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Growth Performance, Carcass Quality, Organ Weights and Haematology of Broilers Fed Graded Dietary Levels of Turmeric (*Curcuma longa* L.) Powder as Feed Additive

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Abstract: The growth performance, carcass qualities, organs weight and haematology of ninety-six (96) day-old Agritech broiler birds fed Turmeric powder additive were evaluated. The birds were reared on deep litter system and were randomly allotted to four (4) treatments of graded dietary levels (0, 1.5, 3.0 and 4.5%) of Turmeric powder denoted as; T_1, T_2, T_3 and T_4 respectively. Each treatment with 24 birds was also replicated thrice with 8 birds per replicate in a Completely randomized design for 56 days. Performance indicators measured included feed intake, body weight gain, feed conversion ratio, carcass and organ weights and haematological parameters. Results showed that turmeric additive elicited significant differences ($P \leq 0.05$) across treatments. Bodyweight gain (2113.00g) and feed conversion ratio (2.02) were significantly higher in broilers fed diets with 1.5% turmeric powder ($T_{2)}$ than those on other treatments. Turmeric additive also improved the carcass and organ weights as well as the haematological parameters in which the erythrocytic and leukocytic counts were not significantly different ($P \geq 0.05$) in T_2, T_3 and T_4 except for the control. However, the overall positive effect of turmeric powder in broiler diet was observed in T_2 (1.5%) following improved feed intake, body weight gain and feed conversion ratio and this inclusion level is advocated while further research in other avian species available in warm wet regions of Nigeria is suggested.

Keywords: Performance, Haematology, Broiler, Turmeric, Feed Additive

1. Introduction

Broiler production has turned into a dynamic industry with potentials to solve malnutrition and unemployment, poverty reduction as well as encouraging income generation [1, 2]. Broilers have fast growth rate, high carcass yield, efficiency of feed utilization, short generation period, ease of management and small space requirement [3, 4]. However, broiler industry has several challenges amongst the high cost of feed ingredients. Feeds account for about 65-75% of the total cost of production [5] and in bracing up the challenge of high cost of feeds, broiler operators are unrelently making efforts to explore alternative feed ingredients including feed additives which are used as antibiotics, anti-oxidants, binders, colourants and lubricants [6].

The plethora of criticisms on adverse effects of using synthetic antibiotics and their complete ban by the European Union and United State Departments of Agriculture in 2006 have given rise to search for natural, plant-based feed additives known as phytobiotics [7, 8]. Phytobiotics are believed to prevent diseases, improve flavour and palatability of feeds [9]. Phytobiotics Feed Additives (PFAs) have also been regarded as safe to the birds, operators, consumers and the environment [8, 10].

Given the interest and benefits from using phytobiotics, extensive research works have been conducted and reported on the wide use of several plants as phytobiotic feed additives in broiler diets. One of such plants is Tumeric (*Curcuma long L.*), a perennial herb belonging to Zingiberaceae family. The rhizome is the part used both as spice and feed additive after it is cleaned, boiled and dried to yield yellow powder [11, 12]. Phytochemical analysis of Turmeric rhizome had been reported [13, 14] to

contain Curcuminoids which is made up of Curcumin I (94%) and Curcumin II (6%), protein (6.3%), fat (5.1%), carbohydrates (69.4%), minerals (3.5%), essential oils (5.8%) and moisture (13.1%). Curcumin has been described [8, 15, 16] as the main yellow bioactive component that has a wide spectrum of biological, medical and pharmacological actions as anti-oxidant, antibacterial, antiviral, antifungal, antiprotozoal, anti-carcinogenic, anti-inflammatory, immunomodulatory, heptoprotective and hypocholesteremic activities. Curcumin is estimated to be 2-5% of Turmeric and its content in Turmeric can be influenced by species diversity, different stages of growth at which the plant is harvested, difference in regions, soil nutrients and acidity [17]. Curcumin is non-toxic residue free and well tolerated at very high doses in broilers.

Despite numerous experiments conducted on Turmeric as phytobiotic feed additives in broiler diets, there is still paucity of reliable or consistent reports regarding the herb efficacy on performance parameters. Therefore, this current study was initiated to investigate the effect of turmeric additive on growth performance, carcass qualities, organ weights and haematology of broilers reared in warm wet climate.

2. Materials and Method

2.1. Study Site

The study was conducted at the Poultry Unit, Teaching and Research Farm of the Department of Animal Science, University of Uyo Akwa Ibom State, Nigeria located on Latitude 5°17` and 5°27`North of the Equator and Longitude 7°27` and 7°58` East of the Greenwich with temperature ranges between 26°C – 28°C and average annual rainfall range of 2000mm – 3000 mm. Relative humidity ranges between 78% - 93% ([18].

2.2. Experimental Birds and Management

Ninety-six day old broiler chicks of Agrictech strain were purchased in Uyo, Akwa Ibom State, Nigeria. The birds were reared on deep litter system. All vaccines and drugs were administered. Sufficient warmth and light were also supplied as recommended [19].

The experiment lasted for 8 weeks. The formulated starter mash and water were provided *ad libitum* at 0-4 weeks. At the end of the 4th week, the birds were weighed and fed on the formulated finisher mash from 5 - 8 weeks. Daily feed intake was recorded as difference of feed offered and left over.

2.3. Experimental Design

Upon arrival, the day-old chicks were weighed and randomly allotted to 4 dietary treatments of 24 birds. Each treatment was replicated 3 times with 8 birds per replicate in a Completely Randomized Design **(**CRD**)**

Birds in T_1 were fed basal diet, while T_2, T_3 and T_4 were fed basal diets containing 1.5%, 3.0% and 4.5% Turmeric powder as additive respectively during the 8 weeks of experimental period.

2.4. Processing of Turmeric

Fresh Turmeric rhizomes (*Curcuma longa L.*) used for this experiment were purchased from a local market in Uyo, Akwa Ibom State. These rhizomes were washed, sliced, boiled for 45 minutes and oven -dried at 50°C for 24 hours and then ground into powder [17]. The turmeric powder so obtained was incorporated into the experimental diets which were analyzed for proximate composition using the official methods [20].

2.5. Blood Collection and Carcass Analysis

The blood samples were collected from each of the 24 birds. 2.5ml% blood samples taken from the wing veins of the selected birds were put in labeled sterile bottles containing EDTA to determine haematological indices [21].

At the end of the experimental period, 2 birds per replicate were randomly selected and fasted for 18 hours to 24 hours to empty their GIT after which they were weighed alive and slaughtered by cervical dislocation [22].

The carcasses were weighed again before evisceration to extract liver, heart, spleen, pancreas and intestines, while the wing, drumstick, thigh, breast cut and back cut were also obtained from the carcasses.

These organs were weighed with Sensitive Scale (A & Gulf, JS 600H) and were also examined to detect any lesion or damage.

2.6. Data Collection

Data considered and collected were performance indices involving feed intake body weight gain, feed conversion ratio, carcass/organ weights and haematological parameters. The mean weekly feed intake and body weight gain for each treatment group were recorded throughout the experimental period and used to determine FCR.

2.7. Statistical Analysis

Data obtained were subjected to Analysis of Variance [23] and the means were separated using Duncan Multiple Range Test [24] at 5% level.

Table 1. *Ingredient composition (%) of experimental diets with graded dietary levels of Turmeric powder.*

Treatments	Starter Phase				Finisher Phase			
	T1	T2	T3	T4	T1	T2	T3	T4
Turmeric powder (%)	0	1.5	3.0	4.5	0	1.5	3.0	4.5
Ingredients:								
Maize	49.0	49.0	49.0	49.0	62.0	62.0	62.0	62.0
Soybean meal	34.0	34.0	34.0	34.0	25.0	25.0	25.0	25.0

Treatments	Starter Phase				Finisher Phase			
	T1	T2	T3	T4	T1	T2	T3	T4
Palm kernel cake	5.20	3.70	2.20	0.70	4.20	2.70	1.20	0.00
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Turmeric	0.00	1.50	3.00	4.50	0.00	1.50	3.00	4.50
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
*Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100
Crude Protein (%)	22.86	22.73	22.59	22.46	20.21	20.05	19.89	19.78
ME (kcal/kg)	2843.2	2826.8	2803.6	2783.5	2951.0	2931.2	2911.4	2896.6
Calcium (%)	1.20	1.46	1.70	1.96	1.18	1.44	1.68	1.94
Phosphorous	0.81	1.26	1.71	2.15	0.71	1.15	1.61	2.05

*Vitamin premix per kg of diet: Mg, Vit. A, 2.7 (iu/kg); Vit D3, 0.005 (iu/kg); Vit. E, 18 (ppm); Vit. K3, 2 (iu/kg); Thiamin, 1.8 (ppm); riboflavin, 6.6 (ppm); pantothenic acid, 10 (ppm); pyridoxin, 3 (ppm); cyanocobalamin, 0.015 (ppm); niacin, 30 (ppm); biotin, 0.1 (ppm); folic acid, 1 (ppm); choline chloride, 250 (ppm); antioxidant, 100 (ppm). ME = Metabolizable energy.

3. Results and Discussion

The growth performance of broiler chicken fed graded dietary levels of Turmeric powder for 56 days on deep litter house is as shown in Table 2 below. There were significant differences ($P<0.05$) observed for all the parameters measured. Feed intake showed a higher increase in T_2 (4261g) as compared with other treatments except the control. The body weight for birds fed diets with 1.5% turmeric powder (2193g) and those on control diet (2137g) significantly decreased with increasing levels of dietary Turmeric powder to 1833g and 1551g for those fed diets with 3.0 and 4.5% respectively. Regarding the feed conversion ratio, birds fed 1.5% dietary Turmeric powder were adjudged the best followed by the control diet.

Table 2. *Growth Performance of broiler chicken fed graded dietary levels of Turmeric Powder.*

Treatments	T_1	T_2	T_3	T_4	SEM
Turmeric powder (%)	0	1.5	3.0	4.5	
Parameters:					
Initial body weight (g/bird)	80.00	80.00	80.00	80.00	0.00
Final body weight (g/bird)	2137^a	2193^a	1833^b	1551^c	18.26
Body Weight gain (g/bird)	2057^a	2113^a	1753^b	1471^c	18.26
Feed intake (g/bird}	4197^a	4261^a	3868^b	3771^b	31.06
Daily Weight gain (g/bird/day)	41.99^a	43.12^a	35.77^b	30.02^b	0.37
Daily Feed intake (g/bird/day)	85.66^a	86.96^a	78.92^b	76.95^b	0.63
Feed Conversion Ratio (FCR)	2.04^c	2.02^c	2.21^b	2.56^a	0.02

$^{a-c}$ Means along the same row with different superscripts are significantly different ($P < 0.05$)
SEM = Standard Error of means.

Improvement in feed intake, body weight gain and feed conversion ratio obtained for birds fed 1.5% (T_2) over other treatments might be attributed to the presence of bioactive compound called Curcumin in turmeric powder. Curcumin is a natural antioxidant that stimulates protein synthesis in birds' enzymatic system [19]. As an antioxidant, Curcumin can destroy free radical, increase antioxidant enzymes and inhibit lipid peroxidation [26]. The findings also agreed with [17, 25,] who reported positive effects of turmeric on bodyweight gain (2277g and 1287.4g) and feed conversion ratio (1.87 and 2.27) of finisher broilers. It has also been observed [12] that broilers fed with diets supplemented with 5g/kg turmeric powder had better feed conversion ratio than that of 2.5g and 10g/kg supplementation levels. This beneficial effect as observed by [17] was attributed the beneficial effect of turmeric to its antimicrobial properties as it limits the growth and colonization of numerous pathogenic and non-pathogenic species of bacteria in chickens' gut, thus resulting in balanced gut microbial ecosystems which enhanced better feed utilization as reflected by improved FCR. It was also reported [27] that inclusion of 3g and 6g/kg of turmeric to the aflatoxin contaminated diet indicated improved feed conversion ratio when compared with birds fed contaminated diets alone.

The decrease in feed intake and body weight gain in T_3 and T_4 might also be attributed to higher percentage of turmeric powder causing excessive bitter taste that prevent birds from taking more of the diet. A reduced feed intake had been reported [12, 28] when turmeric additive (even at 2g/kg) was fed to chicken.

The haematological parameters of broilers fed diets with different levels of Turmeric powder is as shown in Table 3 below. Broilers fed diets with Tumeric powder (T_2, T_3 and T_4) were similar ($P > 0.05$) in values for RBC and WBC, but significantly higher than what obtained for those on control treatment (RBC, 1.82 x 10^3/µl; WBC, 191.03 x 10^6/µl). Studies by [25] demonstrated a significant increase in values of erythrocytes at 268,000 and leukocytes at 3,000,200 when the diet of broiler chicken was supplemented with 10g/kg turmeric meal. A significant increase in erythrocytic count had been reported [8, 18, 29], following the inclusion of 600mg/kg of Tumeric in broiler diet.

Table 3. *Haematological parameters of broilers fed diets with different levels of Turmeric powder.*

Treatments	T_1	T_2	T_3	T_4	SEM
Turmeric powder (%)	0	1.5	3.0	4.5	
Parameters (%):					
Red Blood Cells (x 10^3/µl)	1.82[b]	2.45[a]	2.36[a]	2.29[a]	0.15
White Blood Cells (x 10^6/µl)	191.03[b]	226.35[a]	224.08[a]	219.67[a]	7.92
Platelets (x 10^3/µl)	10.00[a]	9.83[a]	7.00[b]	6.50[b]	2.16
Haemoglobin (g/dl)	9.60[b]	11.05[a]	10.03[a]	7.60[b]	0.65
Lymphocytes (x 10^3/µl)	90.35[a]	88.15[a]	85.95[b]	82.98[b]	2.99

[a-c] Means along the same row with different superscripts are significantly different ($P<0.05$)

The platelet and lymphocytes values obtained for broiler fed diets with 3.0% curcumin (7.0 and 85.95 x 10^3/µl respectively) and 4.5% curcumin powder (6.50 and 82.98 x 10^3/µl) were similar and significantly lower than the values obtained for those on control treatment (10.0 and 9.83 x 10^3/µl respectively) and 1.5% curcumin powder. Turmeric powder had been reported [17] to promote the activation of T-lymphocytes, B-lymphocytes, macrophages, neutrophils and natural killer cells in chickens. These improvements in many haematogical parameters might be attributed to the immunomodulatory activity of Curcumin [8, 17].

As the level of curcumin powder increased in the diet to 3.0% the haemoglobin significantly increased to 10.03 g/dl after which it dropped significantly to 7.60 g/dl at 4.5% inclusion level of curcumin powder which is similar to what obtained for birds on control treatment without curcumin powder. Higher levels of curcumin as a result of increasing levels of turmeric powder in broiler chicken's diet up to 4.5% might have negative effects on haemoglobin, platelets and lymphocytes as observed in this study.

Haematological parameters obtained from the current study had values within the limits reported in the literature [21] and their increased rates might be due to the positive effects of Curcumin, the bioactive substance in turmeric, on blood parameters as reported by some researchers earlier [8, 29]. Both leukoytic and erythrocytic values in this study are also in line with what had been reported [25] that increase in WBC and RBC can be attributed to the immune stimulatory activity of Curcumin. The normal ranges for RBC, WBC, Haemoglobin, PCV and Lymphocytes in broiler chickens had been put at 2.0 – 4.0 x 10^3mm, 3.0 – 6.0 x 10^3mm, 7.0 – 13.0g/dl, 25-45% and 50% respectively [30].

The carcass and organ weights (expressed as% body live weight) of broiler chicken fed diets with different levels of Turmeric powder is as shown in Table 4 below. Broilers fed diets with up to 1.5% turmeric powder had significantly higher body weights and dressed weights than those on 3% turmeric powder which in turn was significantly higher than those on diet with 4.5% turmeric powder. Increase in the inclusion level of turmeric powder beyond 1.55 elicited a significant decrease in body live weights and dressed weights, though the dressing percentage were similar across treatments. The carcass and organ weights showed that birds fed with diet containing 1.5% of Turmeric powder had significantly ($p < 0.05$) higher values than those fed diets with 3.0 (T3) and 4.5% (T4) turmeric powder.

Significantly ($p < 0.05$) higher weights for cut parts such as wing (13.08%), drumstick (14.86%), thigh (15.96%), breast cut (30%), back cut (25.09%), and neck (6.22%) and selected organs like the heart (0. 92%), lungs (0.86%), liver (3.36%), spleen (0.24%), pancreas (0.41%), small intestine (7.20%) and large intestine (0.33%) were obtained for broilers fed diet with 1.5% turmeric powder. These weights decreased across other dietary treatments with increasing levels of turmeric powder.

The results from the data also revealed that carcass and organ parameters were significantly affected ($p < 0.05$) by dietary inclusion levels of turmeric powder. This observation might be due to the effect on growth performance such as body weight gain obtained during the rearing period. Improved carcass quality, dressing percentage as well as increase in breast cut, thigh and giblet weight had been reported [12] in broilers fed diet with 5g/kg turmeric powder supplementation, while 3 g/kg Turmeric diet supplementation reduced carcass fat content and improved carcass quality in broilers [8]. The body weight of birds fed turmeric powder at 5g/kg was attributed [8, 12] to the stimulation of protein synthesis in birds' enzymatic system and the weight increase could be attributed to the control of growth of pathogenic bacteria in the chickens' gut by the antimicrobial properties of curcumin in turmeric, thus ensuring a balanced microbial ecosystem that enhance better feed utilization. These beneficial effects may, in turn, be responsible for tissue, bone and organ development, hence reasonable appreciation or increase in weight. Similar positive effects from reduced fat content on carcass, thigh, pancreas and intestines had also been reported [26, 28]. Some researchers [31] also reported a better dressing percentage (78.06%) and carcass yield [32]

when broilers were fed diets with up to 7.5g/kg and 1.0% turmeric powder respectively which was attributed to the positive influence of turmeric powder as growth promoter that led to more gain in body weight of the broilers.

Table 4. *Carcass and Organ weights (expressed as% body live weight) of broiler chicken fed diets with different levels of Turmeric powder.*

Treatments	T_1	T_2	T_3	T_4	SEM
Turmeric powder (%)	0	1.5	3.0	4.5	
Parameters:					
Live weight /bird (g)	1917[a]	1983[a]	1717[b]	1417[c]	47.10
Dressed weight/(g)	1533[a]	1587[a]	1373[b]	1133[c]	37.70
Dressing percentage	80.00	80.00	80.00	80.00	0.82
Cut Parts (%):					
Wing	10.26[b]	13.08[a]	10.40[b]	10.33[b]	0.27
Drumstick	13.50[b]	14.86[a]	13.26[b]	12.92[b]	0.34
Thigh	13.55[b]	15.96[a]	13.09[b]	12.24[c]	0.33
Breast cut	29.08[ab]	30.00[a]	27.88[b]	25.97[c]	0.71
Back cut	21.97[b]	25.09[a]	20.85[b]	18.18[c]	0.55
Neck	5.77[b]	6.22[a]	5.57[b]	4.83c	0.14
Organ weights (%):					
Caecum	0.89[b]	1.12[a]	0.76[c]	0.84[b]	0. 02
Heart	1.04[a]	0.92[b]	0.67[c]	1.02[a]	0.02
Proventriculus, Crop & Gizzard	4.02[ab]	5.04[a]	4.01[ab]	2.62[b]	0.66
Liver	3.25[a]	3.36[a]	3.38[a]	2.66[b]	0.10
Spleen	0.25[a]	0.24[a]	0.19[b]	0.14[c]	0.01
Gall bladder	0.18[a]	0.19[a]	0.16[b]	0.11[c]	0.01
Pancreas	0.39[b]	0.41[c]	0.45[b]	0.48[c]	0.01
Small intestine	6.27[b]	7.20[a]	5.70[c]	5.43[c]	0.15
Large intestine	0.23[b]	0.33[a]	0.21[c]	0.14[d]	0.01
Lungs.	0.77[b]	0.86[a]	0.86[a]	0.76[b]	0.02

[a-d]Means along the same row with different superscripts are significantly different ($p < 0.05$). SEM = Standard error of means.

4. Conclusion

Feeding broiler chicken with diet that contain up to 1.5% turmeric powder induced better growth, carcass, and organic weight as well as haematological performances which has promoted the positive effects of Curcumin in poultry nutrition.

Besides, given the promising status of Turmeric as a non-toxic and natural phytobiotic feed additive, it is suggested that further research be undertaken on other avian species available in the warm wet regions as well as devising efficient storage methods and conditions for making Turmeric powder available all year round since its present scanty cultivation remains a major challenge to its use in research.

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