

## Haematological Parameters and on Serum Biochemical Indices of Broiler Chickens Fed Diets Containing Garlic and Turmeric Powder Mixture

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**Annotation:** A study was conducted to evaluate the effect of dietary inclusion of garlic (*Allium sativum*) and turmeric (*Curcuma longa*) powder mixture at ratio 1:1 on the performance of broiler chickens. A total of one hundred and fifty (150) day old (Arbor Acres) broiler chicks were randomly allotted into five dietary treatments in a completely randomised design (CRD). Each treatment was replicated three times, with ten birds per replicate. A basal diet was formulated to meet the nutrient requirement of broiler chicks and served as the control diet (treatment 1). Birds on treatments 2, 3, 4, and 5 were fed the basal diet with garlic and turmeric powder mixture at 0.2g, 0.4g, 0.6g, and 0.8g inclusion levels, respectively. Feed and clean water were provided ad-libitum throughout the experimental period, which lasted for 56 days. Data were collected on blood indices. Results of phytochemical composition show alkaloids (6.22%), terpenoids (5.78%), flavonoids (12.12%), phenols (4.67%), saponins (3.09%), oxalates (0.21%), and tannins (7.88%). The result of the haematological parameters indicated a significant difference ( $P<0.05$ ) in packed cell volume, red blood cell, haemoglobin, mean corpuscular haemoglobin, mean corpuscular volume, and mean corpuscular haemoglobin concentration. The white blood cells, monocytes, and lymphocytes indicate significant ( $P<0.05$ ) differences in dietary treatments. The serum

biochemistry result showed significant ( $p < 0.05$ ) difference in all the parameter measured. Creatinine (mg/dl) indicated a higher significant ( $P < 0.05$ ) effect in 0.8 g than other dietary treatments. However, cholesterol (mg/dl), alanine phosphatase ( $\mu/L$ ), aspartate aminotransferase ( $\mu/L$ ), and alanine transaminase ( $\mu/L$ ) indicated a higher significant effect ( $P < 0.05$ ) in the control diet. Hence the results obtained from this research can be recommended for the inclusion of a garlic and turmeric powder mixture up to 0.8 g that improves blood indices and overall health of the chickens; this implies that their use can be recommended to farmers in place of antibiotics and growth promoters.

**Keywords:** Broiler, Poultry birds, Turmeric, Garlic, additive, antibiotics, Serum Indices, Haematology parameters.

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## 1.0 Introduction

Poultry plays an important economic, nutritional, and socio-cultural role in the livelihood of rural households in developing countries, including Nigeria, as the major source of animal protein (Chandrasekaran, 2014). For years, public concern over the utilisation of synthetic antibiotics in livestock production has increased because of their possible contribution to the emergence of antibiotic-resistant bacteria (Kummerer, 2009). Several antibiotics, such as penicillin, tetracycline, macrolide, aminoglycoside, and amphenicol, have been detected in animal products (Diarra and Malouin, 2014).

The continuous and indiscriminate use of antibiotics has been reported to cause multiple drug resistance, drug toxicity and residues on the carcasses of animals, thereby leading to serious health problems when such final products are consumed more by humans (Ogbe and John, 2012). The use of synthetic antibiotics could also cause heart problems and, in some cases, cardiovascular diseases leading to death (Philips *et al.*, 2004).

The trend in poultry nutrition presently is having readily available alternatives that are less competitive, low production cost, and with better health benefits (Iji *et al.*, 2017; Tanimu *et al.*, 2020).

The pharmacological benefits of medicinal plants are primarily due to the presence of phytochemicals produced in the plant tissues as primary and secondary metabolites. Primary metabolites include protein, chlorophyll, and common sugars, while alkaloids, terpenoids, flavonoids, saponins, phenols, and tannins are included in secondary constituents (Olafadehan *et al.*, 2020). Over the years, antibiotics have been used as a growth promoter in livestock feeds; however, their continuous usage has led to antimicrobial resistance as well as drug residues in carcasses, which could lead to health problems in humans when consumed (Oluwafemi *et al.*, 2020).

Garlic (*Allium sativum*), a member of the allium family (liliaceae), is a well-known spice. Garlic contains several bioactive compounds such as flavonoids, phenols, and organo-sulphur components, which have been shown to have therapeutic and antioxidant effects in both broilers

and layer hens (Chowdhury *et al.*, 2002; Sallam *et al.*, 2004).

Turmeric (*Curcuma longa*), a medicinal plant, is a rhizomatous herbaceous perennial plant of the ginger family, Zingiberaceae. Traditionally, garlic and turmeric have been used to treat various diseases and disorders, e.g., liver problems, jaundice, ulcers, Diabetics, stomach disorder, fresh wound, insect stings and viral infection including chicken pox and smallpox, they also have anti-inflammatory, antioxidant properties (Chattopadhyay *et al.*, 2004).

## 2.0 MATERIALS AND METHODS

This research was carried out at the Poultry Unit of the Teaching and Research Farm of Animal Science Department, Faculty of Agriculture University of Abuja, Nigeria.

### 2.1 Source and preparation of test ingredients

Five kilogram each of fresh garlic (*Allium sativum*) and fresh turmeric (*Curcuma longa*) were purchased from Suleja Local Market. Fresh garlic and turmeric were thoroughly washed separately under running tap water to remove dirt and later chopped into bits for easy drying. The chopped garlic and turmeric were shade-dried until a constant weight was gotten. The dried samples were blended separately into fine powder (figure 1 and figure 2) using Silvercrest dry miller. Samples were mixed in a ratio of 1:1 by weights and later stored in a well airtight container for further analysis.



**Figure 1: Garlic and turmeric after drying under shade.**



**Figure 2: Dried samples of garlic and turmeric powder**

### 2.2 Management of birds

One hundred and fifty (150) day old (Arbor Acres) broiler chicks were purchased from a

commercial hatchery in Ibadan, Oyo State, Nigeria. A battery cage housing system with twine mesh at the base for easy collection of the faeces was used to house the birds.

### 2.3 Experimental diets

Five broiler starter diets were formulated according to NRC (1994) to meet the nutritional requirements of the experimental birds as shown in Table 2. Diets containing 0.0 g, 0.2 g, 0.4 g, 0.6 g, and 0.8 g of garlic and turmeric powder mixture served as treatments 1, (control), 2, 3, 4 and 5 respectively. To ensure the birds in each replicate consumed all the mixture, this is first added to a portion (20g) of the daily ration and fed first before the remaining portion is served.

### 2.4 Experimental design and Procedures

In a Completely Randomized Design (CRD), thirty birds were randomly allotted to five treatments (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>), replicated three times with each replicate consisting of ten birds. The birds were served their daily ration each day and at the end of the day, uneaten feed were retrieved before serving them the next day, first with a small portion of the diets mixed with the garlic and turmeric powder before the remaining portion is served. Clean water was served *ad libitum* and other management practices were strictly adhered to throughout the research period, which lasted for 56 days.

### 2.5 Chemical composition

Dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and Ash of the test ingredients were determined according to the standard procedures of AOAC (2000). The fibre fractions such as neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL). Calcium and phosphorus of the test ingredients were determined by the methods of Gruelling (1966). The gross energy of the ground samples was determined using a Gallenkamp ballistic bomb calorimeter (Cam Metric Ltd., Cambridge, UK).

### 2.6 Phytochemical analysis

The test samples were subjected to phytochemical analysis in order to find out the presence of phytochemical constituents. Saponin was determined by the method described by AOAC (1999).

### 2.7 Blood profile analysis of experimental birds

At the study endpoint, three chickens were randomly selected per replicate group for blood sampling. The jugular vein was identified as the collection site. Sterile needles and syringes were used to collect approximately 5 mL of blood from each bird under hygienic conditions.

The collected blood was divided into two portions for separate analyses.

### Haematological analysis

Blood samples (3 ml) were collected through the wing vein of each bird per replicate into a 5 ml sterile syringe and transferred onto an ethylene diamine tetra acetic acid (EDTA) bottle to determine the packed cell volume (PCV), red blood cell (RBC) count, haemoglobin (Hb) concentration, white blood cell (WBC) counts, and differential counts. The packed cell volume (PCV), erythrocyte concentration (RBC), haemoglobin (Hb), and leucocyte concentration (WBC) counts were calculated using an automated cell counter. While mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) were calculated using the formula below as described by Jain (1986).

*HB*

MCHC (g/dl) =  $\frac{\text{Hb}}{\text{PCV}} \times 100$

*PCV*

*PCV*

$$\text{MCV (fl)} = \frac{\text{---}}{\text{---}} \times 10$$

RBC

HB

$$\text{MCH (pg)} = \frac{\text{---}}{\text{---}} \times 10$$

RBC

## 2.8 Serum biochemical analysis

Additional blood sample (2 ml) was transferred to the separate labelled vials not containing anticoagulant. This sample was centrifuged (4000 rpm for 5 minutes at 20°C) to separate the serum, the liquid component of the blood, from the red blood cells. Commercially available kits were used to analyse the serum parameters on a biochemical auto-analyser. The concentration of the biochemical constituents was calculated according to the manufacturer's instructions. Lipid profile studies were carried out by employing a chemistry auto-analysing kit, using the appropriate enzymatic methods.

The serum biochemical indices examined were cholesterol, creatinine, aspartate transaminase, alanine transaminase, and total protein. The serum samples were kept in sterile vacutainer tubes and kept deep frozen prior to analysis to determine cholesterol and were used to assess bilirubin and creatinine by colometry techniques. Aspartate transaminase and alanine transaminase levels were determined as described by Huang *et al.* (2006).

## 2.10 Statistical analysis

All data generated were subjected to one-way analysis of variance (ANOVA) using SPSS (22.0), and significant means were separated using Duncan multiple range tests (Duncan, 1955). Significant differences were declared if  $P \leq 0.05$ .

## Result

### 3.1 Proximate composition of garlic and turmeric powders

The proximate composition of garlic and turmeric powders are presented in Table 1. Dry matter of garlic and turmeric were 89.44% and 87.3% respectively while moisture content was 10.56% for garlic powder and 12.7% for turmeric powder. Crude protein and crude fibre were 14.02%; 8.8% and 6.05%; 7.03% for garlic and turmeric respectively. ether extract (8.04%), ash (13.22%), and NFE (65.49%) were higher in garlic powder compared to turmeric powder (5.72%, 3.70% and 61.98%).

### 3.2 Phytochemical composition of garlic and turmeric powder mixture

The result of the phytochemical composition of the garlic and turmeric powder mixture (GTPM) is presented in Table 2. Phytochemical constituents of garlic and turmeric mixture revealed that flavonoid (12.12%) was the most abundant phytochemical in mixture followed by tannins (7.88%), alkaloids (6.22%), terpenoids (5.78%), phenols (4.67%), saponins (3.09%) and oxalates (0.21%) was the least abundant.

### 3.3 Haematological parameters of broiler chickens fed dietary inclusion of GTPM

The haematological parameters of broiler chickens fed dietary inclusion of garlic and turmeric powder mixtures are shown in Table 3. The results showed significant differences ( $P < 0.05$ ) different haematological parameters such as packed cell volume (PCV) which ranged from 28.64 to 36.05%, red blood cell count (RBC) from 2.53 to 3.08  $\times 10^6/\mu\text{L}$ , haemoglobin concentration (Hb) (10.27 to 15.74 g/dl), mean corpuscular haemoglobin (MCH) (62.91 – 90.72 Pg), mean corpuscular volume (MCV) (81.08 – 151.03 fl), and mean corpuscular haemoglobin concentration (MCHC) (51.76 – 61.80 g/dl). Similarly, significant ( $P < 0.05$ ) variations were

also observed in white blood cell count (WBC) ( $17.82 - 32.19 \times 10^6/\mu\text{L}$ ), monocyte count ( $0.77 - 2.25 \times 10^3/\mu\text{L}$ ), and lymphocyte count ( $14.15 - 23.29 \times 10^3/\mu\text{L}$ ) across the dietary treatments.

The haematological profile showed that PCV was higher ( $P < 0.05$ ) in broiler chickens fed with the 0.8 g GTPM compared with all other treatments. Red blood cell counts showed no significant differences ( $P > 0.05$ ) between broiler chickens fed the 0.6 g and 0.8 g diets, but both differed significantly ( $P < 0.05$ ) from the control (0 g), 0.2 g, and 0.4 g diets. Haemoglobin concentration followed a similar pattern, with the highest value ( $P < 0.05$ ) recorded in birds fed 0.8 g diet.

Mean corpuscular haemoglobin (MCH) and MCV values were also highest ( $P < 0.05$ ) in broiler chickens fed 0.8g diets, however, no significant differences ( $P > 0.05$ ) were observed between those fed 0.4 g and 0.6 g diets. For MCHC, birds fed 0.8 g and 0.6 g diets both recorded higher values, with no significant differences ( $P > 0.05$ ) when compared to those fed 0.4 g and 0.2 g diets. White blood counts showed a similar trend, increasing with increase in inclusion levels of GTPM with birds fed 0.8 g diets having significantly higher ( $P < 0.05$ ) WBC compared with other birds fed other inclusion levels. Monocyte counts showed significant differences ( $P < 0.05$ ) across treatments, though no differences ( $P > 0.05$ ) were observed between 0.8 g and 0.6 g, or between 0.4 g and 0.2 g diets. Similarly, lymphocyte counts did not differ significantly ( $P > 0.05$ ) between the 0.8 g and 0.6 g treatments.

### 3.4 Serum biochemical indices of broiler chickens fed dietary inclusion of GTPM

Table 4 show the results of serum biochemical indices of broiler chickens fed dietary inclusion of garlic and turmeric powder mixtures. Albumin (ALB) ranged from 1.61 to 2.29 g/dl, globulin (GLO) from 1.45 to 2.24 g/dl, total protein (TP) from 2.96 to 4.89 g/dl, urea (UA) from 3.06 to 4.48 mg/l, creatinine from 78.67 to 146.67 mg/dl, cholesterol (CHO) from 19.73 to 20.47 mg/dl, alanine phosphatase (ALP) from 1.09 to 1.61  $\mu\text{L}$ , aspartate amino-transferase (AST) from 71.03 to 119.07  $\mu\text{L}$ , and alanine transaminase (ALT) from 43.33 to 87.13  $\mu\text{L}$ .

Albumin levels (g/dl) did not show any significant difference ( $P > 0.05$ ) in birds fed diets containing 0.4 g, 0.6 g, and 0.8 g GTPM, however, differences were observed in broiler chickens fed 0.2 g and the control diets. Globulin (g/dl) and urea (mg/l) followed a similar trend, with higher but non-significant ( $P > 0.05$ ) values recorded in the 0.8 g dietary treatment.

For total protein (g/dl), no significant differences ( $P > 0.05$ ) were observed in the 0.6 g and 0.8 g treatments, but the values were significantly different ( $P < 0.05$ ) when compared with the other dietary groups. Creatinine (mg/dl) showed a significant increase ( $P < 0.05$ ) in the 0.8 g treatment compared to all other diets. Cholesterol (mg/dl), ALP ( $\mu\text{L}$ ), AST ( $\mu\text{L}$ ), and ALT ( $\mu\text{L}$ ) showed significantly higher values ( $P < 0.05$ ) in broiler chickens fed control diets compared to all the garlic and turmeric supplemented diets.

**Table 1: Proximate composition of garlic and turmeric powders**

Parameter	Garlic	Turmeric
Dry matter (%)	89.44	87.30
Moisture content (%)	10.56	12.70
Crude protein (%)	14.02	8.87
Crude fibre (%)	5.02	7.03
Ether extract (%)	0.69	5.72
Ash (%)	4.22	3.70
Nitrogen free extract (%)	65.49	61.98

**Table 2: Phytochemical composition of Garlic and Turmeric powder mixture**

Parameters	Composition %
Alkaloids	6.22
Terpenoids	5.78

Flavonoids	12.21
Phenols	4.67
Saponins	3.09
Oxalates	0.21
Tannins	7.88

**Table 3: Haematological parameters of broiler chickens fed dietary inclusion of GTPM**

Parameters	Garlic and turmeric powder mixture (GTPM)					SEM
	0.0g	0.2g	0.4g	0.6g	0.8g	
Pack cell volume (%)	28.64 <sup>e</sup>	32.31 <sup>d</sup>	33.68 <sup>c</sup>	35.19 <sup>b</sup>	36.05 <sup>a</sup>	0.98
Red blood cell (x10 <sup>6</sup> /μL)	2.53 <sup>d</sup>	2.65 <sup>c</sup>	2.93 <sup>b</sup>	3.03 <sup>a</sup>	3.08 <sup>a</sup>	6.14
Hb (g/dl)	10.27 <sup>e</sup>	12.38 <sup>d</sup>	14.03 <sup>c</sup>	15.02 <sup>b</sup>	15.74 <sup>a</sup>	4.42
MCH (Pg.)	62.91 <sup>d</sup>	70.46 <sup>c</sup>	71.36 <sup>b</sup>	77.60 <sup>b</sup>	90.72 <sup>a</sup>	8.70
MCV (fl)	81.08 <sup>e</sup>	88.67 <sup>d</sup>	98.48 <sup>c</sup>	130.28 <sup>b</sup>	151.03 <sup>a</sup>	3.24
MCHC(g/dl)	51.76 <sup>c</sup>	55.37 <sup>b</sup>	55.39 <sup>b</sup>	60.78 <sup>a</sup>	61.80 <sup>a</sup>	4.10
White blood cell (x10 <sup>3</sup> /μl)	17.82 <sup>e</sup>	22.87 <sup>d</sup>	25.74 <sup>c</sup>	29.56 <sup>b</sup>	32.19 <sup>a</sup>	1.54
Monocyte (x10 <sup>3</sup> /μL)	0.77 <sup>c</sup>	2.00 <sup>b</sup>	2.06 <sup>b</sup>	2.35 <sup>a</sup>	2.52 <sup>a</sup>	0.12
Lymphocytes (x10 <sup>3</sup> /μL)	14.15 <sup>d</sup>	17.98 <sup>c</sup>	19.73 <sup>b</sup>	22.28 <sup>a</sup>	23.29 <sup>a</sup>	3.38

<sup>a-d</sup> Means in the same row with different superscripts differ significantly ( $P < 0.05$ )

**Table 4: Serum biochemical indices of broiler chickens fed dietary inclusion of GTPM**

Parameters	Garlic and turmeric powder mixture (GTPM)					SEM
	0.0g	0.2g	0.4g	0.6g	0.8g	
Albumin (g/dl)	1.61 <sup>c</sup>	2.13 <sup>b</sup>	2.24 <sup>a</sup>	2.27 <sup>a</sup>	2.29 <sup>a</sup>	1.64
Globulin (g/dl)	1.45 <sup>c</sup>	1.51 <sup>b</sup>	2.15 <sup>a</sup>	2.19 <sup>a</sup>	2.24 <sup>a</sup>	0.22
Total protein (g/dl)	2.96 <sup>d</sup>	3.18 <sup>c</sup>	3.41 <sup>b</sup>	4.67 <sup>a</sup>	4.89 <sup>a</sup>	0.28
Urea (mg/l)	3.06 <sup>c</sup>	3.59 <sup>b</sup>	4.43 <sup>a</sup>	4.46 <sup>a</sup>	4.48 <sup>a</sup>	0.32
Creatinine (mg/dl)	78.67 <sup>e</sup>	83.59 <sup>d</sup>	92.84 <sup>c</sup>	101.97 <sup>b</sup>	146.67 <sup>a</sup>	14.34
Cholesterol (mg/dl)	20.47 <sup>a</sup>	19.99 <sup>b</sup>	19.79 <sup>b</sup>	19.73 <sup>b</sup>	19.76 <sup>b</sup>	0.48
Alanine phosphatase (μ/L)	1.61 <sup>a</sup>	1.41 <sup>b</sup>	1.23 <sup>c</sup>	1.17 <sup>d</sup>	1.09 <sup>e</sup>	0.12
Aspartate Aminotransferase (μ/L)	119.07 <sup>a</sup>	94.21 <sup>b</sup>	87.06 <sup>c</sup>	79.67 <sup>d</sup>	71.03 <sup>e</sup>	3.16
Alanine Transaminase (μ/L)	87.13 <sup>a</sup>	67.89 <sup>b</sup>	59.81 <sup>c</sup>	49.34 <sup>d</sup>	43.33 <sup>e</sup>	1.76

<sup>a-d</sup> Means in the same row with different superscripts differ significantly ( $P < 0.05$ )

## DISCUSSION

### 4.1 Proximate composition of garlic and turmeric powders

The proximate composition of garlic and turmeric powders reveals their nutritional significance and potential as dietary additives. Garlic powder contains a notably high dry matter content, which indicates that it is predominantly composed of solid constituents. This observation is in line with findings from other studies (Smith *et al.*, 2023). Its low moisture content reflects minimal water retention, a quality that enhances shelf life and stability, and is typical of dehydrated garlic products (Jones and Brown, 2022). The crude protein content of garlic powder is relatively high compared to many other spices, making it a valuable dietary protein source (Lee *et al.*, 2024). In addition, the crude fibre fraction highlights garlic's contribution to dietary fibre intake, an important factor for maintaining digestive health in broiler chickens (Lee *et al.*,

2024). The ether extract, which accounts for the fat fraction, includes essential oils and other lipid-soluble compounds that not only influence garlic's flavour but also contribute to its health-promoting properties (Garcia *et al.*, 2023). The ash content points to a rich mineral profile that is vital for various physiological functions, while the nitrogen-free extract (NFE) value of 65.49% demonstrates that carbohydrates are the dominant energy source in garlic powder.

Similarly, turmeric powder also shows a high dry matter content of 87.30%, confirming that it is largely composed of solid constituents, consistent with earlier reports (Lahari *et al.*, 2020). Its moisture content suggests a moderate level of water retention, which helps preserve texture and reduces the risk of spoilage (Wu *et al.*, 2024). The crude protein level in turmeric, though modest, still contributes to its nutritional value, typically ranging between 6–8% as noted in previous studies (Wu *et al.*, 2024). The crude fibre fraction plays an important role in supporting digestive health, while the ether extract, at 5.72%, reflects the presence of essential oils and lipid-soluble compounds known to provide both health benefits and turmeric's distinctive qualities. The ash content further confirms a notable mineral composition, consistent with earlier findings (Adebisi *et al.*, 2021). The nitrogen free extract (NFE) of 61.98% demonstrates that carbohydrates are the main energy providing component in turmeric powder, a characteristic that aligns with its reputation as a carbohydrate-rich spice (Adebisi *et al.*, 2021).

The proximate composition of garlic and turmeric powders shows their complementary nutritional roles. Garlic powder contributes appreciably to protein, fibre, minerals, and energy, while turmeric provides carbohydrates, fibre, and essential oils with known health benefits. These characteristics emphasize the value of incorporating both powders into poultry diets as functional feed additives that can enhance nutrition and promote overall health of poultry.

#### **4.2 Phytochemical composition of garlic and turmeric powder mixture (GTPM)**

The phytochemical composition of the garlic and turmeric powder mixture reveals the presence of several secondary metabolites, which perform multiple biological activities. This report agreed with the result of Adebisi *et al.* (2021) on turmeric powder bioactive properties. The presence of alkaloids in the test ingredients confers their ability to function as antibacterial, antimicrobial, and anticancer; this is in line with the findings of Alagbe (2019).

According to the report of Nwachukwu *et al.* (2020), tannin was absent in turmeric powder while terpenoid was absent in garlic, respectively. However, these complement each other and exert positive influences on the nutritional composition of the diets. Flavonoids have the ability to scavenge for biological radicals and superoxide anion radicals and thus have the ability to promote health (Adebisi *et al.*, 2021). Saponin performs both antibacterial and antifungal functions (Alagbe, 2019). Phenolic acids are capable of activating antioxidant enzymes, reducing and inhibiting oxidases, and also preventing the entry of diseases (Oboh *et al.*, 2007; Alagbe, 2019). Terpenoid has high therapeutic value and functions as antimicrobial, anti-carcinogenic, and anti-diuretic also, tannin has therapeutic applications as antiviral and antibacterial (Adisa *et al.*, 2010). Bioactive chemicals vary in plants according to species, age, soil type and geographical location (Omokore and Alagbe, 2019).

#### **4.3 Haematological parameters of broiler chickens fed dietary inclusion of garlic and turmeric powder**

The haematological results from this study indicate that dietary inclusion of garlic and turmeric powders had a generally positive effect on the blood profile of broiler chickens. The packed cell volume (PCV) values were consistent with the findings of Ari *et al.* (2012) and Oleforuh-Okoleh *et al.* (2015) on garlic supplementation, and they also fell within the

30 – 38% range reported by Oluwafemi *et al.* (2021) for turmeric oil in broiler diets. Similarly, red blood cell (RBC) counts agreed with earlier reports by Mikaili *et al.* (2013) and Oluwafemi *et al.* (2021), while haemoglobin concentrations aligned with the increases observed by Ari *et al.* (2012) and Oleforuh-Okoleh *et al.* (2015). These consistent results suggest that garlic and

turmeric improve oxygen-carrying capacity and support normal physiological function in broilers.

The mean corpuscular haemoglobin (MCH) showed a significant ( $P < 0.05$ ) effect across treatments, but importantly, this effect was positive and not detrimental to performance, confirming the earlier findings of Khaidem *et al.* (2019). Similarly, the mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) were in line with values reported by Oleforuh-Okoleh *et al.* (2015). White blood cell (WBC) counts also matched the range ( $19.82\text{--}30.19 \times 10^6/\mu\text{L}$ ) reported by Oluwafemi *et al.* (2021), indicating strong immune responsiveness. In addition, monocyte and lymphocyte counts were significantly increased ( $P < 0.05$ ) across treatments, again supporting the reports of Khaidem *et al.* (2019). The increased levels of WBC, monocytes, and lymphocytes in this study show the improved immune variation in the birds fed diets with garlic and turmeric powder mixtures, an effect similar to that achieved with conventional antibiotics. On the contrary, the increases in RBC and WBC agree with earlier studies by Fadlalla *et al.* (2010), Toghyani *et al.* (2011), and Oluwafemi *et al.* (2021), all of which reported improved blood cell counts in birds fed garlic-based diets compared with controls. This confirms that garlic and turmeric enhance both blood oxygenation and immune function, strengthening the case for their use as natural antibiotic alternatives in poultry production.

#### **4.4 Serum biochemical indices of broiler chickens fed dietary inclusion of garlic and turmeric powder**

The serum biochemical indices also revealed that garlic and turmeric powder mixtures can be used in place of antibiotics in poultry production. Albumin (ALB) levels were significantly influenced by the garlic and turmeric powder mixture inclusion, agreeing with Ahmadi *et al.* (2021) on garlic supplementation and Oluwafemi *et al.* (2021) on turmeric supplementation. Globulin (GLO) levels similarly aligned with Ahmadi *et al.* (2021), suggesting better general health and immune competence. Total protein (TP) showed positive effects across treatments, confirming earlier reports by Oleforuh-Okoleh *et al.* (2015) and Oluwafemi *et al.* (2021). These improvements in protein metabolism point to enhanced nutrient utilization and general health status. Other serum parameters also reflected beneficial outcomes. Urea (UA) results supported Oleforuh-Okoleh *et al.* (2015) and Ahmadi *et al.* (2021), while creatinine and cholesterol (CHO) values showed significant ( $P < 0.05$ ) positive effects, consistent with Oluwafemi *et al.* (2021). Enzyme activities such as aspartate aminotransferase (AST) and alanine transaminase (ALT) increased significantly but positively ( $P < 0.05$ ), supporting Oleforuh-Okoleh *et al.* (2015) and Oluwafemi *et al.* (2021). Alkaline phosphatase (ALP) results further correlated with Ahmadi *et al.* (2021). These findings suggest that garlic and turmeric powders improve liver function and lipid metabolism, both of which are important for growth and disease resistance.

The blood and serum biochemical results indicate that dietary garlic and turmeric powders improved health, immunity, and performance in broilers. The enhancements in red and white blood cell counts, together with higher serum protein levels and better enzymatic activity, point to stronger immune responses and more efficient nutrient utilization. Birds fed diets with 0.8 g inclusion levels, in particular, showed the best performance. These findings demonstrate that garlic and turmeric powders can effectively serve as natural replacements for synthetic antibiotics in poultry production, promoting both growth and health without adverse effects.

#### **CONCLUSION**

The dietary inclusion of garlic and turmeric powder mixtures, particularly at 0.8 g enhanced blood profile confirmed the safety and nutritional benefits of garlic and turmeric mixtures. The values obtained for haematological and serum biochemical indices remained within normal physiological ranges, indicating that dietary inclusion of these additives did not pose health risks to the birds. Instead, the stable blood parameters suggest that garlic and turmeric supported normal physiological functioning while enhancing performance. These improvements translated

into higher chances of survival, performance and profitability, demonstrating the benefits of supplementation and established garlic and turmeric mixtures as both performance enhancing and quality-improving feed additives in broiler production.

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