P-ISSN: 2304-3075; E-ISSN: 2305-4360

International Journal of Veterinary Science

www.ijvets.com; editor@ijvets.com

Research Article https://doi.org/10.47278/journal.ijvs/2026.016

Effect of Ivermectin on Morphobiochemical Parameters of Blood and Meat Quality of Muscovy Ducks

A. Shamshidin [1], A. Nugmanova [1]*, A. Sabyrzhanov [1], A. Abylgazinova [2], Zh. Makhimova [1], Y. Batyrgaliyev [1] and Y. Sengaliyev [1]

[1]Zhangir Khan Agrarian Technical University, 51 Zhangir khan str., Uralsk 090009, Republic of Kazakhstan
[2]Research and Production Center for Livestock and Veterinary Medicine LLP, 40 Kenesary str., Astana 010000, Republic of Kazakhstan
***Corresponding author:** aru_kyz_90@mail.ru

Article History: 25-296 Received: 12-Nov-25 Revised: 21-Dec-25 Accepted: 17-Dec-25 Online First: 27-Jan-26

ABSTRACT

This study was conducted to evaluate the effect of a single administration of ivermectin. This study was done at different doses on hematological, biochemical, and meat quality parameters of clinically healthy Muscovy ducks (*Cairina moschata*). The experiment was conducted on six groups of ducks and drakes: two experimental groups treated once with ivermectin subcutaneously at doses of 0.1mL/kg and 0.2mL/kg, and four corresponding control groups (two untreated drake groups and two untreated duck groups) serving as negative controls. Blood samples were collected on days 7, 14, and 21 after treatment to determine hematological (erythrocytes, leukocytes, hemoglobin, ESR) and biochemical (total protein, albumin, globulin, ALT, AST, glucose) indices. The results showed that the administration of ivermectin did not cause statistically significant ($P>0.05$) changes in most blood parameters when compared with controls. A significant increase ($P<0.05$) in erythrocyte count was observed in drakes that received 0.1mL/kg on day 7. However, all other hematological parameters were found to be in normal physiological ranges. Biochemical parameters like liver enzyme activity (ALT, AST), total protein, and glucose showed minor non-significant changes. It also indicated no hepatic or metabolic disturbances. Veterinary-sanitary and physicochemical examinations revealed that meat from treated ducks was fresh, safe, and of high quality. The meat was found to have a normal pH, gave negative reactions to protein decomposition, and had significantly lower ($P<0.05$) amino-ammonia nitrogen content than the control group. It was further concluded that a single therapeutic dose of ivermectin (0.1–0.2mL/kg) is safe for Muscovy ducks. It does not impair hematological or biochemical balance and preserves the sanitary and organoleptic quality of meat intended for human consumption.

Keywords: Muscovy duck, Hematology, Blood biochemistry, Meat Quality, Poultry.

INTRODUCTION

Modern stages of poultry farming development with the rational use of materials and other resources, are based on large-scale industrial agricultural enterprises. These conditions require the use of appropriate knowledge and new advanced methods of veterinary care (He 2020; Zhang et al. 2025), including preventive, antiepizootic measures and prevention of the introduction of parasitic diseases to reduce or avoid further economic losses (Makhonina 2016). The growth of livestock production in general is now closely linked to the progressive increase in population in Kazakhstan and worldwide, in line with the growing demand for food for people (Hassan et al. 2018; Hefnawy et al. 2024). Increasing the productive output of animals depends not only on providing a balanced diet that supplies essential minerals, vitamins, proteins, and other nutrients (Mohamed et al. 2020; Krunt et al. 2023; Zhang et al. 2024), but also on maintaining environmental conditions that preserve the quality and nutritional value of the final market products (Kokoszynski et al. 2021).

Modern veterinary medicine has at its disposal a large arsenal of medications, as well as methods for preventing and treating parasitic diseases (Phuong et al. 2025). However, most often, all measures taken to address the problem are limited to the uncontrolled use of anthelmintic agents of older generations (Nasr et al. 2022). It has been established that the excessive and irrational use of such compounds leads to increased resistance in helminths, and toxic reactions develop in birds, especially in Muscovy

Cite This Article as: Shamshidin A, Nugmanova A, Sabyrzhanov A, Abylgazinova A, Makhimova Z, Batyrgaliyev Y and Sengaliyev Y, 2026. Effect of ivermectin on morphobiochemical parameters of blood and meat quality of muscovy ducks. International Journal of Veterinary Science 15(3): 708-717. https://doi.org/10.47278/journal.ijvs/2026.016

ducks (Arias-Sosa and Rojas 2021). On the other hand, humoral and cellular immune defense factors can also be suppressed (Costa et al. 2019; Umagiliya et al. 2022; de Oliveira Carvalho et al. 2023; Zhang et al. 2024).

Special attention has been given to ivermectin, a broad-spectrum anthelmintic used for the treatment and prevention of parasitic infections in various animal species, including birds. Ivermectin is effective against nematodes, ectoparasites, and certain arthropods, making it a convenient and versatile tool in veterinary practice (Jamil et al. 2022). Nevertheless, despite its proven effectiveness, the use of ivermectin in poultry farming, especially when working with waterfowl, requires a careful approach. This is due to the increased sensitivity of ducks to the components of the preparation, as well as the peculiarities of metabolism in Muscovy ducks (Park et al. 2018; Sartini et al. 2022).

There are cases of toxic reactions with a wrong dosage or frequency of administration, which can lead to suppression of physiological functions and even death (Saganuwan 2017). In addition, if the timing of preparation withdrawal from the body is not sufficiently observed, there is a risk of accumulation of residual amounts in products intended for human consumption. This, in turn, can lead to veterinary, sanitary, and ethical risks in the meat production process (Canton et al. 2021). Thus, the scientific justification of the dosage, mode of use, and assessment of the effects of using ivermectin in Muscovy ducks is an urgent task aimed at ensuring both therapeutic efficacy and food safety of products. The work aimed to evaluate the pharmacotoxicological properties of ivermectin, as well as to determine its effect on morphological and biochemical parameters of blood and meat quality of clinically healthy Muscovy ducks and drakes.

To achieve this goal, the study evaluated the morphological and biochemical parameters of the blood of experimentally infected with heterakidosis and healthy Muscovy ducks after administration of ivermectin. In addition, a veterinary and sanitary assessment of Muscovy duck meat was conducted after the use of ivermectin.

MATERIALS AND METHODS

Sample analysis

Blood samples were collected from clinically healthy, helminth-free Muscovy ducks and drakes. Blood was drawn from the jugular and axillary veins of each bird using sterile disposable needles and vacuum tubes containing anticoagulant (EDTA for hematology and serum separator tubes for biochemistry). Venipuncture was performed by trained personnel under standard restraint to minimize stress and avoid hemolysis.

Immediately after collection, all tubes were gently inverted to ensure proper mixing with anticoagulants. Samples were transported from the sampling site to the Zhardem-Vet Training and Production Center laboratory in insulated transport boxes at 4–6°C to maintain sample integrity. Hematological samples were analyzed within 1 hour of collection to prevent erythrocyte distortion or coagulation, while serum samples were allowed to clot at room temperature for 20–30 minutes before centrifugation. After centrifugation, serum was separated, stored at 4°C, and analyzed on the same day to avoid biochemical degradation.

The samples were examined at the Zhardem-Vet Training and Production center of Zhangir Khan West Kazakhstan Agrarian Technical University (ZKATU) using the Abacus 5 Vet hematology analyzer and the Mindray BS-240 Pro automatic biochemical analyzer. All hematological analyses were performed according to the operating protocol of the Abacus 5 Vet hematology analyzer, while all biochemical analyses followed the manufacturer's instructions for the Mindray BS-240 Pro automatic biochemical analyzer, in compliance with standard veterinary diagnostic guidelines. The effect of ivermectin on the morphological and biochemical parameters of the blood of clinically healthy helminth-free birds was studied in 120 Muscovy ducks and drakes of the black and white breed, aged 60 days and weighing 2.4-3.5kg. Helminth-free status of all birds was confirmed prior to the experiment by performing fecal examinations using the flotation method (McMaster technique) and by conducting a clinical inspection for external parasites; only birds with negative parasitological results were included in the study.

Experimental design

Experiment 1 – Hematological and biochemical assessment

A total of 120 Muscovy ducks and drakes (60 days old, 2.4–3.5kg) of the black-and-white breed were used. Birds were randomly assigned to six groups: Group 1 (Ducks – ivermectin 0.1mL/kg); Group 2 (Ducks – ivermectin 0.2mL/kg); Group 3 (Drakes – ivermectin 0.1mL/kg); Group 4 (Drakes – ivermectin 0.2mL/kg); Group 5 (Ducks – control, untreated); Group 6 (Drakes – control, untreated). Muscovy ducks and drakes of the first group were individually treated with ivermectin as a single dose either subcutaneously at 0.1mL/kg body weight or subcutaneously at 0.2mL/kg body weight. Blood was taken from all groups on days 7, 14 and 21 after the introduction of ivermectin. To ensure comparability of the results, all blood samples were taken in the morning on an empty stomach. The samples were processed within one hour after collection to prevent hemolysis and biochemical distortions.

Experiment 2 – Veterinary-sanitary and meat quality assessment

For meat quality evaluation, 15 Muscovy ducks were assigned to three groups: Group A: Ivermectin 0.1mL/kg intramuscularly; Group B: Ivermectin 0.2mL/kg orally; Group C: Control group, no treatment. Birds were monitored for 14 days and then slaughtered for carcass evaluation. Sampling, organoleptic, biochemical, and microbiological studies were carried out in accordance with GOST 32151-2013 "Duck meat (carcasses and parts thereof) Trade descriptions"; GOST R 51944-2002 "Poultry meat. Methods for determining organoleptic parameters, temperature, and weight"; GOST 31990-2012 "Duck meat (carcasses and parts thereof) Technical requirements."

Special attention was paid to the visual assessment of carcasses, the consistency of muscle tissue, the presence of bruises, the moisture content of the cut, and the smell. The physico-chemical analysis included the determination of pH, reactions to protein degradation products, peroxidase activity, and the level of aminoammoniacal nitrogen. Control over the observance of slaughter technology, shelf life of samples, and transportation conditions was maintained at all stages to exclude external influences on the quality of meat.

Statistical analysis

All data were processed using SPSS version 26.0 (IBM Corp., USA) and Microsoft Excel 2019. Results are presented as mean ± standard deviation (SD). Data normality and variance homogeneity were verified with the Shapiro–Wilk test. Differences among groups at each sampling time (7, 14 and 21 days) were evaluated by one-way ANOVA followed by Tukey's HSD post hoc test. When assumptions for parametric analysis were not met, the Kruskal–Wallis test was applied. Statistical significance was accepted at $P<0.05$. Mean values with different superscript letters (a, b, c) in the tables differ significantly. The identical letters indicate no significant difference.

RESULTS

Muscovy ducks and drakes in the six experimental groups received a single oral dose of 0.1mL/kg and 0.2mL/kg of ivermectin on day 7, day 14, and day 21 to collect blood samples. The resultant hematological and biochemical parameters are provided in Table 1-4.

Baseline showed all the cohorts with a normal clinical status and hematologic values within the reference ranges. On the 7th day after treatment, erythrocyte counts increased significantly ($P<0.05$) in drakes which received 0.1mL/kg of ivermectin as compared with the control. Whereas, the group which received 0.2mL/kg group showed a moderate and non-significant rise. There were slight variations in leukocyte counts in all groups, which did not significantly differ with pre-treatment or control levels ($P>0.05$), which, however, did not indicate any case of inflammation and immunosuppression. Hemoglobin concentrations remained within the normal physiological range (144–151g/L). Only a minor and non-significant increase was observed at 0.1mL/kg after 14 days, which was followed by restoration of baseline values by day 21.

The erythrocyte sedimentation rate (ESR) ranged between 3.9 and 5.4mm/h between groups and sampling days. The changes were not significant and fell within reference limits, and confirmed that there were no changes in plasma viscosity or red-cell morphology by ivermectin. By the 14th and 21st days, all the hematological parameters (erythrocytes, leukocytes, hemoglobin, ESR) of the treated ducks and drakes were brought to pre-treatment levels with no significant differences ($P>0.05$) to the control group (Fig. 1).

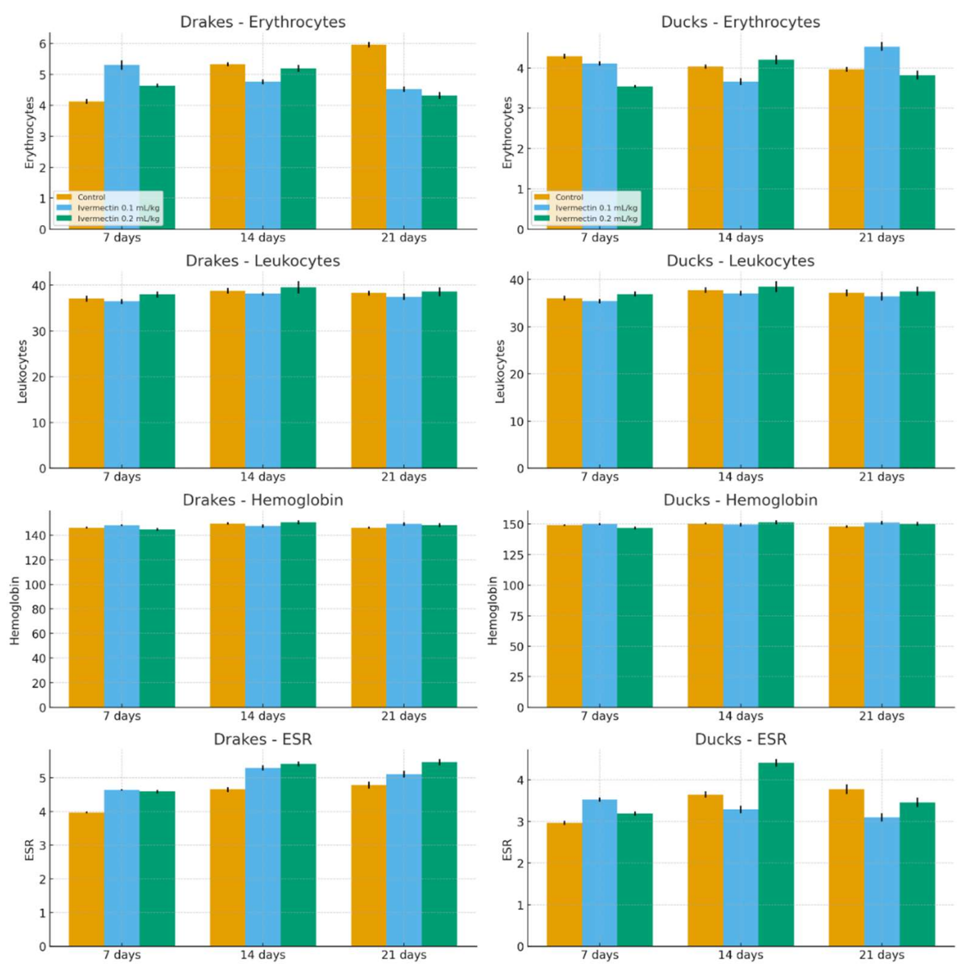

Fig. 1: Panel comparison of hematological parameters in drakes (left column) and ducks (right column) following administration of ivermectin at doses of 0.1mL/kg and 0.2mL/kg over 7, 14, and 21 days. Each bar represents the mean ± standard deviation (SD) for the respective treatment group. Measured parameters include erythrocyte count ($\times10^{12}$/L), leukocyte count ($\times10^{9}$/L), hemoglobin concentration (g/L), and erythrocyte sedimentation rate (ESR, mm/hour).

Table 1: Hematological parameters of drakes after administration of ivermectin in different doses

Indicators	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)
	After 7 days			14 days			21 days		
Erythrocytes, $\times 10^{12}$/L	4.13 ± 0.08^{b}	5.31 ± 0.15^{a}	4.64 ± 0.06^{b}	5.33 ± 0.06^{a}	4.76 ± 0.08^{b}	5.20 ± 0.11^{ab}	5.96 ± 0.09^{a}	4.53 ± 0.09^{c}	4.32 ± 0.11
Leukocytes, $\times 10^{9}$/L	37.05 ± 0.63^{a}	36.45 ± 0.58^{a}	37.95 ± 0.62^{a}	38.75 ± 0.60^{a}	38.10 ± 0.39^{a}	39.55 ± 1.35^{a}	38.25 ± 0.53^{a}	37.45 ± 0.71^{a}	38.55 ± 0.92^{a}
Hemoglobin, g/L	146.15 ± 0.71^{b}	148.05 ± 0.72^{a}	144.75 ± 1.11^{b}	149.45 ± 0.95^{a}	147.45 ± 1.29^{a}	150.55 ± 1.73^{a}	146.00 ± 0.87^{b}	149.10 ± 1.49^{a}	148.20 ± 1.57^{a}
ESR, mm/hour	3.97 ± 0.03^{c}	4.63 ± 0.02^{b}	4.59 ± 0.05^{b}	4.65 ± 0.07^{b}	5.29 ± 0.08^{a}	5.41 ± 0.07^{a}	4.78 ± 0.10^{b}	5.10 ± 0.10^{b}	5.46 ± 0.09^{a}

Note: Values are expressed as mean±standard deviation (SD). Different superscript letters (a, b, c) within the same row indicate significant differences between treatment groups ($P<0.05$). Identical letters denote no significant difference.

Table 2: Hematological parameters of ducks after administration of ivermectin in different doses

Indicators	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)
	After 7 days			14 days			21 days		
Erythrocytes, $\times 10^{12}$/L	4.29 ± 0.06^{a}	4.11 ± 0.05^{ab}	3.54 ± 0.03^{b}	4.03 ± 0.05^{b}	3.66 ± 0.08^{c}	4.20 ± 0.11^{a}	3.96 ± 0.06^{b}	4.53 ± 0.11^{a}	3.82 ± 0.11^{b}
Leukocytes, $\times 10^{9}$/L	36.05 ± 0.53^{a}	35.45 ± 0.48^{a}	36.95 ± 0.52^{a}	37.75 ± 0.60^{a}	37.10 ± 0.49^{a}	38.55 ± 1.15^{a}	37.25 ± 0.73^{a}	36.45 ± 0.91^{a}	37.55 ± 0.92^{a}
Hemoglobin, g/L	149.15 ± 0.61^{ab}	150.05 ± 0.74^{a}	146.75 ± 1.15^{b}	150.45 ± 0.75^{ab}	149.45 ± 1.39^{ab}	151.55 ± 1.73^{a}	148.00 ± 0.97^{b}	151.10 ± 1.59^{a}	150.20 ± 1.57^{a}
ESR, mm/hour	2.97 ± 0.05^{c}	3.53 ± 0.05^{b}	3.19 ± 0.05^{c}	3.65 ± 0.08^{b}	3.29 ± 0.09^{c}	4.41 ± 0.09^{a}	3.78 ± 0.12^{b}	3.10 ± 0.10^{c}	3.46 ± 0.11^{b}

Note: Values are presented as mean ± standard deviation (SD). Different superscript letters (a, b, c) within the same row indicate statistically significant differences between treatment groups ($P<0.05$). Identical letters denote no significant difference

Table 3: Biochemical parameters of the blood of drakes after application of Ivermectin in different doses

Indicators	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)
	After 7 days			14 days			21 days		
Total protein, g/L	35.20±0.61^{a}	34.64±0.72^{ab}	34.46±0.75^{b}	33.15±0.44^{b}	34.83±1.02^{ab}	36.02±0.99^{a}	34.65±1.18^{b}	33.75±0.88^{b}	36.61±0.21^{a}
Albumins, g/L	19.35±0.49^{a}	15.62±0.55^{b}	16.01±0.34^{b}	14.61±0.78^{a}	13.52±0.07^{ab}	13.26±0.47^{b}	14.35±1.01^{a}	12.38±0.63^{b}	14.21±0.17^{a}
Globulins, g/L	18.13±0.78^{ab}	19.00±0.69^{a}	18.05±0.66^{b}	17.87±0.79^{b}	18.24±0.33^{b}	21.08±0.82^{a}	19.00±0.13^{b}	19.27±0.31^{b}	20.61±0.19^{a}
Alanine transaminase (ALT), unit/L	40.15±0.75^{a}	40.82±0.99^{a}	39.93±0.06^{a}	40.50±0.99^{a}	38.47±0.56^{ab}	39.43±0.64^{ab}	39.84±0.85^{a}	39.27±1.13^{a}	40.64±1.60^{a}
Aspartate aminotransferase (AST), unit/L	73.75±1.14^{a}	76.45±0.98^{a}	74.82±0.71^{a}	74.12±0.95^{a}	75.42±1.32^{a}	76.18±0.99^{a}	76.52±0.78^{a}	75.71±0.84^{a}	75.41±0.60^{a}
Glucose, mmol/L	6.52±0.18^{b}	7.04±0.28^{ab}	7.19±0.26^{a}	6.19±0.26^{b}	8.23±0.54^{a}	7.04±0.11^{ab}	8.50±0.28^{a}	7.72±0.33^{ab}	7.80±1.24^{ab}

Values are expressed as mean ± standard deviation (SD). Different superscript letters (a, b, c) within the same row indicate statistically significant differences between treatment groups (P<0.05). Identical letters denote no significant difference.

Table 4: Biochemical parameters of the blood of ducks after application of Ivermectin in different doses

Indicators	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)	Control (mean±SD)	Ivermectin 0.1mL/kg (mean±SD)	Ivermectin 0.2mL/kg (mean±SD)
	After 7 days			14 days			21 days		
Total protein, g/L	40.20±0.81^{ab}	39.64±0.92^{b}	40.46±0.95^{a}	38.15±0.94^{b}	40.83±1.06^{a}	41.02±0.99^{a}	40.58±1.04^{ab}	40.93±0.86^{a}	40.79±1.07^{a}
Albumins, g/L	18.35±0.49^{a}	17.72±0.55^{ab}	18.11±0.50^{a}	17.81±0.78^{b}	19.42±0.87^{a}	18.26±0.47^{ab}	18.34±0.68^{a}	18.19±0.71^{a}	18.26±0.47^{a}
Globulins, g/L	22.13±0.78^{ab}	21.70±0.69^{b}	22.05±0.66^{a}	20.47±0.79^{b}	21.44±0.63^{b}	23.08±0.82^{a}	22.25±0.53^{b}	21.70±0.69^{b}	23.08±0.82^{a}
ALT, unit/L	38.15±0.55^{a}	38.82±0.69^{a}	37.93±0.56^{a}	38.50±0.79^{a}	36.47±0.76^{ab}	37.43±0.64^{ab}	37.81±0.57^{ab}	38.52±0.81^{a}	37.43±0.64^{b}
AST, unit/L	71.75±1.04^{a}	74.45±0.92^{a}	72.82±0.91^{ab}	72.12±0.95^{b}	73.42±1.02^{ab}	74.18±0.89^{a}	74.33±0.92^{ab}	74.45±0.92^{a}	74.18±0.89^{a}
Glucose, mmol/L	8.52±0.28^{b}	9.04±0.28^{ab}	9.19±0.26^{a}	8.19±0.46^{b}	9.23±0.64^{a}	9.04±0.41^{a}	9.49±0.37^{a}	9.04±0.28^{ab}	9.04±0.41^{ab}

Values are presented as mean ± standard deviation (SD). Different superscript letters (a, b, c) within the same row indicate statistically significant differences between treatment groups (P<0.05). Identical letters denote no significant difference.

There was a very pronounced stability of serum biochemical composition between treatments (Table 3 and 4). There was a slight, non-significant rise in total protein content in both ivermectin-treated groups after 14 days, and the values were between 34 and 41g/L, which were within physiological ranges. Ducks that were treated had slightly lower concentrations of albumin compared with controls, particularly at 0.1mL/kg, but this difference was not significant (P>0.05). The globulin fractions were more inclined to increase slightly at higher dose indicating a short-term response of the immune system but within the reference range. Enzymatic liver activity (ALT and AST) was normal in all birds. ALT ranged between 37 and 41U/L and AST between 72 and 76U/L, with no significant dose-related or time-related effect (P>0.05). These results suggest that hepatocellular injury or metabolic stress did not occur after the administration of ivermectin. On day 14, serum glucose had been slightly increased in treated ducks, especially at 0.1mL/kg on day 14 (P>0.05), which corresponded to mild stimulation of the metabolism; nevertheless, all the levels of serum glucose were within the physiological range of Muscovy ducks (6–9mmol/L). None of the biochemical markers showed signs of toxicity or interfered with protein, carbohydrate, or hepatic metabolism (Fig. 2).

Post-slaughter veterinary-sanitary inspection showed that there were no pathological changes that could be associated with ivermectin. The birds showed a normal post-mortem appearance, which is characterized by well-drained muscle, even color, and clean skin without blood spots. The freshness and marketability of the meat of experimental and control groups in the study were established through organoleptic judgment (Table 5 and 6). The color of the carcass on the surface was yellowish-gray and slightly reddish; the fat under the skin was pale yellow; and the serous membranes were shiny and moist. Incision of muscle tissue presented normal red color, moderate humidity, and elastic consistency. The broth during cooking was clear, fragrant, and without coagulated particles, like fresh and healthy meat.

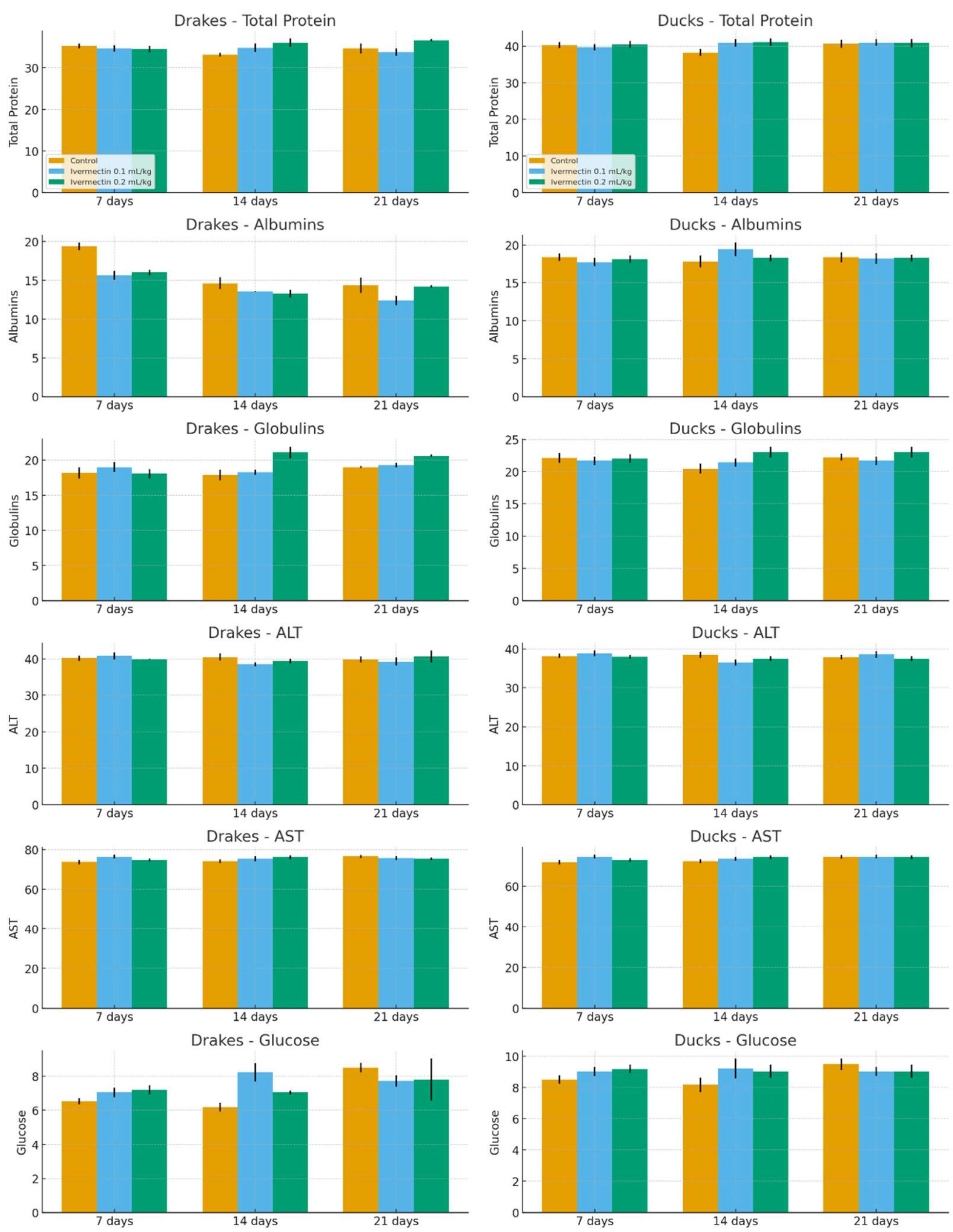

Fig. 2: Panel comparison of biochemical blood parameters in drakes (left column) and ducks (right column) following administration of ivermectin at doses of 0.1mL/kg and 0.2mL/kg over 7, 14, and 21 days. Each bar represents the mean ± standard deviation (SD) for the respective treatment group. Measured biochemical indicators include total protein (g/L), albumins (g/L), globulins (g/L), alanine transaminase (ALT, U/L), aspartate aminotransferase (AST, U/L), and glucose (mmol/L).

Table 5: Organoleptic parameters of poultry meat

Experimental groups	
Group 1 (0.1mL/kg)	Group 2 (0.2mL/kg)
Appearance and color of the carcass surface	
The color of the carcass varies from yellowish-gray to reddish. The skin is clean, without bruises or feathers and has a noticeable drying crust.	
The appearance and color of subcutaneous and internal adipose tissue	
The fat shows no signs of spoilage, such as fatty overgrowth or a rancid smell. A pale yellow color and a small amount in the tail of the carcass characterize the subcutaneous fat. The inner fat has a pronounced yellow color.	
Appearance and color of the serous membrane of the abdominal cavity	
The color is pale pink, with a slight moisture that gives it a shine, and there are no signs of slime or mold.	
The appearance and color of the muscle on the incision	
The muscles show good development. The cut of the tissue has a red tint, the surface is slightly moistened, and no liquid is released upon contact with the filter paper.	
Consistency	
The muscles have good turgor. Palpation determines the rapid recovery of the skin fold after pressure is applied.	
Odor	
It has a pleasant and characteristic aroma characteristic of fresh and high-quality poultry meat of this species.	
Transparency and odor of broth	
A clear broth with a delicious aroma was topped with large drops of fat that had gathered on the surface.	

Table 6: Physicochemical parameters of poultry meat

Group	Indicator			
	pH	Reaction to primary decomposition products of proteins	Reaction to peroxidase	Amino ammonia nitrogen, mg
Experimental 1 (0.1mL/kg)	5.76±0.41^a	negative	positive	0.58±0.02^b
Experimental 2 (0.2mL/kg)	5.88±0.15^a	negative	positive	0.56±0.02^b
Control	5.83±0.26^a	negative	positive	0.69±0.04^b
Reference values	5.8-6.2	negative	positive	<1.26

Note: Values are presented as mean ± standard deviation (SD). Different superscript letters (a, b) within the same column denote statistically significant differences between groups (P<0.05). Identical letters indicate no significant difference.

The physicochemical parameters of meat (Table 5) were in accordance with reference standards. The mean pH of the 0.1mL/kg and 0.2mL/kg groups and the controls were found to be 5.76, 5.88, and 5.83, respectively, and there were no significant inter-group differences (P>0.05). All the samples showed negative reactions to primary protein decomposition products ($CuSO_4$ test), which confirmed the lack of protein degradation. The positive peroxidase activity in all groups was associated with normal oxidative enzyme activities in fresh meat. Amino-ammonia nitrogen was found to be significantly lower (P<0.05) in treated ducks, by 15% and 18% of 0.1 and 0.2mL/kg, respectively, than in controls (0.69mg). This loss signifies reduced proteolytic action and slower build-up of nitrogenous decomposition items, a positive outcome of meat freshness. Surface swabs revealed only small quantities of microorganisms that were limited to superficial layers, but the deep muscle tissues were sterile; therefore, no tissue degradation and bacterial flora proved the microbiological safety and freshness of meat after ivermectin treatment.

DISCUSSION

The present study demonstrates that a single therapeutic dose of ivermectin in healthy Muscovy ducks produces minimal changes in blood morphology and serum biochemistry, while leaving meat quality characteristics largely unaltered (Bueno et al. 2017; Ali and Reshag 2021). All measured indicators remained within normal physiological limits, and treated birds showed meat quality comparable to that of untreated controls. These findings confirm that therapeutic doses of ivermectin are safe for Muscovy ducks under the conditions of this study. Overall, the findings suggest a high safety margin for ivermectin in ducks, aligning with prior research in poultry where standard doses had no deleterious effects on physiological parameters (Arisova 2020).

Ivermectin administration did not significantly alter erythrocyte and leukocyte profiles in Muscovy ducks, as post-treatment red blood cell (RBC) counts, hemoglobin (Hb) concentration, and total leukocyte counts were comparable to untreated controls. This outcome is consistent with studies in chickens, which report that recommended ivermectin doses produce no adverse changes in hematological values. Arisova (2020) noted that chickens given 400µg/kg oral ivermectin twice showed hematocrit, RBC, Hb, and leukocyte levels indistinguishable from controls, all falling in the physiological range. Indyuhova et al. (2022) similarly found that a therapeutic dose of an ivermectin-based formulation caused no hematological disturbances in layer hens, whereas even a three-fold dose only led to mild, transient shifts (e.g., ~10% decline in RBC count and ~3% drop in Hb at day 8) that reversed by day 17. Likewise, a recent study in rabbits receiving weekly ivermectin (0.24mg/kg for 4 weeks) showed slight decreases in RBC count and packed cell volume by day 30, but no change in Hb and no clinical anemia, suggesting that repeated exposure can subtly affect erythropoiesis in sensitive species (Salahal-Zuhairy et al. 2024).

It is worth contrasting these findings in healthy ducks with cases where ivermectin is used therapeutically in parasitized animals. In parasite infestation, ivermectin treatment often leads to improvements in hematological status as the parasitic burden is relieved. For example, the untreated mange-infested goats were treated with a single dose of ivermectin (0.2mg/kg SC), which led to a significant increase in the number of RBC counts, Hb, and packed cell volume. The chronic mange caused anemia and low levels of proteins in the untreated goats, and the value of blood levels of the treated goats returned to normal after the removal of parasites (Habeeb 2015; Gariglio et al. 2022). Similar hematologic rebounds have been reported in poultry helminthiasis. Angel et al. (2019) noted depressed Hb and hematocrit in naturally infected Aseel hens, which slowly improved when ivermectin was used, with the treated hens recording a significantly higher Hb 2-4 weeks after treatment and untreated controls remaining anaemic.

Ivermectin application showed no negative changes in serum biochemical parameters in ducks, especially liver and metabolic parameters. Liver enzyme activities, i.e., alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels, were also found in normal physiological range after treatment with no significant difference from the control values. This confirmed that there was no hepatocellular injury or ivermectin enzyme induction (Chia et al. 2022). We find these results as consistent with those of Al-Najmawi and Al-Zubaidy (2024), who found that even large oral doses of ivermectin in chicks did not increase ALT or AST levels. Moving toward the application, Indyuhova et al. (2022) found no differences in chicken plasma proteins or ALT at the standard dose of ivermectin. In present study, given a single therapeutic dose to ducks, we detected no such enzyme elevations even at the earlier sampling points, indicating that the hepatic cells were essentially undisturbed by the treatment. The ratio of AST:ALT in treated ducks was also not different, and it further indicated the normal functioning of the hepatic system. These results give a good indication that ivermectin at a normal dose does not inhibit the liver function of the duck.

Besides the enzymes, the study also tested metabolites such as glucose and lipids. Ducks treated with ivermectin showed similar blood glucose concentrations to the controls, which showed that carbohydrate metabolism was not disturbed. This is in agreement with the majority of reports that ivermectin does not have significant effects on avian glycemic status. Indyuhova et al. (2022) reported a slight reduction in blood glucose levels in chickens treated with three times the standard ivermectin dose, which the authors attributed to a temporary disturbance in hepatic glycogen mobilization caused by the high drug exposure. Nonetheless, the chickens on the normal dose did experience a slight rise in glucose (~23 percent on day 8), which might indicate a slight stimulation of metabolism or lower stress levels in the treated birds. Anyways, the changes were small and soon normalized. Our study indicated that ivermectin did not induce hypoglycemia or hyperglycemia; values have remained within the normal range of waterfowl. Our study didn't find any such effect at therapeutic levels, which is in line with the normal lipid metabolic profile after treatment.

The indicators of protein metabolism were stable as well. The total protein, albumin, and globulin concentrations in ivermectin-treated ducks showed no major changes. The level of albumin: globulin ratio was normal, which means that both the hepatic synthetic activity and immune protein synthesis were not negatively impacted. Normal protein levels are maintained, which is consistent with the literature, in which the levels of protein synthesis were not altered by ivermectin. According to Indyuhova et al. (2022), hepatic protein synthesis changes were absent even in their triple-dose group (no decrease in total protein), and they explained this by the stable protein metabolism of the liver. At the time point studied, our ducks did not demonstrate any protein decrease. The results support the conclusion that a single dose of ivermectin is not hepatotoxic; the medication does not impair hepatocyte functioning and does not produce protein-losing issues.

Beyond live health parameters, our study examined whether ivermectin impacts the quality of duck meat, which is crucial for consumer acceptance and safety. The results show that meat from ivermectin-treated ducks was organoleptically and chemically equivalent to meat from untreated ducks. There were no detectable differences in color, texture, or odor of the meat, indicating that the drug did not impart any off-flavors or abnormal appearance. Ducks typically exhibit a slightly acidic muscle pH after the post-mortem decline; values around 5.5-6.2 at 24 hours post-slaughter are considered normal for duck breast meat (Wang et al. 2025). In our study, the ultimate pH of duck meat fell in this range for both groups, and ivermectin had no effect on the pH decline rate. This indicates that the post-mortem glycolysis (conversion of muscle glycogen to lactic acid) proceeded normally in treated ducks, with no evidence of either excessive stress (which can lead to high initial pH and DFD meat) or any glycolytic disruption that could cause aberrant pH. Thus, ivermectin did not induce either PSE (pale, soft, exudative) or DFD (dark, firm, dry) meat defects; the muscle acidification was normal, reflecting good meat quality.

Other meat quality attributes, such as moisture content, tenderness (shear force) and color, were not adversely affected (based on our organoleptic assessment and pH stabilization). If anything, the normal pH and lack of drip loss issues suggest that water-holding capacity remained high, and there were no textural defects. The meat color in both groups was the characteristic reddish-pink for duck muscle; there was no paleness or darkening induced by treatment. Similar conclusions have been drawn in chickens: for example, studies investigating ivermectin as a feed additive for parasite control reported no differences in meat quality metrics between treated and untreated broilers (meat pH, tenderness, and spoilage counts remained normal) (Mestorino et al. 2017). Our study extends this reassurance to ducks, indicating that producers can use ivermectin to improve duck health without fear of downgrading the meat.

A key aspect of using any drug in food animals is ensuring it leaves no harmful residues in edible products. Our findings underscore that ivermectin, when used at a single therapeutic dose in ducks, is not only clinically safe for the animals but also leaves negligible residues in the meat by the time of slaughter (as reflected indirectly by the normal meat quality indices and presumed undetectable drug levels). This outcome is supported by pharmacokinetic and residue studies in poultry. Ivermectin is known for its rapid distribution and elimination in chickens: after oral dosing, peak plasma levels occur within 0.5–1 hour and decline sharply within hours, dropping below quantification by 12–24 hours (Arisova 2020).

The findings from this study have direct practical relevance for poultry veterinarians and duck producers. The essentially negligible impact of ivermectin on duck health parameters and meat quality supports its use as a safe antiparasitic in duck farming. Ducks, especially Muscovy and Pekin ducks, are often raised in environments where they can be exposed to internal parasites (worms) or external parasites (mites, lice) similarly to chickens. Yet, there are few anthelmintics explicitly approved for ducks. Our results provide evidence that ivermectin – a broad-spectrum endectocide widely used in other animals – can be employed in ducks without harming the birds or rendering their meat unfit. Our findings also carry implications for animal welfare. By confirming ivermectin's safety, we encourage its responsible use to alleviate parasitic diseases that cause suffering (such as mites causing "scaly-leg" in ducks or Giardia causing enteritis). Often, backyard duck owners or organic farmers hesitate to use pharmaceuticals, but evidence-based reassurances like ours can help them make informed decisions to treat their birds.

Conclusion

The present study demonstrated that the administration of ivermectin at single doses of 0.1 and 0.2mL/kg body weight in clinically healthy Muscovy ducks and drakes did not cause any adverse effects on their physiological, hematological, or biochemical parameters. All measured indicators remained within the normal physiological ranges throughout the observation period, indicating that the drug did not disrupt metabolic or hematopoietic functions. Veterinary and sanitary assessments confirmed that the meat of treated birds retained its freshness, characteristic odor, and normal organoleptic and physicochemical properties, with no evidence of tissue degradation or the presence of residual drug amounts when withdrawal periods were respected. These findings provide scientific justification for the safe use of ivermectin in Muscovy duck farming. Given the increasing importance of effective anthelmintic management in poultry production, the results support the inclusion of ivermectin as a reliable antiparasitic treatment under controlled dosing conditions. Furthermore, this work contributes to improving food safety standards and consumer confidence in duck meat products. Future studies should focus on long-term administration and residue dynamics in tissues to further strengthen the regulatory framework for Ivermectin use in waterfowl species.

DECLARATIONS

Funding: The study was conducted within the framework of grant funding for fundamental and applied scientific research on scientific and/or technical projects for 2024-2026, under the project AP23488151, "Progressive resource-saving technologies for the production of meat and hatching eggs of Muscovy ducks".

Acknowledgement: The authors acknowledge the funder and anonymous reviewers for improving the quality of manuscript.

Conflict of Interest: The authors have no conflict of interest to declare.

Data Availability: The supplementary data can be available from the corresponding author on a reasonable request.

Ethics Statement: All animal procedures were approved by the Ethics Committee of NJSC "West Kazakhstan Agrarian and Technical University named after Zhangir Khan" (Uralsk, Republic of Kazakhstan), Approval No. 07/2025, dated July 12, 2025. The study was conducted in accordance with the national legislation of the Republic of Kazakhstan on animal welfare and internationally accepted ethical standards for the use of animals in research. All procedures were performed by trained personnel to minimize stress and ensure humane treatment of the birds.

Author's Contribution: A. Shamshidin: Conceptualization, experimental design, and supervision of laboratory work. A. Nugmanova: Data curation, statistical analysis, manuscript drafting, and correspondence with the journal. A. Sabyrzhanov: Experimental execution, sample collection, and analysis of hematological and biochemical data. A. Abylgazinova: Biochemical assays, data interpretation, and validation of analytical results. Zh. Makhimova: Preparation of figures and tables, literature review, and manuscript editing. Y. Batyrgaliyev: Data visualization, results interpretation, and technical support in laboratory procedures. Y. Sengaliyev: Critical review, discussion formulation, and approval of the final manuscript. All authors have read and approved the final version of the manuscript and agree to be accountable for its contents.

Generative AI Statement: The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

Publisher's Note: All claims stated in this article are exclusively those of the authors and do not necessarily represent those of their affiliated organizations or those of the publisher, the editors, and the reviewers. Any product that may be evaluated/assessed in this article or claimed by its manufacturer is not guaranteed or endorsed by the publisher/editors.

REFERENCES

Ali MA and Reshag AF, 2021. Morphometrical and histological changes in domestic duck salt glands in response to salinated water. Plant Archives 21(1): 338-342.

Al-Najmawi TK and Al-Zubaidy MH, 2022. Acute toxicity events of ivermectin in chicks' model. Iraqi Journal of Veterinary Sciences 36(4): 1119-24. https://doi.org/10.33899/ijvs.2022.133188.2188

Angel C, Akhter N, Arijo A, Qureshi TA, Gandahi JA and Qazi IH, 2019. Comparative efficacy of ivermectin and *Nigella sativa* against helminths in Aseel chickens (*Gallus gallus domesticus*). Journal of Helminthology 93(5): 533-8. https://doi.org/10.1017/S0022149X18000718

Arias-Sosa LA and Rojas AL, 2021. A review on the productive potential of the Muscovy duck. World's Poultry Science Journal 77(3): 565-588. https://doi.org/10.1080/00439339.2021.1921668

Arisova GB, 2020. Efficacy of ivermectin-based drugs against ectoparasites in broiler chickens. World's Veterinary Journal

10(2): 160-4. https://dx.doi.org/10.36380/scil.2020.wvj20

Bueno JPR, Nascimento MRB de M, Martins JM da S, Marchini CFP, Gotardo LRM, Sousa GMR de, Mundim AV, Guimarães EC and Rinaldi FP, 2017. Effect of age and cyclical heat stress on the serum biochemical profile of broiler chickens. Semina: Ciências Agrárias 38(3): 1383-1392. https://doi.org/10.5433/1679-0359.2017v38n3p1383

Canton L, Lanusse C and Moreno L, 2021. Rational pharmacotherapy in infectious diseases: issues related to drug residues in edible animal tissues. Animals 11(10): 2878. https://doi.org/10.3390/ani11102878

Chia S, Adagi J, Ate M and Uma K, 2022. Comparative studies on blood serum profiles of liver enzymes, proteins, total bilirubin and liver organ morphometry of Muscovy ducks. Black Sea Journal of Agriculture 5(2): 167-171. https://doi.org/10.47115/bsagriculture.1032032

Costa VR, Cruz FGG, Rufino JPF, Silva AF, Freitas BKM, Feijó JC and Guimarães CC, 2019. Available phosphorus levels in diets for Muscovy ducks in housing. Brazilian Journal of Poultry Science 21(2): 1-8. https://doi.org/10.1590/1806-9061-2018-0914

de Oliveira Carvalho DC, Gois GC, da Silva LCC, de Souza FFN, Queiroz MAÁ, Antunes KV, de Souza Rodrigues RT, Junior RGCS, de Cássia Rodrigues de Souza R, Pinheiro SRF and Neto AF, 2023. Effect of different levels of sodium in water on performance, carcass yield, and meat quality of slow-growing chickens. Tropical Animal Health and Production 55(4): 263. https://doi.org/10.1007/s11250-023-03679-0

Gariglio M, Dabbou S, Gai F, Valle E, Piacente F, Odetti P, Placha I, Gasco L and Schiavone A, 2022. Muscovy duck fed black soldier fly larvae meal: Effects on blood parameters and antioxidant status. Proceedings of "7th Mediterranean Poultry Summit", Cordoba, Spain, 8-10 June 2022.

Habeeb BK, 2015. Hematological and biochemical changes following Ivermectin treatment in mange infested goats. Al-Qadisiya Journal of Veterinary Medicine Sciences 14(1): 69-74.

Hassan FAM, Roushdy EM, Zaglool AW, Ali MA and El-Araby IE, 2018. Growth performance, carcass traits, and economic values of Pekin, Muscovy, and Mulard ducks. Slovenian Veterinary Research 55(Suppl. 20): 357-365. https://doi.org/10.26873/SVR-663-2018

He Z, 2020. Sustainable development of livestock and poultry scale-breeding based on integration control of resource losses and external environmental costs. Environmental Progress & Sustainable Energy 39(6): e13528. https://doi.org/10.1002/ep.13528

Hefnawy E, Elgazzar E, Sabek A, El-laithy S and Ahmed S, 2024. Effect of different LED light colors on welfare, performance, some behavioral patterns, and blood parameters of Muscovy ducks. BMC Veterinary Research 20: 350. https://doi.org/10.1186/s12917-024-04200-x

Indyuhova E, Arisov M, Maximov V and Azarnova T, 2022. Subchronic toxicity of ivermectin and butaphosphan in layer chickens. Journal of World's Poultry Research 12(1): 38-45. https://dx.doi.org/10.36380/jwpr.2022.5

Jamil MU, Idrees AT, Qadir ZA, Elahi ME, Imran FA, Qasim MU, Khan MS, Aziz H, Iqbal Z, Qazi IM and Sadia BI, 2022. Medical and veterinary ectoparasites' importance: An insight on alternative control. Pakistan Journal of Medical and Health Sciences 16(01): 667. https://doi.org/10.53350/pjmhs22161667

Kokoszynski D, Wilkanowska A, Saleh M, Fik M and Bigorowski B, 2021. Comparison of some meat and liver quality traits in Muscovy and Pekin ducks. Journal of Applied Animal Research 49(1): 118-124. https://doi.org/10.1080/09712119.2021.1895173

Krunt O, Zita L, Kraus A, Vejvodová K, Drábek O, Kuře J and Chmelíková E, 2023. The impact of different environments on productive performance, welfare, and the health of muscovy ducks during the summer season. Agriculture 13(7): 1319. https://doi.org/10.3390/agriculture13071319

Makhonina V, 2016. A study of the morphological and chemical composition of the meat of gutted duck carcasses to determine its grade. Poultry & Chicken Products 1: 61-64.

Mestorino N, Buldain D, Buchamer A, Gortari L, Daniele M and MarchettimL, 2017. Residue depletion of ivermectin in broiler poultry. Food Additives & Contaminants: Part A. 34(4): 624-31. https://doi.org/10.1080/19440049.2016.1278307

Mohamed R, Abou-Elnaga A, Ghazy E, Mohammed H, Shukry M, Farrag F, Mohammed G and Bahattab O, 2020. Effect of different monochromatic LED light colour and intensity on growth performance, physiological response, and fear reactions in broiler chicken. Italian Journal of Animal Science 19(1): 1099-1107. https://doi.org/10.1080/1828051X.2020.1821802

Nasr MAF, Alkhedaide AQ, Radwan MME, Hafez ASE, Hussein MA and El Bayomi RM, 2022. Growth, carcass parameters, biochemical and oxidative stress indices, and meat traits of duck breeds under different stocking densities. Poultry Science 101(9): 101992. https://doi.org/10.1016/j.psj.2022.101992

Park BS, Um KH, Park SO and Zammit VA, 2018. Effect of stocking density on behavioral traits, blood biochemical parameters, and immune responses in meat ducks exposed to heat stress. Archives Animal Breeding 61(4): 425-432. https://doi.org/10.5194/aab-61-425-2018

Phuong LT, Thuy NT and Thiet N, 2025. Effects of saline drinking water on growth performance, carcass traits, and blood biochemistry in crossbred Muscovy ducks. Veterinary World 18(4): 782-790. https://doi.org/10.14202/vetworld.2025.782-790

Saganuwan SA, 2017. Toxicity studies of drugs and chemicals in animals: an overview. Bulgarian Journal of Veterinary Medicine 20(4): 983. https://doi.org/10.15547/bjvm.983

Salahal-Zuhairy NA, Husain WM, Nasri MM and Alzand KI, 2024. Assessment Of hematological parameters in rabbits treated with ivermectin. African Journal of Biomedical Research 27(3): 1926-29. https://doi.org/10.53555/AJBR.v27i3.4714

Sartini I, Łebkowska-Wieruszewska B, Krupa M, Lisowski A, Poapolathep A and Giorgi M, 2022. Pharmacokinetics of ivermectin after oral and intravenous administration in Biłgorajska geese (Anser anser domesticus). New Zealand Veterinary Journal 70(6): 313-8. https://doi.org/10.1080/00480169.2022.2104398

Umagiliya MD, Bandara N, Jayasena DD, Macelline SP, Nawarathne SR and Manjula P, 2022. Comparison of meat quality traits in muscovy ducks reared under two different management systems. Animal Industry and Technology 9(2): 65-77. https://doi.org/10.5187/ait.2022.9.2.65

Wang L, Chen X, Yang Y, Ye S, Gong P, Wang Y, Zhai M, Wu Y and Qian Y, 2025. The effect of duck breeds on carcass composition and meat quality at different slaughter ages. Animals 15(14): 2106. https://doi.org/10.3390/ani15142106

Zhang Y, Qi S, Fan S, Jin Z, Bao Q, Zhang Y, Zhang Y, Xu Q and Chen G, 2024. Comparison of growth performance, meat quality, and blood biochemical indexes of Yangzhou goose under different feeding patterns. Poultry Science 103(2): 103349. https://doi.org/10.1016/j.psj.2023.103349

Zhang F, Chen Z, Shi J, Han C, Zhan Q, Ren Z and Yang X, 2025. Challenges and constraints to the sustainability of poultry farming in China. Animal Bioscience 38(4): 789. https://doi.org/10.5713/ab.24.0794