NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 56, Number 3, December 2025, Page 442-459
Available online at: https://www.ajol.info/index.php/naj
https://doaj.org/toc/0300-368X
Creative Commons User License CC:BY

Growth Performance and Blood Profile of Broiler Chickens Administered West African Black Pepper (*Piper guineense*)

***[1]Ezike, J. C., [1]Ezea, J., [2]Chima, M. U. and [3]Ewa, E. U.**
[1]Department of Animal Breeding and Physiology, Michael Okpara University of Agriculture, Umudike
[2]Department of Veterinary Physiology and Pharmacology, Michael Okpara University of Agriculture, Umudike
[3]Department of Animal Nutrition and Forage Science, Michael Okpara University of Agriculture, Umudike
*Corresponding author's email: ezikejohnson96@gmail.com

Abstract
Improvement in growth parameters is an important factor that determines the profitability of a broiler chicken production enterprise. West African black pepper (*Piper guineense*) is one of the plants that has strong antimicrobial sensitivity, which is being explored as an alternative antibiotic growth promoter in broiler chickens. This study evaluated the growth performance and blood profile of broiler chickens administered West African black pepper (*Piper guineense*) seed meal. One hundred and sixty (160) unsexed Ross 308 broiler chicken strain were randomly divided into 4 treatments (B_1 - B_4) in 4 replicates with 10 birds per replicate. The birds were fed a basal starter diet from 0-4 wk and a finisher diet from 5-8 wk *ad libitum*. Four levels (0.00, 0.50, 1.00, and 1.50 g) of West African black pepper seed powder (WBP) were administered through 4 litres of drinking water to B_1, B_2, B_3, and B_4, respectively, for 42 days. Data were collected on body weight changes, haematological parameters, lipid profile, liver function, and kidney function markers. The result showed a significant ($p < 0.05$) dose-dependent effect on growth parameters. Final body weight (2274.05 g) and daily weight gain (59.21 g) were lowest in birds administered 1.50 g of WBP. Daily feed intake was significantly higher (25.33 g) in birds administered 1.50 g of WBP. FCR and percentage mortality did not vary between the control and the treated birds ($p < 0.5$). Haemoglobin (7.67 g/dl), MCV (14.11fl), and MCH (34.77 pg) were statistically the same, but significantly higher in birds administered the control diet and 0.5g WBP. Red blood cell count was significantly ($p < 0.05$) higher (3.163×10^6 /µl) in birds administered 1.5g WBP than in the other treatments. Total white blood cell was significantly ($p < 0.05$) higher (35.83×10^3/µl) in the treated birds than in the control. Lipid profile was significantly ($p < 0.05$) affected by the treatments. Total cholesterol (84.72 mg/dl), triglyceride (46.98 mg/dl), and very low-density lipoprotein cholesterol (7.21 mg/dl) were significantly higher in birds administered 1.50 g WBP. The liver function markers were significantly ($p < 0.05$) affected by treatments. Glucose was higher (148.10 mg/dl) in birds administered 0.50 g, and lowest in control birds and those administered 1.00 g WBP. Total protein (3.97 g/dl), albumin (1.54 g/dl), and globulin (2.43 g/dl) concentrations were statistically the same, and significantly higher in birds 0.5g and 1.50 g WBP. AST activity was significantly higher (187.83 IU/L) in control birds, while ALP activity was significantly lower (78.83 IU/L) in birds administered 1.00 g WBP. Kidney function markers were significantly ($p < 0.05$) affected by the treatments. Creatinine (0.62 mg/dl) and urea (2.28 mg/dl) levels were higher in birds administered 0.50 g and 1.50 g WBP. Potassium and sodium ion levels were significantly lower (1.35 mmol/l) and (83.83 mmol/l) in birds administered 1.00 g WBP, respectively. In conclusion, Final body weight and daily weight gain were best in birds given 0.50 g (3334.78 g) and 1.00 g (3337.70 g), while 1.50 g compromised growth performance generally. Some haematological parameters were compromised at a higher dose (1.50 g). Birds on 0.500 g and 1.00 g generally had better lipid profiles. Liver function markers were not affected across the treatments. Lower doses, 0.50 g and 1.00 g, greatly improved the kidney function markers, while 1.50 g of WBP was toxic to the heart. It is recommended that WBP should not be administered beyond 1.00 g in broiler chicken production.

Keywords: Piper guineense, growth, haematology, kidney and liver function

Introduction

Organic farming is a farming system that does not involve the use of synthetic antibiotics and chemical supplements/additives (Diaz–Sánchez *et al*., 2015; Tăpăloagă *et al*., 2018; Bela *et al.,* 2024). Organic farming systems are usually preferred because animal health and welfare, environmental friendliness, and better quality of output are of utmost priority (Amato and Castellini, 2022). Recent survey reports indicate that organically produced crop and animal products are higher in demand, especially in developed parts of the world, than their inorganically produced counterparts (Schipmann-Schwarze and Hamm 2020; Mak *et al*., 2022). Higher demands for organically produced animal products, especially broiler chickens, have been linked to the evolution of multidrug-resistant microorganisms and widespread antibiotic residues in meat, milk, and eggs, resulting in complex public health challenges (Bela *et al*., 2024). It was projected that if unchecked, multidrug resistance would cause more human morbidity than cancer by the year 2050 (Abreu *et al*., 2023).

There are empirical facts that stringent regulatory policies have been put in place in many developed countries to tackle the issues of multidrug resistant microorganisms and antibiotic residues in edible animal products (Ogunniyi *et al*., 2025), and that production strategies have equally been evolved by farmer to meet the consumer preference and expectations (El Jeni *et al*., 2021; Gheorghe - Irimi *et al*., 2022). On the other hand, Nigeria is not proactive, resulting in high prevalence of antibiotic and chemical residues in meat, milk, and eggs sold in open Nigerian markets. For instance, Olusola *et al*. (2012), Olatoye *et al*. (2019), and Habeeb *et al*. (2022) reported that the residues of tetracycline, ciprofloxacin, oxytetracycline, deoxycycline, chlortetracycline, and gentamicine in beef, poultry meat, and catfish sold in Nigerian markets were found to be above the maximum residue limits recommended by WHO and FAO.

Although there are no statistics on multidrug-resistant-associated deaths in Nigeria, it is good to know that annual human morbidity has increased geometrically in recent times, many of which could be due to antibiotic resistance. With the abundant forests and grasslands in Nigeria, it has become imperative that Nigerians join the league of other nations to embrace organic farming and organically produce food items in the face of multidrug-resistant organisms' threats. Medicinal plants and spices are being explored across the globe as alternatives to pharmaceuticals in livestock and poultry production. Herbs and spices have been used in such forms as decoctions, extracts, and main active ingredient isolates in broiler production to enhance digestive enzyme secretions and efficiency of feed utilization (Mohamed *et al*., 2024). Zheng *et al*. (2025) reported that herbal preparations demonstrate some levels of efficacy in alleviating the challenges of pharmaceutical antibiotic overuse.

West African black pepper (*Piper guineense*), also known as Ashanti, Uziza, Iyere, Benin pepper, Guinea pepper, and false cubeb, is one of the nutraceuticals that has been evaluated and reported as a potent alternative antimicrobial feed additive (Okpiabhele and Aihiokhai, 2022; Anolaba *et al*., 2025; Ogunjesa and Alamuoye, 2025).

Empirical reports on the phytochemical composition of *Piper guineese* seed indicate the presence of alkaloids, saponins, tannins, anthraquinones, flavonoids, steroidal nucleus, carotenoids, phenols, and terpenoids (Oluwafemi *et al*., 2022; Ogunjesa and Alamuoye, 2025). It has been reported that flavonoids and saponins have antimicrobial, antioxidant, and anti-inflammatory activities, while alkaloids and phenols have potential bioactive compounds that are toxic and can predispose animals to oxidative stress at high doses (Ogunjesa and Alamuoye, 2025). Prasad et al. (2008) reported that tannins bind with protein and limit nutrient availability, resulting in compromised growth, and could be toxic at high doses. The antimicrobial activity of *Piper guineese* was corroborated by Anolaba *et al*. (2025), who reported that crude methanol extracts of *Piper guineese* seeds and leaves showed activity against *Staphylococcus aureus, Proteus mirabilis, Escherichia coli, Aspergillus flavus, Aspergillus niger, Aspergillus fumigatus, and Penicillium notatum.*

Although Okpiabhele et al. (2022) reported that oral administration of 30mg/100g body weight of Piper *guineense* seed extract for 28 days had a high degree of safety in guinea pigs, Madueke *et al*. (2021) found that continuous intake of high doses of West African black pepper seed extract impaired renal function in rats, while Anolaba *et al*. (2025) reported that a high dose (200mg) of Piper guineense seed extract affected the colon, jejunum, liver, and kidney of rats. The presence of antioxidants and anti-inflammatory compounds (flavonoids, terpenoids, and saponins) indicates a high tendency of induced organ damage at high doses due to pro-oxidative stress. This is because Sharifi-Rad *et al*. (2020) reported that curcumin switched from an antioxidant to a pro-oxidant at a high dose. A similar scenario was reported by Madueke *et al*. (2021) in Wistar rats administered a high dose of West African black pepper seed extract.

While much more works have been done on West African black pepper seed and leaves using rats and guinea pigs, scanty research reports on West African black pepper seed powder in broiler chickens formed the basis of this study, which is aimed at closing the knowledge gap. Evaluation of the blood profile is intended to establish the safe and toxic levels of West African black pepper seed powder in the experimental birds. The result of this investigation will go a long way in establishing the efficacy limit of this potent seed and in establishing a standard that could be replicated in small, medium, and large-scale broiler farms, especially in Nigeria, in the face of the high prevalence of antibiotic residues in edible animal products.

Materials and Methods

Ethical approval

The conduct of this study was approved by the research and animal welfare committee of the College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, reference number: 002/ABP/002025/PF. The experimental birds were handled according to animal welfare ethics.

Experimental location

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike. Umudike lies on coordinates 05^0 29^0 and 07^0 33' E, and an altitude of about 122 m above sea level. The average annual rainfall ranges from 1700 to 2100mm. minimum and maximum temperatures are in the ranges 18 – 23 ^{0}C and 26-36 ^{0}C, respectively; while relative humidity is 57-91 (NRCRI, 2017).

Experimental birds and management

A total of one hundred and sixty (160) unsexed ROS 308 broiler chickens were used for the study. The birds were purchased from a reputable farm in Ibadan, Nigeria, and raised in deep litter pens from day-old under standard conditions. The birds were fed a compounded starter diet containing 24.00CP and 2417 kcal/kg DM metabolizable energy from 0-4 wk and then a finisher diet containing 19.80 CP and 2430 kcal/kg DM metabolizable energy from 5-8 wk of age (42 days) as presented in Table 1. The birds were vaccinated as recommended by the National Veterinary Research Institute, Nigeria. At 3 weeks of age, the birds were randomly allotted to 4 treatments (B_1 - B_4) in a completely randomized design (CRD). Each treatment had 40 birds in 4 replicates, with 10 birds.

Procurement and preparation of the Piper guineense seed

Fresh West African black pepper seeds were purchased from Ubani Market in Abia State, Nigeria. The seeds were identified by a botanist at the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike. The seeds were sun-dried for 3 weeks, and then ground into powder with a hammer milling machine. The powder was stored in a dry, cool place in an air-tight plastic gallon.

Administration of the Piper guineense seed powder

A small quantity of the West African black powder was weighed out with a sensitive scale (XY2000-2C, PEC MEDICAL, China). B_1 (control) received only clean water, while B_2 received 0.5 g, B_3 received 1 g, and B_4 received 1.5 g of the West African black powder dissolved in 4 litres of water daily, respectively, for 42 days, starting from 5-8 weeks. Fresh, clean water was subsequently supplied where necessary.

Duration of the study

The experiment lasted for 56 wk.

Data Collection

Blood sampling and analysis

At the end of the experiment, 8 birds were randomly selected from each treatment, 2 birds from each replicate, for haematology and serum biochemistry. In each treatment, 4ml of blood was taken from the jugular vein between the hours of 8 am and 10 am with a syringe. Blood samples for haematology were dropped in sample bottles containing ethylenediaminetetraacetic acid, while samples for serum biochemistry were dropped in ethylenediaminetetraacetic acid-free sample bottles. The blood samples for haematology were assessed immediately after collection. Blood samples for serum biochemistry were kept for 30 minutes at room temperature to clot. The samples were centrifuged for 10 minutes at 3000 rpm, and the serum was harvested.

Determination of Haematological parameters

The PCV was determined by the microhaematocrit method as described by Schalm *et al.* (1975) with a microhaematocrit centrifuge and reader (Hawksley and Sons, England). Haemoglobin (Hb) was determined using a standard haemoglobinometer (Marienfeld, Germany). Red blood cells and total white blood cells were measured with a haemocytometer using Natt and Herrick's solution as diluting fluid according to Campbell (1994). The smears for white blood cell differential count were prepared and stained by the Leishman technique and enumerated by the battlement counting method (Thrall and Weiser, 2002). The Mean corpuscular volume, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration were calculated according to Schalm *et al.* (1975).

Determination of serum biochemistry

Specific Randox kit (Randox Co. UK) for each parameter was purchased, and the procedures were strictly followed during laboratory analyses. Alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP) activities, and bilirubin level were assayed with the Randox kit. Serum glucose was determined using a single-touch glucometer (Accucheck, Roche Laboratories, UK). Total protein (direct Biuret method) and albumin were assayed using the Randox kit. Globulin was calculated as the difference between total protein and albumin (Colville, 2002). Total cholesterol, triglyceride, and high-density lipoprotein cholesterol were assayed with a photospectrometer (Mindray, India) following Randox kit procedures. Low-density lipoprotein and very low-density lipoprotein cholesterol fractions were calculated according to Friedwald's equation. Urea, creatinine, Sodium, potassium, and chloride ions were assayed with a specific Randox kit.

Experimental Model

The experiment was conducted using a Completely Randomized Design (CRD) with the statistical model stated below:

The model of the design is $Y_{ij} = \mu + B_i + e_{ij}$

Where

Y_{ij} = Single observation, i.e., j^{th} observation on the ith treatment.

μ = Overall mean

B_i = the effect of the i^{th} level of treatment

e_{ij} = Experimental error

Statistical Analysis

The data collected were subjected to one-way analysis of variance using SAS 2006 software. Significantly different means were separated using The Turkey Multiple Range Test (Tukey, 1977). Significantly different means were accepted at 5% confidence level.

Results

Growth performance of broiler chickens administered WBP

The result shows significant ($p < 0.05$) differences in growth performance parameters, except for feed conversion ratio and percentage mortality. Final body weight (2274.05 g) and daily weight gain (28.67 g) were lowest in birds administered 1.5g of WBP. Daily feed intake was significantly higher (146.8 g) in birds administered 1.50 g of WBP. FCR was lower, and statistically the same in birds administered 0.50 g and 1.00 g WBP compared to the other treatments. Percentage mortality did not vary ($p < 0.05$) between the control and the treated birds (Table 2).

Haematological parameters of broiler chickens administered WBP

Haematological parameters were significantly ($p < 0.05$) affected by the treatment, except HCHC. Hb and PCV were significantly lower (6.33 g/dl) and (26.67%) respectively in birds administered 1g of West African black pepper seed powder (WBP) compared to the other treatments. RBC was significantly higher (3.16 $x10^6$ mm^3) in birds administered 1.5g of WBP compared to the other treatments. WBC count was significantly higher and the same (36.67 $x10^3$ mm^3) in the treated groups than in the control. MCV and MCH were significantly lower (100.91 fl) and (22.87 pg) in birds on 1.50 g WBP, respectively (Table 3).

Lipid Profile of broiler chickens administered WBP

The lipid profile was significantly ($p < 0.05$) affected by WBM treatment. Total cholesterol (84.72 mg/dl), triglycerides (46.98 mg/dl), and VLDL-C (7.21 mg/dl) were significantly higher in birds administered 1.5g of WBP. HDL-C was higher (61.14 mg/dl) and lowest (40.97 mg/dl) in birds administered 0.50 mg/dl and 1g of

WBP ($P < 0.05$), respectively, while LDL-C was significantly higher (30.53 mg/dl) and the same in birds administered 1g and 1.5 g WBP (Table 4).

Liver Function Markers of broiler birds administered WBP

Liver function markers were significantly ($p < 0.05$) affected by the treatment, except ALT. Serum glucose was significantly higher (148.00 g/dl) in birds administered 0.50 g WBP. Total protein was significantly higher (4.04 g/dl) and (3.97 g/dl) in birds given 0.50 g and 1.50 g WBP. Albumin was significantly higher and statistically the same (1.5 g/dl) in control and those treated with 0.05 and 1.50 g WBP. Globulin concentration was higher (2.43 g/dl) and similar in birds administered 0.50 g and 1.5 g of WBP compared to the other treatments. AST was significantly lower and statistically the same (125.37 IU/L) in birds administered 1g and 1.50g WBP. ALT values did not vary between the control and the treated birds, while ALP activity was significantly higher (92.580 IU/L) in birds on 0.50 g and lowest (78.83 IU/L) in birds on 1.00 g WBP (Table 5).

Kidney function markers of broiler chickens administered WBP

Kidney function markers were significantly ($p < 0.05$) affected by the treatments, except for chloride ions. Urea (2.27 mg/dl), creatinine (0.61 mg/dl), and Potassium (3.07 mEq/l) were significantly higher in birds administered 1.50 g WBP compared with the other treatments. Sodium ion significantly higher and statistically the same (125.39 mEg/L) in birds administered 0.00, 0.50, and 1.50 g than those on 1.00 g WBP (Table 6).

Discussion

Our result shows a dose-dependent effect on growth performance indices. The significantly higher final live body weight and daily weight gain we recorded in this study were the same as those of El-Kashef (2022), Animashahum *et al.* (2022), and Mohamed *et al*. (2024) on broiler chickens, Noiler chickens, and broiler chickens fed dietary ginger (0.25, 0.50, and 0.75%), *Parkia biglobosa* leaf meal (5.00, 10.00, and 15.00%), and *Piper nigrum* powder (2.50, 5.00, and 7.50%), *respectively*. In contrast, Ijoma *et al*. (2024) found no significant differences in growth performance between male ROS 308 broiler chickens fed 2.50 g/kg West African black pepper and the control group. Dosage, sex, stocking density, the way the test ingredient was given to the birds, and the source of the test ingredient could be implicated in the difference between our results and the contrasting report.

While we used unsexed ROS 308 broilers, a lower dose through the drinking water was used in the other study; in-feed West African black pepper was used on only the males at a higher dose. In this study, the higher live weight and daily weight gain in birds on 0.50 and 1.00 g WBP could be attributed to the antioxidant, anti-inflammatory, and antimicrobial effects of Piperine and other phytochemical contents in *Piper guineense* seed.

Our result supports earlier empirical findings that West African black pepper seeds contain phytochemical compounds that increase the activities of pancreatic protease, lipase, and amylase, which improve nutrient digestion and absorption, and improve gut health by reducing microbial metabolites, which suppress growth (Ogunmefun *et al*., 2017).

The higher feed intake we recorded in control birds and those on higher dose (1.50 g) WBP aligns with Adegoke *et al*. (2015) on broiler chicken fed 100 g/kg dietary cayenne pepper powder. The reason for the higher feed intake recorded in the control birds could be to balance the energy expenditure due to the increased rate of absorptive epithelial cell turnover and the energy lost to competing opportunistic microbes. For birds on the highest dose, higher feed intake could be to balance calorie loss due to increased metabolic rate caused by hyperactivation of the appetite control centre, and digestive enzyme secretions by the active components of *Piper guineense*.

The significant reduction in live weight we found in birds given the highest dose (1.50 g) WBP is supporting finding of Ndelekwute *et al*. (2016) on broiler chickens fed diets supplemented with 0.75% and 1% *Piper nigrum*. Similarly, decreased body weight was reported in mice given a high dose of a pharmaceutical antibiotic that drastically reduced the gut microbiota (Murphy *et al*., 2013; Cox *et al*., 2014). The significantly lowered live body weight in birds on high doses of the WBP appears to confirm earlier findings of Al-Mufarrej *et al.* (2019) that a dietary blend of cloves above 2% negatively affected growth performance in broiler chickens.

The decrease in general growth performance at higher doses in our study could be attributed to the stronger antimicrobial effect of the WBP, corroborating Ogunmefun *et al.* (2017) that aqueous extract of *Piper guineense* seed could be used as an alternative antibiotic. Nevertheless, increased weight gain recorded in our study was not accompanied by a significant improvement in feed conversion ratio, which is usually observed with antibiotic growth promoters. This indicates that the mechanisms of growth promotion with WBP are quite different from those of conventional antibiotics. From our observation, improvement in growth performance with WBP is dependent on optimization of the tolerable levels, which we found to be 0.50 g and 1.00 g/ 4litre of drinking water, above which growth was compromised.

Blood parameters are paramount in determining the state of health of an animal, its nutritional condition, and the physiological state (Kareem *et al*., 2024). Changes in blood parameters induce disease conditions (Klasing and Korver, 2020). The result of our investigation shows a dose-dependent effect of WBP on the haematological parameters. Similar trend was reported by Animashahun *et al*. (2022), Adegoke *et al*. (2024), Ijoma *et al*. (2024), Aikpitanyi *et al*. (2024) and Islam *et al*. (2025) on Noiler chickens and finisher broiler chickens fed dietary *Parkia biglobosa* leaf meal (5, 10 and 15%), cayenne pepper (100 g – 400 g/kg), *Piper guineense* seed powder (2.5 g/kg), *Piper nigrum* and red pepper (1.5%) and Renamycin* vet (1.00 g/l) respectively.

This result contrasts those of Aribo *et al*. (2019) and Anolaba *et al*. (2025) on albino rats treated with 200 and 500 mg/ml of methanol *Piper guineense* seed extract. Generally, PCV, Hb, and MCH are the main indices used for appraising circulating erythrocytes, and in anaemia diagnosis, and the ability of the bone marrow to produce red blood cells (Campbell, 2013). Increases in MCHC indicate good condition of the blood, while low levels of MCH and MCHC indicate anaemia. An increase in red blood cell count (polychromasia) is associated with nutritional deficiency, especially iron (Campbell, 2012). It was

empirically established that Polyphenolic compounds present in red pepper limited iron absorption in broiler chickens (Siripon *et al*., 2006). It was also found that *Piper guineense* seeds contain abundant quantities of polyphenols (Ogunjesa and Alamuoye, 2025; Madueke *et al*., 2025).

The significant reduction in Hb we found in birds on 1.00 g and 1.5 g WBP could be linked to the binding of circulating iron in the blood to the polyphenol, leading to the reduced Hb concentration. Similar scenarios were recorded earlier on broiler chickens (Galib *et al*., 2011; Al-Kassie, 2012). The PCV values in our study were within the normal range (25-45%) for broiler chickens (Mitruka and Rawnsley, 1997), and also similar to the range reported by Aikpitanyi *et al*. (2024) in broiler chickens' dietary blends of black pepper and red pepper. The significantly higher RBC count, with lowered MCV and MCH values, we recorded in birds given 1.5 g of WBP confirms anaemia, indicating that daily administration of 1.5 g of WBP could limit iron circulation in the blood and potentiate anaemia in broiler chickens.

High WBC count in the blood is a sign of trauma, stress, nutritional toxicity, or neoplasm, while a low count is an indication of chronic inflammation, microbial invasion, or impaired bone marrow function (Doneney and Doneney, 2010). The significantly higher WBC counts we observed in the treated birds compared with the control support Al-Sultan (2003), Adegoke *et al*. (2018), and Aikpitanyi *et al* (2024), who found higher WBC counts in broiler chickens dietary inclusions of turmeric, turmeric and black pepper, and cayenne pepper, respectively. Our finding contrasts those of Ijoma *et al*. (2024) on broiler chickens fed diets containing turmeric and *Piper guineense* seed powder. Nutritional toxicity and stress could be implicated in the higher WBC count we found in the treated groups than in the control. The increase in WBC count could be attributed either to a physiological/ humoral antibody response by the birds to WBP intake or a sensitization of the bone marrow by the stem cells to suppress the degenerative effect of the piperine absorbed by the body tissues (Adegoke *et al*. 2018).

The significant reductions in total cholesterol, triglyceride and high-density lipoprotein and very low-density lipoprotein cholesterol we observed in birds given 0.50 g and 1.00 g of WBP agree with Imasuen and Ijeh (2017), Maradi *et al.* (2016), and Ijoma *et al* (2024) on broiler chickens fed diets containing garlic, black pepper, and hot red pepper; black pepper, and West African black pepper respectively.

The significant increases in cholesterol and triglycerides we found in birds on the highest dose were also reported by Sayeed *et al*. (2016) on broiler chickens fed diets containing black pepper and red pepper. The significant increase in HDL-c we recorded in birds on 0.50 g of WBP supports those of Adegoke *et al*. (2018) and Ijom *et al*. (2024) on broiler chickens fed diets supplemented with 200 g of turmeric and 2.50 g/kg *Piper guineense* seed powder, respectively. Although the range of cholesterol we recorded was within the 88.00-110.67 mg/dl reported by Ijoma *et al*. (2024) on male ROS 308 broiler chickens. High serum cholesterol and triglyceride levels are indicators of overfeeding, liver disease, or steatosis, while low levels are linked to starvation or high body exercise. The reason for the reduction in total cholesterol, triglycerides, HDL-c, and VLDL-c in our study

could be attributed to the hypocholesterolemic and hypolipidaemic effects of piperine and other phytochemical constituents in WBP.

The mechanisms by which lipids were reduced in birds given WBP in our study could be inferred from earlier studies by Puvača, *et al*. (2015) who noted that phytobiotics (rich in flavonoids, terpenoids and saponins) reduce cholesterol and triglycerides either by limiting Acetyl-CoA synthase activities or by suppressing the enzymes that synthesize cholesterol and lipoprotein in the liver, leading to reductions in the serum concentrations of triglycerides and cholesterol. The observed surge in cholesterol and triglycerides in birds on high dose 1.5 g of WBP in our study could be due to overfeeding, as shown in Table 2 of this study.

The significantly higher serum glucose we recorded in birds on the lowest dose of WBP supports the reports of Imasuen and Ijeh (2017), Adedoyin *et al*. (2019), and Aikpitanyi *et al*. (2024) on broiler chickens fed diets containing black pepper and ginger, black pepper, black pepper and red pepper, respectively, but disagrees with Adedoyin *et al*. (2019), who found no differences in glucose levels of broiler chickens fed a diet containing red pepper. Since an increase in serum glucose level could be due to growth, feed intake, and high productivity (Platel and Sirinivasan, 4004), the high glucose level we found in the group administered 0.50 g WBP could be attributed to the effect of piperine on adrenocorticotropic hormone, which enhanced growth and production in the birds.

Blood proteins (albumin and globulin) are mainly synthesized by the liver and are very important in the transport of hormones, the regulation of blood pH, blood volume, biochemical reactions, and the body's line of defense (Campbell, 2012; Melillo, 2013).

Hypoproteinemia in birds is associated with hypoalbuminemia and hypoglobulinemia due to overhydration during fluid therapy or a proportional loss of albumin and globulins. Hypoproteinemia with hypoalbuminemia also occurs due to starvation, malnutrition, intestinal malabsorption, and intestinal parasite infestation, resulting in amino acid deficiencies (Campbell, 2012). Total protein concentration within the normal reference range indicates normal synthetic activity of the liver (Campbell, 2012). An increase in globulin level indicates improved humoral immune systems of the host as well as enhanced hepatic function of the liver (Ayodele *et al.,* 2021). Also, higher serum total protein indicates a better health condition (Kraus *et al.,* 2021; Aikpitanyi *et al*., 2024).
The significantly higher total protein, albumin, and globulin levels we recorded in birds administered 0.50 g and 1.50 g of WBP support those of Aikpitanyi *et al*. (2024) on broiler chickens fed dietary black pepper and red pepper. However, our result is in contrast to that of Ijoma *et al* (2024) on broiler chickens fed diets containing *Piper guineense* seed powder and *Curcuma longa* rhizome powder. Earlier research reports showed that total protein in the blood is influenced by genotype, sex, age, housing/management system, species, and nutrition (Albokhadaim *et al.,* 2012), which could be responsible for the difference between our results and the contrasting results.

Since the total protein concentration fell within the normal range (2.50-4.50 g/dl). Since drinking water was offered *ad libitum* (ruling out dehydration) and there was no case of

disease outbreak during our study, the increases in total protein in the birds on 0.50 g to 1.50 g of WBP could be attributed to higher protein efficiency and enhanced hepatic function.

Evaluation of liver enzyme activities is important in the determination of the health status of the liver (Ambrosy *et al.,* 2015). Increases in liver enzymes (AST, ALT, and ALP) indicate liver injuries/disease, while lower levels indicate good liver health (Robin, 2012). The significantly lower AST and ALP we observed in birds on higher doses in our study were similar to the report of Ijoma *et al*. (2024) on broiler chickens fed dietary *Piper guineense* seed and turmeric powder*,* and in part to those of Aikpitanyi *et al*. (2020) and Aikpitanyi *et al*. (2024) on broiler chickens fed dietary pepper and ginger, and black pepper and red pepper, respectively. Our result is in contrast to Imasuen and Ijeh (2017) and Adedoyin *et al*. (2019), who found no change in AST, ALT, and ALP concentrations in broiler chickens fed a diet containing black pepper. Elevated levels of ALT, AST, total protein, and total cholesterol are sensitive biomarkers for possible liver toxicity (Abozaid *et al*., 2018). In our study, ALT, AST, total protein, and total cholesterol did not increase in a definite pattern, which eliminates the chances of liver assault. An increase in AST that potentiates liver toxicity is indicated when it is greater than 275 IU/L, while the normal range for ALT in birds is 19-50 IU/L (Campbell, 2012).

In our study, the AST and ALT values we obtained across the treatments were within the range that does not suggest liver toxicity. Since skeletal growth, nutritional deficiency and coccidial infection can increased levels of ALP in birds (Campbell, 2012), the higher AST and ALP we recorded in birds fed control diet and those on 0.5 g WBP could be attributed to skeletal growth activities in some birds in those groups, because the birds were adequately fed, and there were no cases of coccidiosis in the farm during the experimental period. Our finding indicates that the doses of the WBP we used were tolerable and improved liver functions.

Serum electrolytes such as urea, creatinine, sodium, potassium, and chloride ions are useful in monitoring kidney health (Folorunsho *et al*., 2019). High levels of urea and creatinine are the major indicators of compromised kidney function (Balogun *et al*., 2014). The significantly higher urea and creatinine levels we found at a particular dose (1.50 g) are in agreement with Balogun *et al*. (2014) and Folorunsho *et al*. (2019) on Wistar rats administered higher doses of *Lagenaria breviflora* fruit extract. In contrast to our result, Okpiabhel and Aihiokhai (2022) found significantly lower urea and creatinine, but higher levels of sodium, potassium, and bicarbonate ions in *Cavia porcellus* administered 10, 100, and 1,000 mg/kg body weight of *Piper guineense* seed extract. Duration of administration and species differences could be implicated for the discrepancy between our results and those of Okpiabhele and Aihiokha. Since an increase in serum potassium ion level is associated with heart disease (Folorunsho *et al*., 2019), the elevated potassium ion level we observed in birds administered the highest dose of WBP suggests induction of heart disease, probably due to contraction of the heart vessels. Our finding aligns with those of Madueke *et al*. (2021), who reported renal toxicity in Wistar rats subjected to continuous intake of a high dose of *Piper guineense* seed extract. Similarly, Anolaba *et al*. (2025) reported that a high dose (200mg) of *Piper guineense* seed extract

affected the kidney functional integrity of albino rats. However, the significant increase in Na^+ concentration in birds administered LBFJ is a pointer to the relative blood water to Na^+ ratio, which is an indication of normal function of the nephrons and enhanced membrane integrity of the kidney cells. This supports the report of Ajani *et al*. (2015) on Wistar rats. Browse (2005) found a positive correlation between Na^+ reabsorption and Cl^- reabsorption, while Cl^- is associated with HCO_3 excretion (Folorunsho *et al*., 2019). It has also been reported that decreases in Cl^- and HCO_3 concentrations suggest tubular and glomerular dysfunction (Chawla, 1999). In our study, Cl^- did not vary between the control and treated birds. The HCO_3 was not measured in our study to ascertain its relationship with the Na^+ and Cl^- and confirm the tubular and glomerular functions of the birds. Our result appears to suggest that the toxic effect of the WBP at a higher dose (1.50 g) was more pronounced on the heart than the kidney.

Conclusion

The result of our study shows a dose-dependent effect of *Piper guineense* seed powder on growth performance, haematological parameters, lipid profile, liver function, and kidney function of the broiler chickens. Final body weight and daily weight gain were best in birds given 0.50 g and 1.00 g, while 1.50 g compromised growth performance generally. Haematological parameters were compromised more at a higher dose (1.50 g). Birds on 0.500 g and 1.00 g generally had better lipid profiles. Liver function markers were not affected across the treatments. Lower doses, 0.50 g and 1.00 g, greatly improved the kidney function markers, while 1.50 g of WBP affected some kidney function parameters, but had a more pronounced toxic effect on the heart. In conclusion, 0.50 g and 1.00 g WBP are tolerable and could be used to improve growth performance and general wellbeing of broiler chickens. It is therefore recommended that administration of WBP through the drinking water should not exceed 1.00 g in broiler chickens.

References

Abozaid, O. A. R., El-shawi, O. E., Aziza, S. A. H., and Abu-Elazm, A. (2018). Safety and/or toxicity of acute dual propolis and ginger co-treatment in female albino rats. *BenhaVaterinary Medical Journal,* 34(1): 453 - 460.

Abreu, R., Semedo-Lemsaddek, T., Cunha, E., Tavares, L. and Oliveira, M. (2023). Antimicrobial drug resistance in poultry production: current status and innovative strategies for bacterial control. *Microorganisms*, 11: 953. https://doi.org/ 10.3390/microorganisms11040953.

Adedoyin, I. A., Yusuf, I. A., Oni, O. O., and Oladunjoye, I. O. (2019). Effect of red pepper (*Capsicum annum*) on growth performance and blood parameters of broiler chickens. *Nigerian Journal of Animal Science*, 21(2), 157-168.

Adegoke, A.V., Abimbola, M.A., Sanwo, K.A., Egbeyale, L.T., Abiona, J.A., Oso, A.O., and Iposu, S. O. (2018). Performance and blood biochemistry profile of broiler chickens fed dietary turmeric (*Curcuma longa*) powder and cayenne pepper (*Capsicum frulenscens*) powder as antioxidants. *Veterinary and Animal Science*, 6:96 – 102.

Aikpitanyi, K. U. and Egweh, N. O. (2020). Haematological and biochemical profile of broiler chickens fed diets containing ginger and black pepper additives. *Nigerian Journal of Animal Science,* 22(2): 114 – 125.

Aikpitanyi, K. U. and Imasuen, J. A. (2020). Evaluation of growth performance and blood

parameters of broilers fed pepper and ginger additives. *Nigerian Journal of Animal Science*, 22(2), 100-108.

Aikpitanyi, K. U. and Imasuen, J. A. (2024.). Influence of dietary black pepper and red pepper additives on the haematological and biochemical profiles of broiler chickens. *International Journal of Advanced Research in Biological Science,* 11(10): 55-69.DOI:http://dx.doi.org/10.22192/ijarbs.2024.11.10.005.

Ajani, E. O. Sabiu, S., Bamisaye, F. A., Ibrahim, S., and Salanu, B. A. (2015). Evaluation of the acute sub-acute toxicity effects of ethanolic leaves extract of Lagenaria breviflora (Bitter gourd) on hepatic and renal function of rats. *European Journal of Medicinal Plants*, 5(2): 210-219.

Albokhadaim, I., Althnaian, T. and El-Bahr, S. M. (2012). Investigation of some selected biochemical parameters of local chickens of different ages and sexes in Al-ansa, Saudi Arabia. *Pakistan Journal of Biological Sciences*, 15(19):827-832.

Al-Mufarreji. I., Fazea, E.H., Al-Baadani, H.H., and Qaid, M.M. (2019). Effect of clove powder supplementation on performance, blood biochemistry, and immune response in broiler chickens. *South African Journal of Animal Science*, 49(5): 835- 844.

Al-Sultan, S.I. and Gameel, A.A. (2004). Histopathological changes in the livers of broiler chickens supplemented with turmeric (*Curcuma longa*). *International Journal of Poultry Sci*ence, 3: 333-336. https://doi.org/10.3923/ijps.204.333.336.

Amato, M., Castellini, C. (2022). Adaptability challenges for organic broiler chickens: a commentary. *Animals*, 12(11), 1354. https://doi.org/10.3390/ani12111354.

Ambrosy, A.P., Dunn, T.P. and Heidenreich, P.A. (2015). Effect of Minor Liver Function Test Abnormalities and Values within the Normal Range on Survival in Heart Failure. American Journal of Cardiology, 115(7), 938–941. https://doi.org/10.1016/j.amjcard.2015.01.023

Amimashahum, R.A., Alabi, O.O., Okeniyi, F.A., Olawoye, S.O., Shoyombo, J.A. and Falana, B. M. (2022). Performance and blood profile of Noiler Chickens fed diets containing graded levels of *Parkia biglobosa* leaf meal. *Food Research*, 6(5); 256 – 265.

Anolaba, C. I., Ugwu, P. N., and Didam, J. G. (2025). Toxicity of crude methanol extract of Piper guineense (uziza) seeds and leaves. *Global Science Journal*, 13 (11): 285-304. www.globalscientificjournal.com.

Aribo, E.O., Udefa, A.L., and Beshel, F.N. (2019). Consumption of aqueous leaf extract of *Piper guineense* alters hematological and biochemical parameters in Wistar rats. *Saudi Journal of Biomedical Research,* 4:3-4

Ayodele, A. D., Tayo, G. O., Olumide, M. D., Adeyemi, O. A., and Akanbi, A. S. (2021). Haematological and serum biochemical response of pullet chicks fed diets containing single and combined levels of turmeric and clove. *Nigerian Journal of Animal Production*, 48(3): 71 - 85.

Balogun, M. E., Ajayi, A. F, Oji, O. J., Besong, E. E., Finbarrs–Bello, E., and (2014). Toxicological and biochemical studies of ethanolic fruit extract of Adenopus breviflorus (Lagenaria breviflora Roberty). *American Journal of Phytomedicine and Clinical Therapeutics,* 2(9) 111 2 – 1123.

Bela, S.I., Tăpăloagă, D., Sonea, C., Gheorghe-Irimia, R. A., Roșu, P. M., Al Dulaimi, M. K. H. and Tăpăloagă, P.R. (2024). Organic vs. conventional: a comparative review of health-related welfare issues and their economic impact on poultry production. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development,* 24 (2):165-174.

Browse, N. (2005). Introduction to the symptoms and signs of surgical diseases (4th edition), book power, USA.

Campbell, T. W. (1994). Haematology. In: Avian Medicine: Principles and Application. (BW Ritchie, GJ Harrison, L R. Harrison, editors). Winger Publishers Incorporated, Lake Worth, Florida, USA. Pp. 279-198.

Campbell, T.W. (2012). Hematology of birds. Veterinary Hematology and Clinical Chemistry. Second Edition by Mary Anna Thrall. Glade Weiser, Robin W. Allison, and Terry W. Campbell. John Wiley and Sons. Inc. publisher. Pp. 238 - 276.

Chawla, R. (1999). Kidney Function Test. In: Practical Clinical Biochemistry, Methods and Interpretation. (2nd edition), New Delhi, India Pp. 90-92.

Colville, J. (2002). Blood chemistry. In: Hendriy CM (ed) Laboratory procedures for veterinary technicians, 4th edition, Mosby Inc., St. Louis, Pp. 75-103.

Cox, L.M., S. Yamanishi, J. Sohn, A.V. Alekseyenko, L.M. Leung, I. Cho, S.G. Kim, H. Li, Z. Gao, D. Mahana et al. (2014). Altering the intestinal microbiota during a critical developmental window has lasting metabolic consequences. *Cell*, 158:705–721. doi:10.1016/j.cell.2014.05.052.

Díaz-Sánchez, S., D'Souza, D., Biswas, D., Hanning, I. (2015). Botanical alternatives to antibiotics for use in organic poultry production. *Poultry Science*, 94(6), 1419-1430. https://doi.org/10.3382/ps/pev014.

Doneley, B., & Doneley, A. (2010). Blood profiles and white blood cell count implications in poultry health. *Journal of Avian Medicine*, 22(2):108-112.

El Jeni, R., 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), 101156. https://doi.org/10.1016/j.psj.2021.101156.

El-Kashef, M.M.A. (2022). Evaluation of using ginger (*Zingiber officinale*) on growth performance, carcass characteristics, blood biochemistry, and immune response of quail birds. *Egyptian Poultry Science*, 42(11): 199-212.

Folorunsho, A.A, Olorunnisola, O.S., Adetutu, A., and Owoade, A.O. (2019). Prolonged administration of methanolic whole fruit extract of *Lagenaria breviflora* (Benth.) Roberty provokes oxidative stress and kidney dysfunction in male Wistar rats. *Journal of Bioanalysis and Biomedicine*, 11:142-148. doi:10.4172/1948-593X.1000225.

Galib, M. A., Ahmed, M. H., and Haroon, M. R. (2011). Dietary hot red pepper and its effect on white blood cell count in broilers. Journal of Poultry Science, 3(2), 120-127.

Gheorghe-Irimia, R. A., Tăpăloagă, D., Militaru, M., Georgescu, M. (2022). Prospects for using essential oils in the meat industry: A review. *Revista Romana de Medicina Veterinaria*, 32, 43-50.

Habeeb, M.L., Opasola, A.O., Garba, M., Olalekan, M.R. (2022). A wake-up call: determination of antibiotic residue level in raw meat in abattoir and selected slaughter houses in five local governments in Kano State. *Nigerian Journal of Veterinary and Health Science*, 3: 54-61.

Ijoma, D.C., Oranye, H.C., Chukwudi, P., and Ndofor-Foleng. H.M. (2024). Dietary impact of West African black pepper (*Piper guineense*) and turmeric (*Curcuma longa*) on the growth performance, carcass traits, haemato-biochemical profile, and oxidative stress markers of broiler chickens. Discover Animals, 2024: 1-21. https://doi.org/10.1007/s44338-04-00020-3.

Imasuen, J. A., & Ijeh, O. F. (2017). Effect of black pepper and ginger on glucose levels in

broilers. *Nigerian Journal of Animal Production*, 44(3), 105-115.

Islam, M.M., Islam, M.S., Sujan, K.M., and Miah, M.A. (2025). Growth progression and hematobiochemical dynamics in broiler chickens treated with antibiotics, probiotics, and acidifiers. *Open Veterinary Journal*, 15 (8): 3477-3485.

Kareem, D.U., Amos, A.T., Idowu, O.P.A., Bonagurio, L.P., and Idowu, O.M.O. (2024). Blood profile as a health indicator in broiler chickens fed diets of different particle sizes supplemented with multienzyme. Agricultura Tropica Et Subtropica, 57(45): 45-59. https://doi.org/10.2478/ats-2024-0005.

Klasing, K. C, & Korver, D. R. (2020). In D. E. Swayne, M. Boulianne, C. M. Logue, L. R. McDougald, V. Nair, & D. L. Suarez (Eds.), *Nutritional diseases. Pages 1257-1285 in Diseases of Poultry* (14th ed.). Hoboken, New Jersey, USA: Wiley Blackwell.

Kraus, A. Zita, L., Krunt, O., Hartlova, H., and Chemlikova, E. (2021). Determination of selected biochemical parameters in blood serum and egg quality of Czech and Slovak native hens depending on the housing system and hen age. *Poultry Science*, 100:1142 - 1153.

Madueke, S. P., Ugwu, P. I., Uru, C. A., Okeke, A. P., Omire-Oluedo, O. M., Ugwu, S. U., Nwannadi, V. I., and Nwachukwu, D. C. (2021). Continuous intake of high doses of Piper guineense (ashanti pepper) aqueous seed extract impairs renal function in Wistar rats. *Biosciences Biotechnology Research Asia,* 18 (3): 585-590.http://dx.doi.org/10.13005/bbra/2942. www.globalscientificjournal.com

Mak, P., Rehman, M., Kiarie, E., Topp, E., Diarra, M. (2022). Production systems and important antimicrobial-resistant pathogenic bacteria in poultry: a review. *Journal of Animal Science and Biotechnology*, 13(1). https://doi.org/10.1186/s40104-022-00786-0.

Melillo, A. (2013). Serum proteins and their role in avian health. *Journal of Veterinary Research*, 44(4), 303-315.

Mitruka, B. M., and Rawnsley, H. M. (1977). Clinical biochemical and haematological reference values in normal experimental animals. (Pp. 134 - 135). Masson Publishing Inc.

Mohamed, R. E.G., Tork, M. D., and Ibrahim, A. E.S. (2024). Effects of black pepper (*Piper nigrum*) as feed additives on growth performance, carcass traits, some blood parameters, and gut morphology in broiler chickens. *Egyptian Poultry Science Journal*, 44 (IV): 403-415. http://www.epsj.journals.ekb.eg/

Moradi, S., Azizi, S. and Taghipour, A. (2016). Comparative study of herbal additives on cholesterol and lipid profiles in broilers. *Poultry Science Journal*, 11(3), 115-123.

Murphy, E.F., Cotter, P.D., Hogan, A., Sullivan, O. O., Joyce, A., Fouhy, F., Clarke, S.F., Marques, T.M. O'Toole, P. W. Stanton, C. Quigley, E Daly, C., Ross, P., O'Doherty, R., and Shanahan, F. (2013). Divergent metabolic outcomes arising from targeted manipulation of the gut microbiota in diet-induced obesity. *Gut,* 62:220–226. doi: 10.1136/gutjnl2011-300705

Ndelekwute, E. K., C. O. Okereke, U. L. Unah, and E. M. Assam (2016)**.** Carcass yield, meat quality, and internal organs of broiler chickens fed diets containing ground black pepper (*Piper nigrum*). *Nigerian Journal of Animal Production*, 43:281–288.

NRCRI (2017). Agro-meteorological Unit, National Root Crop Research Institute, Umudike, Umuahia, Nigeria.

Ogunjesa, A. B. and Alamuoye, O. F. (2025). Characterization of Turmeric and West African Black Pepper as Potential Livestock

Feed Additives. *African Journal of Agriculture and Food Science*, 8(2), 1-8. DOI: 10.52589/AJAFSHFZVTHX1.

Ogunniyi, T. J., Fatokun, B. S., Isah, K. O., Abdulbaki, A., Emiola, A. R., and Batisani, K. (2025). Current Status of Cancer Diagnosis and Treatment in Nigeria. *Health Science Reports*, Pp. 1-7 https://doi.org/10.1002/hsr2.70877.

Okpiabhele, A. O. and Aihiokhai, M. O. (2022). Effects of *Piper guineense* (African Black Pepper) seeds on lipid profile, renal function parameters, and antioxidant status of Cavia porcellus*. Medical Laboratory Journal,* 16 (5): 1-8. DOI: 10.29252/m1j.16.5.3

Olatoye, O.I., Ojomo, T.O., Adeseko, Y.J. (2019). Antibiotic use and gentamicin residues in commercial poultry and chicken eggs from Oyo and Lagos States, Nigeria. *Revue d'élevage et de Médecine Vétérinaire des pays Tropicaux,* 72 (4): 161-165. DOI: 10.19182/REMVT.31510.

Olayinka, T. O., Akharaiyi, F.C.and Adegunle, S. J. (2017). Phytochemical and antimicrobial properties of *Piper guineense* (Shumach and Thonn) on selected human pathogens. Journal of Chemical and Pharmaceutical Research, 9(11):180-186. www.jocpr.com

Olusola. J. A., Makinde, O. J., Egena, S. S. A., Mbajiorgu, F.E., and Adewara, O.A. (2024). Review article: Antibiotics in broiler chicken production: a review of impacts, challenges, and potential alternatives. *Veterinary Integrative Sciences*, 559-578. Website; www.vet.cmu.ac.th/cmvj.

Oluwafemi, A.G., Ajayi, O.B., and Oseni, O.A. (2022). Phytochemical screening, nutritional composition, and antioxidant activities of turmeric (Curcuma longa) found in Ado-Ekiti, Nigeria. Journal of Applied Life Sciences International, 25 (1): 1-8. https://doi.org/10.9734/jalsi/2022/v25iI30278.

Platel, K. and Srinivasan, K. (2004). Homeostatic regulation of blood glucose in poultry is influenced by dietary spices. *Journal of Poultry Science*, 22(2), 65-75.

Prasad, N.R., Viswanathan, S., Devi, J.R., Nayak, V., Swetha, V.C., Archana, B.R., Parathasarathy, N., Rajkumar, J. (2008). Preliminary phytochemical screening and antimicrobial activity of *Samanea saman*. *Journal of Medicinal Plants Research* 2(10):268–270.

Puvača, N., Kostadinović, L., Ljubojević, D., Lukač, D., Lević, J., Sanja Popović, S., Novakov, N., Vidović, B., and Đuragić, O. (2015). Effect of garlic, black pepper, and hot red pepper on productive performances and blood lipid profile of broiler chickens. *European Poultry Science*, 79: 1-13. DOI: 10.1399/eps.2015.73

SAS (2006). Statistical Analysis System. SAS User's Guide: Statistics SAS Institute Inc., Cary, NC, USA.

Sayeed, A., Ahmed, M. I., and Bhuyan, A. H. (2016). Comparative study of black and red pepper on lipid profiles in poultry. *Poultry Science Journal*, 17(2), 34-43.

Schalm, O. W., Jain, N. C., and Card, E. J. (1975). Veterinary Haematology. 3rd ed. Lea and Febiger Philadephia, 51-81.

Schipmann-Schwarze, C., Hamm, U. (2020). Exploring drivers and barriers for organic poultry consumption. *British Food Journal*, 122(12): 36793693. https://doi.org/10.1108/bfj-11-2018-0787.

Sharifi-Rad, J., Rayess, Y.E., Rizk, A., Sadaka, C., Zgheib, R., Zam, W., Sebtito, S., Rapposelli, S., Neffe-Skocinska, K., Zielinska, D., Salehi, B., Setzer, W.N., Dosoky, N.S., Taheri, Y., Beyrouthy, M.E., Martorell, M., Ostrander, E.A., Suleria, H.A.R., Cho, W.C., Maroyi, A and Martins, N. (2020). Turmeric and its major compound curcumin on health: bioactive effects and safety profiles for food

pharmacological and medicinal applications. *Frontiers in Pharmacology*, 11:1 – 23.

Tăpăloagă, D., Tăpăloagă, P.R., Ilie, L.I., Georgescu, M., Dinita, G. (2018). From conventional to organic agriculture - Romanian past and future perspectives. *Scientific Papers-Series D-Animal Science*, 61(1), 239-244.

Thrall, M. A. and Weister, M.G (2002). Haematology In: Laboratory Procedures for Veterinary Technicians (CM Hendrix, editor), fourth edition. Mosby incorporated, mission, Pp. 29 – 74.

Turkey, J.W. (1977). Exploratory data analysis. Addison-Wesley. Reading, MA.

Zheng, S., Li, Y., Chen, C, Wang, N., and Yang, F. (2025). Solutions to the dilemma of antibiotics use in livestock and poultry farming: regulation policy and alternatives. *Toxics*, 13-348. https:// doi.org/10.3390/toxics13050348.

Table 1: Experimental Diets: Composition and Calculated Analysis

Parameter / Ingredients	Starter	Finisher
Ingredient Composition (% inclusion)		
Maize	47.00	62.30
Wheat offal	14.00	10.00
Palm kernel meal	4.00	2.00
Soybean meal	10.10	7.00
Groundnut cake	15.00	8.00
Fish meal	6.20	8.00
Bone meal	3.00	2.00
Premix	0.25	0.25
Salt	0.25	0.25
Lysine	0.10	0.10
Methionine	0.10	0.10
Total %	**100.00**	**100.00**
Calculated Nutrient Analysis		
Crude protein (%)	23.00	20.00
Energy (kcal/kg ME)	2808	3000
Lysine (%)	1.18	1.04
Methionine (%)	0.42	0.40
Crude fibre (%)	4.78	4.41
Calcium (%)	1.50	1.19
Phosphorus (%)	0.70	0.60

Vitamin mineral premix supply: Vitamin A (1500IU), Vitamin D3 (1600IU), Riboflavin (9.0mg), Biotin (0.25mg), Pantothenic acid (11.0mg), Vitamin K (3.0mg), Vitamin B2 (2.5mg), Vitamin B12 (8.0mg), Nicotinic acid (8.0mg), Iron (5.0mg), Selenium (0.01mg), Magnesium (10.0mg), Zinc (4.5mg) and Cobalt (0.02mg)/kg feed.

Table 2: Growth performance of broiler chickens administered WBP

Parameters	B1	B2	B3	B4	SEM
Initial body weight (g)	421.66	421.67	421.69	421.67	0.01
Final body weight (g)	2639.17^{c}	3334.78^{a}	3337.70^{a}	2274.05^{c}	118.35
Daily weight gained (g)	39.50^{b}	46.93^{a}	46.66^{a}	28.67^{c}	1.92
Daily feed intake (g)	146.02^{a}	110.74^{b}	110.99^{b}	146.80^{a}	4.59
FCR	3.70^{a}	2.36^{c}	2.38^{c}	5.13^{a}	0.30
Mortality (%)	0.12	0.10	0.10	0.10	0.01

Means along the same row with different superscripts are significantly (p<0.05) different. SEM= standard error of mean, FCR= feed conversion ratio

Table 3: Haematological parameters of broiler chicken administered WBP

Parameters	B_1	B_2	B_3	B_4	SEM
Hb (g/dl)	7.60^{a}	7.67^{a}	6.33^{b}	6.87^{ab}	0.21
PCV (%)	31.33	31.33	26.67	30.67	1.19
RBC (x $10^{6}mm^{3}$)	2.19^{b}	2.21^{b}	2.14^{b}	3.16^{a}	0.16
WBC (x $10^{3}mm^{3}$)	23.68^{b}	38.17^{b}	35.53^{ab}	36.67^{a}	2.46
Lymphocytes (%)	86.33	90.67	90.00	89.00	1.22
Heterophils (%)	13.64	9.33	10.00	10.67	1.26
Basophil (%)	0.00	0.00	0.00	0.00	0.00
Monocyctes (%)	0.00	0.00	0.00	0.00	0.08
Eosinophils (%)	0.00	0.00	0.00	0.33	0.11
MCV (fl)	142.97^{a}	142.10^{a}	124.43^{ab}	100.91^{b}	6.69
MCH (pg)	34.26^{a}	34.77^{a}	29.53^{ab}	22.87^{b}	1.75
MCHC (g/dl)	24.26	24.53	23.74	22.92	0.51

Means along the same row with different superscripts are significantly (p < 0.05) different. SEM = standard error of mean, Hb = haemoglobin, PCV = packed cell volume, RBC= red blood cell count, WBC= total white blood cell count, MCH = mean corpuscular hemoglobin, MCV = mean corpuscular volume, TWBC = total white blood cells count, MCHC = mean corpuscular hemoglobin counts

Table 4: Lipid Profile of broiler chickens administered WBP

Parameters	B_1	B_2	B_3	B_4	S.E.M
Cholesterol (mg/dl)	77.58^{b}	75.69^{b}	72.05^{c}	84.72^{a}	1.48
Triglycerides(mg/dl)	28.74^{b}	18.01^{c}	21.84^{c}	46.98^{a}	2.20
HDL-C(mg/dl)	56.17^{a}	61.14^{a}	40.97^{c}	46.98^{b}	2.47
VLDLC(mg/dl)	5.75^{b}	3.60^{c}	4.37^{c}	7.21^{a}	0.44
LDL-C(mg/dl)	15.67^{b}	10.93^{b}	26.74^{a}	30.53^{a}	2.61

Means within a row with different superscripts are significantly different (P<0.05); HDL-C = High Density Lipoprotein cholesterol, VLDL-C = Very Low Density Lipoprotein cholesterol, LDL-C = Low Density Lipoprotein cholesterol, SEM = Standard Error of Mean

Table 5: Liver Function Markers of broiler chickens administered WBP

Parameters	B_1	B_2	B_3	B_4	S.E.M
Glucose(mg/dl)	107.00 ^{c}	148.00^{a}	108.00^{c}	118.00^{b}	5.11
Total Protein(g/dl)	3.41^{b}	4.04^{a}	3.42^{b}	3.97^{a}	0.09
Albumin(g/dl)	1.49^{ab}	1.54^{a}	1.45^{b}	1.54^{a}	0.01
Globulin(g/dl)	1.92^{b}	2.50^{a}	1.96^{b}	2.43^{a}	0.08
AST (IU/L)	172.23^{a}	187.83^{a}	108.07^{b}	125.37^{b}	6.55
ALT(IU/L)	4.16	4.48	4.43	4.16	0.16
ALP(IU/L)	84.10^{c}	92.58^{a}	78.83^{d}	86.11^{b}	0.14

Means along the same row with different superscripts are significantly different (P<0.05), ALT= alanine aminotransferase, AST = aspartate aminotransferase, ALP = alkaline phosphatase, SEM= Standard Error of Mean

Table 6: Kidney function markers of broiler chickens administered WBP

Parameters	B_1	B_2	B_3	B_4	SEM
Urea (mg/dl)	1.05^{c}	1.06^{c}	1.68^{b}	2.27^{a}	0.13
Creatinine (mg/dl)	0.41^{c}	0.41^{c}	*0.51^{b}*	0.61^{a}	0.02
Sodium ion (mEq/L)	125.13^{a}	125.39^{a}	116.02^{b}	124.22^{a}	1.65
Potassium ion (mEq/L)	1.71^{c}	1.71^{c}	2.77^{b}	3.07^{a}	0.16
Chloride ion (mEq/L)	92.30	92.30	92.30	92.26	0.21

Means within a row with different superscripts are significantly different (P<0.05); SEM = Standard Error of Mean