International Journal of Global Affairs, Research and Development (IJGARD), Vol.4, No.1, 2026,320-338, ISSN 2992-2488

HAEMATOLOGICAL AND SERUM BIOCHEMISTRY INDICES OF BROILER CHICKEN FED DIETS CONTAINING GRADED LEVELS OF CINNAMON(*Cinnamomum verum*) AND RED PEPPER (*Capsicum annum*) MIXTURE

[1]Ugwuowo Leonard Chidi*, [1]Nnamani Lynda, [1]Okafor Emilia Chibuzo, [1]Nwabueze Henry, [1]Nwosu Ngozi and [2]Umeakuana Doris Chidinma

[1]Department of Animal Science, Nnamdi Azikiwe University Awka Nigeria
[2]Department of Food and Industrial Biotechnology. National Biotechnology Research and Development Agency, Umaru Musa Yar,adua Road Abuja, Nigeria

***Corresponding Author E mail** – lc.ugwuowo@unizik.edu.ng

ABSTRACT

This study was conducted to evaluate the effect of diet containing cinnamon and red pepper on serum biochemistry and hematological indices of broiler. One hundred and twenty (120) day old broiler chicks (Ross 308) were randomly divided into 4 treatment groups and 3 replicates of 10 birds per replicate in a completely randomized design. A mixture of cinnamon and red pepper at the ratio of 1:1was added in broiler diets at 0%, 0.5%, 1.0% and 1.5% at starter and finisher stages and were fed to broilers for 8 weeks. At the end of the experiment, 3 birds per replicate were selected and used for analyses of serum biochemistry and haematological indices. Results of serum biochemistry showed significant (P <0.05) effects of dietary cinnamon and red pepper mixture on Cholesterol, aspartate aminotransferase, creatinine, urea, alkaline phosphate, alanine aminotransferase, total protein, albumin, glucose, red blood cell count, white blood cell count, hemoglobin, packed cell volume, mean cell hemoglobin, neutrophils, platelet, mean cell volume and mean cell haemoglobin concentration. The results of the experiment showed that cholesterol and urea levels decreased as the level of cinnamon and red pepper increased but treatment three had the normal cholesterol level for broiler. Therefore, cinnamon and red pepper mixture should be included at 1.0% for optimum growth and performance of broiler birds.

Keywords: *broiler, hematology, serum biochemistry, cinnamon, red paper*

1.0 INTRODUCTION

There is concerted effort to improve the protein quality and quantity from broiler due to its high demand for human consumption. Protein from animal sources is important in human nutrition due to its high level of amino acid with low fat content (Sulaiman *et. a*l., 2024). Protein malnutrition as a result of deficiency of essential amino acids has been an issue of serious concern in most developing countries of the world (Rashid *et al*., 2020). Available data shows that poultry industry

is the fastest means of bridging the animal protein deficit in developing countries (Shivakant et. al., 2025). Poultry has a short generation interval, a high rate of reproduction, and is distinguished by relatively high efficiency of nutrient modification into quality animal protein (Aminu and Hermanns 2021).

Broiler production is considered most profitable in poultry industry. Broilers are bred as mixed-sex flocks in large intensive conditions (Olaifa Ro *et al.,* 2019). Farmers can raise broilers severally in batches within a year and in large numbers in order to meet the demand for an ever increasing human population.

There had been an increasing demand for organic products from organic farming to reduce the use of antibiotics and other synthetic products as growth enhancers due to their high expensive nature and negative effect on human health (Hassan, 2003). European Union in 2006 banned the use of antibiotics as growth enhancers in livestock feed. Plants are therefore alternative to antibiotics because they possess phytochemicals or secondary metabolites.

Phytobiotics are natural bioactive compounds that are got from plants and included in animal feed or water as an extract to promote productivity through the improvement of digestibility, nutrient absorption, and elimination of pathogens found in the alimentary canal of animals (Rachwał and Gustaw, 2025).

In order to enhance chicken health and to meet consumer demands about food quality, poultry producers are currently using natural feed supplements, mainly herbs (Gardzielewska *et al*., 2003). The beneficial effects of herbal supplements on growth performance, carcass quality, and quality traits of broiler meat have been indicated (Elwy *et al.*, 2025). Hussain *et al*. (2017), has observed that serum and hematological indices of broilers are affected by including phytobiotics in their diets. Two phytobiotics of interest are cinnamon and red pepper. Cinnamon is one of the oldest medicinal plants. Cinnamon can increase appetite and is also a digestion stimulant but its antimicrobial properties are mainly related to its cinnamaldehyde content followed by eugenol and carvacrol (Krauze *et al*., 2021). Cinnamaldehyde and eugenol have been reviewed to have antibacterial activity against bacteria (chang *et al.*, 2001) antioxidant properties (Gurdip *et al.*, 2007) and inhibitory properties against Aspergillus focus.

Red pepper is commonly used in diet and traditional medicine. It is a good source of protein and also reduces the cholesterol level with their antioxidant potential. It has antimicrobial peptides which are very efficient in inhibiting growth in human and plant pathogenic bacteria and fungi. It is very rich in vitamin C and pro-vitamin A and B and it is very high in potassium, magnesium, and iron. The substances that give hot pepper the heat are capsaicin and several related chemicals collectively called capsaicinoids.

These two phytobiotics with their amazing properties can have synergistic effect to improve the Serum biochemical and hematological indices of broiler which are reliable indicators of the health status of animals and may have vital roles in prognosis, diagnosis and treatments of poultry diseases.

2.0 MATERIALS AND METHODS

2.1 Study Location

The study was carried out at the poultry unit of the teaching and research farm of the Department of Animal Science and Technology Nnamdi Azikiwe University, Awka Anambra state.

The location lies between latitude 6.24°N and 6.28°N and Longitude 7.00°E and 7.08°E on the southeastern part of Nigeria. The climatic condition is the tropical wet and dry type with a clear season. The mean daily maximum temperature is usually 27°c all-round the year and can be 34°c in March. The mean annual rainfall is about 1600m according to the local meteorological station which has maintained records since 1978 with a relative humidity of 80% at night.

2.2 Collection and Processing of Cinnamon and Red Pepper

Air dried cinnamon bark and red pepper were procured from commercial dealers. The air-dried cinnamon and red pepper were milled into fine particles using a local milling machine. The ground samples were stored in an airtight container under room temperature (23.1 – 24.6 ^{0}C).

2.3 Experimental Diets

According to the Hubbard classic nutrient requirements, two basal diets were formulated and offered as broiler starter diet (0 - 28 days of age) and broiler finisher diets (28 to 56 days of age).

Cinnamon and red pepper were mixed at the ratio of 1:1 and the mixture was included at 0, 0.5, 1 and 1.5% levels to represent T1,T2, T3 and T4 respectively in the ration of starter and finisher to form eight different treatment diets. The feed ingredients and composition of the experimental diets are presented in Table 1 and 2.

Table 1: **Composition of broiler starter diets containing different inclusion levels of cinnamon and red pepper mixture.**

INGREDIENTS (%)	T1 (0%)	T2 (0.5%)	T3 (1.0%)	T4 (1.5%)
Maize	44	43	42	40.5
Wheat offal	8	8	8	8
Rice bran	6	6	6	6
Soybean meal	20	18.5	17	16
Fish meal	4	4	4	4
Groundnut cake	10	12	14	16
Bone meal	3	3	3	3
Oyster shell	3	3	3	3
Salt	0.5	0.5	0.5	0.5
Cinnamon + red pepper mixture	0	0.5	1.0	1.5
Lysine	0.5	0.5	0.5	0.5
Methionine	0.5	0.5	0.5	0.5
Vit/min premix	0.5	0.5	0.5	0.5
Total	100	100	100	100
Calculated Crude protein (%)	22.16	22.10	22.04	22.00
Calculated ME (kcal/kg)	2700.00	2700.00	2700.00	2700.00
Analysed crude protein (%)	21.38	21.00	21.7	21.2
Analysed ME (kcal/kg)	2677.00	2650.00	2630.00	2690.00

*Bio-addmix Mineral-Vitamin premixes of 1kg contains vitamin A: 10,000,000iu, Vitamin D3: 2,000,000iu, Vitamin E: 10,000iu Vitamin B1: 2,000mg, Vitamin B2: 70,000mg, Vitamin B6: 2,000mg, Vitamin B12: 15mg, Pantothenic Acid: 5,000mg, Niacin: 50,000mg, Folic Acid: 750g, Biotin: 100mg, Choline Chloride: 400gr, Vitamin K: 2,500mg and minerals such as Manganese: 10gr, Zinc: 100gr, Cobalt: 200mgr, Iron: 30gr, Copper : 10gr, Iodine: 1.5gr and Selenium: 200mgr, Lysine: 15gr, BHT: 125gr, methionine: 20gr, Biotin: 100mgr.

Table 2:**C*omposition of broiler finisher diet containing different inclusion levels of cinnamon and red pepper mixture*.**

INGREDIENTS(%)	**T1 (0%)**	**T2 (0.5%)**	**T3 (1.0%)**	**T4 (1.5%)**
Maize	49	47	45	43
Wheat offal	9	9	9	9
Rice bran	6	6	6	6
Soybean meal	20	20	20	20
Fish meal	4	4	4	4
Groundnut cake	4	5.5	7	8.5
Bone meal	3	3	3	3
Oyster shell	3	3	3	3
Salt	0.5	0.5	0.5	0.5
Cinnamon+red pepper mixture	0	0.5	1.0	1.5
Lysine	0.5	0.5	0.5	0.5
Methionine	0.5	0.5	0.5	0.5
Vit/min premix	0.5	0.5	0.5	0.5
Total	100	100	100	100
Calculated Crude protein(%)	20.20	20.05	20.01	20.00
Calculated ME(Kcal/kg)	3000.00	3000.00	3000.00	3000.00
Analysed crude protein (%)	19.50	19.60	19.00	19.80
Analysed ME (kcal/kg)	2900.00	2900.50	2998.00	2950.00

*Bio-addmix Mineral-Vitamin premixes of 1kg contains vitamin A: 10,000,000iu, Vitamin D3: 2,000,000iu, Vitamin E: 10,000iu Vitamin B1: 2,000mg, Vitamin B2: 70,000mg, Vitamin B6:

2,000mg, Vitamin B12: 15mg, Pantothenic Acid: 5,000mg, Niacin: 50,000mg, Folic Acid: 750g, Biotin: 100mg, Choline Chloride: 400gr, Vitamin K: 2,500mg and minerals such as Manganese: 10gr, Zinc: 100gr, Cobalt: 200mgr, Iron: 30gr, Copper : 10gr, Iodine: 1.5gr and Selenium: 200mgr, Lysine: 15gr, BHT: 125gr, methionine: 20gr, Biotin: 100mgr.

2.4Experimental Birds

One hundred and twenty (120) unsexed day-old broiler chicks (Ross 308) were used in this study. The broiler chicks were procured from AGRITED hatchery Ibadan, Oyo state through their state distributor.

2.5 Experimental Design

Complete randomized design was used in the study. One hundred and twenty (120) broiler chicks were divided into four treatment groups. Each treatment contained 30 chicks and was randomly subdivided into 3 replicates with 10 chicks per replicate. Each treatment group was assigned to each of the treatment diets.

2.6 Experimental Procedure

2.6.1 Blood collection.

Birds in each replicate pen were reared in individual pen. On the 56th day of study, blood samples were randomly collected from four birds per treatment. Blood samples of 2ml were collected via the wing veins using sterile needles and syringes. The blood samples were put in properly labeled and sterilized anticoagulant (EDTA) tubes and used for hematological analysis. Also, 2ml of blood was collected from each bird and was put into tubes without anticoagulant, for estimation of serum biochemistry. The blood samples inside tubes without anticoagulant were placed in a slanting position at room temperature for 6 h and incubated overnight in the refrigerator at 4^{o}C to obtain serum. The serum samples were kept at -20 °C before biochemical analysis.

2.6.2 Assessment of serum biochemistry indices. The following biochemistry analyses were estimated: total protein, albumin, creatinine, glucose, cholesterol, urea, AST, ALT, ALP,

2.6.3 Evaluation of hematological indices. The samples were subjected to hematological analysis which included hemoglobin (Hb) concentration, red blood cells (RBC), packed cell

volume (PCV), mean cell hemoglobin (MCH), mean cell HB concentration (MCHC), white blood cells (WBC), mean cell volume (MCV), neutrophils, lymphocytes (LY), using Hematological Analyzer Sysmex XP- 100 (Japan).

2.7Statistical Analysis

Data generated were subjected to one way analysis of variance (ANOVA). Differences ($P<0.05$) between treatments means were separated using Duncan's multiple range test (DMRT) as outlined by Steel *and Torrie (*1997).

3.0 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Haematological indices of broiler finisher birds fed diets containing different levels of cinnamon and red pepper mixture.

The effects of different levels of inclusion of cinnamon and red pepper mixture on haematological indices of broiler finisher are shown in Table 3.

Table 3: **Haematological indices of broiler finisher birds fed diets containing different levels of cinnamon and red pepper mixture**

PARAMETERS	TREATMENTS				
	T (0%)	T2 (0.5%)	T3 (1%)	T4 (1.5%)	P value
Hemoglobin (g/dl)	12.03^{b}	13.17^{d}	12.97^{c}	11.03^{a}	0.00
Pack Cell Volume (%)	35.00^{a}	38.43^{b}	39.07^{b}	34.00^{a}	0.00
Red Blood Cell(10^{6}/L)	2.51^{a}	2.49^{a}	2.63^{b}	2.82^{c}	0.00
White Blood Cell (x10^{3}/mcl)	194.17^{c}	192.57^{b}	202.87^{d}	47.43^{a}	0.00
Mean Corpuscular Hemoglobin (pg)	50.77^{a}	52.67^{c}	$52.1O^{b}$	50.70^{a}	0.00
Mean Cell Volume (fL)	146.10^{b}	138.33^{a}	138.37^{a}	147.20^{b}	0.00
Mean Corpuscular Hemoglobin Concentration (g/dl)	34.50^{a}	38.10^{c}	37.73^{b}	34.57^{a}	0.00
Platelets (x10^{3}/mcl)	28.00^{b}	17.00^{a}	15.33^{a}	45.67^{c}	0.00
Lymphocyte (%)	2.97^{c}	1.00^{a}	2.00^{b}	1.00^{a}	0.00
Neutrophils (%)	96.20^{b}	97.13^{c}	94.17^{a}	96.23^{b}	0.00

a,b,c,d Means on the same row bearing different superscripts are significantly different ($P < 0.05$)

Hemoglobin, packed cell volume, red blood cell count, White blood cell count, Mean cell hemoglobin, Mean cell hemoglobin concentration, Lymphocyte, platelets and neutrophils showed significant differences ($p<0.05$) among treatment groups for the haematological indices of 8 weeks old broiler birds.

3.1.2Serum biochemistry indices of broiler birds fed diets containing different levels of cinnamon and red pepper mixture

The effects of cinnamon and red pepper on serum biochemistry of broiler at finisher phase are shown in Table 4.

Table 4: Serum biochemistry indices of broiler birds fed diets containing different levels of cinnamon and red pepper mixture

PARAMETERS	TREATMENTS				
	T1 (0%)	T2 (0.5%)	T3 (1%)	T4 (1.5%)	P value
Total Protein(g/dl)	5.54^{d}	5.36^{b}	5.19^{a}	5.48^{a}	0.00
Albumin (g/dL)	3.24^{a}	3.64^{c}	3.71^{d}	3.50^{b}	0.00
Creatinine(mg/dl)	1.27^{b}	1.04^{a}	1.93^{c}	1.17^{ab}	0.00
Glucose (mg/dl)	72.00^{a}	99.00^{c}	81.00^{b}	81.33^{b}	0.00
Cholesterol (mg/dl)	195.00^{d}	99.17^{b}	105.67^{c}	90.43^{a}	0.00
Urea (mg/dl)	42.05^{d}	30.23^{c}	18.83^{a}	26.00^{b}	0.00
AST (u/L)	50.27^{c}	22.00^{a}	55.00^{d}	35.00^{b}	0.00
ALT (u/L)	50.32^{c}	28.87^{a}	62.33^{d}	32.33^{b}	0.00
ALP (u/L)	128.30^{a}	156.47^{b}	225.43^{d}	201.00^{c}	0.00

a,b,c,d Means on the same row bearing different superscripts are significantly different ($P < 0.05$)

Total protein, Albumin, creatinine, glucose, cholesterol, urea, AST, ALT, ALP showed significant differences ($p<0.05$) among treatment means for serum indices of 8 weeks old broiler birds.

3.2 DISCUSSION

3.2.1 Haematological indices of broiler finisher birds fed diets containing different levels of cinnamon and red pepper mixture

Haematological indices test of experimental animals are very important when evaluating the toxic effect of a supplemented compound or plant extract. Haematology tests are also tools that can be used to know the physiological and pathological statuses of the animals.

The findings of the current study indicated significant ($p<0.05$) increase in HB, RBC, WBC, PCV, MCH, MCHC, Platelets and neutrophils and these outcomes agreed with the results of Resis *et al* (2018), who reported that inclusion of phytochemicals such as cinnamic aldehyde, thymol and carvaacrol in broiler birds significantly increased red blood cell counts and haemoglobin in comparism with the control group. Similar findings in another study were reported by krauze *et al.,* (2020) who studied the dietary effects of probiotic, bacillus subtilis (0.25g/l) enterococcus faecium 0.25g/l), and phytobiotics containing cinnanmon oil (0.25g/l) in broiler birds and found improvements in the immune system and parameters such as red blood cell count and hemoglobin. Also, broiler chicken fed garden cress seed meal according to Shawle *et al.,* (2016), turmeric powder and cayenne pepper according to Adegoke *et al.,* (2018) and pawpaw leaf and seed meal as reported by Oloruntola *et al.,* (2019), showed increased values of HB, PCV and RBCs.

Hemoglobin concentration of T2 was significantly higher ($p<0.05$) than the other dietary treatments. Hemoglobin values 11.03-13.17 obtained for the birds agreed with Onibi *et al.*, (2011) who reported the hemoglobin range for normal chicken as 6.5- 13.0g/ml. Similar values (7.45-8.6%) was obtained by Al-kassie *et al.*, (2011) when 0.25- 1.00% hot red pepper based diets were fed to broilers for six weeks.

Red blood cell of the broiler birds of T4 were significantly higher ($p<0.05$) than values of other treatment means, whereas T1 and T2 treatment means were found to be similar. The red blood cells obtained in this experiment were within the normal range of 2.0 x 10^6/mm3 to 3.2 x 10^6/mm3 as obtained by Usman & Muin, (2022).

White blood cell of T3 was significantly higher ($p<0.05$) than the values of other treatment means. Mean cell hemoglobin of T2 was significantly higher ($p<0.05$) than the values of other treatment means. Mean cell volume ofT1 and T4 were similar but significantly higher ($p<0.05$) than the value of other treatment means whereas MCV of T2 and T3 were similar. Mean cell haemoglobin concentration of T2 was significantly higher ($p<0.05$) than the value of other treatment means while T1 and T4 were similar.

The RBC values, WBC, MCH, MCV and MCHC values obtained for the birds in this study were higher than the value reported for normal chicken by Orawan and Aengwanich (2007) and also higher than the WBC value of 40.50 ×10^{12}/L to 31.51 × 10^{12}/L as reported by Salifu *et al.*, (2025). Hemoglobin, mean cell hemoglobin and mean cell hemoglobin concentration are important blood parameters whose values are used to determine anemic conditions in animals (Tvedten 2010). They also serve as useful determinant of the bone marrow capacity to produce erythrocytes in mammals. The number of red blood cells in chicken influences the overall conditions of the birds.

Therefore, the increases in packed cell volume, Hemoglobin and erythrocyte counts of the birds fed the test ingredients are indication that the oxygen carrying capacity of the blood was improved. A decrease in the hemoglobin, mean corpuscular volume, and MCH levels in birds is also an indication that the birds were exposed to stressors (Huff *et al*., 2008).

In this present study, there were significant differences ($P<0.05$) in both HB and MCH.

However, the T4 at 1.5% had a significantly higher ($P<0.05$) MCV value of 147.20 compared to the other group. It can be said therefore that the test additive improved the bird's ability to withstand stress at treatment T4 of 1.5% inclusion.

Packed cell volume of T2 and T3 were similar but significantly higher ($p<0.05$) than the value of other treatment means while packed cell volume of T1 and T4 were similar ($p>0.05$).

In the present study, the PCV value obtained was between 34.00-39.07ml and were the same values as reported for normal chicken (30.4- 32.5.0ml%) by Gambo *et al*., (2021) and it also agreed with Onibi *et al*., (2011) who reported the PCV range for normal chicken as 22- 43%.

Lymphocyte of T1 treatment mean was significantly higher ($p<0.05$) than T2, T3 and T4 but T2 and T4 were found to be similar. Platelets of T4 was significantly higher ($p<0.05$) than T1, T2 and T3 of other treatment means.

Lymphocyte value in control group was higher than those in the treatment group, which is an indication that the treatment with cinnamon and red pepper mixture had no effect on the lymphocyte. Neutrophils of T2 was significantly higher ($p<0.05$) than the values of other treatment means. Dietary additive of cinnamon and red pepper mixture improved the blood cells suggesting better utilization of the dietary nutrients.

3.2.2 Serum biochemistry indices of broiler birds fed diets containing different levels of cinnamon and red pepper mixture

Serum biochemistry parameters show the extent of utilization of nutrients in the body and highlight the possible changes emanating from intrinsic and extrinsic factors (Liu *et al*., 2015). The liver is an important organ of living organisms that play the role of detoxification, metabolism, and removal of endogenous and exogenous substances (Paul *et al*., 2016).

Cholesterol of T1 control group was significantly higher ($p<0.05$) than the values of those in the treatment groups fed diets containing mixture of cinnamon, and red pepper.

Lipid metabolism is a determinant of serum concentrations of cholesterol in the body (He *et al.*, 2015). The findings of the current study showed that cholesterol level significantly decreased compared to the control group. Also, it was observed that the increasing dosages of cinnamon and red pepper linearly decreased the levels of cholesterol. This agrees with the findings of Odutayo *et al* (2021) who reported a reduction in the low density lipids of the breast meat of broiler fed diets containing 4% cinnamon powder.

AST, ALT and ALP of T3 were significantly higher ($p<0.05$) than the other treatment group while ALP of T1 was the lowest value.

The liver is the center of several metabolic, productive and digestive activities, and as such, is exposed to varying levels of chemical and biological damages. Such damages are manifested by the serum levels of specific enzymes originating from the liver. These enzymes, depending on their quantity may cause some disruptions to physiological mechanisms of the body, thereby resulting in poor health and production performance. The activities of aspartate aminotransferase (AST), alkaline phosphatase (ALP), and alanine aminotransferase (ALT) in the blood are bioindicators of liver damage and function (Yildirim *et al.*, 2011). Increased quantities of these enzymes are associated with liver or muscle damage, resulting from the body reactions to stress. The values of these enzymes in the present study showed significant differences ($p<0.05$) between the control and the treatment group. Ye *et al*. (2025), observed that induced liver damage using aflatoxin in broilers and layers increased serum ALT. Therefore, the reduction in AST and ALT due to cinnamon and red pepper treatments can be deduced as an indication of better liver function. This is however contrary to the findings of a study of the effect of turmeric rhizome powder on the activity of some blood enzymes in broiler chickens, which found no significant differences in these enzymes' levels (Emadi *et al.*, 2007).

Hoffman *et al*., (2008) observed that alkaline phosphatase is another enzyme produced mainly by the liver, intestinal mucosa, bone, kidney, and placenta; however, the intestinal ALP does not contribute much to serum ALP levels. Reduced activity of ALP may be an indication of a slowdown of bone growth (Szabo *et al*., 2005). Higher serum levels of alkaline phosphatase are observed when there is improved osteoblastic activity, involving the formation and mineralization of bone associated with increased skeletal growth (Lumeij *et al.*, 2008). Also, the values of ALP in the present study are in agreement with the referenced values of 167ul – 305ul for poultry birds (Oleforuh-Okoleh *et al.*, 2015).

Creatinine of T3 fed diet containing 1.0% inclusion level of cinnamon and red pepper showed higher value than the other dietary group and it also shows that T4 was statistically similar to T1 and T2.

Urea value of T1 was higher than the values of those in the other treatment groups.

The kidneys are seen as the second target organs that may be damaged due to metabolic dysfunctions. The activities of kidney determine the possible toxicity of any compound. The status of kidney function can be determined through the increase or decrease in serum levels of urea and creatinine. Higher creatinine levels result from reduced glomerular filtration, which shows kidney impairment (Rhiouani *et al*., 2008) while a high serum urea level shows cardiac and renal tissue damages. The findings from the current study showed that serum levels of creatinine and urea were significantly ($p<0.05$) decreased as the cinnamon and red pepper dosage increased except for T3 at 1.0%that showed high level of creatinine at increasing level of cinnamon and red pepper mixture. These findings indicated that mixture of cinnamon and red pepper had no harmful effects on kidney function. Various studies using phytobiotics supplementation in broiler chickens have supported this present study results, including the work by Rubio *et al*, (2019), Ahmad *et al*.,(2018), and Adegoke *et al*.,(2018).

Glucose value of T2 fed diet containing 0.5% level of cinnamon and red pepper mixture was significantly higher ($p<0.05$) than the values of other treatment group.
The normal reference range of serum glucose in broiler is 200 to 500 mg/dL (Thrall *et al*., 2012). The present study showed that the serum glucose concentrations were influenced by cinnamon and red pepper in the experimental chickens; however, low values were recorded in the control group compared to treatment groups.

Total protein of T1 was higher than the ones in the treatment group containing cinnamon and red pepper mixture.

Albumin of T3 fed diets containing 1.0 inclusion levels of cinnamon, and red pepper mixture showed higher value than the ones in the other group.

The quantity of serum protein in birds is considered an important indicator for the determination of their health status. The current study results showed that the inclusion of cinnamon and red pepper significantly increased the levels of albumin compared to the control group but the total protein decreased among treatment group and increased in the control group. In addition, albumin showed linear increases with increasing supplementation of cinnamon and red pepper mixture at 1.5%.

4,0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The research results show that incorporating cinnamon and red pepper mixture at 0.5 % in broiler diets improved the serum biochemistry and haematological indices which led to better health and

4.2 Recommendations

Cinnamon and red pepper mixture at 0.5 % in broiler diets is recommended for improved serum haematological and serum biochemical and hence better health

.

REFERENCES

Adegoke, A.V.; Abimbola, M.A.; Sanwo, K.A.; Egbeyale, L.T.; Abiona, J.A.; Oso, A.O.; Iposu, S.O.(2018). Performance and blood biochemistry profile of broiler chickens fed dietary turmeric (Curcuma longa) powder and cayenne pepper (Capsicum frutescens) powders as antioxidants. *Vet. Anim. Sci*. 2018, 6, 95–102. [CrossRef]

Ahmad, S.; Khalique, A.; Pasha, T.N.; Mehmood, S.; Hussain, K.; Ahmad, S.; Bhatti, S.A. (2018). Influence of Feeding Moringa oleifera Pods as Phytogenic Feed Additive on Performance, Blood Metabolites, Chemical Composition and Bioactive Compounds of Breast Meat in Broiler. Kafkas Univ. *Vet. Fak. Derg.* 2018, 24, 195–202. [CrossRef]

Al-Kassie, G.A.M., Al-Nasrawi, M.A.M. and Ajeena, S.J.(2011). The Effects of Using Hot Red Pepper as a Diet Supplement on Some Performance Traits in Broiler. *Pakistan J. Nutr.* 10(9):842-845.

Aminu F. O. and Hermanns U. (2021). Profitability evaluation of poultry production in Lagos state, Nigeria. Discovery Agriculture, 2021, 7(17), 3.

Chang, Shang-Tzen, Wu, Jyh-Horng, Wang, Sheng-Yang, Kang, Pei-Ling, Yang, Ning-Sun, Shyur, Lie-Fen. (2001). Antioxidant Activity of Extracts from Acacia confusa Bark and Heartwood. *Journal of agricultural and food chemistry.* VL - 49.DOi - 10.1021/jf0100907

Elwy A. Ashour, Saad A. Al-Ardhi, Mohamed E. Abd El-Hack, Ahmed I. Elsherbeni, Ahmed A. Elolimy, Mahmoud Madkour, Vincenzo Tufarelli, Ayman A. Swelum, (2025).

Effects of lactic acid and herbal blend as antibiotic alternatives on growth, carcass traits, blood chemistry, and microbial load in broiler chickens, *Poultry Science*,Volume 104, Issue 5,2025,105050,ISSN 0032-5791,https://doi.org/10.1016/j.psj.2025.105050. (https://www.sciencedirect.com/science/article/pii/S0032579125002895)

Emadi, M. and Kermanshahi, H. 2007. Effect of turmeric rhizome powder on the activity of some blood enzymes in broiler chickens. *International Journal of Poultry Science*. 6:48-51.

Gambo, H.I., Alkali, I.M. & Badau, S.J. (2021). Haematological parameters in relation to age, sex and body weight of free range village chickens (Gallus gallus domesticus) in Maiduguri, Nigeria. *Journal of Sustainable Veterinary and Allied Sciences*. Vol 1, Issue 1: 78-84.

Gardzielewska, J., Pudyszake, K., Majewska, T., Jakubowska, M., & Pomianowski, J. (2003). Effect of plant-supplemented feeding on fresh and frozen storage quality of broiler chicken meat. *Electronic Journal of Polish Agricultural Universities*, *6*(2), 12.

Gurdip, S., Sumitra, M., DeLampasona, M.P., cease, A.N.C., 2007. A comparison of chemical,antioxidant and antimicrobial studies of cinnamon leaf and bark volatile oils, oleoresins and their constituents. *Food Chem. Toxicol*.45,1650-1661.

Hassan, G.M. 2003. Quality assessment of some dairy products at consumer level. Ph.D. Thesis, Fac. Vet. Med., Cairo Uni.

He, J.; Dong, L.; Xu, W.; Bai, K.; Lu, C.; Wu, Y.; Wang, T. 2015. Dietary tributyrin supplementation attenuatesinsulin resistance and abnormal lipid metabolism in suckling piglets with intrauterine growth retardation.PLoS ONE 2015, 10, e0136848. [CrossRef]

Hoffman, W.E. and Solter, P.F. 2008. Diagnostic enzymology of domestic animals. Pages 351–378 in Clinical Biochemistry of Domestic Animals. 6th ed. J. J. Kaneko, J. W. Harvey, and M. L. Bruss, ed. Academic Press, Burlington, MA.

Huff, G.R., Huff, W.E., Rath, N.C., Anthony, N.B. and Nestor, K.E. 2008. Effects of Escherichia coli challenge and transport stress on hematology and serum chemistry values of three genetic lines of turkeys. *Poultry Science.* 87:2234–2241

Hussain Shahid, Rafia Rahman and Ayesha Mushtaq, Asma El Zerey-Belaskri (2017). Clove: A review of a precious species with multiple uses. *International journal chemical and biochemical sciences.* 11(129-133).

Krauze, M.; Abramowicz, K.; Ognik, K. 2020. The effect of the addition of probiotic bacteria (Bacillus subtilis or Enterococcus faecium) or phytobiotic containing cinnamon oil to drinking water on the health and performance of broiler chickens. *Ann. Anim. Sci.* 2020, 20, 191–205. [CrossRef]

Krauze, M., Cendrowska-Pinkosz, M., Matusevičius, P., Stępniowska, A., Jurczak, P., & Ognik, K. (2021). The Effect of Administration of a Phytobiotic Containing Cinnamon Oil and Citric Acid on the Metabolism, Immunity, and Growth Performance of Broiler Chickens. *Animals*, *11*(2), 399. https://doi.org/10.3390/ani11020399

Liu, Q.W.; Feng, J.H.; Chao, Z.; Chen, Y.; Wei, L.M.; Wang, F.; Sun, R.P.; Zhang, M.H. 2015. The influences of ambient temperature and crude protein levels on performance and serum biochemical parameters in broilers. *J. Anim. Physiol. Anim. Nutr.* 2015, 100, 301–308. [CrossRef]

Lumeij, J.T. 2008. Avian clinical biochemistry. Pages 839–872 in Clinical Biochemistry of Domestic Animals. 6th ed. J. J. Kaneko, J. W. Harvey, and M. L. Bruss, ed. Academic Press, Burlington, MA.

Oleforuh-okoleh, V.U., Ndofor-foling, H.M., Olorunlekes, S.O. and Uguru, J.O. 2015. Evaluation of growth performance, hematological and serum biochemical response of broiler chickens to aqueous extract of ginger and garlic. *Journal of Agricultural Science* 7(4):167-173.

Thrall, M.A.; Weiser, G.; Allison, R.; Campbell, T. 2012. Veterinary Hematology and Clinical Chemistry, 2nd ed; John Wiley & Sons: Oxford, UK, 2012; pp. 582–598.

Odutayo, O. J., Adeyemo, A. A., Ibigbami, D. J., Sogunle, O. M., Olaifa, R. O., Akinwale, O. A., Orebiyi, V. A., Ojebisi, V. A. and Joel, A. O. (2021). Influence of cinnamon (Cinnamomum cassia) powder as additive on jejenalhistomophometry, growth performance, haemato-biochemical indices, carcass traits and breast meat lipid profile of broiler chickens. *Nig. J. Anim. Prod.* 2021, 48(6):167 - 184. https://doi.org/10.51791/njap.v48i6.3290.

Olaifa RO, Sogunle OM, Obileye LI, Ibitoye SA, Ayodeji TM, Odutayo OJ and Ogundele MA (2019). Effect of oral administration of three different phytobiotics on growth performance of locally-adapted turkeys. *EC Veterinary Science*, 4: 656-662.

Oloruntola O D, Ayodele S O, Agbede J O and Oloruntola D A (2019). Effect of feeding broiler chickens with diets containing *Alchornea cordifolia* leaf meal and enzyme supplementation. *Archivos de Zootecnia*, 65, 489-498.

Onibi, G. E. ; Bobadoye, A. O. ; Folorunso, O. R., 2011. Haematological indices, serum cholesterol and meat quality of broiler chickens fed diets with palm oil sludge substituting maize. *Agric. Biol. J. North America*, 2 (3): 552-558.

Orawan, C., & Aengwanich, W. (2007). Blood cell characteristics, hematological values and average daily gained weight of Thai indigenous crossbred and broiler chickens. *Pak J Biol Sci.*, 10(2), 302-9.

Paul, S.; Islam, M.; Tanvir, E.M.; Ahmed, R.; Das, S.; Rumpa, N.E.; Khalil, M. Satkara (2016). (Citrus macroptera) fruitprotects against acetaminophen-induced hepatorenal toxicity in rats. Evid. Based Complement. Altern. Med.2016, 2016, 9470954. [CrossRef] [PubMed]

Rachwał, K., and Gustaw, K. (2025). Plant-Derived Phytobiotics as Emerging Alternatives to Antibiotics Against Foodborne Pathogens. *Applied Sciences*, *15*(12), 6774. https://doi.org/10.3390/app15126774

Rashid N., Ali Khatibjoo, Kamran Taherpour, Mohammad Akbari-Gharaei,, Hassan Shirzadi, (2020). Effects of licorice extract, probiotic, toxin binder and poultry litter biochar on performance, immune function, blood indices and liver histopathology of broilers exposed to aflatoxin-B1,*Poultry Science*, Volume 99, Issue 11,2020,Pages 5896-5906, ISSN 0032-5791,https://doi.org/10.1016/j.psj.2020.08.034.

Resis, S., Scheer, U., Sachs, S. & Kear, B.P. (2018): Filling the biostratigraphical gap: First choristoderan from the Lower – mid-Cretaceous interval of Europe.- *Cretaceous Research*, 96: pp. DOi - 10.1016/j.cretres.2018.12.009.

Rhiouani, H.; El-Hilaly, J.; Israili, Z.H.; Lyoussi, B. (2008). Acute and sub-chronic toxicity of an aqueous extract of the leaves of Herniaria glabra in rodents. *J. Ethnopharmacol.* 2008, 118, 378–386. [CrossRef

Rubio, M.S.; Laurentiz, A.C.; Sobrane, F.; Mello, E.S.; Filardi, R.S.; Silva, M.L.A.; Laurentiz, R.S. (2019). Performance and Serum Biochemical Profile of Broiler Chickens Supplemented with Piper Cubeba Ethanolic Extract. *Braz. J. Poult. Sci.* 2019, 21, 1–8. [CrossRef]

Salifu, A-R. S., Agolisi, H. M., Nartey, E. K., Essilfie, P. & Dabuoh, F. (2025). Growth Response,Haematological Parameters and Carcass Characteristics of Broiler Chickens Fed Varied Levels of Bovine Blood Meal. *Journal of Basics and Applied Sciences Research*, 3(4), 65-72. https://dx.doi.org/10.4314/jobasr.v3i4.865.

Shawle, K.; Urge, M.; Animut, G. 2016. Effect of different levels of Lepidium sativum L. on growth performance, carcass characteristics, hematology and serum biochemical parameters of broilers. *Springer Plus* 2016, 5, 1441.[CrossRef]

Shivakant, P., Mangalasseri Anoop and Kumari Tulika (2025). Efficiency Analysis of Broiler Poultry Production in Mirzapur District of Uttar Pradesh. *Indian Journal of Economics and Development.*Vol. 21. Pp-402-407. DOi - 10.35716/IJED-24481.

Steel, R.G.D. and Torrie, J.H. 1997. Principles and Procedures of Statistics: A Biometrical Approach. 3rd edition.

Sulaiman, R., Sulaiman, Z., Jaafar, A.M. and Sabo, A. (2024). performance, haematological indices and organoleptic properties of broiler chickens fed diet containing cinnamon (*Cinnamomum cassia*) AS FEED ADDITIVE. *Nigerian Journal of Agriculture and Agricultural Technology*. Volume 4, Number 3, September, 2024 .ISSN (Print): 2811-1885; ISSN (Online): 2811-1893

Szabo, A., Mezes, M., Horn, P., Suto, Z.,Bazar, G. and Romvari, R. 2005. Developmental dynamics of some blood biochemical parameters in the growing turkey (Meleagris gallopavo). *Acta Veterinary Hungary*, 53:397-409

Tvedten, H. (2010). What is your diagnosis? Discrepancy in platelet counts determined using a Sysmex XT-2000 Iv haematology analyzer. *Veterinary clinical pathology*, 39 (3): 395-396.

Usman, Yusnita, & Muin, Rahmatullah. (2022). Uji Aktivitas UV Protektif Secara In Vivo pada Krim dari Bahan Aktif Cangkang Telur Ayam Ras Menggunakan Hewan Coba Kelinci Betina. *Jurnal MIPA*, *11*(1), 33. https://doi.org/10.35799/jm.v11i1.36911.

Ye, X., Yang, Y., Yao, Q. *et al.* (2025). The ameliorative role of phlorotannin on aflatoxin B_1-induced liver oxidative stress and mitochondrial injury is related to the activation of Nrf2 and Nrf1 signaling pathways in broilers. *J. Animal Sci Biotechnol* **16**, 75 (2025). https://doi.org/10.1186/s40104-025-01210-z

Yildirim, E.I., Yalchinkaya, M., Kanbur, M. Ç. and Oruc, E. 2011. Effects of yeast lucomannan on performance, some biochemical parameters and pathological changes in experimental aflatoxicosis in broiler chickens. *Révue de Médicine Vétérinaire*, 162: 413–420.