

Effect of Different Levels of Turmeric Powder on Growth Performance and Body Weight Gain in Broiler Chickens

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ABSTRACT

This study evaluated the effects of different dietary levels of turmeric powder on growth performance, body weight gain, and selected morphological traits in Ross 308 broiler chickens. A total of 72 five-day-old broiler chicks were randomly assigned to four dietary treatment groups, each with three replicates and six chicks per replicate. The experimental diets included a basal diet supplemented with turmeric powder at levels of 0, 2, 4, and 6 g/kg of feed. The feeding trial was conducted over 45 days under standard management and environmental conditions. We recorded growth performance parameters, including body weight, weight gain, feed intake, and feed conversion ratio, throughout the experimental period. In addition, we measured physical characteristics such as wing length and beak length at the end of the trial. All collected data were statistically analyzed using SPSS software. The results showed that dietary supplementation with turmeric powder significantly affected growth performance. Broilers receiving 6 g/kg turmeric powder showed significantly higher final body weight and overall performance than the other treatment groups ($P < 0.05$), with an average final body weight of 2561.66 g. Moreover, supplementation with 2 g/kg turmeric powder significantly increased wing length (26.9 cm) and beak length (3.56 cm) compared to the remaining treatments. The control group had the highest feed conversion ratio (FCR), indicating the least efficient feed utilization, whereas broilers receiving turmeric-supplemented diets showed lower FCR values and, consequently, improved feed efficiency. In conclusion, turmeric powder supplementation, particularly at 6 g/kg of feed, can be considered a beneficial natural feed additive for improving growth performance in broiler chickens.

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INTRODUCTION

With the continuous increase in the global population and the growing demand for animal protein, the poultry industry has developed significantly in recent years (Godfray et al., 2018). Due to its high nutritional value, affordability, and widespread consumer acceptance, chicken

meat has become one of the most important sources of animal protein worldwide (Raha, 2000; FAO et al., 2023). Consequently, the number of poultry farms has increased substantially across many countries.

Despite this expansion, the poultry industry still faces major challenges in optimizing resource use and improving production efficiency. These challenges can adversely affect farm profitability and contribute to fluctuations in poultry meat production and market prices. Therefore, identifying effective nutritional strategies to improve productivity and ensure sustainable poultry production has become increasingly important (Shamsuddoha et al., 2015; Shariatmadari, 2000; Mottet & Tempio, 2017).

One of the most effective approaches for improving broiler production efficiency is reducing feed costs while maintaining optimal growth performance. Feed represents about 65–70% of total production costs in commercial broiler farming (National Research Council, 1994; Kleyne & Roosendaal, 2024; Abedullah et al., 2007). Therefore, improving feed conversion ratio (FCR) through dietary manipulation is an important strategy to reduce production costs and increase profitability. In this regard, the incorporation of natural feed additives that enhance nutrient digestion, absorption, gut health, and metabolic activity has received considerable attention (Abd El-Ghany, 2020; Kallam & Sejian, 2021; Choi et al., 2023).

Turmeric (*Curcuma longa*), a perennial herbaceous plant belonging to the family Zingiberaceae, is characterized by underground rhizomes that serve as storage organs and represent the principal source of its bioactive compounds. The major bioactive constituents of turmeric include curcuminoids, namely curcumin, demethoxycurcumin, bisdemethoxycurcumin (Murugesu et al., 2019; Hewlings & Kalman, 2017), and tetrahydrocurcuminoids (Osawa et al., 1995). The characteristic yellow-orange color of turmeric is primarily attributed to curcumin and related curcuminoids (Hewlings & Kalman, 2017).

Curcuminoids possess a broad spectrum of biological activities, including antioxidant, anti-inflammatory, and antimicrobial properties (Joe et al., 2004; Dulbecco & Savarino, 2013). These beneficial effects mainly stem from their ability to regulate cellular signaling pathways involved in inflammation and oxidative stress (Anand et al., 2007). In addition to curcuminoids, turmeric contains several volatile compounds, including monoterpenoids and sesquiterpenoids, which also contribute to its pharmacological and biological activities. These compounds exhibit antioxidant, antimicrobial, and immunomodulatory effects and may act synergistically with curcuminoids to enhance turmeric's overall biological activity (Joe et al., 2004).

In poultry production, turmeric has received increasing attention as a natural feed additive because it can improve gut health, stimulate immune function, and enhance growth performance (Mondal et al., 2015; Oluwafemi et al., 2020). Several studies have reported that dietary turmeric supplementation improves body weight gain, feed intake, and feed

conversion ratio in broiler chickens (Samarasinghe et al., 2003; Oluwafemi et al., 2020). However, published findings remain inconsistent. While some researchers have observed significant improvements in productive performance (Samarasinghe et al., 2003), others have reported limited or no significant effects on body weight, feed intake, or FCR (Emadi & Kermanshahi, 2006; Mondal et al., 2015). These discrepancies may reflect differences in turmeric dosage, broiler genotype, dietary composition, management practices, and environmental conditions (Mondal et al., 2015). Despite the growing body of literature, important knowledge gaps remain regarding the optimal dietary inclusion level of turmeric and its effects on morphometric development under local production conditions. The optimal dietary inclusion level of turmeric has not yet been clearly established because previous studies have reported inconsistent responses in growth performance and feed efficiency.

Furthermore, most published studies have primarily focused on productive performance, whereas the effects of turmeric supplementation on detailed morphometric development have received comparatively little attention. In addition, limited information is available under local poultry production conditions in Afghanistan, where environmental conditions, feeding systems, and management practices differ from those reported in many previous studies. Addressing these knowledge gaps is essential for determining whether turmeric supplementation can consistently improve both productive performance and structural development in broiler chickens.

Therefore, this study evaluated the effects of different dietary levels of turmeric powder on growth performance, feed efficiency, and morphometric characteristics of Ross 308 broiler chickens. Specifically, the study assessed body weight, shank length, wing length, comb height, beak length, feather length, leg length, body girth, and leg diameter to provide a more comprehensive evaluation of the biological effects of turmeric supplementation.

The findings are expected to provide additional evidence for determining an effective dietary supplementation level of turmeric and to improve our understanding of its effects on both productive performance and morphometric development in broiler chickens under local production conditions.

METHODS AND MATERIALS

The experiment was conducted at a private poultry production facility located in Ibrahim Khil Village, Kunduz City, Afghanistan. The study was carried out over a 45-day experimental period under standard broiler management conditions.

A total of seventy-two Ross 308 broiler chicks, five days of age, with an average initial body weight of 39.75 ± 1.60 g, were used in this experiment. The chicks were obtained from a local commercial distributor in Kunduz Province, Afghanistan. Day 5 marked the start of the experimental period and served as the initial measurement point. Birds were randomly allocated to four dietary treatments according to a Completely Randomized Design (CRD). Each treatment consisted of three replicates with six chicks per replicate.

The experimental dietary treatments were as follows:

- * T₁: Basal diet without turmeric powder (Control)
- * T₂: Basal diet supplemented with 2 g turmeric powder/kg feed
- * T₃: Basal diet supplemented with 4 g turmeric powder/kg feed
- * T₄: Basal diet supplemented with 6 g turmeric powder/kg feed

The dietary supplementation levels of turmeric powder (2, 4, and 6 g/kg feed) were selected based on previous studies demonstrating beneficial effects of turmeric supplementation on broiler growth performance and feed efficiency (Samarasinghe et al., 2003; Emadi & Kermanshahi, 2006; Mondal et al., 2015). These inclusion levels fall within the range commonly evaluated in previous broiler nutrition studies and were chosen to investigate the dose-dependent effects of turmeric supplementation and to identify the optimum dietary inclusion level under local production conditions.

Turmeric powder was thoroughly mixed with the basal diet before feeding to ensure uniform distribution throughout the feed. The experimental diets were provided continuously throughout the entire study. The feeding program consisted of three production phases: starter (days 1–15), grower (days 16–30), and finisher (days 31–45).

Birds were reared on a litter-floor system in simple wooden and mud-brick pens. We maintained a stocking density of six birds per square meter. We provided feed and fresh drinking water ad libitum throughout the experiment. Brooding temperature was maintained between 28 and 30°C during the early rearing period and was gradually reduced according to the age and management requirements of the birds. A continuous 24-hour lighting program was provided using both the main electricity supply and rechargeable backup lighting systems. All birds were vaccinated against Newcastle Disease and Infectious Bronchitis according to the routine vaccination schedule.

We collected growth performance data throughout the experiment. We measured individual body weight using a digital scale on days 5 (initial), 15, 30, and 45. Body weight gain was calculated as the difference between the final and initial body weights. Feed intake was determined by recording the quantity of feed offered and the remaining feed in each replicate pen. Feed conversion ratio (FCR) was calculated using the following equation:

$$\text{FCR} = \text{Feed Intake (g)} / \text{Body Weight Gain (g)}$$

We also calculated Specific Growth Rate (SGR) and Daily Growth Rate (DGR) to evaluate growth performance.

We recorded morphometric measurements on days 15, 30, and 45. The evaluated traits included body length, wing length, shank length, shank diameter, comb length, beak length, body girth, body height, and feather length. Body length was measured from the tip of the beak to the base of the tail. Wing length was measured from the shoulder joint to the tip of the longest primary feather. Shank length was measured from the hock joint to the footpad, whereas shank diameter was measured at the midpoint of the shank using a digital Vernier

caliper. Body girth was measured around the thoracic region using a flexible measuring tape. Body height was measured from the floor to the highest point of the comb while the bird was standing naturally. Comb length was measured from the anterior to the posterior end of the comb using a digital Vernier caliper. Beak length was measured from the base of the upper beak to its tip, and feather length was determined by measuring the longest feather of each bird. The same investigator performed all morphometric measurements to minimize observer bias and measurement error.

We analyzed all collected data using IBM SPSS Statistics Version 26. We used one-way analysis of variance (ANOVA) to evaluate the effects of dietary turmeric supplementation on growth performance and morphometric characteristics. Whenever significant treatment effects were detected, treatment means were separated using Duncan's Multiple Range Test. Statistical significance was declared at $P < 0.05$. The results are presented as Mean $\pm$ Standard Deviation (SD).

FINDINGS

Dietary turmeric supplementation significantly affected growth performance and morphometric characteristics in Ross 308 broiler chickens ($P < 0.05$). Birds fed 6 g turmeric/kg feed exhibited the highest final body weight (2561.66 g), followed by 4 g/kg (2533.33 g), 2 g/kg (2521.66 g), and the control group (2503.33 g). The 6 g/kg treatment also resulted in the highest values for body length (25.9 cm), shank length (23.6 cm), shank diameter (7.4 cm), body height (39.93 cm), and feather length (26.36 cm) at day 45, while the highest wing length (26.9 cm) and beak length (3.56 cm) were observed in birds receiving 2 g/kg turmeric. Detailed results are presented in Tables 1–6.

No significant differences in initial body weight were observed among treatment groups on day 0 ($P > 0.05$), indicating uniformity at the start of the experiment. From day 15 onward, significant differences were observed ($P < 0.05$), with birds receiving turmeric supplementation consistently exhibiting higher body weights than the control group throughout the experimental period. Birds fed 6 g turmeric/kg feed achieved the highest final body weight (2561.66 g), whereas the control group recorded the lowest final body weight (2503.33 g) (Table 1).

Table 1. Comparative Analysis of Mean Body Weight (g) in Ross 308 Broiler Chickens Across Different Turmeric Powder Supplementation Levels

Treatment Groups	Initial Weight (Day 0) (g)	Weight at Day 15 (g)	Weight at Day 30 (g)	Final Weight (Day 45) (g)
Control (0 g Turmeric/kg Feed)	39 $\pm$ 1.00	496.66 $\pm$ 5.77d	1631.66 $\pm$ 2.88d	2503.33 $\pm$ 5.77d
2 g Turmeric/kg Feed	40 $\pm$ 2.00	521.66 $\pm$ 2.88c	1651.66 $\pm$ 2.88c	2521.66 $\pm$ 2.88c

4 g Turmeric/kg Feed	40±1.73	576.66±4.63b	1680.00±0.00b	2533.33±5.77b
6 g Turmeric/kg Feed	40.00±2.00	595.00±5.00 ^a	1700.00±0.00 ^a	2561.66±2.88 ^a
Degrees of Freedom (df)	3	3	3	3
Coefficient of Variation (CV)	0.042	0.008	0.008	0.001

Dietary turmeric supplementation significantly increased cumulative weight gain compared with the control group ($P < 0.05$). The highest value was observed in birds receiving 6 g turmeric/kg feed (2.52 kg), followed by 4 g/kg (2.49 kg) and 2 g/kg (2.48 kg), while the control group recorded the lowest value (2.46 kg). These results are presented in Figure 1.

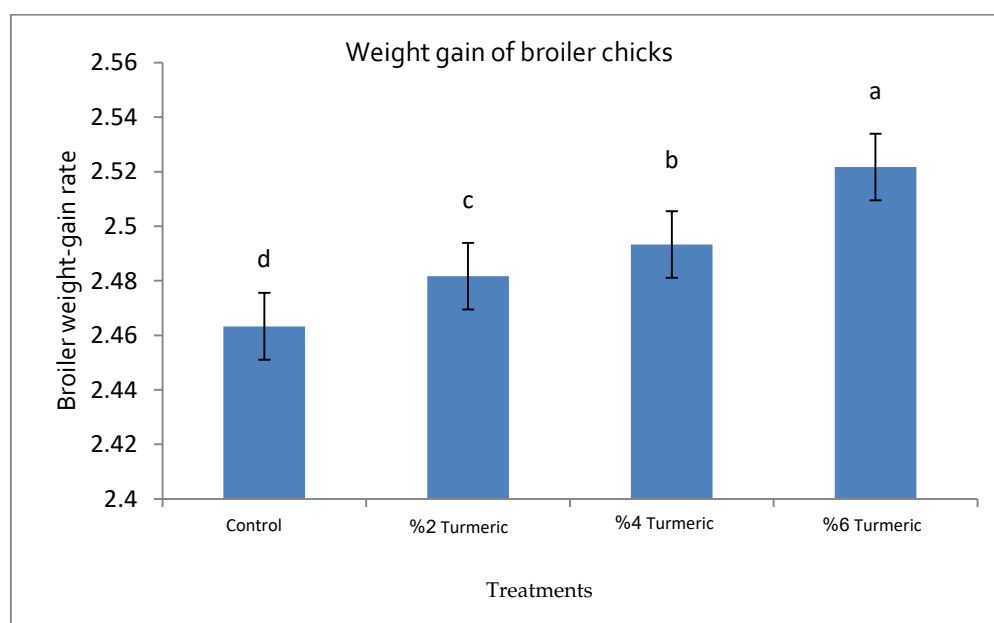


Figure 1. Weight gain of broiler chickens fed diets containing different levels of turmeric

*Different letters within each column indicate a statistically significant difference in the weight gain of broiler chickens ($P < 0.05$) (Mean ± SD).

Specific growth rate (SGR) was significantly increased following dietary turmeric supplementation ($P < 0.05$). The SGR values for birds fed 0, 2, 4, and 6 g turmeric/kg feed were 9.155%, 9.178%, 9.182%, and 9.200%, respectively. Birds receiving 6 g turmeric/kg feed exhibited the highest SGR value, followed by those receiving 4 g/kg and 2 g/kg. Meanwhile,

the control group recorded the lowest value, indicating improved growth efficiency with higher turmeric inclusion levels (Figure 2).

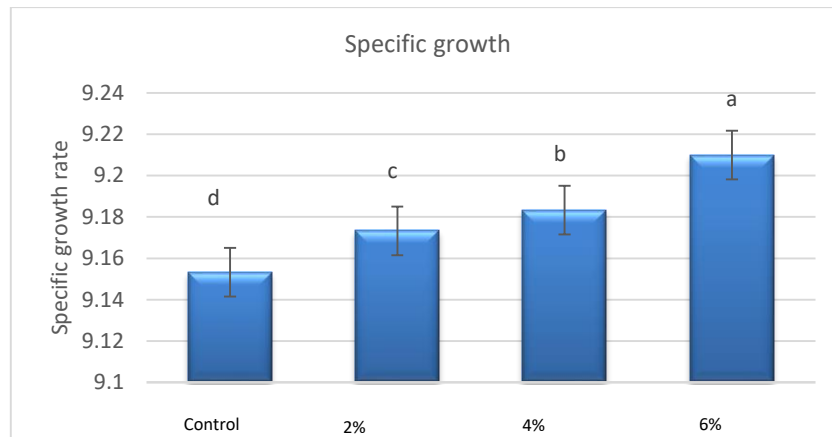


Figure 2. Specific growth rate (SGR) of broiler chickens fed diets containing different levels of turmeric

*Different letters within each column indicate a statistically significant difference in the specific growth rate of broiler chickens ($P < 0.05$) (Mean $\pm$ SD).

Despite the pronounced improvements in growth-related parameters, feed efficiency showed a more complex response to turmeric supplementation. The FCR was significantly higher in the control group than in turmeric-supplemented groups ($P < 0.05$), indicating poorer feed efficiency in unsupplemented birds. However, differences in FCR among turmeric inclusion levels were not strictly proportional to the improvements observed in growth performance. Although higher turmeric doses improved body weight and growth rates, they did not consistently reduce FCR further. This suggests that turmeric may influence growth-related metabolic pathways in ways that do not always translate into maximal feed efficiency (Figure 3).

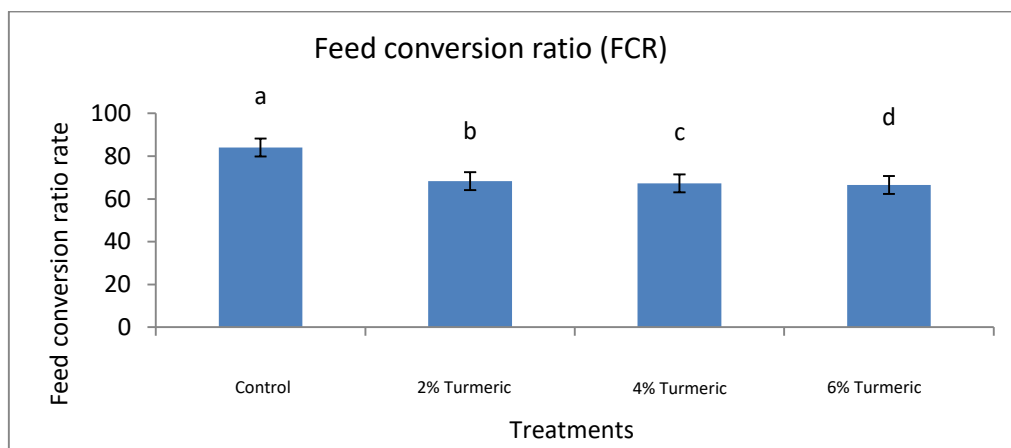


Figure 3. Feed conversion ratio (FCR) of broiler chickens fed diets containing different levels of turmeric.

Different letters within each column indicate a statistically significant difference in the feed conversion ratio of broiler chickens ($P < 0.05$) (Mean $\pm$ SD).

Daily growth rate followed a comparable pattern to that observed for SGR. Turmeric supplementation significantly increased daily weight gain compared with the control group ($P < 0.05$), with the highest daily growth rate observed in broilers fed 6 g turmeric/kg feed. The daily growth rate values for birds fed 0, 2, 4, and 6 g turmeric/kg feed were 5.475, 5.525,

5.540, and 5.610 g/day, respectively. Collectively, the consistent trends observed across body weight, weight gain, SGR, and daily growth rate indicate that turmeric supplementation not only increases final body mass but also enhances growth velocity and efficiency over time (Figure 4).

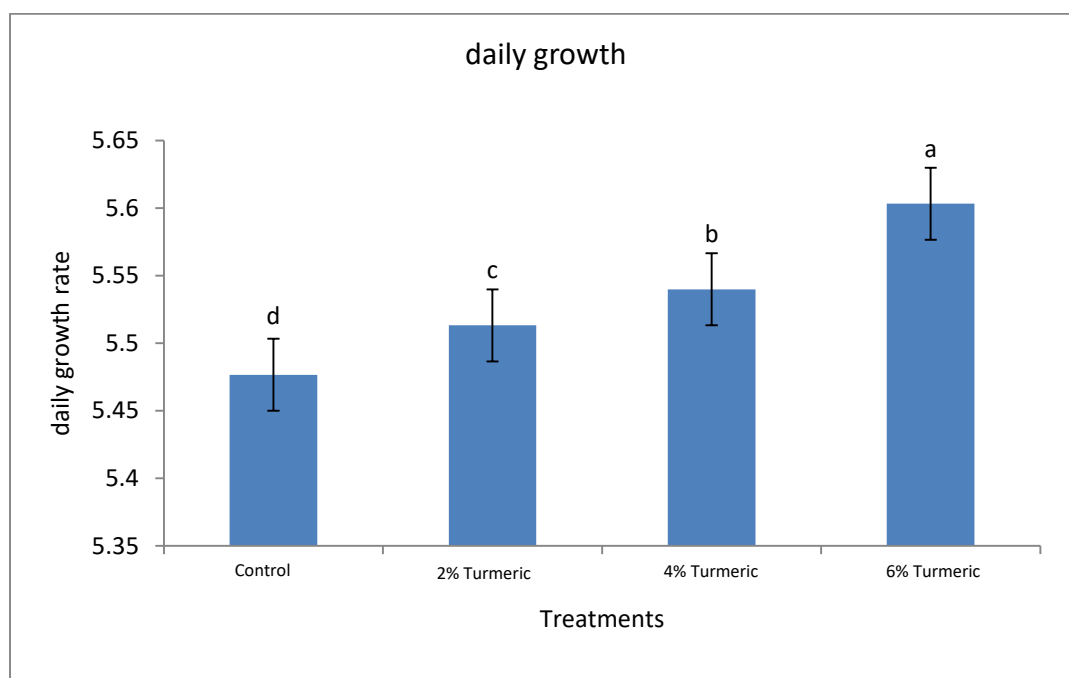


Figure 4. Daily growth rate of broiler chickens fed diets containing different levels of turmeric.

*Different letters within each column indicate a statistically significant difference in the daily growth rate of broiler chickens ($P < 0.05$) (Mean $\pm$ SD).

To evaluate the effects of turmeric supplementation on physical development, we measured several morphometric characteristics at different ages. Body length and wing length increased progressively with age in all treatment groups. Significant differences among dietary treatments were observed at different measurement periods ($P < 0.05$), with turmeric-supplemented groups generally exhibiting higher values than the control group. At day 45, birds receiving 6 g turmeric/kg feed exhibited the greatest body length (25.90 cm), followed by those receiving 4 g/kg (25.60 cm), 2 g/kg (24.96 cm), and the control group (24.03 cm). In contrast, the greatest wing length at day 45 was recorded in birds supplemented with 2 g turmeric/kg feed (26.90 cm), followed by 6 g/kg (26.36 cm), 4 g/kg (26.10 cm), and the control group (26.03 cm) (Table 2).

Table 2. Comparative Analysis of Mean Body Length and Wing Length (cm) in Ross 308 Broiler Chickens

Treatment Groups	Body Length (cm) - Day 15	Body Length (cm) - Day 30	Body Length (cm) - Day 45	Wing Length (cm) - Day 15	Wing Length (cm) - Day 30	Wing Length (cm) - Day 45
Control (0 g/kg)	14.5 $\pm$ 0.5 ^b	20.03 $\pm$ 0.05 ^d	24.03 $\pm$ 0.57 ^d	7.06 $\pm$ 0.11 ^c	23.46 $\pm$ 0.57 ^d	26.03 $\pm$ 0.57 ^c
2 g/kg Turmeric	16.6 $\pm$ 0.52 ^a	21.06 $\pm$ 0.11 ^c	24.96 $\pm$ 0.57 ^c	7.66 $\pm$ 0.3 ^b	24.03 $\pm$ 0.57 ^c	26.9 $\pm$ 0.1 ^a
4 g/kg Turmeric	15.96 $\pm$ 0.15 ^a	22.1 $\pm$ 0.10 ^b	25.6 $\pm$ 0.1 ^b	8.0 $\pm$ 0.2 ^{ab}	24.76 $\pm$ 0.57 ^b	26.1 $\pm$ 0.1 ^c

6 g/kg Turmeric	16.7±0.26 ^a	22.66±0.15 ^a	25.9±0.1 ^a	8.2±0.23 ^a	25.03±0.57 ^a	26.36±0.57 ^b
Degrees of Freedom (df)	3	3	3	3	3	3
CV	0.002	0.004	0.013	0.027	0.023	0.012

Leg development parameters, including shank length and shank diameter, were significantly increased by turmeric supplementation compared with the control group ($P < 0.05$). At day 15, the 4 and 6 g/kg treatments produced the greatest shank length (16.8 cm each), while the control group recorded the lowest value (12.73 cm). At day 30 and day 45, the 6 g/kg treatment consistently produced the highest shank length (21.63 cm and 23.6 cm, respectively). Similarly, shank diameter at day 45 was greatest in the 6 g/kg treatment (7.4 cm), followed by 4 g/kg (7.2 cm), 2 g/kg (7.03 cm), and the control group (5.6 cm) (Table 3).

Table 3. Comparative Analysis of Mean Shank Length and Shank Diameter (cm) in Ross 308 Broiler Chickens

Treatment Groups	Shank Length (cm) - Day 15	Shank Length (cm) - Day 30	Shank Length (cm) - Day 45	Shank Diameter (cm) - Day 15	Shank Diameter (cm) - Day 30	Shank Diameter (cm) - Day 45
Control (0 g/kg)	12.73±0.25 ^c	20.66±0.57 ^b	22.03±0.57 ^d	3.83±0.28 ^d	4.26±0.11 ^c	5.6±0.1 ^d
2 g/kg Turmeric	15.7±0.36 ^b	20.93±0.11 ^b	22.93±0.11 ^c	4.36±0.15 ^c	4.86±0.15 ^b	7.03±0.05 ^c
4 g/kg Turmeric	16.8±0.0 ^a	21.4±0.1 ^{ab}	23.4±0.1 ^b	4.9±0.25 ^b	5.03±0.05 ^{ab}	7.2±0.1 ^b
6 g/kg Turmeric	16.8±0.0 ^a	21.63±0.11 ^d	23.6±0.1 ^a	5.4±0.17 ^a	5.3±0.0 ^a	7.4±0.05 ^a
Degrees of Freedom (df)	3	3	3	3	3	3
CV	0.009	0.01	0.009	0.045	0.015	0.011

Comb length and beak length were significantly influenced by turmeric supplementation, especially at later growth stages ($P < 0.05$). At day 45, comb length was greatest in the 6 g/kg treatment (2.93 cm), followed by 4 g/kg (2.7 cm), 2 g/kg (2.46 cm), and the control group (2.13 cm). For beak length at day 45, the 2 g/kg treatment produced the greatest value (3.56 cm), followed by 6 g/kg (3.26 cm), the control group (3.03 cm), and 4 g/kg (2.78 cm) (Table 4).

Table 4. Comparative Analysis of Mean Comb Length and Beak Length (cm) in Ross 308 Broiler Chickens

Treatment Groups	Comb Length (cm) - Day 15	Comb Length (cm) - Day 30	Comb Length (cm) - Day 45	Beak Length (cm) - Day 15	Beak Length (cm) - Day 30	Beak Length (cm) - Day 45
Control (0 g/kg)	1.1±0.1 ^c	1.2±0.05 ^d	2.13±0.05 ^d	2.03±0.05 ^d	2.16±0.11 ^c	3.03±0.05 ^{ab}
2 g/kg Turmeric	1.66±0.05 ^b	1.68±0.05 ^c	2.46±0.05 ^c	2.46±0.05 ^c	2.52±0.05 ^b	3.56±0.05 ^a
4 g/kg Turmeric	1.73±0.11 ^a	1.74±0.1 ^b	2.7±0.1 ^b	2.66±0.05 ^b	2.71±0.05 ^a	2.78±0.05 ^b
6 g/kg Turmeric	1.66±0.11 ^b	1.93±0.11 ^a	2.93±0.05 ^a	2.83±0.05 ^a	2.93±0.11 ^a	3.26±0.63 ^{ab}
Degrees of Freedom (df)	3	3	3	3	3	3
CV	0.051	0.052	0.024	0.002	0.038	0.067

Body girth and height were significantly increased in turmeric-supplemented groups compared with the control group ($P < 0.05$). At day 45, the 6 g/kg treatment recorded the highest girth (43.33 cm), followed by 4 g/kg (43.1 cm), 2 g/kg (42.9 cm), and the control group (42.4 cm). Similarly, body height at day 45 was greatest in the 6 g/kg treatment (39.93 cm), followed by 4 g/kg (39.7 cm), 2 g/kg (37.93 cm), and the control group (37.1 cm) (Table 5).

Table 5. Comparative Analysis of Mean Girth and Height (cm) in Ross 308 Broiler Chickens

Treatment Groups	Girth (Circumference) (cm) - Day 15	Girth (cm) - Day 30	Girth (cm) - Day 45	Height (cm) - Day 15	Height (cm) - Day 30	Height (cm) - Day 45
Control (0 g/kg)	22.16±0.28 ^c	40.23±0.25 ^d	42.4±0.17 ^c	20.5±0.5 ^c	32.26±0.25 ^d	37.1±0.1 ^d
2 g/kg Turmeric	24.5±0.5 ^b	41.1±0.1 ^c	42.9±0.1 ^b	21.9±0.17 ^b	32.83±0.05 ^c	37.93±0.05 ^c
4 g/kg Turmeric	26.06±0.40 ^a	42.06±0.11 ^b	43.1±0.1 ^b	23.26±0.15 ^a	33.16±0.05 ^b	39.7±0.1 ^b
6 g/kg Turmeric	26.63±0.32 ^a	42.93±0.11 ^a	43.33±0.05 ^a	23.5±0.1 ^a	34.6±0.17 ^a	39.93±0.11 ^a
Degrees of Freedom (df)	99.35	3	3	3	3	3
CV	0.015	0.003	0.002	0.01	0.003	0.002

Feather length was significantly increased by turmeric supplementation at all sampling points compared with the control group ($P < 0.05$). At day 15, the 6 g/kg treatment produced the longest feathers (8.26 cm), followed by 4 g/kg (8.0 cm), 2 g/kg (7.66 cm), and the control group (7.06 cm). At day 45, the 2 g/kg treatment yielded the longest feathers (26.9 cm), followed by 6 g/kg (26.36 cm), 4 g/kg (26.1 cm), and the control group (26.03 cm) (Table 6).

Table 6. Comparative Analysis of Mean Largest Feather Length (cm) in Ross 308 Broiler Chickens

Treatment Groups	Largest Feather Length (cm) - Day 15	Largest Feather Length (cm) - Day 30	Largest Feather Length (cm) - Day 45
Control (0 g/kg)	7.06±0.11 ^c	23.46±0.05 ^d	26.03±0.05 ^c
2 g/kg Turmeric	7.66±0.3b ^c	24.03±0.05 ^c	26.9±0.1 ^a
4 g/kg Turmeric	8±0.2 ^{ab}	24.76±0.05 ^b	26.1±0.1 ^c
6 g/kg Turmeric	8.26±0.23 ^a	25.03±0.05 ^a	26.36±0.05 ^b
Degrees of Freedom (df)	3	3	3
CV	0.027	0.002	0.002

DISCUSSION

This study investigated the dose-dependent effects of dietary turmeric powder supplementation on growth performance, feed efficiency, and morphometric traits in Ross 308 broiler chickens. The principal findings indicate that turmeric supplementation significantly enhanced body weight, weight gain, specific growth rate (SGR), daily growth

rate, and most morphometric characteristics when compared with the control group. These effects were largely dose-dependent and became more pronounced with age. Among the tested treatments, the diet containing 6 g turmeric/kg feed consistently produced the highest final body weight, growth indices, skeletal dimensions, and feather length. In contrast, lower inclusion levels (2 and 4 g/kg) selectively improved certain traits, such as wing length and beak length.

The observed improvements in growth performance may be attributed to the bioactive compounds present in turmeric, particularly curcumin. Curcuminoids have been reported to stimulate digestive enzyme activity, including amylase, protease, and lipase, thereby enhancing nutrient digestibility and absorption (Rajput et al., 2013). In addition, turmeric may improve intestinal health by modulating the gut microbiota and reducing oxidative stress through its antioxidant and anti-inflammatory properties, ultimately promoting growth performance (Wang et al., 2015). The beneficial effects observed in the present study generally align with previous reports, although optimal dietary inclusion levels of turmeric have varied across studies. Samarasinghe et al. (2003) reported significant improvements in broiler performance with moderate dietary turmeric supplementation. In contrast, Mondal et al. (2015) found that supplementation levels between 2 and 6 g/kg feed improved growth performance without adverse effects. Similarly, Hussein (2013) and Saleh and Attia (2021) demonstrated that dietary turmeric supplementation significantly increased body weight and weight gain compared with unsupplemented birds. In the present study, supplementation with 6 g turmeric/kg feed consistently produced the highest body weight and the best overall growth performance, whereas 2 g/kg feed was more effective for certain morphometric traits such as wing and beak length. These findings indicate that the optimal inclusion level may depend on the production trait being evaluated.

The highest supplementation level evaluated in the present study was 6 g turmeric/kg feed because previous studies have generally reported beneficial responses within this range. In contrast, information regarding higher inclusion levels remains limited and inconsistent. Excessive dietary turmeric may reduce feed palatability or alter nutrient utilization without providing additional productive benefits. Therefore, the present study focused on evaluating supplementation levels that are practical and supported by previous literature. Further research is recommended to investigate whether inclusion levels above 6 g/kg feed provide additional biological or economic advantages under commercial broiler production conditions. The findings of the present study agree with previous reports demonstrating the growth-promoting effects of turmeric and its bioactive compound, curcumin, in poultry nutrition. Hussein (2013) and Saleh and Attia (2021) similarly reported increased body weight and weight gain in broilers fed turmeric-supplemented diets. The enhanced SGR and daily growth rate observed in the current study support the hypothesis that curcuminoids stimulate digestive enzyme secretion and improve nutrient digestibility, as Rajput et al. (2013) suggest. Moreover, improvements in skeletal and morphometric traits align with reports that turmeric improves mineral utilization and reduces oxidative stress, thereby

supporting bone growth and structural development. In contrast, the inconsistent response of FCR across turmeric levels aligns with Emadi and Kermanshahi (2006), who reported no significant effect of turmeric on feed conversion. These discrepancies may reflect differences in dosage, broiler strain, diet composition, or experimental duration.

The lack of a strictly linear dose-response relationship between turmeric supplementation and FCR in the present study warrants further investigation. This observation may reflect complex interactions between curcuminoids and digestive physiology. While curcumin enhances nutrient digestibility through enzyme stimulation and gut microbiota modulation, the energetic costs of detoxifying and metabolizing high doses of phytochemicals may partially offset improvements in feed efficiency. Furthermore, the optimal dose for maximizing feed conversion may differ from that needed to maximize growth rate, suggesting that production goals should guide dosage recommendations. These findings are consistent with those of Emadi and Kermanshahi (2006), who also reported no significant effect of turmeric supplementation on FCR in broiler chickens. Such variability highlights the importance of optimizing turmeric dosage to balance growth performance and feed utilization.

The significant improvements in morphometric traits observed in turmeric-supplemented broilers are particularly noteworthy. Enhanced skeletal development, as evidenced by increased shank length and diameter, body length, girth, height, and feather length, suggests that turmeric may positively influence bone mineralization and structural growth, reflecting enhanced skeletal robustness and overall body conformation. This aligns with curcumin's antioxidant properties, which can reduce oxidative damage to growing tissues and support proper skeletal development, as well as its potential positive effects on calcium and phosphorus utilization. The selective effect of lower turmeric doses (2 g/kg) on wing length and beak length is an interesting finding that may indicate differential sensitivity of tissues to curcuminoids or the involvement of specific signaling pathways optimally activated at lower concentrations. Such improvements are particularly relevant in fast-growing commercial broilers, where inadequate skeletal development can compromise welfare and productivity. These findings suggest that turmeric supplementation not only improves productive performance but also supports structural integrity, which is essential for maintaining bird welfare in intensive production systems.

Despite the robust findings, several limitations should be acknowledged. First, the study did not evaluate physiological, biochemical, or molecular markers such as digestive enzyme activity, antioxidant status, or gut microbiota composition, which could provide mechanistic insights into turmeric's mode of action. Second, the study examined only one broiler strain (Ross 308) and a single production cycle, limiting the generalizability of the results across different genetic lines and management systems. Additionally, the study did not assess the economic efficiency or cost-benefit of turmeric supplementation. Future studies should elucidate the underlying mechanisms of turmeric action by integrating biochemical, histological, and microbiological analyses. Investigating the interaction between turmeric

and other phytogetic additives or enzymes may also help optimize feed formulations. Furthermore, long-term studies evaluating carcass traits, meat quality, immune responses, and economic profitability are recommended to validate the practical application of turmeric supplementation in commercial broiler production.

In conclusion, dietary turmeric powder supplementation has significant, dose-dependent positive effects on growth performance, growth dynamics, and morphometric development in Ross 308 broiler chickens. While higher inclusion levels (particularly 6 g/kg feed) yielded the most pronounced overall benefits, lower doses demonstrated selective advantages for certain traits. These findings support the potential use of turmeric as a natural growth-promoting feed additive and highlight the importance of dosage optimization to maximize biological and productive efficiency in broiler production systems.

CONCLUSION

This study demonstrated that dietary supplementation with turmeric powder significantly enhanced the growth performance of broiler chickens. Birds receiving 6 g turmeric powder/kg feed exhibited the highest final body weight and overall growth performance among all treatment groups. In addition, turmeric supplementation improved feed utilization efficiency, as indicated by lower feed conversion ratio (FCR) values compared with the control group. These findings support turmeric's potential as a natural growth-promoting feed additive in broiler production.

Furthermore, supplementation with 2 g turmeric powder/kg feed significantly increased wing length and beak length, suggesting that lower inclusion levels may affect specific morphometric characteristics. In contrast, higher supplementation levels primarily promoted body weight gain.

The beneficial effects observed in the present study may be attributed to improved nutrient digestion and absorption, enhanced digestive enzyme activity, modulation of the intestinal microbiota, and turmeric's antioxidant properties, all of which have been reported in previous studies. However, these mechanisms were not directly investigated in the present experiment and therefore require further confirmation.

Future studies should investigate the molecular and histological mechanisms underlying the observed responses and determine the optimum dietary inclusion level of turmeric under different production systems and environmental conditions. Such studies would help optimize the practical use of turmeric to improve growth performance, feed efficiency, and other economically important traits in broiler chickens.

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Authors contributions

Author 1 and Author 2 conducted the research and were responsible for data collection. Author 3 prepared the manuscript structure, developed the scientific writing, and ensured that the article complied with the journal's formatting and submission requirements. All authors reviewed and approved the final manuscript.

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Conflict of interest statement

The authors declare no conflict of interest.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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