementing new technology. Semak *et al.* (2021) note that improving employee qualifications and implementing modern product-quality assessment methods are key to success. A comprehensive strategy that combines technological, organizational, and economic measures ensures a sustainable reduction in microbiological risks.

CONCLUSION

Broiler meat's microbiological safety is a challenge that requires integrating modern technology with strict control at all levels of production. Our findings confirm that modified atmosphere and antimicrobial packaging materials significantly reduce *Campylobacter* and *Salmonella* contamination. This is particularly relevant in intensive production settings, where contamination risks increase because of high poultry density.

We found that risk-based systems, such as RB-MSAS, help optimize control procedures and minimize risks to consumers' health. Minimized product loss and enhanced competitiveness attest to these measures' economic viability. Our study showed that cryogels with clove essential oil reduce the microbial burden by 24% over a week of storage, which demonstrates the innovative potential of this solution.

Strict adherence to sanitary regulations and staff development are essential to implementing novel technologies successfully. We believe future research should focus on creating universal standards and adapting best practices for different production settings. This strategy improves food safety worldwide and guarantees the industry's sustainable growth.

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REFERENCES

Bazargaliyeva, A., Jenis, J., Shybyray, Y., Admanova, G., Kuanbay, Z., Duzelbayeva, S., Sarimbayeva, B., Kaisagaliyeva, G., Alzhanova, B., & Kozhagaliyeva, R. (2026). Phytochemical profiles and antimicrobial activity of Alnus glutinosa (L.) Gaertn. leaves growing in Kazakhstan. *Molecules, 31*(7), 1189. doi:10.3390/molecules31071189

Calvo-Fernandez, C., Takeuchi-Storm, N., Nauta, M., Sandberg, M., & Lassen, B. (2025). Effect of post-chilling processes and modified atmosphere packing on Campylobacter in broiler meat. *Food Control, 171*, 111087. doi:10.1016/j.foodcont.2024.111087

Dzhancharova, G. K., Potekhina, E. V., Tretyak, E. B., Shepelyuk, S. I., & Lebedev, K. A. (2024). Building a knowledge economy in the context of growing international competitiveness. *Relacoes Internacionais no Mundo Atual, 2*, 234-243.

Dzhancharova, G., Kosheleva, A., Drobysheva, N., Pasternak, S., Shelygov, A., & Lebedev, K. (2023b). Economic and legal aspects of foreign economic risks within the framework of sustainable development of Russian enterprises. *Journal of*

Law and Sustainable Development, 11, e317. doi:10.55908/sdgs.v11i3.317

Dzhancharova, T., Rozanova, T., Pasternak, S., Dmitrieva, O., Romanova, A., & Lebedev, K. (2023a). Introduction of economic and legal measures for the development of the ecologization system at an enterprise. *Journal of Law and Sustainable Development, 11*, e972. doi:10.55908/sdgs.v11i7.972

Filonova, A., Zokoev, V., Nesterenko, A., Smirnova, A., & Lebedev, K. (2024). Accounting and legal aspects of environmental policy in the context of globalization. *Relacoes Internacionais no Mundo Atual, 2*, 425-435.

Kubatbekov, T. S., Kosilov, V. I., Semak, A. E., Prosekova, E. A., Belyaeva, N. P., Rakhimzhanova, I. A., & Yuldashbayeva, A. Yu. (2022). Histological structure of the skin of the Simmental breed bulls and Simmental crossbreeds with Red Steppe and Black-and-White cattle. *International Journal of Ecosystems and Ecology Science, 12*, 511-516. doi:10.31407/ijees12.465

Logachev, M., & Fomin, V. (2026). International digital system for collective food security support. *Future Internet, 18*(7), 338. doi:10.3390/fi18070338

Nauta, M. J., Sanaa, M., & Havelaar, A. H. (2012). Risk based microbiological criteria for Campylobacter in broiler meat in the European Union. *International Journal of Food Microbiology, 158*, 209-217. doi:10.1016/j.ijfoodmicro.2012.07.018

Rauber Kleinübing, N., Pacheco da Cruz, E., Martins Fonseca, L., Ramires, T., Schneid Kröning, I., Lopes Crizel, R., Inchauspe Corrêa Alves, P., Hiroyoshi Ossugui, E., Lopes G. V., & Zavareze, E. D. R., et al. (2025). Antimicrobial activity of corn starch cryogels incorporated with clove essential oil (Syzygium aromaticum) against antimicrobial-resistant Campylobacter jejuni: Application as an absorbent pad in broiler meat packaging. *International Journal of Food Microbiology, 442*, 111391. doi:10.1016/j.ijfoodmicro.2025.111391

Safitri, R. A., & Van Asselt, E. D. (2024). Comparison of food safety hazards in pigs and broilers from intensive and extensive production systems: A literature review. *Journal of Food Protection, 87*, 100389. doi:10.1016/j.jfp.2024.100389

Seliwiorstow, T., Uyttendaele, M., De Zutter, L., & Nauta, M. (2016). Application of TRiMiCri for the evaluation of risk based microbiological criteria for Campylobacter on broiler meat. *Microbial Risk Analysis, 2-3*, 78-82. doi:10.1016/j.mran.2016.05.001

Semak, A. E., Kazakova, E. V., Cherepanova, N. G., Prosekova, E. A., & Altunina, Ju. O. (2021). Improving the quality of evaluation of meat products. *Entomology and Applied Science Letters, 8*, 78-84. doi:10.51847/CUMJASGUCH

Trevisani, M., Rosamilia, A., Micheli, M. R., Guidi, E., & Cenci Goga, B. T. (2024). Perspectives in the implementation of risk-based meat safety assurance system (RB-MSAS) in broiler meat production. *Food Control, 160*, 110308. doi:10.1016/j.foodcont.2024.110308