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Effect of *Curcuma longa* powder on growth performance, haematological and microbiological parameters of cockerels

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***Target audience:** Researchers, students, livestock farmers*

Abstract

This study was conducted to assess the effect of Curcuma longa on growth performance, hematological and microbiological parameters of cockerels. A total of one hundred and eighty (180) cockerels with an average weight of 250±0.50g were randomized into six treatment groups. Each treatment group comprised of ten birds per replicate and was replicated three times. Treatment 1 (T1) (250 mg turmeric/kg of feed + coconut oil), treatment 2 (500 mg turmeric/kg of feed + coconut oil), treatment 3 (250 mg turmeric/kg of feed), treatment 4 (500 mg turmeric/kg of feed), treatment 5 (control), treatment 6 (500 mg turmeric/kg of feed + Vitamin C).Weekly body weight and daily feed intake of the birds were recorded for 7 weeks, after which carcass analysis was carried out. At the end of seven weeks, blood samples from ten birds per treatment were collected for haematology and serum biochemical parameters after which six chickens were humanely sacrificed for carcass analysis. Samples of ingesta were collected from crop and ileum and analyzed for lactobacillus counts. There was significant difference ($p<0.05$) in the average weight gain of birds with birds in treatment 2 having the highest weight gain. In all carcass parameters, there was no significant difference among the treatments. The packed cell volume (PCV) of birds in T1 group (27.00±0.45%) was significantly highest when compared with birds in other treatments. The serum total protein and albumin of birds in groups T4 (7.860±0.15g/dl) and T6 (7.880±0.36g/dl) were significantly ($p<0.05$) highest compared to other groups. There was no significant difference in the lactobacillus counts in the crop while birds in T2 group had the highest (2.68±0.21 CFU/ml) lactobacillus counts. It can be concluded that Curcuma longa fed to cockerels have no deleterious effect and can be included in their feed up 500 mg/kg of feed with or without coconut oil.

***Keywords:** Curcuma longa, cockerel, growth performance, haematological parameters, microbiological indices*

Description of Problem

With gradually rising human population, an increasing demand for poultry meat is expected in the nearest future; for this reason, poultry health is an important issue (1). Male chicks, popularly known as cockerels constitute 50% of day-old layer chicks. Such chicks have become an indispensable component of poultry development with the rapidly increasing trends of commercial layer farming. Consumers' choice, lower chick price, lower mortality and morbidity, lower management cost, lower initial investment, better market demand, low abdominal fat, more organoleptic preference, family labour utilization and easy management are the strategic advantages for cockerel rearing (2). Despite all the good characteristics, cockerels are slow growing birds that reach maturity at six to eight months. Over the years, antibiotics are extensively used to maintain health and activate bird growth (3). However, with increasing concerns on the emergence of antibiotic resistant bacteria, the widespread use of antibiotics as a preventive tool for diseases and growth promotion was questioned (4). Although antibiotics achieve good performance, their potential side effects

became a real public health concern globally and eventually led to the ban of the products especially in the western world (5). This triggered an explosion of interests in the use of herbs and spices and their products as supplements in animal rations (6).

Turmeric (*Curcuma longa*) is a rhizomatous herbaceous perennial plant of the ginger family, Zingiberaceae (7). Though it is known to be native to the tropical South Asia, it is also widely grown in Nigeria and other tropical and sub-tropical Africa since it requires temperature between 20 and 30℃ and a considerable amount of annual rainfall for growth (8). The rhizome of turmeric is a rich source of bioactive compounds used non-medicinally as a spice and medicinally as human remedies (8). Turmeric powder is approximately 60-70% carbohydrate, 6-13% water, 6-8% protein, 5-10% fat, 3-7% dietary minerals, 3-7% essential oils, 2-7% dietary fiber, and 1-6% curcuminoids (9). Active constituents include curcuminoids which refer to a group of chemically related active phenolics present in turmeric rhizhome i.e. curcumin (diferuloylmethane), demethoxycurcumin and bisdemethoxycurcumin (10). Curcumin is an orange-yellow crystalline powder obtained by solvent extraction of turmeric rhizome powder, and subsequent purification of extract done by crystallization. Curcumin has the nature of an oily soluble crystalline powder with a melting point of 174℃ (11). Curcumin has been shown to have several biological effects which include antioxidant properties (12), anti-inflammatory activities (10), antiviral and antifungal activities (13,14), and immunomodulatory properties (15), antibacterial (16), antimalarial (17), antitumor (18), hepatoprotective (19), renoprotective (20) and hypocholesterolemic (21). It is also used in gastrointestinal and respiratory disorders (22). The fat-soluble quality of curcumin makes turmeric more potent when consumed in combination with healthy fat like avocado, coconut oil, olive oil etc. (23). Coconut oil, or copra oil is an edible oil extracted from the kernel or meat of mature coconuts harvested from the coconut palm (24).

Hence this study evaluated the effect of turmeric powder with or without coconut oil on growth performance, hematological parameters and microbiological parameters of cockerels.

Materials and Methods

Experimental site/location

This research was carried out at the poultry unit of Teaching and Research Farm of Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. Ile- Ife lies on longitude 4° 69'E and latitude *70° 50′* N, 906 ft elevation and average precipitation is about 1340mm, the rainy period of the year lasts for 9.6 months, from February to November (25).

Experimental design

One hundred and eighty (180) growing four week old cockerels (average weight 245g) were purchased from Teaching and Research Farm of Obafemi Awolowo University, Ile-Ife and were randomly allotted using Completely Randomized Design into six groups tagged as Treatments (T1) to (T6) and were replicated three times. Each replicate consisted of ten birds and the experiment lasted for seven weeks.

Preparation of Turmeric powder

Rhizomes of *Curcuma longa* were purchased from the Oja tuntun, Ile-Ife, Osun state, located in the South West of Nigeria. The rhizomes were cut into small sizes and oven dried at 35℃ for 12 hours to a moisture content of 11 to 13% at the Animal Sciences Meat Laboratory. Then, the rhizomes were grinded to obtain a golden yellow powder.

Experimental diet and feeding

Isocaloric and isoproteic feed containing 21% CP and 3100 Kcal/kg was fed to the birds. Coconut oil and turmeric powder were added as experimental materials. The following were the breakdown of experimental materials added to the feed per bird per day:

T1- 250 mg turmeric/kg feed (mixed with 5 ml coconut oil), T2- 500 mg turmeric/kg of feed mixed with 5ml coconut oil, T3- 250 mg turmeric/kg of feed, T4- 500 mg turmeric/kg of feed, T5- Control (feed only), T6- 500 mg Vitamin C/kg feed.

Sample collection and analysis

The birds were weighed weekly and at the end of the experiment, blood was collected through the wing veins using disposables syringes and needles from ten birds per treatment. The blood samples (5 mls/ bird) were collected into sample bottles one without and one with di-potassium salt of ethylene diamine tetra acetic acid (EDTA) which served as anticoagulants for biochemical and haematological analyses respectively. Haematological indices were estimated using standard procedures as described (26) for haemoglobin, red blood cells (RBC), packed cell volume (PCV) and white blood cells (WBC) contents. Biochemical indices measured were Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST), total protein, albumin, albumin/globulin ratio, total bilirubin, creatinine level and blood urea nitrogen (27). Six birds per treatment were used for carcass analysis; the organs (crop and ileum) were removed from the bird during dissection and were inoculated according to microbiological standard procedure (28). A sterile molten nutrient agar was used and the bacteria colony that grew on the nutrient agar was picked with an inoculation loop. The microbiological index was tested for presence of Lactobacillus bacteria. Feed conversion ratio was calculated as average feed intake per daily weight gain.

Packed Cell Volume (PCV)

A micro capillary tube was filled with anti-coagulated blood and the end was sealed with plasticine by heating. The tube was centrifuged in a micro hematocrit centrifuge. The plasma at the top of the capillary tube could be used for determining plasma protein and fibrinogen and for assessing plasma color and turbidity. The level of the settled blood cells was read by placing the tube on special hematocrit reader (26).

Red Blood Cell Count

The red blood cell count per million was done using blood containing anticoagulants by the hemocytometer method. A red blood cell dilution pipette was used to draw blood up to 0.5 mark, the blood was diluted using red blood cell dilution fluid up to 1.2 mark and was dropped on a glass slide called Neubauer's chamber. It was smeared and covered with a cover slip. This was viewed under the microscope. The slide view showed both smaller and larger squares. The smaller squares in the center are used for the calculation of the red blood cell count. Hence, the number of red blood cells was calculated in 5 small squares. The volume counted was calculated using the formula below: (26)

$$\text{RBC} = \frac{\text{total number of cell count} \times \text{dilution factor}}{0.02\ \text{mm}^3}$$

White blood cell count

The total white blood cells were counted under the microscope using the hemocytometer. A white blood cell pipette was used to draw blood to 0.5 mark and diluted to 1.2 mark with the aid of the white blood cell dilution fluid. The leucocytes in the four lower squares were counted. The number of cells counted was calculated using the formula below (29):

$$\text{WBC} = \frac{\text{total number of cell count} \times \text{dilution factor}}{0.4\ \text{mm}^3}$$

To determine the biochemical parameters, blood samples (4mls per bird) were collected into plain sample bottles and allowed to clot and centrifuged for 15 minutes at 2200-2500 rpm (G-force 600.92) to separate the sera. The sera samples were used for the biochemical parameters determination. The levels and activities of liver enzymes such as Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST), total protein, albumin, albumin/globulin ratio, total bilirubin, creatinine level and blood urea nitrogen were determined according to the enzymatic colorimetric method described by Schmidt and Schmidt (27) using a commercial diagnostic reagent kits (Randox Laboratories Ltd., UK).

Microbiological analysis

By means of dissection, 36 samples were obtained from the crop and ileum of the birds, eighteen (18) samples each from the crop and ileum, respectively.

Presence of *Lactobacillus* spp. and Count: Sterile molten De Man Rogosa and Sharpe agar (MRS) was aseptically poured into plates. 0.1 ml from 10-2 diluent was seeded into a sterile prepared MRS Petri-plates and spread using a sterile glass spreader. After few minutes, the plates were inverted and incubated in an anaerobic jar at room temperature (25±2℃) for 48 hours.

Relative organ weight calculation

Relative organ weight (%): ([organ weight (g)/live weight (g)] x100). (30)

Statistical analysis

The statistical software SAS version 9.1 (2003) was used to analyze the data obtained. Data were subjected to analysis of variance (ANOVA) and the means were separated using Duncan Multiple Range Test, and values with $p<0.05$ were considered statistically significant.

Results and Discussion

The growth performance indices of cockerels administered turmeric are shown in Table 1.There was no significant difference ($p>0.05$) in average final weight of the birds in all treatments (T1-T6) but T2 (Turmeric at 500 mg/kg feed + coconut oil) had the highest numerical value (701.33±21.19) compared to T5 which is control group (652.33±39.07). There was significant difference ($p<0.05$) in average daily weight gain with 500 mg/kg with coconut oil group of birds having the highest value (451.33±21.01), followed by T4 (500 mg turmeric/kg of feed) with the value (448.33±21.01) compared to control (T5) with value of (430.66±44.20). This result is in agreement with the findings of Al- Sultan (31) and Kumari et al (32) who reported that the inclusion of 0.5% turmeric powder significantly increased body weight gain and feed conversion ratio compared to control in broilers ($p<0.05$). Also Al-Jaleel (33) reported that turmeric powder at the level of 0.5 g/kg feed significantly increased the body weight gain and FCR compared with control in broilers. In contrast, Akbarian et al (34), Namagirilakshmi (35) and Emadi and Kermanshahi (36) reported that addition of turmeric rhizome powder up to 10 g/ kg feed in broiler did not affect the body weight gain in broiler chickens. The result obtained from this present study could be due to antioxidant activity of turmeric whose absorption was enhanced by the addition of oil that stimulates protein synthesis by enzymatic system (37, 38, 39).

There were no significant differences ($P>0.05$) in feed intake and feed conversion ratio (FCR) although birds in T2 group have the highest value of feed intake (56.10±1.69) compared to control group (52.18±3.12). This result agrees with the reports of Emadi and

Kermanshahi (36); Durrani *et al*, (40); Ahmadi (41) and Nouzarian et al (42) who reported that the inclusion of *Curcuma longa* at different inclusion levels have no effect on feed intake. There was no significant difference in the different parameters measured for the carcass analysis except for the body/liver ratio. This agreed with El-Deek et al (43)who found increase in liver weight of broilers fed *Saccharomycese cervicia* supplemented diets.

The hematological parameters of cockerel chickens are shown in Table 3. Haematocrit measures the percentage of the volume of whole blood that is made up of red blood cells (44). The packed cell volume of birds in was highest ($p<0.05$) in birds (29.40±0.60) administered with 250 mg turmeric which is not significantly different from the value obtained in birds on control treatment. This result is in concordance with reports (45, 46) that inclusion of turmeric had no significant effect on hematocrit level of broiler. The red cell count and hemoglobin count of birds in treatment 1(8.78±0.13),3(9.42±0.35) and control birds were significantly different and higher compared to other treatments, showing that turmeric does not have an effect in increasing the hemoglobin count at 250 mg/kg or at 500 mg/kg of feed. There was no significant difference in the white blood cell counts of the birds supplemented with turmeric at 250 mg/kg feed and control, but the birds in 500 mg/kg turmeric supplemented group had significantly reduced white blood cell count. This corroborates the findings (47) whereby white blood cell count reduced markedly after *Curcuma longa* extract supplementations thereby suggesting that this supplement possesses some anti-inflammatory effects towards collagen induced arthritis in rats. This is also in accordance with an earlier research (48) which stated that treatment with curcumin reduced the proliferation of lymphocytes following the inductive action of IL-2.

Table 1: Growth parameters of Cockerels administered turmeric supplementation at different inclusion levels

Parameters	T1	T2	T3	T4	T5	T6
Avg. Initial weight (g)	258.30±1.66	250.30±0.01	243.30±1.67	226.60±3.33	221.67±6.67	233.30±6.67
Avg. Final weight (g)	635.33±48.36	701.33±40.46	596.00±65.23	675.67±76.96	652.33±39.07	623.00±54.37
Total weight gain(g)	387.00±47.60	451.33±40.46	347.00±64.36	448.33±77.20	430.67±44.20	389.67±47.97
Avg. daily weight gain (g)	7.89±0.97^{c}	9.21±0.83^{a}	7.08±1.31^{c}	9.14±1.57^{a}	8.79±0.90^{b}	7.92±1.00^{c}
Avg. feed intake (g)	50.83±4.39^{ab}	56.11±3.24^{a}	47.23±5.26^{b}	54.00±5.90^{a}	52.19±3.13^{ab}	49.84±4.35^{b}
FCR	6.48±0.24	6.12±0.19	6.83±0.53	6.05±0.45	5.99±0.27	6.35±0.28

Means within each row with different superscripts are significantly ($P<0.05$) different How did you calculate the total weight gain?

AIW- Average Initial weight, AFW- Average Final Weight, AFI- Average Feed Intake, DWG- Daily Weight Gain, FCR- Feed Conversion Ratio**.** T1- 250 mg turmeric/kg feed (mixed with 5 ml coconut oil), T2- 500 mg turmeric/kg of feed mixed with 5 ml coconut oil, T3- 250 mg turmeric/kg of feed, T4- 500 mg turmeric/kg of feed, T5- Control (feed only), T6- 500 mg Vitamin C/kg feed

Table 2: Carcass characteristics of Cockerels fed with Turmeric at different Inclusion Levels

Parameters	T1	T2	T3	T4	T5	T6
Live weight (g)	635.33±54.96	701.33±40.45	596.33±65.68	675.67±76.96	652.33±39.07	623.01±54.37
Carcass weight (g)	547.33±54.96	613.33±40.45	510.33±59.46	587.66±74.30	564.33±39.07	535.00±54.37
Dressing yield (%)	86.09±3.25	87.45±0.54	73.95±4.04	87.06±1.89	86.50±5.81	85.87±2.49
Thigh and Drumstick (g)	119.33±12.97	124.66±5.04	108.00±12.49	121.66±17.48	124.00±15.63	106.33±6.48
Breast (g)	74.00±7.00	90.33±6.74	74.33±6.33	88.00±11.50	86.33±13.83	75.66±10.86
Wings (g)	66.00±6.35	66.33±4.25	61.66±4.05	64.66±4.84	61.00±7.76	52.33±5.20
Liver (g)	10.66±2.18	15.00±2.08	12.66±2.66	14.00±2.64	16.00±1.73	14.66±3.71
Body liver ratio	53.30±4.87^{a}	41.68±2.84^{ab}	41.80±4.07^{ab}	43.20±3.20^{ab}	37.36±3.03^{ab}	39.2±45.82^{b}
Gizzard (g)	30.66±3.66	31.33±2.02	29.00±3.21	30.33±2.96	32.66±5.04	31.00±4.93
Kidney (g)	3.33±0.33	3.33±0.33	2.66±0.33	2.33±0.33	2.33±0.33	2.66±0.33
Crop (g)	4.33±0.33	5.00±0.57	4.33±0.33	6.00±2.00	6.00±1.15	5.66±1.20
Small intestine (g)	26.33±2.40	30.66±4.48	30.00±2.51	33.66±8.25	32.00±3.05	32.66±6.35
S.I/B.W(%)	4.81	5.00	5.88	5.73	5.67	6.10

Means within each row with different superscripts are significantly (P<0.05) different
T1- 250 mg turmeric/kg feed (mixed with 5 ml coconut oil), T2- 500 mg turmeric/kg of feed mixed with 5 ml coconut oil, T3- 250 mg turmeric/kg of feed, T4- 500 mg turmeric/kg of feed, T5- Control (feed only), T6- 500 mg Vitamin C/kg feed S.I/B.W- Small intestine/body weight

Table 3: Hematological parameters of Cockerels administered turmeric supplementation at different inclusion levels

PARAMETER	T1	T2	T3	T4	T5	T6
PCV (%)	27.00±0.45^{b}	23.60±0.68^{c}	29.40±0.60^{a}	21.80±0.97^{c}	28.40±0.75^{ab}	21.80±0.92^{c}
Hb (g/dl)	8.78±0.13^{a}	7.72±0.30^{b}	9.42±0.35^{a}	7.10±0.27^{c}	9.08±0.31^{a}	7.18±0.27^{b}
RBC (x10^{12}/l)	2.98±0.23^{a}	2.05±0.21^{b}	3.41±0.06^{a}	1.82±0.19^{b}	3.23±0.22^{a}	3.26±0.17^{a}
WBC (x10^{6}/l)	16.90±0.79^{a}	14.00±0.12^{b}	16.20±0.4^{ab}	14.80±0.99^{ab}	16.30±0.40^{a}	14.70±1.00^{ab}
PLA (x10^{9}/l)	128.0±3.6	137.0±4.9	148.0±12.1	131.0±7.7	135.0±6.2	139.0±8.0
LYM (%)	61.4±2.16^{ab}	61.4±2.42^{ab}	67.8±2.75^{a}	56.8±2.52^{b}	60.0±3.29^{ab}	60.0±2.0^{ab}
HET (%)	31.8±1.69^{ab}	31.8±2.42^{ab}	26.0±3.08^{b}	36.4±2.48^{a}	34.2±3.90^{ab}	31.6±1.54^{ab}
MON (%)	3.00±0.45^{a}	3.00±0.45	2.60±0.24	3.20±0.20	3.00±0.45	3.40±0.40
EO (%)	3.40±0.93^{a}	0.60±0.02	3.40±0.40	3.60±0.75	3.80±0.49	4.40±0.75
BA (%)	0.40±0.02^{ab}	0.00±0.0^{ab}	0.20±0.02^{ab}	0.00±0.0^{ab}	0.20±0.02^{ab}	0.60±0.02^{a}

The values in the same row with different superscript are significantly (p<0.05) different. PCV: Packed cell volume, Hb: Hemoglobin, RBC: Red blood cell, WBC: White blood cell, PLA: Platelets LYM: Lymphocytes, HET: Heterophils, MON: Monocytes, EO: Eosinophils, BA: Basophils

Table 4: Biochemical parameters of Cockerels administered turmeric supplementation at different inclusion levels

PARAMETERS	T1	T2	T3	T4	T5	T6
Total Protein (g/dl)	5.68±0.17^{c}	7.06±0.11^{b}	6.52±0.04^{b}	7.86±0.15^{a}	6.64±0.07^{b}	7.88±0.36^{a}
ALB (g/dl)	1.12±0.21^{c}	1.84±0.17^{b}	1.58±0.06^{b}	2.36±0.07^{a}	1.66±0.09^{b}	2.46±0.16^{a}
GLO (g/dl)	4.56±0.19^{c}	5.22±0.20^{ab}	4.82±0.06^{bc}	5.50±0.10^{a}	4.86±0.14^{bc}	5.30±0.18^{ab}
A/G Ratio	0.25±0.05^{b}	0.35±0.04^{a}	0.33±0.00^{ab}	0.42±0.00^{a}	0.34±0.03^{ab}	0.46±0.03^{a}
AST (U/L)	180.60±3.14^{c}	191.80±2.63^{ab}	183.40±2.71^{bc}	200.40±2.93^{a}	184.60±1.36^{bc}	197.00±4.62^{a}
ALT (U/L)	25.20±1.71^{c}	26.4±3.06^{c}	28.20±2.20^{bc}	38.2±1.77^{a}	25.00±1.76^{c}	33.40±2.62^{ab}
BUN (mg/dl)	13.02±1.49^{c}	18.20±0.25^{ab}	17.90±0.28^{ab}	19.80±0.25^{a}	16.80±0.15^{b}	19.80±0.28^{a}
CREA (mg/dl)	0.52±0.02^{c}	0.60±0.02^{ab}	0.54±0.02^{bc}	0.64±0.02^{a}	0.56±0.04^{bc}	0.64±0.02^{a}
T.B (mg/dl)	0.18±0.04^{c}	0.32±0.06^{b}	0.24±0.02^{bc}	0.50±0.05^{a}	0.22±0.04^{bc}	0.56±0.02^{a}

The values in the same column with different superscript are significantly different ($p<0.05$). ALB: Albumin, GLO: Globulin, ALT: alanine aminotransaminase, AST: aspartate aminotransaminase, A/G RATIO: Albumin/Globulin ratio, BUN: blood-urea nitrogen, CREA: creatinine, T.B: total bilirubin.

Table 5: **Microbiological parameters showing lactobacillus counts in the crop and ileum of cockerel birds administered turmeric supplementation at different inclusion levels**

TREATMENT	CROP	ILEUM
T1	2.56±0.18	1.68±0.17^{c}
T2	2.72±0.18	2.68±0.21^{a}
T3	2.47±0.17	2.51±0.14^{ab}
T4	2.81±0.23	1.93±0.10^{bc}
T5	2.73±0.30	2.30±0.06^{ab}
T6	2.72±0.14	2.60±0.12^{a}

Means within each column with different superscripts are significantly ($P<0.05$) different.
T1- 250 mg turmeric/kg feed (mixed with 5 ml coconut oil), T2- 500 mg turmeric/kg of feed mixed with 5 ml coconut oil, T3- 250 mg turmeric/kg of feed, T4- 500 mg turmeric/kg of feed, T5- Control (feed only), T6- 500 mg Vitamin C/kg feed

The biochemical parameters of cockerels are shown in Table 4. When testing a therapeutic compound, it is extremely important to evaluate its systemic action and effects on the performance indices, as this will determine the feasibility of its intended use for a particular species (31). Although significant differences in values were observed in the present study, the values were within the normal range for the birds. There were significant differences ($p<0.05$) in total protein, albumin, globulin, albumin-globulin ratio, aspartic transamine acid, alanine transamine acid, blood-urea nitrogen, creatinine and total bilirubin of birds supplemented with 500mg/kg turmeric and vitamin C compared with the remaining four groups in the experiment. The effect on the biochemical parameters of birds supplemented with 500 mg/kg turmeric was similar to those on 500 mg/kg vitamin C, there was significant increase in the total protein levels in these groups. This is in agreement with Azis *et al* (49) that reported high total protein in birds supplemented with DL-methionine and herbal methionine. Kumari *et al*. (32) also recorded significantly higher levels of serum total

protein and globulin of broiler birds fed a diet treated with turmeric powder at a rate of 1 g/kg, Quasm *et al* (50) showed significant increases in total protein and globulin at different weeks of the experiment, revealing high activity in the liver as a result of the curcumin component in turmeric powder

Total protein is an important serum marker, which seems to be related to a better ability of hepatocytes to synthesize protein, high plasma protein has been attributed to good protein reserve reflecting the ability of the birds to store protein for tissue development even after the animal has reached its maximum capacity for depositing tissue. The increase in albumin levels is suggestive of proper maintenance of the integrity of the liver and other extrahepatic tissues involved in protein synthesis (52). Serum albumin and globulin depend on availability of dietary protein (42). The significant increase ($p<0.05$) in the AST of birds in treatment 4 was in agreement with of Emadi & Kermanshahi (36) that stated that the serum activities of AST enzyme increased in broiler chickens fed turmeric powder at rates of 2.5 and 5 g/kg of the basal diet.

The blood urea nitorgen level in birds in treatment 4 (19.78±0.25) and 6 (19.84±0.28) were significantly different and higher compared to other treatments showing the efficient conversion of the total protein in the body to blood urea nitrogen. The creatinine levels of birds in treatments 4 and 6 were significantly higher ($p<0.05$) compared to other treatments. This is in agreement with the report that birds supplemented with DL-methionine or herbal methionine had high BUN and creatinine (52). The levels of BUN and creatinine reported in this experiment is within the normal range for chickens (52).

The result of the total Lactobacillus counts in the crop and ileum as shown in table 5. Birds supplemented with 500 mg turmeric had the highest lactobacillus count, however there were no differences among treatments in the crop. In the ileum, birds on 500 mg turmeric with oil coconut oil showed the highest lactobacillus counts. This is in agreement to the report of Samarasinghe et al (53) that observed increased lactobacillus count in broilers supplemented with 1g/kg turmeric. Cao et al. (54) reported that broiler chickens fed diets supplemented with *Lactobacilli* spp. were more resistant to the pathogenic effects of *E. coli*. So increase in beneficial Lactobacilli spp may reduce the incidence of birds having coliform related diseases.

Conclusion and Application

1. In conclusion, it could be observed that birds on the diet containing Vitamin C had comparable results with birds on Turmeric at 500 mg/kg feed.
2. *Curcuma longa* (Turmeric) or Vitamin C at 500 mg/kg can be added to the feed of cockerel for better intestinal health.
3. There was no advantage of addition of coconut oil to the activities of *Curcuma longa.*
4. *Curcuma longa* at the doses administered had no deleterious effect on cockerels.

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