

Effects of Turmeric (*Curcuma longa*) Powder Additive on Growth Performance, Flock Uniformity and Blood Profile of Japanese Quails (*Coturnix japonica*)

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DOI: 10.47760/cognizance.2023.v03i12.027

Abstract— Turmeric has been reported to possess various bioactive compounds. This study examined the effects of turmeric powder as a natural feed additive on the growth performance, flock uniformity, and blood profile of Japanese quail. Two hundred and fifty-six (256) male Japanese quail of average weight of 115.00 ± 5 g were used for this study. The birds were randomly allotted to four dietary groups with four replicates of sixteen birds each in a Completely Randomized Design. Turmeric powder was added in the diet at 0.00%, 0.25%, 0.50%, and 0.75% to form diet D1, D2, D3, and D4. All the data collected for growth performance were significantly influenced ($P < 0.05$). Birds fed D2 had the highest average daily weight gain (1.33 g/bird) followed by those fed D3 (1.25 g/bird), D1 (1.17 g/bird), and D4 (1.09 g/bird). Birds fed D2 had the highest total feed intake (829.59 g/bird) and D1 had the lowest (786.34 g/bird). Birds fed D4 had the highest flock uniformity and feed conversion ratio (59.40% and 18.17 respectively). All the haematological parameters were significant ($P < 0.05$) except pack cell volume, haematocrit, haemoglobin, red blood cell, and platelet. Birds fed D2 had the highest mean corpuscular volume (163.00 fL). Birds fed D3 had the highest white blood cell count ($189.50 \times 10^3/\mu\text{L}$), heterophils (55.00 cells/ μL), and eosinophils (1.50 cells/ μL). Lymphocyte and platelet count were highest in the birds fed D4. All the serum biochemical parameters were significant ($P < 0.05$) except aspartate aminotransferase, cholesterol, and low-density lipoprotein. Except for total protein, alanine aminotransferase, and globulin, all the significant parameters were highest in birds fed D1. 0.25% of turmeric powder can be included in quail's diet without adverse effect on the growth performance and health.

Keywords— Feed Additive, Growth response, Haematology, Serum biochemistry, Turmeric, Quail.

I. INTRODUCTION

Quail farming has witnessed growing interest and attention over the past few decades (Ojediran *et al.*, 2022). Japanese quail (*Coturnix japonica*) has emerged as a popular choice due to its numerous advantages in commercial production. These birds are characterized by their rapid growth rate, reaching market weight in just 5-6 weeks, and their early sexual maturity, with egg production beginning at 5 weeks of age (Ojediran *et al.*, 2022; Ojediran *et al.*, 2023). Additionally, quail are valued for their high-quality meat, which is low in fat and rich in protein, and their eggs, which are considered a delicacy in many cultures (Quaresma *et al.*, 2022; Lukanov *et al.*, 2023; Kokoszyński *et al.*, 2024). The relatively small space requirements and high feed

conversion efficiency of quail further contribute to their appeal in both small-scale and industrial farming operations (Adom *et al.*, 2023).

As the global demand for quail products continues to rise, as a result of the increasing consumer awareness of their nutritional benefits and the diversification of poultry markets, researchers and farmers are intensifying efforts to optimize quail production systems. A key area of focus is the enhancement of bird performance, health, and welfare through nutritional interventions. Among the various strategies being explored, the use of natural feed additives has gained particular attention due to growing concerns over antibiotic resistance and consumer preferences for organic and naturally raised poultry products (Van *et al.*, 2020; Samreen *et al.*, 2021).

Turmeric (*Curcuma longa*), a rhizomatous herbaceous perennial plant of the ginger family, has emerged as a promising candidate for poultry feed supplementation. It contains a range of bioactive compounds, with curcumin being the most well-studied (Zhang and Kitts, 2021; El-Saadony *et al.*, 2023). Turmeric possesses anti-inflammatory, antioxidant, and antimicrobial properties that have not been effectively exploited, especially in quail production.

The potential benefits of turmeric in poultry nutrition, especially for quail, remain underexplored. This study seeks to provide comprehensive insights into the potential of turmeric as a natural feed additive of the growth response and flock uniformity, haematological parameters, and serum biochemical indices of Japanese quail.

II. MATERIALS AND METHODS

Experimental site

The trial was conducted at the Poultry Unit of Ladoko Akintola University of Technology Teaching and Research Farm (LTR&F), Ogbomoso, Oyo state, Nigeria.

Animal handling and management

Two hundred and fifty-six (256) male Japanese quail were used for this study. They were procured from the National Veterinary Research Institute, VOM, Jos, Nigeria. Prior to brooding, the pen was cleaned and disinfected appropriately, two (2) weeks before the arrival of the chicks. They were brooded in a deep litter pen, acclimatized, and given a diet containing 28% CP for seven (7) days. Thereafter, they were randomly allotted to four (4) dietary treatments with four (4) replicates of sixteen (16) birds each. The housing dimension of each replicate was 1 m × 0.5 m × 1.5 m. The trial lasted for six (6) weeks. Diets and water were offered *ad libitum*.

Test ingredient and experimental diet

The turmeric used for this study was harvested from the agronomy unit of LTR&F, Ogbomoso, Oyo state, Nigeria. After harvesting, the turmeric was thoroughly washed to remove the dirt, chopped into smaller pieces, and air-dried to remove the moisture. The air-dried turmeric was well-grounded into a powdered form using an attrition mill, to increase homogeneity and the surface area for digestion. The turmeric powder was supplemented in the diet at 0.00%, 0.25%, 0.50%, and 0.75% to form diet D1, D2, D3, and D4 as shown on Table 1.

Table 1: Gross composition of experimental diets

Ingredients (%)	D1	D2	D3	D4
Maize	15.00	15.00	15.00	15.00
Corn meal	10.50	10.50	10.50	10.50
Soya bean meal	5.00	5.00	5.00	5.00
Full fat Soya	20.00	20.00	20.00	20.00
Wheat offal	6.00	6.00	6.00	6.00
Limestone	1.00	1.00	1.00	1.00
Palm Kernel Cake	39.00	39.00	39.00	39.00
Bone meal	2.00	2.00	2.00	2.00
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Turmeric Powder	-	+	++	+++
Total (kg)	100.00	100.00	100.00	100.00

Calculated Nutrients

Metabolizable Energy (cal/kg)	2813.1	2813.1	2813.1	2813.1
Crude Protein	20.63	20.63	20.63	20.63
Ether Extract	7.20	7.20	7.20	7.20
Crude Fibre	7.79	7.79	7.79	7.79
Calcium	1.01	1.01	1.01	1.01
Phosphorus	0.41	0.41	0.41	0.41
Methionine	0.37	0.37	0.37	0.37
Lysine	1.06	1.06	1.06	1.06

D1 = Control treatment; D2 = 0.25% turmeric powder; D3: 0.50% turmeric powder; D4 = 0.75% turmeric powder

* Each kg feed contained: Vit. A, 1500IU A, 1500IU; Vit. 2,500IU, Bit. E1101U, Vit B3 40mg; Vit. B6, 20mg; Chlorine chloride, 400mg; Mn 120mg, Fe 70mg; Cu 100m; I 1;2.2m Se 0.2mg,; Zn 45m;Co; 0.02m.

Data collection and analysis

Feed was offered at 8:00 and 14:00hr ad libitum on a daily basis. The leftover feed from the previous day was measured using a kerro (BL 30001E) digital scale. The feed intake was computed by subtracting the leftovers from the amount of feed offered. The data on weight change were measured on a weekly basis using kerro (BL 30001E) digital scale. The conversion ratio was calculated by dividing the feed consumed by the weight gain. The percentage of flock uniformity was estimated using

$$\frac{100 - \text{standard deviation of weight gain (g)}}{\text{average body weight}} \times 100$$

At the end of the experiment, 1ml blood samples were collected from 3 birds per replicate into Ethylene-diamine-tetra acetic acid (EDTA) and plain bottles (without anticoagulants) for haematological analysis and serum biochemistry respectively. The blood samples for haematology analysis were gently mixed with the anticoagulants for analysis (Ojediran *et al.*, 2024). Red blood cell count, white blood cell count, hemoglobin, hematocrit, and platelets were analysed using haematology autoanalyzer following the procedure of Ojediran *et al.* (2017). Mean corpuscular haemoglobin (MCH), Mean corpuscular volume (MCV), and Mean corpuscular haemoglobin concentration (MCHC) were estimated according to Ojediran *et al.* (2017).

Blood samples for serum biochemistry were allowed to clot at room temperature for 30 minutes, centrifuged at 2000-3000 rpm for 10 minutes to separate serum from the cellular components, later transferred to a clean tube, and placed in an automated biochemical analyzer to measure alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and serum proteins following the procedure used by Ojediran *et al.* (2018).

The design of the experiment was Completely Randomized Design (CRD). Statistical software package (SPSS) version 25 was used to analyze the experimental data. All the data obtained were analyzed using one-way analysis. The treatment means were compared using the Duncan Multiple Range (DMR) test procedure at a probability of 5% (P level = 0.05). The statistical model used was $Y_{ij} = \mu + DT_i + e_{ij}$

Y_{ij} = Individual observation

μ = population mean

DT_i = effect of i^{th} diets with turmeric

e_{ij} = random error

III. RESULTS

Growth performance

Table 2 shows the growth response and flock uniformity of Japanese quail fed different levels of turmeric powder. All the data were significantly influenced (P<0.05) except for the initial weight and the average daily feed intake of the birds. Birds fed D2 had the highest total weight gain (53.04 g/bird) followed by birds fed D3 (49.91 g/birds), D1 (46.59 g/bird), and D4 being the least (43.54 g/bird). The birds fed D2 had the highest total feed intake (829.59 g/bird), followed by D3 (816.09 g/bird), D4 (792.75 g/bird), and D1 (786.34 g/bird). The

birds offered D4 had the highest feed conversion ratio (18.17), birds offered D2 had the lowest (15.60), while those fed D3 were comparable (16.24). The flock uniformity (%) increased with turmeric additive.

Table 2 – Growth response and flock uniformity of Japanese quails fed different levels of turmeric powder

Table 2: Growth response and flock uniformity of Japanese quails fed different levels of turmeric powder as additive

Parameters	D1	D2	D3	D4	SEM
Initial Weight (g/bird)	120.00	112.50	115.63	109.37	1.03
Final Weight (g/bird)	166.59a	165.54b	165.54b	152.91c	1.46
Total Weight Gain(g/bird)	46.59c	53.04a	49.91b	43.54d	0.92
Average Daily Weight Gain (g/bird)	1.17c	1.33a	1.25b	1.09d	0.02
Total Feed Intake (g/bird)	786.34d	829.59a	816.09b	792.75c	4.51
Average Daily Feed Intake (g/bird)	19.58	20.68	20.26	19.78	0.19
Feed Conversion Ratio	16.81b	15.60c	16.24bc	18.17a	0.27
Flock uniformity (%)	50.43d	56.59b	52.38 c	59.40 a	0.92

^{abcd}: Means in the same row with different superscripts differ significantly (p<0.05). SEM = Standard error of mean; D1 = Control treatment; D2 = 0.25% turmeric powder; D3: 0.50% turmeric powder; D4 = 0.75% turmeric powder

Table 3 shows the haematological parameters of Japanese quail fed different levels of turmeric powder additive. The mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), white blood cell count (WBC), heterophils, lymphocytes, eosinophils, monocytes, and platelets were significantly influenced (P<0.05). The birds fed D2 had the highest MCV value (163 fL) and the lowest being D3 (153 fL). The MCH and MCHC were reduced across the dietary treatments. Quails fed D3 had 189.50 x 10³/μL, followed by D4 (184.50 x 10³/μL), D2 (181.00 x 10³/μL), and D1 (174 x 10³/μL). The birds fed D3 had the highest value of heterophils (55.00 cells/μL) followed by D2 (51.50 cells/μL), D1 (43.00 cells/μL), and D4 (38.50 cells/μL). D4 had the highest number of lymphocytes (53.00 cells/μL) while D3 had the lowest (34.00 cells/μL). The birds fed D1 and D3 had the highest and similar values for eosinophil and monocyte count while those fed D2 and D4 had the same values too. The platelet count was highest in birds fed D4 (105.00 x 10³/mm³), followed by D3 (93.50 x 10³/mm³), D1 (87.00 x 10³/mm³), and D2 (82.00 x 10³/mm³).

Table 3: Haematological parameters of Japanese quail treated with different levels of turmeric powder as additive

Parameters	D1	D2	D3	D4	SEM	P value
Packed Cell Volume (%)	51.85	52.30	55.55	57.80	1.18	0.24
Haematocrit (%)	0.52	0.52	0.56	0.58	0.01	0.24
Hemoglobin (g/dL)	205.00	196.00	212.00	213.00	3.92	0.42
Red Blood Cell (x 10 ⁶ /μL)	3.29	3.22	3.63	3.63	0.08	0.14
Mean Corpuscular Volume (fL)	158.00 ^{ab}	163.00 ^a	153.00 ^b	159.50 ^a	1.29	0.03
MCH (pg)	62.50 ^a	61.50 ^a	35.50 ^b	59.00 ^b	0.56	0.01
MCHC (g/dL)	396.00 ^a	375.00 ^c	381.00 ^b	368.50 ^d	2.75	0.00
White Blood Cell (x 10 ³ /μL)	174.00 ^b	181.00 ^b	189.50 ^a	184.50 ^{ab}	2.07	0.04
Heterophils (cells/μL)	43.00 ^{ab}	51.50 ^a	55.00 ^a	38.50 ^b	2.44	0.04
Lymphocytes (cells/μL)	45.50 ^{ab}	40.00 ^{ab}	34.00 ^c	53.00 ^a	2.39	0.01
Eosinophils (cells/μL)	1.50 ^a	0.00 ^b	1.50 ^a	0.00 ^b	0.21	0.00
Monocytes (cells/μL)	10.50 ^a	8.50 ^b	9.00 ^b	8.50 ^b	0.27	0.01
Basophils (cells/μL)	0.00	0.50	0.50	0.00	0.11	0.17
Platelets (x 10 ³ /mm ³)	87.00 ^{ab}	82.00 ^b	93.50 ^{ab}	105.00 ^a	0.64	0.02

^{abc}: Means in the same row with different superscripts differ significantly (p<0.05). SEM = Standard error of mean; D1 = Control treatment; D2 = 0.25% turmeric powder; D3: 0.50% turmeric powder; D4 = 0.75% turmeric powder; MCH = mean corpuscular haemoglobin; MCHC = mean corpuscular haemoglobin concentration

Table 4 shows the serum biochemical indices of Japanese quail fed different levels of turmeric powder. All the parameters were significantly influenced ($P < 0.05$) except aspartate aminotransferase, cholesterol, and low-density lipoprotein. The ALT values were similar in birds fed D1, D2, and D3 (32.00, 33.50, and 32.00 u/l respectively). Birds fed D2 had the highest ALP (44.00 u/l) while others were comparable. The total protein, albumin, urea, triglyceride, and VLDL were highest in birds fed D1, followed by D4, D3, and D2.

Table 4: Serum biochemical indices of Japanese quail fed different levels of turmeric powder as additive

Parameters	D1	D2	D3	D4	SEM	P value
AST (u/l)	197.50	205.50	203.00	205.50	2.07	0.52
ALT (u/l)	32.00 ^a	33.50 ^a	32.00 ^a	24.00 ^b	1.41	0.04
ALP (u/l)	23.50 ^{ab}	44.00 ^a	29.50 ^{ab}	37.50 ^{ab}	3.00	0.04
Total protein (g/dl)	34.00 ^a	21.50 ^c	26.50 ^b	34.50 ^a	1.53	0.00
Albumin (g/dl)	12.00 ^a	5.50 ^c	7.50 ^b	8.50 ^b	0.72	0.00
Globulin (g/dl)	22.00 ^b	16.50 ^c	18.50 ^c	25.50 ^a	0.98	0.00
Urea (mg/dl)	18.50 ^a	12.45 ^b	14.35 ^b	15.40 ^b	0.71	0.00
Creatinine (mg/dl)	61.00 ^a	18.00 ^b	32.50 ^b	59.00 ^a	5.58	0.01
Cholesterol (mg/dl)	10.65	6.05	7.75	7.30	0.79	0.21
Triglycerides (mg/dl)	10.35 ^a	4.15 ^b	4.40 ^b	4.95 ^b	0.90	0.02
HDL (mg/dl)	3.25 ^a	1.15 ^b	1.95 ^b	1.90 ^b	0.24	0.01
LDL (mg/dl)	2.65	3.05	3.80	3.15	0.35	0.74
VLDL (mg/dl)	2.05 ^a	0.80 ^b	0.90 ^b	1.00 ^b	0.18	0.03

^{a-d} Means with different superscripts are significantly different. SEM = Standard error of mean; D1 = Control treatment; D2 = 0.25% turmeric powder; D3: 0.50% turmeric powder; D4 = 0.75% turmeric powder; AST = Aspartate Aminotransferase; ALT = Alanine Aminotransferase; ALP = Alkaline phosphatase; HDL = High-Density Lipoprotein; LDL = Low-Density Lipoprotein; VLDL = Very Low-Density Lipoprotein

IV. DISCUSSION

Growth Performance

The inclusion of turmeric powder at 0.25% appears to promote growth, as evidenced by higher final weights and total weight gain. This may be attributed to the bioactive compounds in turmeric, such as curcumin, which have been reported to possess antioxidant, antimicrobial, and anti-inflammatory properties (Zhang and Kitts, 2021; El-Saadony *et al.*, 2023). These properties could improve gut health, enhance nutrient absorption, and promote better growth performance in poultry (Yadav *et al.*, 2020). Rajput *et al.* (2013) reported that supplementing turmeric powder at 0.2 % in broiler chicken rations could improve nutrient digestibility and growth performance. Aderemi and Alabi (2023) also agreed with the report of Rajput *et al.* (2013). At a higher inclusion level of 0.75% turmeric, there was a significant reduction in weight gain. This suggests that while low levels of turmeric might be beneficial, higher levels could have adverse effects, potentially due to toxicity or reduced feed palatability. A lower FCR in the birds fed D2 suggests that turmeric powder at 0.25% improves feed efficiency, meaning the birds convert feed into body weight more effectively. This could be due to the enhanced digestive enzyme activity and improved gut morphology associated with turmeric supplementation, which promotes better nutrient absorption and utilization.

Flock Uniformity

Higher flock uniformity at the 0.75% turmeric level suggests that while overall growth performance was reduced, the birds grew more consistently. This could be due to reduced competition for feed due to lower palatability at higher turmeric levels, which could also result in more uniform growth.

Haematological Parameters

The haematological parameters of the birds provide insights into the health status and physiological responses of the birds. The increase in MCV in the D2 group suggests that the red blood cells were larger on average, which could be due to better erythropoiesis (production of red blood cells) (Aslinia *et al.*, 2006). The decrease in MCH and MCHC with higher turmeric levels might suggest that turmeric at these concentrations could interfere with hemoglobin synthesis or iron metabolism because the bioactive compounds present in turmeric have been reported to cause hypoglycemia (Zhang and Kitts, 2021). Smith and Ashar (2019) also reported that excessive

turmeric might lead to a deficiency in essential minerals like iron, which is crucial for hemoglobin formation, thereby reducing MCH and MCHC. The increase in WBC and leukocytes count (heterophils, lymphocytes, eosinophils, and monocytes) particularly in the D3 treatment, suggests an immune-stimulatory effect of turmeric. Turmeric is known for its immunomodulatory properties, which could enhance the birds' ability to respond to infections or stress (Allegra *et al.*, 2022). The increase in heterophils and lymphocytes indicates that turmeric may boost both innate and adaptive immune responses, which could be beneficial in enhancing disease resistance. An increased platelet count in the birds fed D4 suggests that turmeric at higher levels might influence thrombopoiesis (platelet production), potentially enhancing the birds' ability to form blood clots. This could be beneficial in preventing bleeding and promoting wound healing but could also indicate a risk for thrombotic conditions if excessive (Ojediran *et al.*, 2019).

Serum Biochemistry

ALT is an enzyme indicative of liver health. The lower ALT level in the birds fed D4 might suggest reduced liver stress or improved liver function at the highest turmeric level. The increase in ALT of the birds fed D2 agrees with the findings of Qasem *et al.* (2016) where turmeric powder (up to 0.20%) was fed to broiler chickens. ALP is associated with liver function, bone metabolism, and bile duct health (Han *et al.*, 2023). The higher ALP and lower creatinine in the birds fed D2 might indicate increased bone turnover or bile duct activity, possibly due to the moderate level of turmeric powder affecting metabolic processes. The higher total protein and globulin in the birds fed D4 might suggest better overall protein synthesis or less disruption of protein metabolism and enhanced immune response. The lower urea levels in birds fed D2 suggest reduced protein catabolism or improved renal function, possibly influenced by the turmeric supplementation. The lower triglycerides in birds offered D2 might indicate reduced fat deposition or improved lipid metabolism at the moderate turmeric level. The lower VLDL in these birds might also indicate improved triglyceride metabolism. The report of Dehzad *et al.* (2023) and Yuan *et al.* (2019) attributed reduced cholesterol, triglyceride, HDL, and VLDL to turmeric curcumin.

V. CONCLUSIONS

It can be concluded that up to 0.25% turmeric powder as an additive favours growth performance based on the weight gain and the feed conversion ratio. It also enhanced white blood cell count and reduced lipoprotein concentration in serum biochemical functions.

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