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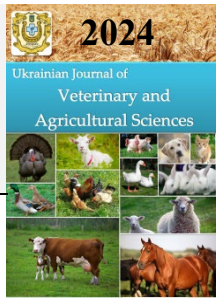

Microbiological analysis of broiler chicken slaughter products using "Subtiform" probiotic and establishment of safety and technological process criteria

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Abstract

Feeding broiler chickens a probiotic biopreparation containing bacteria of the genus *Bacillus subtilis* and *Bacillus licheniformis* leads to improved feed digestion, increased productivity, and immune status, as well as reduced insemination by opportunistic and pathogenic microorganisms of slaughter products. It enhances the level of prevention and treatment of various poultry diseases. The purpose of the work is to carry out a microbiological analysis of the slaughter products of broiler chickens after drinking the probiotic biological preparation "Subtiform" in doses of 0.5 g, 2.0, and 4.0 g per 10 dm^3 of water. The material (major pectoral muscle and internal organs) was examined by bacteriological methods. It was established that the content of MAFAM in the control and experimental groups 1, 2, and 3 of the chilled slaughter products of broiler chickens for 1, 3, and 5 days of storage at a temperature of 0–4 °C was within the limits of standards (no more than 1.0×10^4 CFU/d). It was established that when broiler chickens were given 4.0 g/10 dm^3 of water, the MAFAM content for one day of poultry meat storage decreased by 10.4 % ($P < 0.05$); on the third day of storage, it decreased by 9.6 % ($P < 0.05$); at the beginning of the fifth day of storage, the decrease was, respectively, by 11.3 % ($P < 0.01$) compared to the indicators of the control group. The content of MAFAM in offal, in particular in the heart of broiler chickens, was reduced in experimental group 3 by 36.9 % ($P < 0.001$); in the liver – by 33.6% ($P < 0.001$); in the muscular part of the stomach – by 27.2 % ($P < 0.001$); in the spleen and lungs, there was also a decrease in the content of MAFAM in experimental group 3, respectively, by 20.2 % ($P < 0.01$) and 23.6 % ($P < 0.01$) compared to the indicators of the control group of broiler chickens. It was established that opportunistic pathogenic microorganisms, in particular BGCP, bacteria of the genus *Proteus*, and pathogenic microorganisms, in specific bacteria of the genus *Salmonella*, bacteria of the species *Staphylococcus aureus*, *Listeria monocytogenes* in 25 grams of the large pectoral muscle of broiler chickens and internal organs (heart, spleen, liver, the muscular part of the stomach and lungs) were not detected. According to the results of the conducted research, an adverse effect of the probiotic biopreparation at a dose of 4.0 g/10 dm^3 of water on the development of microorganisms in the large pectoral muscle and internal organs of broiler chickens was established. Therefore, the probiotic "Subtiform" at a dose of 4.0 g/10 dm^3 of water during the drinking of broiler chickens can be recommended to increase productivity and obtain safe slaughter products. The practical value of the work consisted of establishing the microbiological indicators of poultry slaughter products after drinking probiotics, as well as establishing safety criteria and the technological process.

Keywords: poultry; probiotic; slaughter products; bacteriological studies; microbiological indicators; safety criteria; technological process criteria.

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1. Introduction

The relevance of our study was to establish the effect of the probiotic biopreparation Subtiform on the microbiological indicators of the slaughter products of broiler chickens, as well as to establish the criteria for safety and the technological process.

J. Joseph et al. (2023) pointed out that disease resistance in broiler chickens depends on adherence to supply chain control, production technology, slaughter, and storage of slaughter products. The control of several diseases in the broiler population may reduce the mortality of chicks in the first week, thus maintaining the production level and taking into account the continuous monitoring of microorganisms, which is one of the critical control points. For this, it is essential to establish safety criteria and technological process criteria. Scientists also pointed out that probiotics and bacteriophages are the preventive methods of preventing poultry from colibacteriosis, salmonellosis, and other bacterial diseases. Scientists M. A. M. Shaufi et al. (2023) asserted the positive effect of probiotics and their combinations on growth indicators of poultry and intestinal microbiota and

poultry meat during its storage period, in particular, a decrease in the content of mesophilic aerobic and facultatively anaerobic microorganisms by 1.12 % ($P < 0.001$).

According to the requirements of E.U. Regulations No. 1381/2019 (Regarding the transparency and sustainability of risk assessment in the food chain, 2019) and No. 625/2017 of the European Parliament and the Council of the E.U. (Regulation EU No. 625/2017) and Laws of Ukraine "On the basic principles and requirements for the safety and quality of food products" (2023), "On state control over compliance with the legislation on food products, fodder, by-products of animal origin, animal health and welfare" (2023) veterinary medicine inspectors must carry out risk-oriented control of safety indicators, including microbiological indicators, of food products, in particular poultry meat. Official control by veterinary medicine specialists is carried out to gain confidence that the legislation on food products, feed, and rules on the health and welfare of birds for breeding and feeding is being followed, as stated by P. Chaturvedi et al. (2021).

During the slaughter of broiler chickens, the workers of the facility should observe the hygienic requirements of the technological processes to avoid microbiological contamination of the poultry meat, as well as compliance with the requirements for ensuring the well-being of the poultry. Poultry meat must be cooled to 4 °C regardless of packaging and labeled and meet the microbiological criteria for raw poultry meat (Order of the Ministry of Agrarian Policy and Food of Ukraine dated March 27, 2023, No. 625).

A. A. Swelum et al. (2021) indicated that the poultry industry is searching for the use of new methods of combating infectious diseases in connection with the spread of poultry mortality from bacterial infections, in particular escherichia, salmonellosis, which leads to a decrease in productivity and contamination of slaughter products with microflora. Therefore, studies have indicated the usefulness of probiotics in modern poultry farming from 14-day-old broiler chickens. A. Rousseaux et al. (2023) claimed that probiotics were widely used for the prevention and treatment of diseases of infectious etiology.

T. Gunawardana et al. (2022) argued that alternative antibiotics are necessary with the emergence of resistance to antimicrobial drugs in the poultry industry. Their research aimed to establish the immunoprotective effect of synthetic DNA oligodeoxynucleotides and probiotics against *Escherichia coli* infection compared to using antibiotics with a therapeutic effect.

Research by G. A. J. Redweik et al. (2020) indicated bacterial diseases caused by pathogenic serovars Escherichia coli and Salmonella are detected more often in poultry farms growing broiler chickens. Using probiotics increases birds' immunity and improves the response to vaccination; combined treatment is a natural, effective method of reducing *Escherichia coli* and *Salmonella* infection in chickens. L. Zhou et al. (2023) noted that the search for a natural antimicrobial agent should be pursued due to the rapid spread of antibiotic-resistant pathogens. Studies have established a positive effect of the feed additive as an alternative to the antibiotic *Paenibacillus polymyxa* AM20 on increasing the productivity and antioxidant properties of poultry, increasing the growth rate of broiler chickens, and reducing the feed conversion ratio, as well as reducing the number of microorganisms in the intestine and poultry slaughter products.

A. Albrecht et al. (2019) indicated that when using an alternative system of poultry production using corn feed and without antibiotics led to an extension of the shelf life of meat and an improvement in its quality, a decrease in microbiological spoilage under storage conditions at a temperature of 4 °C every two days during storage.

L. Mejia et al. (2021) found that Salmonella contamination of poultry meat was a significant food safety problem because this pathogen can cause severe illness and economic losses worldwide. *Salmonella enterica* in raw poultry meat was established in 38.1 % of samples, and *Salmonella infantis* was the most common serotype, which showed high antibiotic resistance. There is an urgent need to identify *Salmonella* serotypes in food products for comparison with clinical data, conduct epidemiological studies to control the prevention of outbreaks of infections and establish a criterion for the safety of poultry meat. W. Qin et al. (2023) indicated that the probiotic *Lactobacillus reuteri* with bacteriostatic action effectively inhibited the activity of such pathogens as *Salmonella enterica*; in particular, it potentially inhibited Salmonella enterica infection.

W. Pelyuntha and K. Vongkamjan (2023) proved that bacteriostatic agents, in particular bacteriophages, organic acids (propionic acid), and probiotics, were introduced during the processing of poultry meat to combat *Salmonella*, and a logarithmic decrease in the number of *Salmonella* by 4–5 logarithmic units/g on the fifth day of poultry meat storage at a temperature not higher than 4 °C, which led to an improvement in the quality and safety of poultry slaughter products.

E. Bartkiene et al. (2020) indicated that the antimicrobial activity of strains of lactic acid bacteria was established in poultry meat to inhibit antibiotic-resistant species of *Salmonella* spp. Most countries have introduced safety criteria for establishing *Salmonella* in food products concerning the spread of food-borne salmonellosis, particularly in poultry meat. The risk assessment will provide a more thorough approach to the control of raw chicken using microbiological methods as targets linked to the concept of "One Health", considering the consequences for human health should be used throughout the food chain to help establish risk and identify ways to reduce the adverse effect on the health of the average consumer.

S. Bacci et al. (2019) indicated that European legislation regulates risk-based control of biologically hazardous microorganisms in food products. *Escherichia coli* and *Salmonella* were detected in fresh poultry meat, which was stored in refrigerators at sales facilities; in particular, a high prevalence of *Escherichia coli* was observed in poultry products (100 %), other types of meat – in the range from 93.3 to 100 %; *Salmonella* derby and *Salmonella typhimurium* were found in 11.5 % of poultry samples, and *Salmonella typhimurium* in 13.3 % of other meat samples. *E. coli* and *Salmonella* were carriers of antibiotic resistance marker genes.

The purpose of the study is to carry out bacteriological tests of the products of the slaughter of broiler chickens (large pectoral muscle of broiler chickens, heart, spleen, liver, muscle tissue of the stomach, lungs) after drinking the probiotic biological preparation "Subtiform" in different doses and to establish safety criteria and technological process during poultry slaughter.

2. Materials and methods

Microbiological tests were carried out in 2022–2023 in the scientific research bacteriological department of the SSRI for laboratory diagnostics and veterinary-sanitary examination and the accredited research laboratory of the department of veterinary-sanitary examination and laboratory diagnostics of the Institute of Postgraduate Training of Managers and Specialists of Veterinary Medicine of the Bila Tserkva National Agrarian University (Certificate of compliance of the measurement system with the requirements of SSTC ISO 10012:2005 No. 0118 dated April 3, 2023).

The material for the research was samples of the pectoralis major muscle of broiler chickens and internal organs of the bird, in particular the heart, spleen, liver, muscular part of the stomach, and lungs. A control group of 20 broiler chickens was formed, which were not given the probiotic biopreparation "Subtiform" and three experimental groups (20 heads each) – which were given the probiotic biopreparation with water as follows: chickens of experimental group 1 – 0.5 g/10 dm^3, experimental group 2 – 2.0 g/10 dm^3 and experimental group 3 – 4.0 g/10 dm^3. The drug was administered to broiler chickens from 28 to 42 rearing days.

Veterinary-sanitary inspection of broiler chicken carcasses and internal organs was carried out following the requirements of the Rules of pre-slaughter veterinary inspection of animals and veterinary-sanitary examination of meat and meat products (Order of the State Department of Veterinary Medicine No. 28, 2002).

In the pectoral muscles and some internal organs: heart muscles, spleen, liver, muscular part of the stomach, and lungs, a study was conducted on the content of mesophilic aerobic and facultatively anaerobic microorganisms (MAFAM), bacteria of the group of *Escherichia coli* (BGCP coliforms) according to requirements of SSTC 8446:2015 and SSTC 8381:2015, bacteria of the genus *Proteus* – according to the requirements of SSTC 7444:2013, bacteria of the genus *Salmonella* – according to the requirements of SSTC EN/ISO 6579-1:2022, bacteria of the species *Listeria monocytogenes* – according to the requirements of SSTC ISO 11290-1:2003, bacteria of the species *Staphylococcus aureus* – according to the requirements of SSTC SSTC EN ISO 6888-3:2019.

Statistical analysis. The use of certified equipment, modern testing methods, and statistical processing of the obtained results confirmed the research's reliability. Research results were processed using the Microsoft Excel computer program (Maplesoft, 2008). The probability was determined according to the Student's test, considering the significance criteria: $P < 0.05$, $P < 0.01$, $P < 0.001$.

Biological ethics. Experimental studies were conducted according to modern methodological approaches. In compliance with the requirements and national standards, in particular, SSTC ISO/IEC 17025:2019 (2021) and following Directive 2010/63/E.U. (2010), which were approved by the conclusion of the Commission on Ethics and Bioethics of the Faculty of Veterinary of Medicine of Bila Tserkva National Agrarian University dated 04/12/2023. Animals were kept, and all manipulations were carried out following the provisions of the Order of the Ministry of Education and Science, Youth and Sports No. 249, 2012, the European Convention on the Protection of Vertebrate Animals Used for Experimental and other scientific purposes (European convention..., 1998).

3. Results and discussion

3.1. Results

No pathological changes were found during the veterinary and sanitary inspection of broiler chicken carcasses and internal organs. For establishing safety indicators of slaughter products broiler chickens of the experimental groups, which were given the probiotic biopreparation "Subtiform", and the control group, were subjected to bacteriological tests.

According to the bacteriological studies of the large pectoral muscle of the control and experimental groups, which drank the probiotic biopreparation "Subtiform" in different doses: experimental group 1 – 0.5 g/10 dm^3; in experimental group 2 – 2.0 g/10 dm^3; in experimental group 3 – 4.0 g/10 dm^3 of water, the dynamics of insemination by mesophilic aerobic and facultatively anaerobic microorganisms (MAFAM) were established at different times of cooling at a temperature of 0–4 °C. The results are presented in Table 1.

Table 1

Dynamics of the content of MAFAM in the large pectoral muscle of broiler chickens of the control and experimental groups at different times of cooling at temperatures of 0–4 °C (M ± m, n = 6)

Microorganisms	Day of storage	control group (without drinking probiotics)	Experimental groups		
			experimental group 1 (0.5 g/10 dm^3 of water)	experimental group 2 (2.0 g/10 dm^3 of water)	experimental group 3 (4.0 g/10 dm^3 of water)
MAFAM, CFU/g	1	$(1.35 \pm 0.06) \times 10^2$	$(1.30 \pm 0.05) \times 10^2$	$(1.24 \pm 0.05) \times 10^2$	$(1.21 \pm 0.02) \times 10^{2*}$
	3	$(1.36 \pm 0.05) \times 10^2$	$(1.33 \pm 0.06) \times 10^2$	$(1.26 \pm 0.04) \times 10^2$	$(1.23 \pm 0.03) \times 10^{2*}$
	5	$(1.41 \pm 0.04) \times 10^2$	$(1.37 \pm 0.04) \times 10^2$	$(1.28 \pm 0.03) \times 10^{2*}$	$(1.25 \pm 0.02) \times 10^{2**}$

Note: * – P < 0,05; ** – P < 0,01 compared to control indicators

Significant indicators for the content of MAFAM were established for one day of meat storage of broiler chickens in experimental group 3 – a decrease in the content of MAFAM by 10.4 % was established ($P < 0.05$); on the third day of storage in experimental group 3 – a reduction of 9.6 % ($P < 0.05$); at the beginning of the fifth day of storage in experimental groups 2 and 3 – a decrease, respectively, by 9.2 % ($P < 0.05$) and 11.3 % ($P < 0.01$) compared to the indicators of the control group.

During the storage period of breast muscles, the number of mesophilic aerobic and facultatively anaerobic microorganisms gradually increased in all groups and at the beginning of the fifth day reached the level in experimental group 1 – $(1.37 \pm 0.04) \times 10^2$ CFU/g, which by 5.4 % more compared to the indicators of 1 day of storage; experimental

group 2 – (1.28 ± 0.04) × 10^2 CFU/g (P < 0.05), which is 3.2% more compared to the indicators of the first day of storage; experimental group 3 – (1.25 ± 0.02) × 10^2 CFU (P < 0.01), which is 3.3 % more compared to the indicators of the first day of storage. No significant indicators were found for the content of MAFAM in experimental group 1 of the pectoralis major muscle.

At present, the content of MAFAM during the implementation of the established period did not exceed the permissible levels regulated by Ukraine's current regulatory and legal documents – (no more than 1.0 × 10^4 CFU/g) (Rules for pre-slaughter veterinary inspection of animals and veterinary-sanitary examination of meat and meat products, 2002).

So far, it has been established that the content of bacteria of the BGKP group of coliforms (coliform) in 1.0 g of meat, bacteria of the genus *Proteus* in 0.1 g of meat; pathogenic microorganisms, in particular *Salmonella* bacteria, *Staphylococcus aureus* and *Listeria monocytogenes* bacteria in 25 g of breast muscles of broiler chickens of the control and experimental groups during storage for 1, 3 and 5 days at a temperature of 0–4 °C – were not detected.

According to the bacteriological studies of the internal organs of broiler chickens: the heart, spleen, liver, muscular part of the stomach, and lungs, the degree of insemination by mesophilic aerobic and facultatively anaerobic microorganisms (MAFAM) was determined after cooling on the first day of storage at a temperature of 0–4 °C. The results are presented in Table 2.

Table 2

The content of MAFAM in the cooled (0–4 °C) internal organs of broiler chickens of the control and experimental groups after drinking the probiotic biopreparation "Subtiform" after slaughter for one day of cooling, CFU/g (M ± m, n = 6)

Internal organs	Control group (without drinking probiotics)	Experimental groups		
		experimental group 1 (0.5 g/10 dm^3 of water)	experimental group 2 (2.0 g/10 dm^3 of water)	experimental group 3 (4.0 g/10 dm^3 of water)
Heart	(5.56 ± 0.42) × 10^2	(5.50 ± 0.28) × 10^2	(4.37 ± 0.26) × 10^2*	(3.51 ± 0.13) × 10^2***
Liver	(5.60 ± 0.40) × 10^2	(5.56 ± 0.26) × 10^2	(5.12 ± 0.19) × 10^2	(3.72 ± 0.16) × 10^2***
The muscular part of the stomach	(6.25 ± 0.35) × 10^2	(6.17 ± 0.29) × 10^2	(5.33 ± 0.22) × 10^2*	(4.55 ± 0.17) × 10^2***
Spleen	(5.78 ± 0.36) × 10^2	(5.53 ± 0.32) × 10^2	(5.44 ± 0.31) × 10^2	(4.61 ± 0.19) × 10^2**
Lungs	(5.69 ± 0.41) × 10^2	(5.45 ± 0.34) × 10^2	(5.08 ± 0.20)×10^2	(4.35 ± 0.14) × 10^2**

Note: * – P < 0,05; ** – P < 0,01; *** – P < 0,001 compared to control indicators

The lowest content of MAFAM insemination of internal organs was determined for drinking broiler chickens in experimental group 3. With the addition of probiotic biopreparation "Subtiform" to poultry at a dose of 4.0 g per 10 dm^3 of water, these indicators were significant compared to the control group. Thus, the content of MAFAM in the heart of broiler chickens was reduced in experimental group 2 by 21.4 % (P < 0.05) and experimental group 3 by 36.9 % (P < 0.001); the content of microorganisms in the liver decreased in experimental group 3 – by 33.6 % (P < 0.001); in the muscular part of the stomach, the content of MAFAM decreased in experimental group 2 – by 14.7 % (P < 0.05), and in experimental group 3 – by 27.2 % (P < 0.001); in the spleen and lungs, there was also a decrease in the content of MAFAM in experimental group 3, respectively, by 20.2 % (P < 0.01) and 23.6 % (P < 0.01) compared to the indicators of the control group of broiler chickens.

It was established that the content of conditionally pathogenic microorganisms, in particular, BGCP (coliform) in 1.0 g, bacteria of the genus *Proteus* in 0.1 g, and pathogenic bacteria, in particular bacteria of the genus *Salmonella*, bacteria of the species *Staphylococcus aureus*, and *Listeria monocytogenes* in 25 g of internal organs, was not detected.

Therefore, studies have established that using the probiotic biopreparation "Subtiform" in the proposed doses hurts the development of microorganisms during the bird's life and in the slaughter products. Therefore, they are safe and suitable for human consumption.

Our researchers analyzed to establish the safety criteria for broiler chickens' raw meat and the technological process's hygienic criteria. According to the requirements of the E.U. Regulation No. 2073/2005 "On microbiological criteria" and the Order of the Ministry of Health of Ukraine dated 19.07.2012 No. 548 "On the approval of microbiological criteria for establishing food safety indicators", the tests established the safety criteria of raw meat of broiler chickens. According to the defined sample selection plan, five samples taken from a batch of raw poultry meat (n = 5) were tested for the presence of *Salmonella typhimurium* and *Salmonella enteritidis* following the requirements of SSTC EN/ISO 6579-1:2022. According to the results of the tests, Salmonella typhimurium and Salmonella enteritidis were not detected in 25 g of raw broiler chicken meat.

The stage at which it is recommended to apply the established indicator – raw meat of broiler chickens that were in circulation after slaughter: storage in a refrigerated state during their shelf life of no more than five days at a temperature from 0 to 4 °C in wholesale bases, refrigerators at capacities, supermarkets, shops, restaurant business establishments. To control compliance with the safety criterion, patented express, and optimized test methods have been developed, which should be used in the CCP (critical control point) to establish the freshness of broiler chicken meat and compliance with sanitary and hygienic requirements at this stage of meat cooling.

The tests established the hygienic criteria of the technological process on the first day after the slaughter of broiler chickens after skin removal and removal of internal organs, but before cooling. According to the defined sampling plan, 50 samples (including the neck skin of carcasses) taken from a batch of broiler chicken carcasses after slaughter (n = 50), and the number of sampling units 5 (c = 5) were tested for the presence of *Salmonella* spp. (SSTC EN/ISO 6579-1). When detecting *Salmonella* spp. Isolates should be further serotyped for *Salmonella typhimurium* and *Salmonella enteritidis* to verify compliance with the microbiological criteria for the safety of poultry meat.

According to the results of the tests, *Salmonella typhimurium* and *Salmonella enteritidis* were not detected in 25 g of the combined meat sample of broiler chickens. The stage at which it is recommended to apply the established indicator is after the slaughter of broiler chickens, after removing the skin and the internal organs, but before cooling at temperatures within (0–4) °C and/or freezing. Upon detection of these microorganisms, i.e., establishing unsatisfactory results, it is necessary to improve the hygiene of the slaughter of broiler chickens and review the veterinary and sanitary measures to control the technological process, the origin of the animals, and biological safety measures at the poultry breeding facilities.

Therefore, the meat carcasses of broiler chickens and internal edible organs (heart, liver, muscular part of the stomach), which were drunk with water during the prescribed period of the probiotic biological preparation "Subtiform" in recommended doses, according to microbiological indicators, in particular, the content of MAFAM and the absence opportunistically pathogenic (BGCP, Proteus) and pathogenic (*Salmonella, Staphylococcus aureus, Listeria monocytogenes*) microorganisms, are safe in terms of microbiological indicators during the refrigerated storage period and are allowed to be sold in the retail network to ordinary consumers.

3.2. Discussion

Gunjan et al. (2022), one of the problems in the world is the detection of excessive use of antibiotics and resistance to antimicrobial drugs; therefore, the use of probiotics in animal husbandry is currently relevant. M. Alagawany et al. (2018) established by research that in addition to the fact that probiotics improve the quality of meat of broiler chickens, they are also used to combat infectious diseases of poultry, taking into account the mechanism of their action and the selection of probiotic strains and their importance as a feed additive to increase productivity and reduction of microorganism contamination of slaughter products.

As pointed out by scientists R. P. Pandey et al. (2024), probiotics are widely used in poultry farming, which provides an opportunity to improve the health of poultry, obtain safe and high-quality slaughter products, and ensure proper control of microbiological criteria and technological processes criteria during poultry farming according to E.U. Regulation No. 2073/2005. Our studies coincided with the indicators of the studies of these scientists for the establishment of a decrease in the content of mesophilic aerobic and facultatively anaerobic microorganisms in the meat of broiler chickens after drinking the probiotic biopreparation "Subtiform in a dose of 4.0 g/10dm^3 of water, in particular by 11.3 % ($P < 0.01$) compared to the indicators of the control group, as well as no detection of BGCP, Proteus bacteria and pathogenic microorganisms in meat and poultry offal, in particular *Salmonella* bacteria, *Staphylococcus aureus*, *Listeria monocytogenes* bacteria.

Scientists O. M. Chechet et al. (2022) claimed that the use of the synbiotic drug "Biomagn" in combination with the disinfectant "Diolid" had a positive effect on the quantitative composition of microflora in slaughter products, in particular, a decrease in the content of MAFAM in the meat of broiler chickens by 8.2 % ($P < 0.001$), slaughter products – in 25.6 % ($P < 0.001$) compared to the indicators of the control group. These test data coincided with our obtained indicators – the decrease in the content of MAFAM in the pectoralis major muscle amounted to 9.2 % ($P < 0.05$) and 11.3 % ($P < 0.01$) compared to the indicators of the control group in the offal, the content of MAFAM after one day of storage in the 3rd experimental group decreased from 20.2 % ($P < 0.01$) to 36.9 % ($P < 0.001$) compared to the indicators of the control group of broiler chickens. However, a slight gradual increase in the content of MAFAM in the sizeable pectoral muscle from the first day to the beginning of the fifth day of refrigerated storage at a temperature of (0–4) °C was found in the control and experimental groups, but the indicators were not significant.

A. A. Kit et al. (2019) indicated that no bacteria of the genus Proteus and bacteria of the genus *Salmonella*, bacteria of the species *Listeria monocytogenes*, and *Staphylococcus aureus* of the coagulase-positive staphylococcus aureus were detected in the poultry meat sold during the fair events, and the BHCP were within the limits of regulations. These data were correlated with our research results. Scientists T. I. Fotina et al. (2016) in their research established the need to monitor the causative agents of food toxicosis and toxic infections at broiler chicken breeding facilities for the implementation of a system of analysis of dangerous factors (HACCP system), in particular microbiological – *Escherichia coli, Listeria monocytogenes, Salmonella, Staphylococcus aureus*, etc.

To prevent the occurrence of poultry diseases, permanent procedures should be applied at broiler chicken breeding and production facilities: GVP – proper control of poultry health by veterinary medicine specialists; GMP – good manufacturing practice regarding compliance with technological processes; GHP – good hygienic practice regarding compliance with sanitary and hygienic requirements; GLP – good laboratory practice for compliance with standards for detection of microorganisms, reliability of tests.

4. Conclusions

During refrigerated broiler chicken carcasses storage, the MAFAM content in the sizeable pectoral muscle gradually increased slightly in all groups from day 1 to the beginning of day 5. It reached the level in experimental group 1 – $(1.37 \pm 0.04) \times 10^2$ CFU/g, experimental group 2 – $(1.28 \pm 0.04) \times 10^2$ CFU/g, experimental group 3 – $(1.25 \pm 0.02) \times 10^2$ CFU, which did not exceed the standards. In the pectoralis major muscle of experimental group 3 (4.0 g/10 dm^3) for one day of storage, the MAFAM content decreased by 10.4 %, on the third day of storage – by 9.6 %, at the beginning of the fifth day – by 11.3 % compared to the indicators of the control group. The content of MAFAM in internal organs was the lowest in experimental group 3 – from $(3.51 \pm 0.13) \times 10^2$ to $(4.61 \pm 0.19) \times 10^2$ CFU/g compared to the indicators of the control group. The content of bacteria of the group *Escherichia coli* BGCP (coliform) in 1.0 g, bacteria of the genus *Proteus* in 0.1 g; pathogenic microorganisms, in particular bacteria of the genus *Salmonella*, bacteria of the species *Staphylococcus aureus* and *Listeria monocytogenes* in 25 g of breast muscles of broiler chickens during storage for 1, 3 and 5 days and internal organs for one day of control and experimental groups at temperatures of 0–4 °C – not detected. It is necessary to establish safety criteria and technological processes during the slaughter of broiler chickens and the laying of slaughter products for cooling. Slaughter products of broiler chickens (carcasses, heart, liver, muscular part of the stomach), which during the established period drank the probiotic

biopreparation “Subtiform” with water in the recommended doses of 0.5 g, 2.0, 4.0 g/dm^3 for microbiological indicators, in particular the content of MAFAM, are allowed to be sold in the retail network during the refrigerated storage period.

Conflict of interest

The author claim no conflicts of interest.

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