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Research Article

Physiological Responses of Broiler Chickens to Different Dietary Levels of Turmeric Powder

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Abstract | This study was conducted to evaluate the effects of dietary turmeric powder supplementation on selected physiological parameters in broiler chickens. A total of 120 one-day-old unsexed Ross broiler chicks were randomly allocated to four treatment groups, each with three replicates. The dietary treatments were as follows: T1, control diet without turmeric supplementation; T2, diet supplemented with 10 g turmeric powder/kg feed; T3, diet supplemented with 15 g turmeric powder/kg feed; and T4, diet supplemented with 20 g turmeric powder/kg feed. The results showed highly significant improvements ($P \leq 0.01$) in total protein and globulin levels in turmeric-supplemented groups compared with the control group. Serum glucose levels were significantly reduced ($P \leq 0.05$) in the T3 and T4 groups compared with the T1 and control group. Cholesterol, triglycerides, malondialdehyde (MDA), and low-density lipoprotein (LDL) levels were significantly decreased ($P \leq 0.05$) in the turmeric-treated groups relative to the control. In contrast, high-density lipoprotein (HDL) levels increased significantly ($P \leq 0.05$) in turmeric-supplemented groups compared with the control group. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels were not significantly ($P > 0.05$) affected by dietary turmeric supplementation. The study results exhibited that dietary supplementation with turmeric powder improved protein metabolism, lipid profile, and antioxidant status in broiler chickens without adversely affecting liver enzyme activity.

Keywords | Turmeric powder, Broiler chickens, Physiological traits, Broiler chickens, Serum biochemistry, Total protein

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INTRODUCTION

Poultry production is a vital agricultural sector that requires continuous improvement in nutritional strategies to enhance bird health and productivity (Abdallah *et al*., 2017). Nutritional interventions, particularly the use of plant-derived additives, have been widely investigated for their potential to improve growth performance and physiological functions in broiler chickens (Krauze, 2021). Previous studies have shown that the inclusion of medicinal plants, either as dietary supplements or water additives, can improve physiological, biochemical, immune, and reproductive traits in poultry.

Turmeric (*Curcuma longa* L.) is a medicinal plant extensively cultivated in tropical and subtropical regions, especially in South and Southeast Asia. Its principal bioactive compound, curcumin, is a potent antioxidant and free radical scavenger containing phenolic and flavonoid compounds. In addition to its antioxidant properties, turmeric is a rich source of essential nutrients, including proteins, fats, carbohydrates, amino acids, minerals (calcium, iron, and sodium), and vitamins such as vitamin C, vitamin K, and B-complex vitamins (Singh *et al*., 2010).

Curcumin has been noted to reduce intestinal inflammation, augment digestion, modulate hormonal balance, and stimulate metabolic activity, while also exerting hepatoprotective effects and supporting liver function (Lopez-Malo *et al*., 2020; Mohammed and Al-Okaily, 2024). Dietary turmeric supplementation has shown beneficial effects on broiler performance and blood biochemical parameters; however, reported outcomes vary among studies, and the optimal inclusion level remains unclear (Gowda *et al*., 2009). Moreover, information under local production conditions is limited.

Plant-derived bioactive compounds, including polyphenols, carotenoids, and vitamin C, possess antioxidant, antimicrobial, anti-inflammatory, and immunomodulatory properties that may enhance poultry health and metabolism (Kasapidou *et al*., 2016). Therefore, this study aimed to evaluate the physiological responses of broiler chickens to graded dietary levels of turmeric powder and to determine the most effective inclusion level under local production conditions.

MATERIALS AND METHODS

Birds and grouping

The study was carried out at the Animal Production Department, College of Agriculture, Al-Qasim Green University, from March 30 to May 11, 2024. It was aimed to investigate the effects of dietary supplementation of broiler feeds with turmeric powder on certain physiological characteristics. A total of 120 one-day-old unsexed Ross broiler chicks were used in this experiment. The experiment comprised four dietary treatments, each duplicated three times. Each replicate contained 10 chicks, for a total of 30 birds per treatment. The chicks were weighed to ensure similar initial body weight among treatments. The birds were housed in 12 poultry pens. The experimental diets consisted of a basal diet without turmeric powder and three diets supplemented with turmeric powder at levels of 10, 15, and 20 g/kg feed.

Management conditions

All birds were reared under standard management conditions. Chicks were housed in floor pens bedded with clean wood shavings. The temperature was preserved at 33–35 °C during the first week and gradually minimized by 3 °C per week up to 24 °C. A lighting program of 23 hours light and 1 hour dark was applied during the starter period, followed by 20 hours light and 4 hours dark during the grower and finisher phases. A standard vaccination program was administered, including vaccines for Newcastle disease and infectious bursal disease, according to regional recommendations. Feed and water were provided *ad libitum* throughout the experimental period.

Table 1: Percentage of feed ingredients and chemical composition of starter, grower, and finisher diets.

Ingredient	Starter diet (1-10 days) (%)	Grower diet (11-22 days) (%)	Finisher diet (23-42 days) (%)
Yellow Corn	52.8	58.65	62.4
Wheat	10.0	10.0	10.0
Protein concentrate*	5.0	5.0	5.0
Soybean meal 48%**	29.8	24.0	20.5
Sunflower oil	0.3	0.3	0.3
Dicalcium phosphate	0.5	0.35	0.2
Limestone	1.14	1.21	1.22
Methionine	0.17	0.17	0.13
Lysine	0.19	0.22	0.15
Table salt	0.1	0.1	0.1
Total	100.0	100.0	100.0
Calculated chemical composition of the experimental diets			
Metabolizable energy (kcal/kg feed)	2940.0	2995.0	3035.0
Crude protein (%)	21.94	19.66	18.29
Methionine+Cysteine (%)	1.03	0.97	0.9
Lysine (%)	1.39	1.26	1.11
Calcium (%)	0.9	0.88	0.83
Available phosphorus (%)	0.44	0.41	0.38
Crude fiber (%)	2.73	2.64	2.58

*The animal-based protein concentrate was imported from Brocon, the Netherlands. It had 40% crude protein content, 2017 kcal/kg metabolizable energy content, 5% crude fat, 2.20% crude fiber, 5% calcium, 4.68% phosphorus, 3.85% lysine, 4.12% methionine, and 4.12% methionine + cystine, 0.42% tryptophan, and 1.70% threonine. It also contained a vitamin and trace mineral mix for complete nutrient balance. ** The soybean meal used was from Argentina and had 48% crude protein but could be expressed as 2440 kcal metabolizable energy (ME)/kg on an energy basis based on the NRC (1994) chemical composition.

Parameters studied

At the end of the experimental period (42 days of age), blood samples were collected from the brachial (wing) vein of two birds per replicate using sterile syringes. Approximately 3 mL of blood was drawn from each bird. Samples intended for serum biochemical analysis were placed in plain tubes without anticoagulant and allowed to clot at room temperature. The samples were then centrifuged at 3,000 rpm for 15 minutes to obtain serum, which was stored at −20 °C until analysis. Commercial diagnostic kits were used to determine physiological parameters, including total protein, albumin, globulin, glucose, alanine aminotransferase (ALT), aspartate aminotransferase (AST), cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and malondialdehyde (MDA), following the manufacturers' instructions.

Statistical analysis

Data were analyzed using a completely randomized design (CRD). Statistical analysis was performed using SAS software (SAS, 2012), and mean differences among treatments were compared using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

This study aimed to evaluate changes in selected physiological blood traits of broiler chickens, with particular emphasis on glucose concentration and total protein, albumin, and globulin levels. As shown in Table 2, total protein levels increased significantly ($P \leq 0.05$) in treated groups compared with the control. The mean total protein values (± SE) for treatments 1, 2, 3, and 4 were 3.15±0.70, 3.75±0.50, 5.62±1.12, and 5.70±0.70, respectively.

Albumin concentrations did not differ significantly among the experimental treatments ($P > 0.05$). In contrast, globulin level in the T3 was significantly higher than those in the first and second treatments ($P \leq 0.05$), but did not differ from the fourth treatment; moreover, no significant difference was observed between the first and second treatments (Table 2).

Regarding glucose concentration, a significant reduction was observed in the third and fourth treatments, while higher values were recorded in the first and second treatments ($P \leq 0.05$; Table 2).

The results of this study suggest that dietary turmeric supplementation increased total protein and globulin concentrations. The observed increase in total protein may be attributed to the hepatoprotective and antioxidant activities of curcumin, which help maintain normal protein metabolism and liver function (Sharma *et al*., 2005).

The reduction in serum glucose levels observed in birds supplemented with turmeric powder compared with the control group (T1) may be related to the presence of bioactive compounds such as alkaloids and flavonoids in turmeric. This decrease in glucose concentration may reflect improved metabolic efficiency and enhanced antioxidant status induced by turmeric supplementation, as reported in previous studies on broilers (Emadi and Kermanshahi, 2007). Increased glucose utilization may occur through enhanced glycolysis and facilitated glucose uptake across the plasma membrane. In addition, flavonoids present in turmeric may contribute to lowering blood glucose levels by inhibiting hepatic gluconeogenesis from non-carbohydrate sources through suppression of glucose-6-phosphatase activity in the liver (López-Lázaro, 2009).

Table 2: Effect of different levels of turmeric supplementation on blood serum physiological traits of broiler chickens.

Traits (100 g/dL)	T1 (Control)	T2 (10 g)	T3 (15 g)	T4 (20 g)	Significance
Total protein	3.153 ± 0.026^{c}	3.430 ± 0.112^{bc}	4.080 ± 0.180^{a}	3.763 ± 0.274^{ab}	**
Albumin	2.080±0.020	2.287±0.112	2.716±0.063	2.406±0.198	N.S
Globulin	1.073 ± 0.027^{b}	1.143 ± 0.066^{b}	1.563 ± 0.135^{a}	1.356 ± 0.102^{ab}	**
Glucose	216.660 ± 1.419^{a}	213.327 ± 1.471^{a}	201.320 ± 1.468^{b}	193.050 ± 1.453^{c}	*

$^{a-c}$ Different superscript letters on the mean values indicate significant difference between the groups. N.S: not significant, * ($P \leq 0.05$), ** ($P \leq 0.01$).

Table 3: Effect of different levels of turmeric supplementation on fat metabolism in the blood serum of broiler chickens.

Traits (100 mg/dL)	T1 (Control)	T2 (10 g)	T3 (15 g)	Significance T4 (20 g)
Cholesterol	158.71 ± 4.521^{a}	143.673 ± 1.031^{b}	135.670 ± 1.409^{bc}	$130.840 \pm 4.630^{c*}$
Triglycerides	94.963 ± 1.932^{a}	89.143 ± 0.851^{b}	80.333 ± 1.58^{c}	$76.366 \pm 1.426^{c*}$
HDL	86.307 ± 1.546^{b}	95.770 ± 1.225^{a}	97.880 ± 1.152^{a}	$96.520 \pm 1.818^{a*}$
LDL	53.413 ± 5.217^{a}	30.070 ± 2.119^{b}	21.716 ± 1.496^{b}	$19.043 \pm 3.578^{b*}$
MDA(nmol/mL)	228.920 ± 22.894^{a}	167.353 ± 11.161^{b}	186.526 ± 3.603^{b}	$168.450 \pm 10.45^{b*}$

$^{a-c}$ Different superscript letters on the mean values indicate significant difference between the groups. * ($P \leq 0.05$). HDL: high-density lipoprotein; LDL: low-density lipoprotein; MDA: malondialdehyde.

Table 4: Effect of different levels of turmeric supplementation on liver enzymes in broiler chickens.

Traits (100 mg/dL)	T1 (Control)	T2 (10 g)	T3 (15 g)	T4 (20 g)	Significance
ALT	19.690±0.217	10.723±0.406	19.960±0.431	19.556±0.320	N.S
AST	20.213±0.298	20.646±0.747	20.280±0.602	20.656±0.267	N.S

N.S: not significant; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase.

Table 3 presents the effects of different dietary levels of turmeric on lipid metabolism in broilers, including serum cholesterol, triglycerides, HDL, LDL, and MDA concentrations. Turmeric supplementation significantly reduced serum cholesterol levels in supplemented-groups compared with the control ($P \leq 0.05$). The highest cholesterol concentration was recorded in the control group (T1). No significant difference was observed between the second and third treatments, whereas a pronounced reduction was noted in the fourth treatment group receiving 20 g turmeric/kg feed.

Significant differences in high-density lipoprotein (HDL) concentrations were observed in the turmeric-supplemented groups compared with the control treatment. Higher HDL values were recorded in T2 (95.77 mg/dL), T3 (97.88 mg/dL), and T4 (96.52 mg/dL), indicating an overall improvement in lipid profile relative to the control group (Table 3).

In contrast, low-density lipoprotein (LDL) concentrations were significantly lower in all turmeric-treated groups than in the control, which exhibited the highest LDL levels ($P \leq 0.05$). Similarly, malondialdehyde (MDA) concentrations were significantly higher in the control group compared with the turmeric-supplemented treatments ($P \leq 0.05$), reflecting increased lipid peroxidation in birds not receiving turmeric (Table 3).

The observed reductions in cholesterol, triglycerides, and LDL levels, along with elevated HDL concentrations in turmeric-treated groups, may be attributed to the presence of flavonoids in turmeric powder. Flavonoids are known to reduce cholesterol levels and exhibit strong antioxidant activity by scavenging free radicals and reducing circulating free fatty acids, thereby lowering triglyceride concentrations. Additionally, flavonoids may exert vitamin-like effects that contribute to cholesterol reduction. The presence of tannins in turmeric powder may also play a role by inhibiting fat digestion through reduced lipase enzyme activity (Bruneton, 1993). In a recent study, curcumin was reported to significantly improve the reproductive performance of roosters (Al-Sharifi and Ali, 2025). This effect was attributed to the strong antioxidant activity of curcumin, which is also associated with several other biological properties, including antidepressant, anti-inflammatory, and memory-enhancing effects (Brikat *et al*., 2024).

The reduction in MDA levels observed in turmeric-treated groups may result from the antioxidant effects of flavonoids, which inhibit LDL oxidation induced by free radicals. By suppressing membrane lipid oxidation and interrupting free radical chain reactions, turmeric supplementation may reduce lipid peroxidation and subsequently lower serum triglyceride and MDA levels (Lawrence *et al*., 2015).

As shown in Table 4, no significant differences were observed in liver enzyme activities (ALT and AST) among the experimental treatments, indicating that turmeric supplementation did not adversely affect liver function.

CONCLUSION

This study concludes that dietary supplementation of turmeric powder at graded levels is safe and beneficial for improving several physiological and biochemical parameters in broiler chickens. Higher inclusion levels, particularly 15 and 20 g/kg feed, resulted in an improved lipid profile, enhanced antioxidant status, and reduced serum cholesterol, triglyceride, and malondialdehyde (MDA) concentrations. These effects may be attributed to the hepatoprotective and antioxidant properties of curcumin and other bioactive compounds present in turmeric. Overall, dietary turmeric may be considered a promising natural feed additive for enhancing metabolic health and physiological responses in broilers. However, further studies are required to evaluate long-term effects and determine economically optimal inclusion levels under different production conditions.

NOVELTY STATEMENT

The study is novel as it exhibits that dietary supplementation with turmeric powder improves protein metabolism, lipid profile, and antioxidant status in broiler chickens without adversely affecting liver enzyme activity.

AUTHOR'S CONTRIBUTION

All authors contributed equally fro this study.

Generative AI and AI-assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Ethical approval

All experimental protocols related to animals were examined and validated by the Institutional Animal Care and Use Committee (IACUC) of Al-Qasim Green University, Iraq (Approval No.: 11345). The study was carried out following global guidelines for the care and use of laboratory animals.

Conflict of interest

The authors have declared no conflict of interest.

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