НАУКОВІ ГОРИЗОНТИ

Засновник, редакція, видавець:
Поліський національний університет

Рік заснування: 1998

Рекомендовано до друку та поширення
через мережу Інтернет Вченою радою
Поліського національного університету
(протокол № 7 від 28 лютого 2024 року)

Рішення національної ради України
з питань телебачення і радіомовлення № 1533.
Ідентифікатор медіа - R30-01593

Науковий журнал включено до категорії А Переліку наукових фахових видань України,
у яких можуть публікуватися результати дисертаційних робіт на здобуття наукових ступенів доктора та кандидата ветеринарних, економічних, сільськогосподарських і технічних наук зі спеціальностей: 051 – Економіка; 071 – Облік і оподаткування; 072 – Фінанси, банківська справа та страхування; 073 – Менеджмент; 075 – Маркетинг; 076 – Підприємництво, торгівля та біржова діяльність; 101 – Екологія; 133 – Галузеве машинобудування; 201 – Агрономія; 202 – Захист і карантин рослин; 203 – Садівництво та виноградарство; 204 – Технологія виробництва і переробки продукції тваринництва; 205 – Лісове господарство; 206 – Садово-паркове господарство; 208 – Агроінженерія; 211 – Ветеринарна медицина (наказ МОН України № 1166 від 23 грудня 2022 р.)

Журнал представлено у міжнародних наукометричних базах даних, репозитаріях та пошукових системах: Інституційний репозитарій Поліського національного університету, AGRICOLA, CAB Abstracts and Global Health (CABI), Open Academic Journals Index (OAJI), Scopus, Index Copernicus, Реєстр наукових видань України, Національна бібліотека України імені В. І. Вернадського, Crossref, Directory of Open Access Journals (DOAJ), ERIH PLUS, MIAR, International System for Agricultural Science and Technology (AGRIS)

Адреса редакції:
Поліський національний університет
10008, б-р Старий, 7, м. Житомир, Україна
E-mail: info@sciencehorizon.com.ua
https://sciencehorizon.com.ua/uk

SCIENTIFIC HORIZONS

Founder, Editorial and Publisher:
Polissia National University

Year of foundation: 1998

Recommended for printing and distribution
via the Internet by the Academic Council
of Polissia National University
(Minutes No. 7 of February 28, 2024)

Decision of the National Council
of Television and Radio Broadcasting of Ukraine No. 1533.
Media identifier – R30-01593

The scientific journal is included in category A of the List of scientific professional publications of Ukraine, in which the results of dissertations for the degree of doctor and candidate of veterinary, economic, agricultural, and technical sciences can be published in the following specialties: 051 – Economy; 071 – Accounting and Taxation; 072 – Finance, Banking and Insurance; 073 – Management; 075 – Marketing; 076 – Entrepreneurship, Trade and Exchange Activities; 101 – Ecology; 133 – Sectoral Engineering; 201 – Agronomy; 202 – Plant Protection and Quarantine; 203 – Horticulture and Viticulture; 204 – Technology of Production and Processing of Livestock Products; 205 – Forestry; 206 – Park and Gardening Management; 208 – Agricultural Engineering; 211 – Veterinary Medicine (Order of the Ministry of Education and Science of Ukraine No. 1166 of December 23, 2022)

The journal is presented international scientometric databases, repositories and scientific systems: Institutional Repository of Polissia National University, AGRICOLA, CAB Abstracts and Global Health (CABI), Open Academic Journals Index (OAJI), Scopus, Index Copernicus, Register of Scientific Publications of Ukraine, Vernadsky National Library of Ukraine, Crossref, Directory of Open Access Journals (DOAJ), ERIH PLUS, MIAR, International System for Agricultural Science and Technology (AGRIS)

Editors office address:
Polissia National University
10008, 7 Staryi Bvld., Zhytomyr, Ukraine
E-mail: info@sciencehorizon.com.ua
https://sciencehorizon.com.ua/en

НАУКОВІ ГОРИЗОНТИ

Том 27, № 3 2024

НАУКОВИЙ ЖУРНАЛ
Засновано 12 березня 1998 р.
Періодичність випуску: дванадцять разів на рік

SCIENTIFIC HORIZONS

Journal homepage: https://sciencehorizon.com.ua
Scientific Horizons, 27(3), 9-22

UDC 636.52/.56.053.09:637.5:615.324
DOI: 10.48077/scihor3.2024.09

Effect of probiotic biopreparation on fatness, organoleptic, and chemical parameters of broiler chicken meat

Alona Bogatko
Postgraduate Student
Bila Tserkva National Agrarian University
09117, 8/1 Soborna Sq., Bila Tserkva, Ukraine
https://orcid.org/0000-0001-8089-5884
Nadiia Bogatko*
Doctor of Veterinary Sciences, Professor
Bila Tserkva National Agrarian University
09117, 8/1 Soborna Sq., Bila Tserkva, Ukraine
https://orcid.org/0000-0002-1566-1026
Nataliia Bukalova
PhD in Veterinary Sciences, Associate Professor
Bila Tserkva National Agrarian University
09117, 8/1 Soborna Sq., Bila Tserkva, Ukraine
https://orcid.org/0000-0003-4856-3040
Vasyl Lyasota
Doctor of Veterinary Sciences, Professor
Bila Tserkva National Agrarian University
09117, 8/1 Soborna Sq., Bila Tserkva, Ukraine
https://orcid.org/0000-0002-2442-2174
Svitlana Tkachuk
Doctor of Veterinary Sciences, Professor
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0000-0002-6923-1793

Article's History:
Received: 10.08.2023
Revised: 24.01.2024
Accepted: 28.02.2024

Abstract. The relevance of this study was to use the probiotic biopreparation Subtiform in the production of broiler chickens to increase productivity and improve the organoleptic and chemical characteristics of poultry slaughter products. The purpose of this study was to determine the effect of a probiotic biopreparation on the fatness of broiler chickens, the chemical composition of meat and chemical parameters using the developed patented express and optimised methods. The following methods

Suggested Citation:
Bogatko, A., Bogatko, N., Bukalova, N., Lyasota, V., & Tkachuk, S. (2024). Effect of probiotic biopreparation on fatness, organoleptic, and chemical parameters of broiler chicken meat. *Scientific Horizons*, 27(3), 9-22. doi: 10.48077/scihor3.2024.09.

*Corresponding author

were used: physical, organoleptic, chemical. It was found that the use of *Bacillus subtilis* and *Bacillus licheniformis* (2.5×10^9 CFU/g) with whey powder filler increased productivity, specifically, the live weight of broiler chickens increased by 4.02% ($P<0.001$) when fed at a dose of 2.0 g/10 dm^3 of water and by 4.75% ($P<0.001$) in experiment 3 compared to the control group. An increase in indicators in the experimental group 3 was found, namely, the average daily weight gain of carcasses – by 8.33% ($P<0.001$); total weight of the bird carcass and neck giblets – by 26.48% ($P<0.001$); weight of internal fat – by 1.89 times ($P<0.001$) compared to the control. Statistical significance ($P<0.001$) was also found in the increase in the weight of internal organs (stomach, liver, heart, adrenal gland) in experimental groups 2 and 3 compared to the control. The improvement in organoleptic and tasting characteristics of poultry meat and meat broth after feeding the probiotic preparation, specifically in experimental group 3, was summarised. The obtained quantitative and qualitative chemical parameters using express and optimised methods indicated the freshness of broiler chickens meat at (0-4)°C cooling, at which it is allowed to sell poultry carcasses up to 5 days, of control and experimental groups 1, 2, 3. The practical value of this study lies in the use of a probiotic biopreparation by veterinary specialists at broiler chick production facilities to increase the productivity of broiler chickens and improve the quality and safety of their slaughter products

Keywords: probiotic; poultry fatness; chemical composition of meat; qualitative and quantitative indicators; express and advanced methods

INTRODUCTION

The relevance of this study lies in determining the effect of the probiotic biopreparation on the fattening of broiler chickens, as well as on organoleptic, tasting, and chemical parameters. S.L. Weimer *et al*. (2018) noted that in European countries, in the production of broiler chicken meat, the search for probiotic preparations is carried out to satisfy food market operators with intensive poultry rearing technology and obtain high quality and safety indicators of meat and slaughter products. P. Chaturvedi *et al*. (2021) noted that probiotics are an alternative to preventing the use of antibiotics in animal feeding, as antibiotic resistance is emerging, which should be assessed for their toxicity levels when investigating them in the environment and in animals, and to identify potential hazardous risks to human health and the environment.

When broiler chickens were fed the probiotic preparation of *Bacillus subtilis* (10^6 CFU/g) for 6 weeks, an increase in the average weight of the poultry group was determined by 17.19% as early as in the 5th week compared to the control group ($P<0.05$). According to Y. Dong *et al*. (2020), research findings indicated that the probiotic preparation of *Bacillus subtilis* can be used instead of antibiotics to stimulate the growth of poultry, improve immunity, and increase resistance to infectious diseases of poultry. The positive effect of probiotic preparations containing *Clostridium butyricum* (6×10^9 CFU/g) and *Enterococcus faecalis* (2×10^{10} CFU/g) on animal productivity, increase in final weight, increase in average daily gain and feed conversion was established (Wang *et al*., 2019). EU legislation prohibits the use of various antibiotics in poultry feeding. Thus, when a probiotic containing *C. butyricum* was used in the feeding of broiler chickens, poultry productivity increased due to improved morphological characteristics of blood and internal organs and stimulation of immune development.

M.E. Abd El-Hack *et al*. (2020) point out that strict regulatory parameters for the use of antibiotics in poultry feed have been introduced. Therefore, the use of *Bacillus subtilis*, the most popular bacterium, is an alternative to the use of industrial feed for poultry, specifically, it increases immunity, improves productivity, organoleptic characteristics, and the chemical composition of broiler chickens. In the context of the development of intensive technologies for raising broiler chickens, it is necessary to feed them with high-quality probiotic preparations that have inhibitory properties against opportunistic and pathogenic strains of microorganisms and viruses. For fifteen years, H.H. Xiong (2023) has been searching for an alternative use of probiotic preparations that affect the increase in the productivity of animals and poultry due to the effect on antioxidant activity and immunological status. All this indicated an increased resistance of poultry and animals to the effects of opportunistic and pathogenic microorganisms, which is supported by the findings of J. Choi *et al*. (2023).

K. Queenan *et al*. (2022) noted that the use of developed and implemented probiotics in the field of broiler chickens is caused by the growing problem of antibiotic-resistant microorganisms. Therefore, in broiler production, it is necessary to implement food safety and quality control systems for broiler chickens, including traceability systems and hazard analysis systems at critical control points, and to consider the health of the bird, quality feeding, and environmental sustainability. According to C.J. Savelli *et al*. (2021), the Food Safety, Health and Welfare Management System for Poultry regulates risk-based controls related to the safe feeding of animals and poultry during the rearing and production of slaughter products, as well as the establishment of critical control points in the food and feed chains. Food market operators in the production of broiler chickens ensure a new formation of international legislation on

the production of safe poultry products under the supervision of a veterinary specialist, including the use of probiotic preparations in the poultry feeding ration.

Thus, the use of the new probiotic Subtiform preparation is highly relevant for the development of poultry production in Ukraine and the provision of safe food products to ordinary consumers. The purpose of this study was to determine the effect of the probiotic biopreparation on the fatness of broiler chickens, the chemical composition of meat, and chemical parameters using the developed patented express and optimised methods.

THEORETICAL OVERVIEW

C. Chen *et al*. (2020) found that the development of modern poultry farming in foreign countries is based on the use of optimised technological processes for the production, processing, and circulation of broiler meat. Pasture and free-range systems have become the most popular for the production of broiler chickens. However, according to R.E. Jeni *et al*. (2021), there are still problems associated with exposure to microorganisms and their foodborne pathogens in these environments, and therefore, probiotics should be allowed in the poultry diet as feed additives to improve food safety and poultry health by reducing pathogens and improving the production of quality meat.

T.M. Mohamed *et al*. (2022) indicated that when poultry were fed the main diet containing the *Bacillus subtilis* probiotic (5×10^8 CFU/g), the average daily weight gain of broiler chickens and the weight of internal organs increased. The organoleptic and chemical characteristics of the meat were also improved. The use of the probiotic preparation *Bacillus amyloliquefaciens* LFB112 in broiler poultry production resulted in higher live weight and average daily gain, lower feed conversion rate compared to the control group (without the addition of the probiotic), and a decrease in fat content. As reported by M. Ahmat *et al*. (2021), the immune status of poultry also increased during poultry rearing. L. Zhang *et al*. (2021) noted that the addition of 1% probiotics (*L. casei*, *L. acidophilus* and *Bifidobacterium*) to broiler chickens' water had a positive effect on growth performance, carcass characteristics, including the determination of the first category of poultry, immune function and antioxidant capacity in poultry, a decrease in the total number of E. coli and Salmonella, and an increase in the number of lactobacilli ($P<0.05$).

L. Jacobs *et al*. (2020) state that the safety of water for broiler chickens should be considered when feeding probiotics to poultry. It is necessary to follow sanitary and hygienic requirements for watering them, as well as to test the microbiological parameters of the water, as these criteria affect the health and welfare of poultry, as well as their productivity. According to F.V. Baba and Z. Esfandiari (2023), the use of probiotics in broiler production is an urgent issue in that it prevents the occurrence of diseases of infectious aetiology, normalises the composition of the microflora in the intestine, increases poultry fatness, quality, and safety of meat and offal, and prevents the biological risk of diseases in broiler chickens. F.U. Memon *et al*. (2022) found that the safety and quality of broiler chicken meat depends on the health of the poultry, on the safety and quality of feed, and therefore feed should be monitored for toxins produced by harmful microorganisms, specifically *Aspergillus fumigates, Stachybotrys alternans*, *Aspergillus flavus*, etc. Therefore, stabilising the balance of the poultry intestines with the use of probiotics is crucial in terms of poultry disease resistance and the production of high-quality and safe products.

The feeding of broiler chickens with probiotic preparations can reduce the incidence of infectious gastrointestinal diseases, leading to increased poultry productivity and improved quality and safety of poultry meat (Abdulkhaliq & Sabow, 2023). Additionally, it can increase the weight of muscle tissue, improve the taste of meat broth and cooked meat, and enhance the chemical composition of meat, particularly its energy value (caloric content).

N.R. Wani *et al*. (2023) noted that feeding probiotics to broiler chickens for up to 42 days of rearing not only increases their productivity, i.e., an increase in carcass weight, an increase in absolute and average daily gain, a decrease in feed inversion, but also improves the chemical composition of poultry meat, which satisfies ordinary consumers with useful nutrients that are easily absorbed by the body. According to P. Chaturvedi *et al*. (2021), the key issue nowadays is the use of probiotics in poultry farming to prevent and treat gastrointestinal infections of bacterial and viral aetiology, increase poultry fatness, normalise intestinal microflora in dysbiosis of various origins. G. Delgado-Pando *et al*. (2019) found high efficiency in the use of probiotics from the *Bacillus* genus for the prevention and treatment of staphylococcal and salmonellosis infections.

To more effectively determine the quality of poultry meat and fat, including its freshness, scientists are developing rapid and optimised methods. Thus, W. Yao *et al*. (2021) developed and implemented a method for the identification of volatile substances (aldehydes, esters, volatile fatty acids) in broiler chicken meat processing by determining the aroma via ion mobility spectrometry with gas chromatography in free space over steam (HS-GC-IMS). Y. Wang *et al*. (2019) found that the use of probiotic preparations in broiler poultry farming increases their productivity, namely carcass weight gain, safety, and quality of meat and offal, which provides the average consumer with nutrients that are quickly absorbed.

MATERIALS AND METHODS

In 2021-2023, at the Skybynetska Poultry Farm LLC in the village of Skybyntsi, Tetiiv district, Kyiv region,

a study was conducted on the 42nd day of slaughter of broiler chickens of the COBB-500 cross at the end of rearing of the control group, which was not fed with probiotic, and experimental groups 1, 2, 3, which were fed from 28 days to 42 days with the probiotic biopreparation Subtiform in doses, respectively: 0.5, 2.0, and 4.0 g/10 dm^3 of water per 20 birds in a cage. The probiotic biopreparation is a symbiotic preparation manufactured at the Biotechnology Centre of Ukraine, Vinnytsia region, Ukraine, containing bacteria of the genus *Bacillus subtilis* and *Bacillus licheniformis* (2.5×10^9 CFU/g) and whey powder.

The study was conducted in the accredited research laboratory of the Department of Veterinary and Sanitary Expertise and Laboratory Diagnostics of Bila Tserkva National Agrarian University, as well as in the research chemical and toxicological department of the State Research Institute of Laboratory Diagnostics and Veterinary and Sanitary Expertise.

Investigation of carcass fatness indicators of broiler chickens. In the experimental groups of poultry, when fed in different doses, the effect of the probiotic biopreparation on the fattening of broiler chickens carcasses was investigated, namely their live weight at the beginning and end of the experiment; absolute weight gain; average daily weight gain; total weight of the bird carcass, including the neck; weight of the carcass without internal organs; weight of internal fat of the bird carcass; weight of internal organs (stomach, liver, heart, adrenal gland) according to generally accepted methods (Bogatko, 2019).

Investigation of organoleptic and tasting characteristics of broiler chicken meat. After slaughtering broiler chickens, carcass samples in the amount of 6 pieces from each control and experimental groups were subjected to tests for organoleptic parameters, specifically the appearance of carcasses, degree of plumage removal, skin condition, condition of the bone system, muscle consistency, colour of muscle tissue, skin colour, colour of subcutaneous and internal adipose tissue, odour on the surface of the carcass and near the bones, cooking test for assessing the quality of meat broth (DSTU 3143:2013, 2014), and the tasting characteristics of meat broth and cooked meat were determined according to a 5-point scale for evaluating each of the indicators (DSTU 4823.2:2007, 2009).

Study of the chemical composition of broiler chicken meat. Chemical composition of broiler chickens: the mass fraction of moisture was determined by mixing a homogenised meat sample at 25°C with sand and drying it at (103±2)°C, and then calculating it using the formula (DSTU ISO 1442:2005, 2008); mass fraction of solids by calculating the difference from 100% and the mass fraction of water; mass fraction of fat by boiling the meat sample with dilute hydrochloric acid until the bound and unbound lipid fractions are released, filtering the resulting mass, drying, and extracting the fat remaining on the filter with n-hexane or petroleum ether, and then calculating it according to the formula (DSTU ISO 1443:2005, 2008); the mass fraction of protein by the Kjeldahl method, considering the conversion factor for the mass fraction of nitrogen to the mass fraction of protein (DSTU ISO 937:2005, 2007); the mass fraction of ash by determining the mass of the residue after burning the meat sample and then piercing it, and subtracting the mass fraction of crude ash in percentage according to the formula (DSTU ISO 936:2008, 2008); carbohydrate content by subtracting the sum of the mass fractions of protein, fat, and ash from the mass fraction of dry matter, and energy value by determining the energy value by calculating the formula of already known nutritional data (mass fractions of protein, carbohydrates and fat) using energy value coefficients (4.0, 9.0).

Study of chemical parameters of fat and meat of broiler chickens. The chemical parameters of fat and meat of broiler chickens were also determined, namely: the acid number of fat by extracting a sample of meat with an alcohol-benzene mixture and subsequent titration of free fatty acids in the presence of phenolphthalein indicator and subtraction in mg of potassium hydroxide (Utility model patent No. 147314, 2021); fat peroxide number by extracting the fat sample with solutions of a mixture of ice-cold acetic acid and chloroform, potassium iodide solution and subsequent titration of free iodine and subsequent titration with sodium hyposulphite and calculation using the formula in % iodine (Utility model patent No. 147145, 2021); the reaction of the fat sample with neutral red to detect colour change and determine freshness (Utility model patent No. 147144, 2021); Nesler's number using the Nesler reagent and colour change from greenish yellow to intense orange depending on the degree of freshness of the meat (Utility model patent No. 147313, 2021); copper sulphate reaction by precipitation of enzymatic hydrolysis products of proteins accumulated during autolytic decomposition of meat and transferred to the broth during cooking (DSTU 8253:2015, 2017); content of volatile fatty acids by their isolation by water vapour distillation and determination of their mass fraction by titration with sodium hydroxide and calculation according to the formula in mg *KOH*/g(Utility model patent No. 152944, 2023); ammonia content and ammonium salts formed as a result of autolysis of meat, to form yellow-brown mercuric iodide with Nesler's reagent (DSTU 8253:2015, 2017); the optical density of the meat and water extract by the photometric method for the extraction of the meat and water extract with Nessler's reagent using the FEC-3 photoelectrocolourimeter (Utility model patent No. 147315, 2021); *pH* value according to the ionometric method by extracting the meat sample with distilled water, and measuring the ion concentration using an AI ionometer (DSTU ISO 2917-2001, 2003); ammonia nitrogen content by treatment with sodium hydroxide solution in the presence of phenolphthalein

indicator and subsequent calculation in mg according to the formula (Utility model patent No. 153118, 2023); hydrogen sulphide presence by its interaction with lead acetic acid (BM 12.3-2).

Statistical analysis. The reliability of the study was confirmed by the use of certified equipment, modern test methods, and statistical processing of the results. Statistical processing of the research results was conducted using the computer program "Microsoft Excel" (Maplesoft, 2008). The probability was determined according to the Student's t-test, considering the statistical significance criteria: P<0.05, P<0.01, P<0.001.

Biological ethics. Experimental studies were conducted following modern methodological approaches and the requirements and national standards, namely DSTU ISO/IEC 17025:2019 (2021) and Directive 2010/63/EU (2010), which were approved by the conclusion of the Ethics and Bioethics Commission of the Faculty of Veterinary Medicine of Bila Tserkva National Agrarian University dated 12 April 2023. Animal husbandry and all manipulations were performed following the provisions of the Procedure for conducting tests and experiments on animals by scientific institutions (Law of Ukraine No. 249, 2012), and of the European Convention for the protection of vertebrates used for experimental and other scientific purposes (1986).

RESULTS

The results of the study of carcass fatness of broiler chickens in the control and experimental groups 1, 2, and 3 when fed the probiotic biopreparation Subtiform at doses of 0.5 g/10 l, 2.0 g/10 l, and 4.0 g/10 l, including the live weight of broilers at the beginning and end of the experiment are presented in Figure 1.

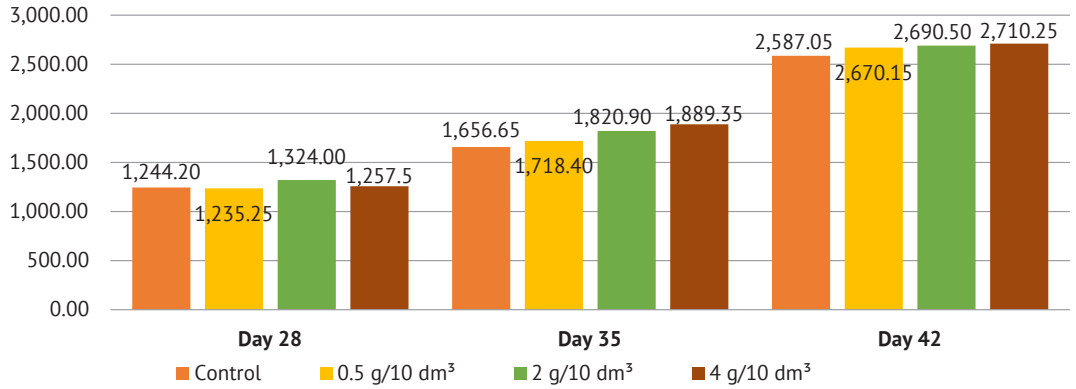

Figure 1. *Weight of broiler chickens at the beginning and end of the experiment with probiotic feeding, g (M±m, n=20)*
Source*: developed by the authors of this study based on the data obtained*

The obtained results suggest that at the beginning of the study, the live weight of broiler chickens with the use of probiotic at a dose of 0.5 g/10 dm³ of water increased by 1.69% (P<0.001), in experimental groups 2 and 3, these indicators also increased, respectively, by 6.19% (P<0.001) and 1.13% (P<0.001) compared to the control. At the end of the experiment, the live weight of broiler chickens increased: in experiment group 1 – by 0.27% (P<0.001), in experiment group 2 – by 4.02% (P<0.001), and in experiment group 3 – by 4.75% (P<0.001) compared to the control, which indicated high feed digestibility when feeding the probiotic biopreparation at 4.0 g/10 dm³ of water per 20 birds in a cage. The results of broiler chickens fattening, namely: absolute weight gain, average daily weight gain, total weight of the bird carcass, neck weight, carcass weight without internal organs, internal fat weight of the bird carcass, weight of internal organs (stomach, liver, heart, adrenal gland) are presented in Table 1.

Table 1. *Results of fattening of broiler chickens and carcass weight, internal organs for the use of probiotic biopreparation on Day 35 of poultry rearing, M±m, n=6*

Indicators	Control	Group 1 (0.5 g/10 l of water)	Group 2 (2.0 g/10 l of water)	Group 3 (4.0 g/10 l of water)
Absolute growth, g	1,343±2.22	1,329±2.44***	1,370±2.89***	1,453±2.38***
Average daily carcass weight gain, g	96±0.21	97±0.20***	98±0.23***	104±0.29***
Feed consumption per 1 kg of weight gain, kg	16.86±0.17	16.68±0.18	16.35±0.19*	15.42±0.16***
Total weight of the poultry carcass, with neck, g	1,945±2.44	1,972±2.21***	2,425±2.44***	2,460±2.21***
Carcass weight without internal organs, g	1,645±2.54	1,704±1.83***	2,075±2.89***	2,080±2.43***

Table 1. Continued

Indicators	Control	Group 1 (0.5 g/10 l of water)	Group 2 (2.0 g/10 l of water)	Group 3 (4.0 g/10 l of water)
Weight of internal fat of poultry carcass, g	13.09±0.02	13.58±0.01***	17.00±0.02***	24.70±0.02***
Stomach weight without contents, g	31.06±0.01	31.19±0.01***	32.24±0.01***	40.75±0.01***
Liver weight, g	46.28±0.03	46.62±0.04***	57.67±0.03***	62.24±0.04***
Heart weight, g	10.51±0.02	10.62±0.01***	12.70±0.02***	14.10±0.02***
Weight of the adrenal gland, g	1.53±0.01	1.67±0.01***	3.33±0.01***	3.81±0.01***

***Note**: ***P<0.05; **P<0.01; ***P<0.001 compared to the control*
***Source**: developed by the authors of this study*

It was found that the absolute weight gain of broiler chickens increased: in the experimental group 2 – by 2.01% (P<0.001), in the experimental group 3 – by 8.19% (P<0.001), and in the experimental group 1 this indicator slightly decreased by 1.04% (P<0.001) compared to the control. The average daily carcass weight gain in the experimental groups of poultry increased and was significant in terms of indicators (P<0.001), namely: in the experimental group 1 – by 1.04%, in the experimental group 2 – by 2.08%, in the experimental group 3 – by 8.33% compared to the control. Feed costs per 1 kg of poultry weight gain in the experimental group 1 were almost at the same level, but in the experimental group 2 this figure decreased by 3.02% (P<0.05), in the experimental group 3 – by 8.54% (P<0.001) compared to the control. Significant results were found in determining the total weight of the bird carcass and neck weight, which increased in the experimental group 1 – by 1.39% (P<0.001), experimental group 2 – by 24.68% (P<0.001), experimental group 3 – by 26.48% (P<0.001) compared to the control. An increase in carcass weight without internal organs was found in the experimental group 1 – by 3.59% (P<0.001), in the experimental group 2 – by 26.14% (P<0.001), in the experimental group 3 – by 26.44% (P<0.001) compared to the control.

The weight of internal fat from poultry carcasses was increased: in the experimental group 1 – by 1.04 times (P<0.001), in the experimental group 2 – by 1.30 times (P<0.001), in the experimental group 3 – by 1.89 times (P<0.001); indicators of internal organs of broiler chickens were increased, namely: weight of the stomach without contents: in the experimental group 1 – 1.01 times (P<0.001), in the experimental group 2 – 1.04 times (P<0.001), in the experimental group 3 – 1.31 times (P < 0.001); liver weight: in in the experimental group 1 – 1.01 times (P<0.001), in the experimental group 2 – 1.25 times (P<0.001), in the experimental group 3 – 1.34 times (P<0.001); heart weight: in in the experimental group 1 – 1.01 times (P<0.001), in the experimental group 2 – 1.24 times (P<0.001), in the experimental group 3 – 1.34 times (P<0.001); adrenal weight: in in the experimental group 1 – 1.09 times (P<0.001), in the experimental group 2 – 2.18 times (P<0.001), in the experimental group 3 – 2.49 times (P<0.001) compared to the control.

The study found the category of broiler chickens carcasses by fatness, namely, carcasses of birds obtained from control and experimental group 1 were assigned to the second category according to the following indicators: muscles are satisfactorily developed; pectoral muscles with the keel form an angle without a depression; fat deposits in the lower abdomen are insignificant; the keel of the thorax is not ossified, stands out. However, the carcasses of poultry from experimental groups 2 and 3 were classified in the first category: muscles were well developed, the shape of the sternum was rounded, fat deposits in the lower abdomen were greater than in the control (group 2) and significant (group 3), the keel of the thorax was not ossified and did not stand out.

The study established the organoleptic characteristics of broiler chickens in the control and experimental groups: appearance of the carcasses – well exsanguinated with a clean surface, without blood clots; degree of plumage removal: plumage was completely removed; skin condition: clean, dry, unweathered, without scratches, tears, spots and bruises; bone system condition: bone system without fractures, slight curvature of the keel of the sternum (control and group 1); bone system without fractures and deformities (groups 2 and 3); consistency of chilled meat (at 0-4°C): muscles are dense, elastic, the dimple is quickly levelled when pressed with a spatula; colour of muscle tissue: pale pink (control and group 1) and from pale pink to pink (groups 2 and 3); skin colour: pale yellow (control and group 1) and yellow (groups 2 and 3); colour of subcutaneous and internal adipose tissue: pale yellow, and internal adipose tissue: white (control and group 1) and yellow (groups 2 and 3); smell: smell on the surface of the carcass and near the bones – typical of good quality poultry meat, without foreign odours; cooking sample: broth of pleasant smell, transparent, with a small amount of fat balls on the surface of the broth (control and group 1) and a significant amount of fat balls (groups 2 and 3), without foreign odours. These indicators suggested the good quality of broiler chicken carcasses, namely their freshness. The tasting characteristics of meat broth and cooked broiler meat were carried out (Figs. 2 and 3).

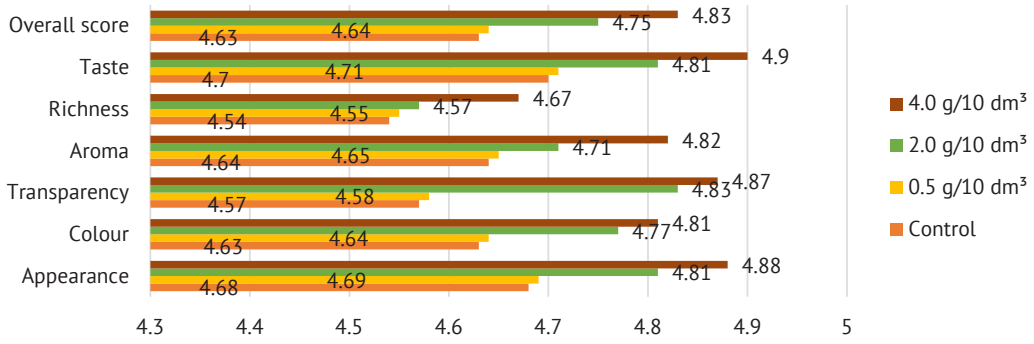

Figure 2. *Tasting characteristics of meat broth from broiler chicken meat (breast), in points*
Source*: developed by the authors of this study based on the data obtained*

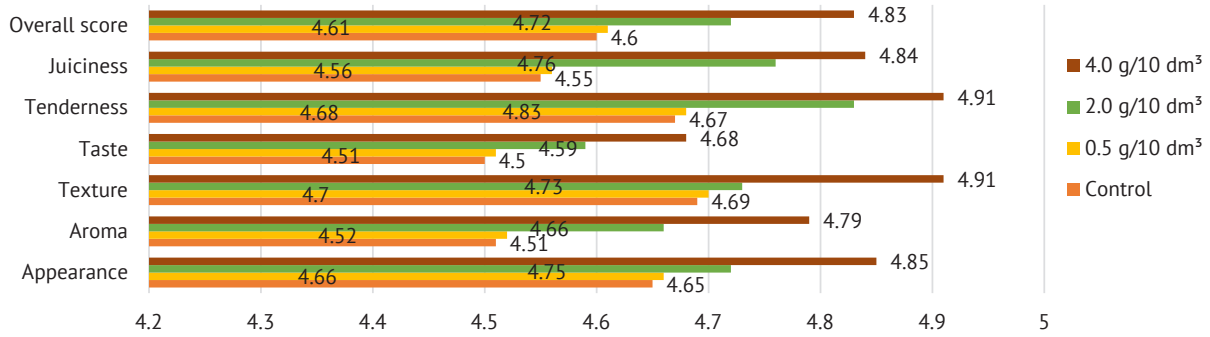

Figure 3. *Tasting characteristics of boiled broiler chicken meat (breast), in points*
Source*: developed by the authors of this study based on the data obtained*

Figure 2 shows that the best tasting characteristics of meat broth in terms of taste, richness, aroma, transparency, colour, and appearance were observed in the experimental group 3, with a total score of 4.85±0.062 points (P<0.05), which is 4.75% higher than in the control. The study also found that the best tasting characteristics of cooked meat in terms of juiciness, tenderness, taste, texture, aroma, and appearance were observed in the experimental group 3 with a total score of 4.83±0.060 points (P<0.05), which is 4.32% higher than in the control. Therefore, when poultry are fed a probiotic biopreparation at 4.0 g/10 dm³ of water per group of 20 birds, the organoleptic and tasting characteristics of broiler meat are improved. Studies were carried out to determine the chemical composition of broiler chickens when they were fed a probiotic biopreparation at different doses – 0.5 g/10 dm³, 2.0 g/10 dm³, 4.0 g/10 dm³ of water (Table 2).

Table 2. *Chemical composition of broiler chicken meat with the use of probiotic biopreparation, M±m, n=6*

Indicators	Control	Group 1 (0.5 g/10 dm³ of water)	Group 2 (2.0 g/10 dm³ of water)	Group 3 (4.0 g/10 dm³ of water)
Mass fraction of moisture, %	74.30±0.05	73.65±0.04***	73.50±0.04***	73.30±0.07***
Mass fraction of dry matter, %	25.70±0.02	26.35±0.02***	26.50±0.03***	26.70±0.06***
Mass fraction of fat, %	3.20±0.02	3.12±0.02***	2.90±0.01***	2.79±0.01***
Mass fraction of protein, %	22.36±0.020	22.41±0.02	22.49±0.04*	22.49±0.02***
Mass fraction of ash, %	0.96±0.01	0.97±0.01	0.98±0.01	0.99±0.01*
Carbohydrate content, g/100 g	0.03±0.001	0.05±0.001***	0.08±0.001***	0.15±0.01***
Caloric value, kcal/100 g	109.80±0.06	109.80±0.06	116.50±0.06***	118.90±0.07***

Notes*: * – P<0.05; *** – P<0.001 compared to the control*
Source*: developed by the authors of this study based on the data obtained*

Analysing the chemical composition of broiler chickens' meat after feeding the probiotic biopreparation Subtiform, it should be noted that the moisture content decreased in all experimental groups 1, 2, and 3 compared to the control group, respectively, by 0.84% (P<0.001), 1.08% (P<0.001), and 1.35% (P<0.001). Accordingly, the content of dry matter in meat increased in the experimental groups, namely, in the experimental

group 1 – by 2.53% (P<0.001), in the experimental group 2 – by 3.11% (P<0.001), in the experimental group 3 – by 3.89% (P<0.001) compared to the control. A decrease in fat content was observed in the meat of broiler chickens in all experimental groups, namely: in group 1 – by 2.50% (P<0.001), in group 2 – 9.38% (P<0.001), in group 3 – 12.81% (P<0.001) compared to the control; however, the protein content slightly increased, respectively, in group 1 – by 0.22%, where statistical significance was not established, in group 2 – by 0.53% (P<0.05), and in group 3 – by 0.76% (P<0.001).

The mass fraction of ash in the meat of groups 1 and 2 increased slightly, without statistical significance, by 1.4% and 2.08%, respectively, while in group 3 – by 3.13% (P<0.05) compared to the control. The carbohydrate content in broiler chicken meat increased in group 1 by 1.67 times (P<0.001), in group 2 – by 2.67 times (P<0.001), and in group 3 – by 5.0 times (P<0.001) compared to the control. The highest energy value of broiler chicken meat was observed in group 3 – 118.90±0.07 kcal/100 g, which is 8.29% (P<0.001). However, in groups 2 and 3, this indicator increased by 2.67% (P<0.001) and 6.10% (P<0.001), respectively, compared to the control. Studies were also carried out to determine the chemical quality indicators of fat and meat of broiler chickens to determine the freshness of the poultry (Table 3).

Table 3. *Chemical parameters of poultry fat and meat with the use of probiotics, M±m, n=6*

Indicators	Control	Group 1 (0.5 g/dm³ of water)	Group 2 (2.0 g/dm³ of water)	Group 3 (4.0 g/dm³ of water)
Acid number of fat using an alcohol-benzene mixture (Patent No. 147314, 2021), mg *NaOH*	0.75±0.029	0.60±0.02***	0.57±0.03***	0.59±0.05***
Fat peroxide number (Patent No. 147145, 2021), % J (% iodine)	0.0058±0.0004	0.0047±0.0004	0.0045±0.0005*	0.0054±0.0005***
Reaction with neutral red (Patent No. 147144, 2021)	presence of a yellow-brown colour			
Nessler number (Patent No. 47313, 2021)	1.55±0.03	1.51±0.03	1.50±0.04	1.45±0.03*
Copper sulphate reaction	broth is clear, blue in colour			
FFA content, mg *KOH/g* (Patent No. 152944, 2023)	3.81±0.11	3.45±0.06***	2.95±0.06***	3.04±0.13***
Ammonia and ammonium salts (qualitative reaction)	extract is greenish-yellow in colour, slightly cloudy	extract is greenish-yellow in colour, transparent		
Optical density of meat and water extract by photometric method, Bel (Patent No. 147315, 2021)	0.824±0.005	0.809±0.003*	0.818±0.003	0.792±0.004***
pH value of the meat and water extract	6.21±0.02	6.19±0.01	6.18±0.01	6.15±0.01**
Ammonium nitrogen content, mg (Patent No. 153118, 2023)	0.61±0.01	0.57±0.01**	0.55±0.02**	0.43±0.02***
Presence of hydrogen sulphide in meat	drop of acetic acid lead turns pale brown			

Notes*: * – P<0.05; ** – P<0.01; *** – P<0.001 compared to the control*
Source*: developed by the authors of this study based on the data obtained*

Table 3 shows that the acid number of fat in experimental groups 1, 2, and 3 was statistically significant when their amount was reduced, respectively, by 1.25 times (P<0.001), 1.32 times (P<0.001), and 1.27 times (P<0.001), as well as a decrease in the peroxide number in the experimental group 2 – by 1.29 times (P<0.05) and in the experimental group 3 – by 1.07 times (P<0.001) compared to the control. In meat, the Nessler count in the experimental groups was within the range of the control group. However, the content of volatile fatty acids in the meat of broiler chickens in experimental groups 1, 2, and 3 was slightly reduced, respectively, by 1.10 times (P<0.001), 1.29 times (P<0.001), and 1.25 times (P<0.001) compared to the control.

The optical density of the meat and water extract in group 3 was statistically significant – 0.792±0.004 (P<0.001) compared to the control. The pH values of the meat and water extract in the experimental groups did not differ from those of the control group. The content of amino-ammonia nitrogen in poultry meat of experimental groups 1, 2, and 3 was statistically significant and, accordingly, decreased by 1.07 times (P<0.001), 1.11 times (P<0.001), and 1.42 times (P<0.001) compared to the control. The obtained quantitative chemical parameters indicated the freshness of broiler chicken meat in the control and experimental groups at a cooling temperature of (0-4)°C, at which it is allowed to sell poultry carcasses for up to 5 days. Based on the qualitative reaction with copper sulphate and the

reaction of fat with neutral red, the absence of ammonia and ammonium and hydrogen sulphide salts, it was found that chicken fat and meat met the standards of freshness.

DISCUSSION

Studies established an increase in the live weight of broiler chickens at the end of rearing (42 days) when they were fed a probiotic biopreparation at 0.5 g, 2.0 g, and 4.0 g per 10 dm^3 of water for 20 birds in a cage, especially in experimental groups 2 and 3, respectively – by 4.02% (P<0.001) and 4.75% (P<0.001) compared to the control, and an increase in the weight of broiler chickens carcasses was observed – in group 2 – by 4.02% (P<0.001) and in group 3 – by 4.75% (P<0.001) compared to the control (Fig. 1). These indicators are consistent with the findings of T. Gunawardana *et al*. (2022). The results of the study indicated a healthy immune status of poultry and high feed digestibility when feeding probiotic biopreparation, and an increase in absolute growth in experimental group 3 was noted – by 8.19% (P<0.001), average daily carcass weight gain – by 8.33% (P<0.001), carcass weight without internal organs – by 26.44% (P<0.001) compared to the control group, and the weight of internal organs and internal fat also increased.

However, feed consumption per 1 kg of bird weight gain in group 3 was reduced by 8.54% (P<0.001) compared to the control (Table 1). P. Maharjan *et al*. (2021) proved a positive effect on the health of broiler chickens, feed digestibility and increased productivity and live weight gain in poultry, as well as improved fatness. This mechanism is explained by stimulating the activity of microorganisms in the poultry intestine and the stability of the balance of this microflora, stimulating feeding processes and activating the immune status of the poultry body. A.A. Masud *et al*. (2020) proved the positive effect of probiotic feed additives on improving the immune status and poultry productivity, specifically, an increase in the weight of carcasses, internal organs, and fat by 1.5-2.5 times.

The study also found that the best organoleptic characteristics of meat and tasting characteristics of meat broth and boiled meat were observed in the experimental group 3 with a total score of 4.85±0.062 points (P<0.05) and 4.83±0.060 points (P<0.05), which is 4.75% and 4.32% more than in the control, respectively. A. Rehman *et al*. (2020) argue that organoleptic and tasting characteristics are influenced by the digestibility of feed when probiotics are fed. The best indicators of the chemical composition of broiler chicken meat were found in experimental group 3 (4.0 g/10 dm^3 of water). These data are consistent with the findings of G.M. Suliman *et al*. (2023), namely, the protein content increased by 0.81% (P<0.001), the fat content decreased by 8.13% (P<0.001). According to X. Liu *et al*. (2023), the mass fraction of water slightly decreased by 1.29% (P<0.001), the mass fraction of dry matter increased by 3.95% (P<0.001). And according to A. Rehman *et al*. (2020), the caloric value increased to 118 kcal/100 g, the carbohydrate content increased by 5.4 times, and the mass fraction of ash slightly increased by 3.5%.

T. He *et al*. (2019) proved an increase in the natural resistance of broiler chickens using probiotics, which influenced the increase in carcass weight, the quality of the chemical composition of meat and offal. M.H. Haque *et al*. (2020) confirmed the positive effect of probiotics of the bacteria genus *Bacillus subtilis* and *Bacillus licheniformis* on increasing the productivity of broiler chickens, which led to an increase in meat quality, specifically, the chemical composition in terms of moisture, fat, protein, dry matter, etc., and affected the freshness of poultry meat, which extends the shelf life of poultry products.

Thus, L.W. Chen *et al*. (2020) argue that the use of probiotics from microbial species has antibacterial properties and immunomodulatory effects on the body of broiler chickens, they have a positive effect on the productivity and immunity of poultry. Notably, feeding the probiotic biopreparation Subtiform for 14 days, i.e., from day 28 to day 42 of broiler chickens rearing, provided an increase in body weight of broiler chickens by 2.0-8.2%, an increase in the average daily weight gain from 96 g to 104 g, and a decrease in feed consumption per 1 kg of weight gain by 1.97-7.55%. Thus, studies have confirmed that feeding broiler chickens with a probiotic biopreparation (*Bacillus subtilis* and *Bacillus licheniformis*) increases poultry productivity and improves the chemical composition of poultry meat. R. Jha *et al*. (2020) proved that probiotics with *Bacillus subtilis* have a positive effect on maintaining gut homeostasis and modelling the intestinal microbiota, preventing poultry intestinal infections, and as a result, increasing productivity and improving the chemical composition and chemical quality and safety of broiler chickens.

The findings are confirmed by N.H. Aziz *et al*. (2020), who found that broiler chicken carcasses were fresh in terms of organoleptic and chemical characteristics for 2, 4, and 5 days at (0-4)°C. According to C. Bortoluzzi *et al*. (2019), poultry are fed probiotics to potentially increase feed intake and nutrient retention and absorption, gut barrier function, antioxidant capacity, apoptosis and immune responses, which ultimately contribute to improved poultry metabolism and gastrointestinal health and performance of broiler chickens. According to J. Ding *et al*. (2017), the use of probiotics in broiler chickens improves health, reduces morbidity and mortality at certain critical stages of production, such as dietary stress (dietary changes, diets rich in concentrates) and health stress. S. Sharma *et al*. (2019) noted that in the functioning of the traceability system and Hazard Analysis and Critical Control Point (HACCP), veterinary

practitioners should use express and optimised methods for monitoring the freshness of broiler chicken meat, which will be effective, inexpensive, and accessible in tests directly at the production and circulation of poultry slaughter products, which will meet the needs of consumers for quality and safe food.

Thus, the findings of the cited studies are in line with the research conducted to establish the effectiveness of using a probiotic biopreparation to increase the productivity of broiler chickens and improve the organoleptic, tasting, and chemical characteristics of poultry meat.

CONCLUSIONS

The present study found that when the probiotic biopreparation was fed to broiler chickens during days 28 to 42 of rearing at doses of 0.5 g/10 dm^3, 2.0 g/10 dm^3, 4.0 g/10 dm^3 of water, the increase in live weight of poultry in experimental groups 1, 2, and 3, respectively, was 0.27% (P<0.001), 4.02% (P<0.001), and 4.75% (P<0.001) compared to the control. It was found that the absolute weight gain of carcasses increased in experimental groups 2 and 3, respectively, by 2.01% (P<0.001) and 8.19% (P<0.001); the average daily weight gain of carcasses in experimental groups 1, 2, and 3 increased, respectively, by 1.04% (P<0.001), 2.08% (P<0.001) and 8.33% (P<0.001); total weight of the bird carcass and neck, respectively – by 1.39% (P<0.001), 24.68% (P<0.001) and 26.48% (P<0.001); weight of internal fat, respectively – by 1.04 times (P<0.001), 1.30 times (P<0.001) and 1.89 times (P<0.001) compared to the control. It was found that feed consumption per 1 kg of poultry weight gain in group 1 was almost at the same level, but in group 2 this indicator decreased by 3.02% (P<0.05), in group 3 – by 8.54% (P<0.001) compared to the control. The studies determined the category of broiler chicken carcasses by fatness: the second category – in the control and experimental group 1 (0.5 g/10 dm^3 of water); the first category – in experimental groups 2 (2.0 g/10 dm^3 of water) and 3 (4.0 g/dm^3 of water).

The studies established statistical significance (P<0.001) in increasing the weight of internal organs of broiler chickens (stomach, liver, heart, adrenal gland) in experimental groups 2 and 3, respectively, within 1.04-1.31 times (P<0.001); 1.25-1.34 times (P<0.001); 1.24-1.34 times (P<0.001); 2.18-2.49 times (P<0.001) compared to the control. The best organoleptic and tasting indices of broiler chicken meat were found in experimental group 3: meat broth – 4.85±0.062 points (P<0.05), which is 4.75% more than in the control; boiled meat – 4.83±0.060 points (P<0.05), which is 4.32% more than in the control.

The obtained quantitative and qualitative chemical parameters using express and optimised methods indicated the freshness of broiler chickens meat at (0-4)°C cooling, at which it is allowed to sell poultry carcasses up to 5 days, of control and experimental groups 1, 2, 3. It was established that according to the findings of the study, the probiotic biopreparation Subtiform at 4.0 g/10 dm^3 of water for 20 heads of poultry can be recommended to increase the fatness of broiler chickens and improve the chemical composition of meat, as well as to recommend patented express and optimised methods for determining the freshness of meat by express and optimised methods. Prospects for further research include determining the amino and fatty acid composition of broiler chicken meat and determining the biological value of meat using a probiotic biopreparation.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Abd El-Hack, M.E., El-Saadony, M.T., Shafi, M.E., Shaza, Y.A., Qattan, S.Y.A., Batiha, G.E., Khafaga, A.F., Abdel-Moneim, A.E., & Alagawany, M. (2020). Probiotics in poultry feed: A comprehensive review. *Journal of Animal Physiological and Animal Nutrition*, 104(6), 1835-1850. doi: 10.1111/jpn.13454.

[2] Abdulkhaliq, F., & Sabow, A.D. (2023). Carcass characteristics and meat quality assessments in broiler chickens subject to different pre-slaughter restraining methods. *Tikrit Journal for Agricultural Sciences*, 23(2), 42-61. doi: 10.25130/tjas.23.2.4.

[3] Ahmat, M., Cheng, J., Abbas, Z., Cheng, Q., Fan, Z., Ahmad, B., Hou, M., Osman, G., Guo, H., Wang, J., & Zhang, R. (2021). Effects of *Bacillus amyloliquefaciens* LFB112 on growth performance, carcass traits, immune, and serum biochemical response in broiler chickens. *Antibiotics*, 10(11), article number 1427. doi: 10.3390/antibiotics10111427.

[4] Aziz, N.H., Khidhir, Z., Hama, Z.O., & Mustafa, N. (2020). Influence of probiotic (Miaclost) supplementation on carcass yield, chemical composition and meat quality of broiler chick. *Journal of Animal and Poultry Production*, 11(1), 9-12. doi: 10.21608/jappmu.2020.77767.

[5] Baba, F.V., & Esfandiari, Z. (2023). Theoretical and practical aspects of risk communication in food safety: A review study. *Heliyon*, 9(7), article number 18141. doi: 10.1016/j.heliyon.2023.e18141.

[6] Bogatko, N.M. (2019). *Methods of determining the fatness of poultry and slaughter animals: Methodical recommendations for improving the qualifications of veterinary medicine doctors*. Bila Tserkva.

[7] Bortoluzzi, C., Serpa Vieira, B., de Paula Dorigam, J.C., Menconi, A., Sokale, A., Doranalli, K., & Applegate, T.J. (2019). *Bacillus subtilis* DSM 32315 supplementation attenuates the effects of *Clostridium perfringens* challenge on the growth performance and intestinal microbiota of broiler chickens. *Microorganisms*, 7(3), article number 71. doi: 10.3390/microorganisms7030071.
[8] Chaturvedi, P., Shukla, P., Giri, B.S., Chowdhary, P., Chandra, R., Gupta, P., & Pandey, A. (2021). Prevalence and hazardous impact of pharmaceutical and personal care products and antibiotics in environment: A review on emerging contaminants. *Environmental Research*, 194, article number 110664. doi: 10.1016/j.envres.2020.110664.
[9] Chen, C., Li, J., Zhang, H., Xie, Y., Xiong, L., Liu, H., & Wang, F. (2020). Effects of a probiotic on the growth performance, intestinal flora, and immune function of chicks infected with *Salmonella pullorum*. *Poultry Science*, 99(11), 5316-5323. doi: 10.1016/j.psj.2020.07.017.
[10] Choi, J., Kong, B., Bowker, B.C., Zhuang, H., & Kim, W.K. (2023). Nutritional strategies to improve meat quality and composition in the challenging conditions of broiler production: A Review. *Animals (Basel)*, 13(8), article number 1386. doi: 10.3390/ani13081386.
[11] Delgado-Pando, G., Alvarez, C., & Moran, L. (2019). From farm to fork: New strategies for quality evaluation of fresh meat and processed meat products. *Journal of Food Quality*, 2019, article number 4656842. doi: 10.1155/2019/4656842.
[12] Ding, J., Dai, R., Yang, L., He, C., Xu, K., Liu, S., Zhao, W., Xiao, L., Luo, L., Zhang, Y., & Meng, H. (2017). Inheritance and establishment of gut microbiota in chickens. *Frontiers in Microbiology*, 8, article number 1967. doi: 10.3389/fmicb.2017.01967.
[13] Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific. (2010). Retrieved from https://www.fao.org/faolex/results/details/ru/c/LEX-FAOC098296/.
[14] Dong, Y., Li, R., Liu, Y., Ma, L., Zha, J., Qiao, X., Chai, T., & Wu, B. (2020). Benefit of dietary supplementation with *Bacillus subtilis* BYS2 on growth performance, immune response, and disease resistance of broilers. *Probiotics Antimicrob Proteins*, 12(4), 1385-1397. doi: 10.1007/s12602-020-09643-w.
[15] DSTU 3143:2013. (2014). *Poultry meat. General technical conditions*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=81578.
[16] DSTU 4823.2:2007. (2009). *Meat products. Organoleptic assessment of quality indicators. Part 2. General requirements*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=83084.
[17] DSTU 8253:2015. (2017). *Poultry meat. Methods of chemical analysis of freshness*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=71556.
[18] DSTU EN ISO/IEC 17025:2019. (2021). *General requirements for the competence of testing and calibration laboratories*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=88724.
[19] DSTU ISO 1442:2005. (2008). *Meat and meat products. Method for determination of moisture content (control method)*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=82535.
[20] DSTU ISO 1443:2005. (2008). *Meat and meat products. Method for determining the total fat content*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=82655.
[21] DSTU ISO 2917-2001. (2003). *Meat and meat products. Determination of pH (control method)*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=89528.
[22] DSTU ISO 936:2008. (2008). *Meat and meat products. The method of determining the mass fraction of total ash*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=89525.
[23] DSTU ISO 937:2005. (2007). *Meat and meat products. Determination of nitrogen content (control method)*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=82211.
[24] European convention for the protection of vertebrate animals used for experimental and other scientific purposes. (1986). Retrieved from https://rm.coe.int/168007a67b.
[25] Gunawardana, T., Ahmed, K.A., Popowich, S., Kurukulasuriya, S., Lockerbie, B., Karunarathana, R., Ayalew, L.E., Liu, M., Tikoo, S.K., & Gomis, S. (2022). Comparison of therapeutic antibiotics, probiotics, and synthetic CpG-ODNs for protective efficacy against *Escherichia coli* lethal infection and impact on the immune system in neonatal broiler chickens. *Avian Diseasea*, 66(2), 165-175. doi: 10.1637/aviandiseases-D-22-00011.
[26] Haque, M.H., Sarker, S., Islam, M.S., Islam, M.A., Karim, M.R., Kayesh, M.E.H., Shiddiky. M.J.A., & Anwer, M.S. (2020). Sustainable antibiotic-free broiler meat production: Current trends, challenges, and possibilities in a developing country perspective. *Biology*, 9(11), article number 411. doi: 10.3390/biology9110411.
[27] He, T., Long, S., Mahfuz, S., Wu, D., Wang, X., Wei, X., & Piao, X. (2019). Effects of probiotics as antibiotics substitutes on growth performance, serum biochemical parameters, intestinal morphology, and barrier function of broilers. *Animals,* 9(11), article number 985. doi: 10.3390/ani9110985.
[28] Jacobs, L., Persia, M.E., Siman-Tov, N., McCoy, J., Ahmad, M., Lyman, J., & Good, L. (2020). Impact of water sanitation on broiler chicken production and welfare parameters. *Journal of Applied Poultry Research*, 29(1), 258-268. doi: 10.1016/j.japr.2019.10.013.

[29] Jeni, R.E, Dittoe, D.K., Olson, E.G., Lourenco, J., Corcionivoschi, N., Ricke, S.C., & Callaway, T.R. (2021). Probiotics and potential applications for alternative poultry production systems. *Poultry Science*, 100(7), article number 101156. doi: 10.1016/j.psj.2021.101156.
[30] Jha, R., Das, R., Oak, S., & Mishra, P. (2020). Probiotics (direct-fed microbials) in poultry nutrition and their effects on nutrient utilization, growth and laying performance, and gut health: A systematic review. *Animals*, 10(10), article number 1863. doi: 10.3390/ani10101863.
[31] Law of Ukraine No. 249 "On the Procedure for Carrying out Experiments and Experiments on Animals by Scientific Institutions". (2012, March). Retrieved from https://zakon.rada.gov.ua/laws/show/z0416-12#Text.
[32] Liu, X., Ma, A., Zhi, T., Hong, D., Chen, Z., Li, S., & Jia, Y. (2023). Dietary effect of *Brevibacillus laterosporus* S62-9 on chicken meat quality, amino acid profile, and volatile compounds. *Foods,* 12(2), article number 288. doi: 0.3390/foods12020288.
[33] Maharjan, P., Martinez, D.A., Weil, J., Suesuttajit, N., Umberson, C., Mullenix, G., Hilton, K.M., Beitia, A., & Coon, C.N. (2021). Physiological growth trend of current meat broilers and dietary protein and energy management approaches for sustainable broiler production. *Animal*, 15(1), article number 100284. doi: 10.1016/j.animal.2021.100284.
[34] Masud, A.A., Rousham, E.K., Islam, M.A., Alam, M.U., Rahman, M., Mamun, A.A., Sarker, S., Asaduzzaman, M., & Unicomb, L. (2020). Drivers of antibiotic use in poultry production in Bangladesh: Dependencies and dynamics of a patron-client relationship. *Frontiers in Veterinary Science*, 7, article number 78. doi: 10.3389/fvets.2020.00078.
[35] Memon, F.U., Yang, Y., Zhang, G., Leghari, I.H., Lv, F., Wang, Y., Laghari, F., Khushk, F.A., & Si H. (2022). Chicken gut microbiota responses to dietary *Bacillus subtilis* probiotic in the presence and absence of *Eimeria infection*. *Microorganisms*, 10(8), article number 1548. doi: 10.3390/microorganisms10081548.
[36] Mohamed, T.M., Sun, W., Bumbie, G.Z., Dosoky, W.M., Rao, Z., Hu, P., Wu, L., & Tang, Z. (2022). Effect of dietary supplementation of *Bacillus subtilis* on growth performance, organ weight, digestive enzyme activities, and serum biochemical indices in broiler. *Animals*, 12(12), article number 1558. doi: 10.3390/ani12121558.
[37] Queenan, K., Cuevas, S., Mabhaudhi, T., Chimonyo, M., Shankar. B., Slotow, R., & Häsler, B. (2022). A food systems approach and qualitative system dynamics model to reveal policy issues within the commercial broiler chicken system in South Africa. *PLOS ONE*, 17(6), article number 0270756. doi: 10.1371/journal.pone.0270756.
[38] Rehman, A., Arif, M., Sajjad, N., Al-Ghadi, M.Q., Alagawany, M., Abd El-Hack, M.E., Alhimaidi, A.R., Elnesr, S.S., Almutairi, B.O., Amran, R.A., Hussein, E.O.S., & Swelum, A.A. (2020). Dietary effect of probiotics and prebiotics on broiler performance, carcass, and immunity. *Poultry Science*, 99(12), 6946-6953. doi: 10.1016/j.psj.2020.09.043.
[39] Savelli, C.J., Simpson, J., & Mateus, C. (2021). Exploring the experiences of members of the international food safety authorities network: An interpretative phenomenological analysis. *Journal of Food Protection*, 84(10), 1683-1697. doi: 10.4315/JFP-21-171.
[40] Suliman, G.M., Hussein, E.O.S., Alsagan, A., Al-Owaimer, A.N., Alhotan, R., Al-Baadani, H.H., Ba-Awadh, H.A., Qaid, M.M., & Swelum, A.A. (2023). Effects of adding nano-emulsified plant oil and probiotics to drinking water during different periods besides sex on processing characteristics, physicochemical properties, and meat quality traits of broiler chickens. *Frontiers in Veterinary Science*, 10, article number 1133605. doi: 10.3389/fvets.2023.1133605.
[41] Utility model patent No. 147144. (2021). *A method for determining the degree of freshness of poultry fat using neutral red*. Retrieved from https://iprop-ua.com/inv/e8u0r6wm/.
[42] Utility model patent No. 147145. (2021). *A method for improving the determination of the peroxide number of poultry fat*. Retrieved from https://iprop-ua.com/inv/etex6ntv/.
[43] Utility model patent No. 147313. (2021). *Method for determining the degree of freshness of poultry meat by Nesler's number.* Retrieved from https://iprop-ua.com/inv/qrv4n61o/.
[44] Utility model patent No. 147314. (2021). *A method for determining the acid number of poultry fat includes the use of an alcohol-benzene mixture*. Retrieved from https://iprop-ua.com/inv/f1disbck/.
[45] Utility model patent No. 147315. (2021). *Method for determining the degree of freshness of poultry meat by photometric method*. Retrieved from https://iprop-ua.com/inv/h2k0rdj4/.
[46] Utility model patent No. 152944. (2023). *Method for improving the determination of the mass fraction of volatile fatty acids in poultry meat*. Retrieved from https://iprop-ua.com/inv/fdsetnd0/.
[47] Utility model patent No. 153118. (2023). *Method for determining the content of amino-ammonia nitrogen in poultry meat.* Retrieved from https://iprop-ua.com/inv/blmv7379/.
[48] Wang, K., Cao, G., Zhang, H., Li, Q., & Yang, C. (2019). Effects of *Clostridium butyricum* and *Enterococcus faecalis* on growth performance, immune function, intestinal morphology, volatile fatty acids, and intestinal flora in a piglet model. *Food & Function*, 10(12), 7844-7854. doi: 10.1039/c9fo01650c.
[49] Wani, N.R., Rather, R.A., Farooq, A., Padder, S.A., Baba, T.R., Sharma, S., Mubarak, N.M., Khan, A.H., Singh, P., & Ara, S. (2023). New insights in food security and environmental sustainability through waste food management. *Environmental Science and Pollution Research*. doi: 10.1007/s11356-023-26462-y.

[50] Weimer, S.L., Wideman, R.F., Scanes, C.G., Mauromoustakos, A., Christensen, K.D., & Vizzier-Thaxton, Y. (2018). An evaluation of methods for measuring tress in broiler chickens. *Poultry Science*, 97(10), 3381-3389. doi: 10.3382/ps/pey204.
[51] Xiong, H.H., Lin, S.Y., Chen, L.L., Ouyang, K.H., & Wang, W.J. (2023). The interaction between flavonoids and intestinal microbes: A review. *Foods*, 12(2), article number 320. doi: 10.3390/foods12020320.
[52] Yao, W., Cai, Y., Liu, D., Chen, Yu., Jianrong, Li, J., Zhang, M., Chen, N., & Zhang, H. (2021). Analysis of flavor formation during production of Dezhou braised chicken using headspace-gas chromatography-ion mobility spectrometry (HS-GC-IMS). *Food Chemistry*, 370, article number 130989. doi: 10.1016/j.foodchem.2021.130989.
[53] Zhang, L., Zhang, R., Jia, H., Zhu, Z., Li, H., & Ma, Y. (2021). Supplementation of probiotics in water beneficial growth performance, carcass traits, immune function, and antioxidant capacity in broiler chickens. *Open Life Sciences*, 16(1), 311-322. doi: 10.1515/biol-2021-0031.

Вплив пробіотичного біопрепарату на вгодованість, органолептичні та хімічні показники м'яса курчат-бройлерів

Альона Федорівна Богатко
Аспірант
Білоцерківський національний аграрний університет
09117, Соборна пл., 8/1, м. Біла Церква, Україна
https://orcid.org/0000-0001-8089-5884
Надія Михайлівна Богатко
Доктор ветеринарних наук, професор
Білоцерківський національний аграрний університет
09117, Соборна пл., 8/1, м. Біла Церква, Україна
https://orcid.org/0000-0002-1566-1026
Наталія Володимирівна Букалова
Кандидат ветеринарних наук, доцент
Білоцерківський національний аграрний університет
09117, Соборна пл., 8/1, м. Біла Церква, Україна
https://orcid.org/0000-0003-4856-3040
Василь Петрович Лясота
Доктор ветеринарних наук, професор
Білоцерківський національний аграрний університет
09117, Соборна пл., 8/1, м. Біла Церква, Україна
https://orcid.org/0000-0002-2442-2174
Світлана Алімівна Ткачук
Доктор ветеринарних наук, професор
Національний університет біоресурсів і природокористування
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0000-0002-6923-1793

Анотація. Актуальність роботи полягала у використанні пробіотичного біопрепарату Субтіформ за виробництва курчат-бройлерів для підвищення продуктивності та покращення органолептичних та хімічних показників продуктів забою птиці. Метою роботи було визначити вплив пробіотичного біопрепарату на вгодованість курчат-бройлерів, хімічний склад м'яса і хімічні показники за розробленими запатентованими експресними і оптимізованими методиками. Використані наступні методи: фізичні, органолептичні, хімічні. Було встановлено, що застосування *Bacillus subtilis* і *Bacillus licheniformis* (2,5×10^9 колонієутворюючі одиниці/г) з наповнювачем – сухої молочної сироватки, сприяло збільшенню продуктивності, зокрема жива вага курчат-бройлерів підвищувалася за випоювання у дозі 2,0 г/10 $дм^3$ води – на 4,02 % (P<0.001) та у досліді 3 – на 4,75 % (P<0,001) порівняно до контрольної групи. Встановлено підвищення показників у досліджуваній групі 3, зокрема, середньодобового приросту маси тушок – на 8,33 % (P<0,001); загальної маси тушки птиці та потроху з шиєю – на 26,48 % (P<0,001); ваги внутрішнього жиру – у 1,89 рази (P<0,001) порівняно до контрольної групи. Також спостерігалося статистична значущість (P<0,001) щодо збільшення маси внутрішніх органів (шлунку, печінки, серця, наднирника) у дослідних групах 2 і 3, порівняно до контрольної групи. Було узагальнено покращення органолептичних та дегустаційних показників мяса та м'ясного бульйону птиці за випоювання пробіотичного

препарату, зокрема у дослідній групі 3. Отримані кількісні та якісні хімічні показники за використання експресних та оптимізованих методик вказували на свіжу ступінь м'яса курчат-бройлерів за охолодження (0-4) °С, за якої дозволено реалізації тушок птиці до 5 діб, контрольної і дослідних груп 1, 2, 3. Практичне цінність роботи полягала у використанні фахівцями ветеринарної медицини на потужностях з виробництва курчат-бройлерів пробіотичного біопрепарату для підвищення продуктивності курчат-бройлерів та покращення якості та безпечності продуктів їх забою

Ключові слова: пробіотик; вгодованість птиці; хімічний склад м'яса; якісні та кількісні показники; експресні та удосконалені методики