



Use of *Cucurma longa* and *Coriandrum sativum* powder as dietary supplements enhances growth performance, expression of growth-related nutritional genes and maintenance in broiler chickens

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Received: 11 September 2024; Accepted: 27 May 2025

ABSTRACT

A 35-day trial was conducted using day-old Cobb 400Y broiler chicks (N=200) to investigate the effects of incorporating turmeric (*Curcuma longa*) and coriander (*Coriandrum sativum*) powders, both individually and in combination, on growth performance metrics such as feed intake, body weight gain, feed conversion ratio, performance index, and gene expression of growth-related markers. The chicks were divided into four treatment groups with 50 birds per group, further split into five replicates of 10 birds each: T-0 (control group receiving a standard basal diet), T-1 (0.75% turmeric powder in the basal diet), T-2 (2% coriander powder in the basal diet), and T-3 (0.75% turmeric plus 2% coriander powder in the basal diet). Results showed significant improvements in feed intake, weekly weight gain, feed conversion ratio, and performance index, especially in the T-3 group, with the T-2 and T-1 groups also outperforming the control group. Growth-related genes, including insulin-like growth factor-1 (IGF-1) and growth hormone receptor (GHR), were expressed at higher levels in the T-3 group, followed by T-2 and T-1. Additionally, significant increases were noted in dry matter, crude protein, and ether extract retention in the groups receiving turmeric and coriander supplements, although calcium and phosphorus retention remained statistically unchanged across all treatment groups compared to the control.

Keywords: Broiler, Feed Conversion Ratio, Gene expression, GHR gene, Growth Performance IGF-1 gene, Phyto-additives

Antimicrobial growth promoters (AGPs) are commonly administered at sub-therapeutic antibiotic levels in poultry farming to enhance growth rates and improve feed conversion efficiency. However, the consumption of poultry meat from birds raised on AGPs has been linked to an increase in multi-drug resistance in humans, leading to more chronic infections and prolonged illnesses. Given the importance of the poultry industry in providing healthy meat to the public, it is critical to explore safe and natural alternatives to AGPs for promoting growth.

One promising avenue is the use of phytogenic feed additives, which are plant-derived and free of chemical residues. These additives are rich in bioactive compounds like flavonoids, alkaloids, polyphenols, glycosides, tannins, and capsaicin, among others. Herbal plants such as *Curcuma longa* (commonly known as turmeric) and *Coriandrum sativum* (coriander) have long been recognized for their roles in promoting health and controlling diseases in both humans and animals. *Curcuma longa*, a perennial herb from

the *Zingiberaceae* family, contains high concentrations of phenolic compounds, especially curcuminoids, which are powerful antioxidants that reduce lipid peroxidation and neutralize harmful free radicals. *Coriandrum sativum*, a member of the *Apiaceae* family, has historically been used for its anti-parasitic, sedative, analgesic, antiseptic, and anti-diabetic properties, with linalool being its key therapeutic compound.

Although *C. longa* and *C. sativum* show potential as natural alternatives to AGPs, research evaluating their effectiveness in promoting growth in broilers remains limited. To address this gap, the present study was designed to test the hypothesis that adding turmeric and coriander powders as phyto-additives to broiler diets could enhance growth performance and improve the feed conversion ratio (FCR). The study assessed their impact on feed intake, body weight gain, FCR, performance index, and the expression of growth-related genes such as insulin-like growth factor-1 (IGF-1) and growth hormone receptor (GHR) in broiler chickens.

MATERIALS AND METHODS

The study was conducted at the Poultry Research

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and Training Centre, Bihar Animal Sciences University (BASU), Patna, Bihar, after receiving approval from the Institutional Animal Ethics Committee (IAEC) of the Bihar Veterinary College (BVC), BASU, Patna. A total of 200 broiler chicks were sourced from the local market, weighed individually, and then randomly assigned to one of four treatment groups. Each group consisted of five replicates of 10 chicks, ensuring the average body weight was similar across all groups. Ingredients for the experimental diets, including feed additives and supplements, were procured from local markets near Patna. Turmeric and coriander were procured, processed and grinded at departmental laboratory. The experimental diets were formulated for the pre-starter (0-7 days), starter (8-21 days), and finisher (21-35 days) growth phases as per Bureau of Indian Standards (BIS 2007) requirements. Details of the ingredients and compositions are provided in supplementary table 1.

The proximate composition, phosphorus content (determined as per AOAC 2005 guidelines), and calcium content (Talapatra *et al.* 1940) were analyzed using standard methods. The metabolizable energy and critical amino acids such as lysine and methionine were balanced to ensure that the diet met the broilers' nutritional needs. Standard management practices were strictly followed throughout the 35-day study period.

Experimental design: There were four treatment groups i.e. T-0 (Control Group): standard basal diet, T-1: standard basal diet supplemented with 7.5 g of turmeric powder per kg of feed, T-2: standard basal diet mixed with 20 g of coriander powder per kg of feed, and T-3: combination of 7.5 g of turmeric powder and 20 g of coriander powder per kg of feed. Feed intake and body weight gain were recorded weekly, and feed conversion ratio (FCR), and performance index were calculated based on the amount of feed consumed by the broilers.

Weekly feed intake was measured by weighing the feed leftovers and subtracting them from the total feed offered. Body weights of individual birds were recorded at the start of the experiment and at weekly intervals. FCR was calculated by dividing the feed intake by the body weight gain, while the performance index was computed using the formula: body weight gain divided by FCR.

Metabolism trial: A five-day metabolism trial was conducted at the end of the fifth week to assess nutrient retention. Five broilers, representing the average body weight from each treatment group, were selected and housed in individual metabolic cages. Birds were fed the experimental diets and had access to water *ad libitum*. After a two-day adaptation period, faecal samples were collected over five days using polythene-covered trays. The collected excreta were dried at 70°C for 48 hours to determine dry matter and were stored for further analysis of nutrient composition. The experimental diets and excreta samples were analyzed for proximate components, phosphorus content (AOAC 2005), and calcium content (Talapatra *et al.* 1940).

Gene expression analysis: At the conclusion of the trial,

liver samples were collected from five randomly selected birds from each group. Total RNA was isolated from the liver tissues using the Trizol method, and the RNA quantity and quality were assessed using spectrophotometry. Samples with an RNA purity ratio of 2.0-2.2 were selected for further analysis. Reverse transcription was performed using the Qiagen Quantitect Reverse Transcription Kit to synthesize complementary DNA (cDNA) from 1 µg of RNA. The quality of the synthesized cDNA was verified using semi-quantitative PCR with β -actin gene primers. Primers for gene expression analysis, including sequence and annealing temperatures, were designed based on prior studies (Suppl. table 2). Quantitative Real-Time PCR (qRT-PCR) was conducted using the Qiagen Quantitect SYBR Green PCR Kit on an Applied Biosystems 7500 Real-Time PCR System. The thermal cycle consisted of an initial denaturation at 95°C for 15 minutes, followed by 40 cycles of denaturation at 95°C for 15 seconds, annealing for 30 seconds, and extension at 72°C for 10 seconds. Melting curve analysis was performed to confirm the specificity of the amplification products. Gene expression levels of target genes were normalized to the housekeeping gene β -actin and fold changes were calculated following methods by Kirrell *et al.* (2021).

The data were analyzed using SPSS software (version 27.0). One-way analysis of variance (ANOVA) was employed, followed by Duncan's multiple range test to compare group means. Differences between treatment groups were evaluated for statistical significance using the Least Significant Difference (LSD) method, as outlined by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

In this study, several parameters such as feed intake, body weight, weekly weight gain, feed conversion ratio (FCR), performance index (PI), and nutrient retention were evaluated.

Feed intake: The average feed intake throughout the study ranged from 2523.58 g in the control group (T-0) to 2771.34 g in the T-3 group. Weekly feed consumption varied significantly, with T-0 recording 173.33 g during the first week compared to 197.10 g in T-3 (Suppl. table 3). The second week saw an intake ranging from 238.33 g in T-0 to 269.16 g in T-3, while third-week intake ranged from 425.66 g in T-0 to 476.61 g in T-3. During the fourth and fifth weeks, feed intake increased from 770.90 g in T-0 to 827.46 g in T-3, and from 915.44 g in T-0 to 1001.00 g in T-3, respectively. Across all weeks, supplementing diets with 0.75% turmeric and 2% coriander improved feed consumption compared to the control. Statistical analysis indicated a significant effect ($p < 0.05$, $p < 0.01$) of dietary treatments on feed intake, with T-3 showing the highest overall consumption, followed by T-2, T-1, and T-0. These results align with Hady *et al.* (2016), who also observed increased feed intake with turmeric supplementation. Similar findings were also reported by Al-Sultan (2003), Durrani *et al.* (2006), and Al-Kassie *et al.* (2011), who

demonstrated enhanced feed intake with turmeric and cumin additives. Ghazanfari *et al.* (2015) also found improvements in broiler performance and intestinal health with coriander oil supplementation.

Body weight: The average body weight varied from 167.50 g in T-0 to 177.25 g in T-3 during the first week. By the second week, weights ranged from 392.83 g in T-0 to 401.77 g in T-3. Body weights in the third, fourth, and fifth weeks showed progressive increases from 682.44 g in T-0 to 722.49 g in T-3, from 1113.12 g in T-0 to 1226.88 g in T-3, and from 1600.01 g in T-0 to 1801.17 g in T-3, respectively. Final body weights were significantly higher ($p < 0.05$, $p < 0.01$) in all treatment groups, with T-3 showing the highest weight of 1801.17 g and T-0 the lowest at 1600.01 g (Suppl. Table 4). These findings are consistent with Sethy *et al.* (2016), who reported significant body weight increases with turmeric supplementation. Similarly, Rajput *et al.* (2013) demonstrated improved weight gain and reduced FCR with phytochemical additives. However, Wang *et al.* (2015) found no significant body weight effects from turmeric powder in the early weeks, though improvements were noted in later stages. Rashid *et al.* (2014) also observed significant weight gains with coriander seed supplementation.

Body weight gain: Weekly weight gains were significantly affected by the inclusion of turmeric and coriander, except during the second week, which showed no significant differences (Supplementary table 5). Average weight gain across the experiment ranged from 1551.97 g in T-0 to 1752.29 g in T-3. Weekly gains varied, with the first week showing a range from 119.44 g in T-0 to 128.37 g in T-3, and the second week from 224.52 g in T-3 to 227.75 g in T-1 (non-significant). Gains in the third, fourth, and fifth weeks ranged from 289.61 g in T-0 to 320.72 g in T-3, from 430.68 g in T-0 to 504.38 g in T-3, and from 486.89 g in T-0 to 574.29 g in T-3, respectively. Overall, T-3 showed the highest weight gain, followed by T-2, T-1, and T-0. The improved weight gains are likely due to turmeric's ability to increase intestinal villi length and decrease intestinal pH (Hady *et al.* 2016), thereby enhancing nutrient absorption (Arslan *et al.* 2017). Ekine *et al.* (2020) similarly reported improved weight gains with turmeric supplementation.

Feed conversion ratio (FCR): The FCR ranged from 1.44 in T-0 to 1.53 in T-3 during the first week, while the second week saw a range from 1.04 in T-0 to 1.19 in T-3. In the third week, FCR varied from 1.45 in T-1 to 1.52 in T-2, and in the fourth week from 1.63 in T-3 to 1.85 in T-2. By the fifth week, FCR ranged from 1.73 in T-3 to 1.87 in T-0 (Suppl. table 6). Overall FCR during the study varied from 1.57 in T-3 to 1.65 in T-1. Statistical analysis revealed significant differences ($p < 0.05$) in FCR among groups, with T-3 consistently showing the best (lower) FCR. The enhanced FCR observed in the T-3 group is likely due to the antimicrobial properties of turmeric and coriander, which improve nutrient absorption by maintaining a healthy gut microbial balance. Similar findings were reported by Barad *et al.* (2016) and Hady *et al.* (2016).

Performance index (PI): The PI values during the first week ranged from 79.71 in T-2 to 84.18 in T-3. In the second week, values ranged from 187.68 in T-3 to 213.94 in T-0. Third-week PI ranged from 197.95 in T-0 to 216.35 in T-3 (Suppl. table 7). Fourth-week PI varied from 235.69 in T-2 to 308.24 in T-3, while the fifth week saw PI values ranging from 259.51 in T-0 to 330.75 in T-3. The overall PI for the study ranged from 956.07 in T-0 to 1111.46 in T-3. The higher PI in T-3 is attributed to better body weight and FCR performance throughout the study. Previous research by Attia *et al.* (2017) also reported improved performance indices with similar feed additives.

Nutrient retention: Dry Matter (DM) retention percentages ranged from 70.61% in T-0 to 74.76% in T-3. Statistical analysis showed significantly higher DM retention in T-3 and T-2 compared to the control, possibly due to the active compounds in coriander enhancing feed consumption. Nitrogen retention ranged from 63.32% in T-0 to 66.80% in T-3 (Suppl. Table 8). Nitrogen retention was significantly higher ($p < 0.05$) in T-3, likely due to the synergistic effects of turmeric and coriander. Ether Extract (EE) retention ranged from 73.50% in T-0 to 75.89% in T-3. T-1 and T-3 showed significant improvements in EE retention compared to the control group. Calcium retention ranged from 16.62% in T-0 to 17.02% in T-3. Statistical analysis revealed no significant differences ($p > 0.05$) among groups. Phosphorus retention ranged from 10.52% in T-0 to 10.99% in T-2, with no significant differences among treatment groups.

Gene expression of IGF-1 and GHR: The expression of IGF-1 and GHR genes was upregulated in all treatment groups, with the highest expression in T-3, followed by T-2 and T-1 ($p < 0.05$) (Fig. 1.). This suggests that turmeric and coriander together have a greater growth-promoting effect, as they positively influence IGF-1 and GHR gene expression, both of which are linked to muscle growth (Lin *et al.* 2024). Similar results were observed in previous studies, including Saxena *et al.* (2020) and Hafez *et al.* (2022), which also reported increased expression of these genes with curcumin supplementation.

Economics of production: Supplementation of mixture of turmeric and coriander powder in T-3 treatment group showed best result in respect of higher gross profit per broiler

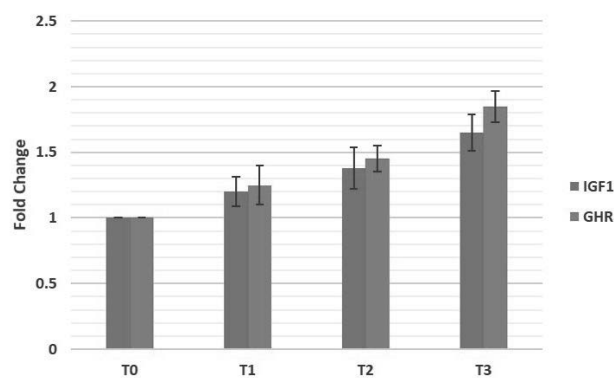


Fig. 1. Comparative fold change of *IGF-1* and *GHR* genes

chicken. The gross profit per broiler chicken in T-3 group was found to be highest as compared with control group. The better gross profit per broiler chicken in T-3 group could be attributed to the better growth performance and improved FCR of broiler chicken due to supplementation of mixture of turmeric and coriander powder in the ration.

This study highlights the potential of using phyto-additives like turmeric and coriander as alternatives to antibiotics in broiler production. The incorporation of 0.75% turmeric and 2% coriander into standard broiler diets improved growth performance, feed conversion efficiency, and nutrient retention.

ACKNOWLEDGMENT

The authors extend their gratitude to the Vice-Chancellor, Bihar Animal Sciences University, Patna, Bihar, for funding this study. The animal experiment was conducted with the approval of the Institutional Animal Ethical Committee (IAEC/BVC/2024/41).

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