Effect of Turmeric (Curcuma longa) Supplementation on Growth Performance, Immune Response, Carcass Characteristics and Cholesterol Profile in Broilers

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Abstract
The present study investigated the effects of turmeric on growth performance, immune response, serum cholesterol and carcass characteristics in broilers. A total of 120 day-old straight-run Hubbard broiler chicks were divided into four treatment groups in completely randomized design. Turmeric powder was supplemented through feed at the rates of 0, 0.5, 1 and 1.5% throughout the rearing period (day 1 to 35). Body weight gain, feed consumption and feed conversion efficiency were measured on a weekly basis. Blood samples (3 birds/replicate) were collected at the 30th and 35th day of age for determination of antibody titers against infectious bursal disease (IBD) and Newcastle disease (ND), respectively. At the end of the experiment, 3 birds per replicate were slaughtered to obtain carcass characteristics data. Results showed that turmeric supplementation positively affected growth performance. Supplementation at 1 and 1.5% improved body weight gain, and 0.5% and 1.5% reduced feed intake. All levels improved feed conversion efficiency but supplementation at the rate of 1.5% showed the best results. Turmeric supplementation improved antibody titers against ND and IBD. Serum total cholesterol was reduced and HDL-cholesterol was increased, while LDL-cholesterol and triglycerides remained unaffected due to turmeric supplementation. It can be concluded that turmeric has the potential to improve growth performance, immune response, dressing percentage and cholesterol profile in broilers, and its use at 1.5% through feed is recommended for better results.

Keywords
poultry — growth promoter — feed additive — turmeric — Curcuma longa

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Introduction
Poultry production focused to optimize growth performance through better growth rate and improved feed conversion efficiency. The optimum performance of birds is mainly dependent on the genetic potential of bird, quality of feed, environmental conditions and disease outbreaks (26).

The removal of antibiotic growth promoters (AGPs) was problematic for growth performance and led to an increase in the incidence of disease outbreaks, especially sub-clinical necrotic enteritis. This has led to discovery of alternatives to AGPs (14).

The modern trend is to replace AGPs with natural growth promoters. For this purpose, different natural growth promoters are used worldwide. Prebiotics, probiotics, organic acids, enzymes, antioxidants and herbs are good antibacterial alternatives. Herbs and their extracts are excellent alternatives due to the variety of beneficial activities (28, 11, 21). Phytotherapeutic growth promoters mainly improved the gut health for optimum functioning (29). Phytotherapeutic growth promoters are ideal for poultry because they are natural, residue free, eco-friendly and having no side effects. The phytogenic growth promoters showed antimicrobial, antiparasitic, insecticidal, antifungal, antiviral and antitoxic effects. They enhanced feed consumption, improved digestion and growth performance, minimized the incidence of disease and increased profitability (29).

Due to its medicinal properties, the use of turmeric in poultry feed became extensive during the last decade (15). It is widely cultivated herbaceous plant of tropical region. Curcumin is the active ingredient that is present at 1.5-2% of weight of turmeric root. Turmeric contains 3 different analogues of curcumin, which contains 5% bis-demethoxycurcumin, 18% demethoxycurcumin, and 77% diferuloylmethane. Rhizomes of this plant are dried to obtain turmeric powder, a yellow or gold-colored spice, which is also used for health care, food preservation and as a dye in textile industry. Its color is due to a pigment, which is diferuloylmethane in structure. Curcumin is insoluble in water and soluble in imethylsulfoxide, ethanol, oils, and acetone (7, 2).

Turmeric has good pharmacological properties and can...
be a useful natural growth promoter and safe alternative to antibiotics. However, the turmeric supplementation levels and results of previous studies are not so consistent. The aim of the present study was to evaluate the effect of different levels of turmeric (*Curcuma longa*) on growth performance, immune response, carcass characteristics and serum cholesterol in broilers.

### Material and Methods

**Experimental birds.** One hundred and twenty day-old straight-run Hubbard broiler chicks were purchased from a local hatchery and assigned into four treatment groups with each group having 3 equal replicates (10 chicks per replicate). Birds were reared in isolated deep-litter floor pens until 35 days of age.

**Treatment Plan.** Birds were offered commercial starter ration (CP 22%, ME 12.8 MJ/kg) for the first three weeks and then commercial finisher ration (CP 20%, ME 13.0 MJ/kg) for the rest of the fattening period. Control group was without turmeric supplementation while other groups were supplemented with turmeric powder (TP) at the rate of 0.5, 1.0 and 1.5% of feed, respectively.

**Vaccination Schedule.** Experimental birds were vaccinated against Newcastle disease (ND) and infectious bursal disease (IBD) by eye-drop method at Day 7 and 12, respectively. Birds were re-vaccinated through drinking water at Day 20 and 25 against IBD and ND, respectively.

**Data Collection.** The data were collected on body weight, feed consumption, and mortality rate. Feed conversion ratio (FCR) was calculated as feed consumption/body weight gain. At the end of the experiment 3 birds from each replicate were randomly selected and slaughtered to obtain data on carcass characteristics.

Blood samples (3 birds/replicate) were collected at Day 30 and 35 for determination of antibody titers against IBD and ND, respectively. These samples were collected from the brachial vein in 5 ml sterilized syringes and pooled from each replicate, and 12 blood samples were analyzed. After collecting blood the syringes were kept in slanted position to obtain serum. The serum was transferred into sterilized 0.5 ml serum cups. The methods described by MAFF (16) and Saeed (22) were used to measure haemagglutination (HA) and haemagglutination inhibition (HI) titer against the ND, and indirect haemagglutination (IHI) titer against IBD. Total cholesterol, triglycerides and HDL were measured using commercial kits, while LDL is measured by indirect method using the Friede-Wald (13) formula:

\[
LDL-\text{Cholesterol (mg/dL)} = \text{Total cholesterol} - \text{Triglycerides} / 5 - \text{HDL-cholesterol}
\]

**Statistical Analysis.** The results were subjected to statistical analysis using One-way ANOVA for completely randomized design. Treatment means were compared by Least Significance Difference test through SPSS (25).

### Results

The results of the present study showed that TP supplementation at the rates of 1.0 and 1.5% significantly improved body weight gain, but 0.5% supplementation had no effect. TP supplementation significantly decreased feed consumption at the rates of 0.5 and 1.5%. All levels of TP improved FCR, but supplementation at the rate of 1.5% proved to be the most efficient (Table 1).

Turmeric supplementation showed positive influence on antibody titers against ND and IBD. All levels of TP supplementation improved antibody titers as compared to control, while adding TP at the rate of 1.5% showed the highest antibody titers against both diseases (Table 1).

Supplementation of TP at the rates of 0.5 and 1.5% significantly improved dressing percentage, while the breast weight was improved when TP was supplemented at the rate of 1.5%. The supplementation did not significantly affect the organs weight (Table 1).

Turmeric supplementation at the rates of 1.0 and 1.5% significantly reduced total serum cholesterol and increased HDL-cholesterol, however, LDL-cholesterol and triglycerides levels remained unaffected due to the treatments.

### Discussion and conclusion

Turmeric supplementation at higher dose (1.0 and 1.5%) improved body weight gains and showed best FCR results. The supplementation at the rate of 0.5% showed better FCR and decreased feed consumption, but did not affect body weight gain. Similar to these findings, Al-Jaleel (3) reported improved body weight gain and FCR at 1.0 and 1.5% turmeric supplementation without the effect on feed intake. Also, Al-Sultan (5) reported a reduced feed consumption at 0.5%, and Qasem *et al.* (20) found less feed intake at 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0% of TP supplementation. In line with the present findings, Mondal *et al.* (17) described an improvement in FCR through TP supplementation at rates of 0.5, 1.0 and 1.5%. Present findings are also in agreement with the results of Al-Sultan (5) and Durrani *et al.* (12), showing that TP supplementation at the rate of 0.5% improved FCR. Nouzarian *et al.* (19) also found better FCR at 1.0% supplementation.

The positive influence may be due to the fact that TP supplementation increased the villi length and decreased the pH of intestine (24). Turmeric decreased the intestinal microbes, selectively increased Lactobacillus count (24, 18), and enhanced the secretion of digestive enzymes thus improving nutrient absorption (10) ultimately resulting in improved growth performance. Turmeric also enhanced the production of the bile, which improves the digestion of fats (6). The results of the present study did not agree with Al-Sultan (5), Durrani *et al.* (12), Abou-Elkhair *et al.* (1) and Mondal *et al.* (17) who found that TP supplementation at the rate of 0.5% significantly improved body weight gain. On the other hand, Mondal *et al.* (17) did not find positive influence of TP on body weight gain even when it was supplemented at 1.0 and 1.5%. Qasem *et al.* (20) also did not find any positive effect either on body weight gain, or FCR when turmeric was supplemented at the rates of 1.0 1.2, 1.4, 1.6, 1.8 and 2.0%. Variation in results with TP supplementation may be due to the variation in curcuminoïds’ contents of turmeric, which varies greatly (2-7%) from species to species. The harvesting of turmeric plant at the different stages of growth also influenced the curcumin...
Table 1. Effect of turmeric powder (TP) on growth performance, immune response, carcass characteristics and cholesterol profile in broilers

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Turmeric (0.5%)</th>
<th>Turmeric (1%)</th>
<th>Turmeric (1.5%)</th>
<th>SEM</th>
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</thead>
<tbody>
<tr>
<td>Initial weight (g)</td>
<td>46.56</td>
<td>45.81</td>
<td>47.05</td>
<td>46.94</td>
<td>0.25</td>
</tr>
<tr>
<td>Body weight (g)</td>
<td>1457.96</td>
<td>1472.53</td>
<td>1565.30</td>
<td>1576.30</td>
<td>19.40</td>
</tr>
<tr>
<td>Body weight gain (g)</td>
<td>1411.40</td>
<td>1426.71</td>
<td>1518.22</td>
<td>1529.35</td>
<td>19.33</td>
</tr>
<tr>
<td>Feed Consumption (g)</td>
<td>2620.85</td>
<td>2463.76</td>
<td>2521.50</td>
<td>2483.99</td>
<td>25.00</td>
</tr>
<tr>
<td>FCR</td>
<td>1.85</td>
<td>1.76</td>
<td>1.68</td>
<td>1.62</td>
<td>0.02</td>
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<tr>
<th>Immune Response (antibody titer)</th>
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<tbody>
<tr>
<td>ND</td>
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<td>IBD</td>
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<table>
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<tr>
<th>Carcass Characteristics</th>
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<tbody>
<tr>
<td>Dressing (%)</td>
</tr>
<tr>
<td>Mean Liver Weight (g)</td>
</tr>
<tr>
<td>Abdominal Fat (g)</td>
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<tr>
<td>Mean Thigh Weight (g)</td>
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<td>Mean Breast Weight (g)</td>
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<tr>
<th>Cholesterol Profile</th>
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<tbody>
<tr>
<td>Total Cholesterol (mg/dL)</td>
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<tr>
<td>HDL-cholesterol (mg/dL)</td>
</tr>
<tr>
<td>LDL-cholesterol (mg/dL)</td>
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<tr>
<td>Triglycerides (mg/dL)</td>
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<sup>abc</sup> Means within a row with no common superscripts differ significantly (P<0.05).

curcumin content in turmeric plants (23).

The results of the present study regarding the immune response coincide with the findings of Qasem et al (20) confirming that TP supplementation at the rates from 1.0 up to 2.0% significantly improved antibody titer against ND, while the titer against IBD was significantly higher when TP was added in the feed at the rates of 1.4 and 1.6%. However, Nouzarian et al (19) observed no significant effect of turmeric on the titer against ND when it was supplemented at the rates of 0.33, 0.66 and 1.0%. Qasem et al (20) also did not find positive results of turmeric on IBD titer when it was supplemented at the rates of 1.0, 1.2, 1.8 and 2.0%.

The results of the present study are in agreement with the findings of Daneshyar et al (9) that TP supplementation at the rate of 0.75% significantly decreased serum cholesterol, but had no significant effect at the rate of 0.5%. Turmeric supplementation also reduced serum cholesterol level at the rates of 1.0% (4) and 0.8% (Hosseini-Vashan et al., 2012). The same authors showed that serum cholesterol also decreased if diets were supplemented with TP at the rates of 0.4 and 0.5%, which have proved to be ineffective in the present study. The results of this study showed that TP supplementation through feed had positive influence on growth performance, immune response, dressing percentage and cholesterol profile in broilers. The use of turmeric powder at the rate of 1.5% showed the best effects on growth performance and immune response in broilers, hence, it can be used as an excellent growth promoter in broiler feed.

References

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Effect of Turmeric (Curcuma longa) Supplementation — 19/20


Efekat dodavanja kurkume (Curcuma longa) u hranu na prirast, imuni odgovor te klaoničke parametre i profil holesterola kod brojlera

Sažetak

Uvod i cilj

U modernoj peradarskoj proizvodnji prisutan je trend zamjene antibiotičkih stimulatora rasta (AGPs) u hrani prirodnim stimulatorima rasta. Začinsko i lijekovito bilje i njihovi ekstrakti su odlične alternative za AGPs, zbog niza korisnih osobina koje posjeduju. Zbog svojih lijekovitih svojstava, upotreba kurkume u hrani za perad postala je raširena praksa u posljednjoj deceniji. Kurkuma ima dobre farmakološke osobine i može predstavljati koristan prirodni stimulator rasta i sigurnu alternativu upotrebi antibiotika. Međutim, količine kurkume koje se moraju dodavati u hranu i rezultati ranijih istraživanja nisu uvijek potpuno jasni. Cilj ovog rada je istražiti efekte dodavanja kurkume u hranu na prirast, imuni odgovor, serumski holesterol i klaoničke parametre kod brojlera.

Materijal i metode

Eksperiment u trajanju od 35 dana proveden je na 120 pilića Hubbard provenijence koji su bili podijeljeni u četiri jednake grupe u potpuno randomiziranom eksperimentalnom planu. Svaka grupa sastojala se od tri replikata sa po 10 pilića u svakom replikatu. Pilići su prve tri nedjelje tova hranjeni komercijalnom starter smjesom (SP 22%, ME 12.8 MJ/kg), a zatim komercijalnom finišer smjesom do kraja tova (SP 20%, ME 13.0 MJ/kg). Kurkuma u prahu je unijesena u hranu u 0, 0.5, 1.0 i 1.5%. Vakcinacija okulonazalnom metodom protiv Newcaste bolesti (ND) i Infektivnog burzitisa (IBD) izvršena je 7. dana, a revakcinacija protiv istih bolesti 20. i 25. dana u vodi za piće. Mjerenje prirasta, konzumacije hrane i izračunavanje konverzije hrane vršeni su sedmično. Uzorci krvi iz krilne vene (3 pileta iz svakog replikata) uzeti su 30. i 35. dana za određivanje titra antitijela protiv IBD i ND. U istim uzorcima krvi određeni su ukupni holesterol, trigliceridi, HDL i LDL holesterol. Na kraju eksperimenta, izvršeno je klanje po tri pileta iz svakog replikata za dobivanje podataka o klaoničkim parametrima.

Rezultati i interpretacija

Dodavanje kurkume u prahu sa učesćem od 1.0 i 1.5% u hranu značajno je povećalo prirast kod brojlera, dok učesće od 0.5% nije imalo efekta u odnosu na kontrolni tretman. Kurkuma je također dovela do značajnog smanjenja konzumacije hrane pri učesću od 0.5 i 1.5%. Svi nivoi dodavanja kurkume pozitivno su utjecali na konverziju hrane, a učesće od 1.5% se pokazalo kao najefikasnije. Kurkuma je pozitivno utjecala na titer antitijela protiv ND i IBD, a dodavanje u hranu sa učesćem od 1.5% rezultiralo je najvećim titrom antitijela protiv obje bolesti. Randman je bio značajno bolji kod pilića koji su u hrani dobivali 0.5 i 1.5% kurkume. Težina prsnih mišića je bila povećana kod učesća kurkume od 1.5%, ali nije imala utjecaja na težinu batka, abdominale masti i jetre. Serumski holesterol je bio smanjen kod učesća kurkume u hranu od 0.5 i 1.5%.

Glavni zaključak

Iz dobivenih rezultata može se zaključiti da kurkuma početno utječe na prirast, imuni odgovor te klaoničke parametre i status holesterola kod brojlera. Njeno dodavanje u hranu pilića sa učesćem od 1.5% se preporučuje za postizanje boljih rezultata tova.