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Review Article

Use of Turmeric (*Curcuma longa*) in Poultry Nutrition: A Review

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استخدام الكركم (*Curcuma longa*) **في تغذية الدواجن**

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Abstract. Turmeric (*Curcuma longa*) is a plant used in herbal medicine that has been used to treat many health problems in poultry, as antibacterial, and antifungal, promoting growth and improving the intestinal environment and immunity. The aim of this article was to review the research focused on using turmeric (*Curcuma Longa*) in rations of broilers and layers on performance, carcass characteristics, blood parameters, egg production, and egg quality characteristics. Most research indicated that turmeric addition to broiler rations improved productive traits (i.e. body weight, weight gain, feed intake and feed conversion), increased livability and had insignificant effects on carcass traits (i.e. dressing percentage, carcass cuts percentages), abdominal fat, edible giblets, cooking loss and water holding percentage). There were different results of turmeric addition on blood parameters; some indicated that it had positive effects, and indicated negative effects, while others found insignificant effects on blood characteristics. Most researchers found a decrease in feed consumption when turmeric was added to layer rations, while different results were observed on laying performance and egg quality traits.

Keywords: Turmeric, Broiler, Layers, Performance, carcass, blood

الملخص: الكركم (كركما لونجا) هو نبات يستخدم في طب الأعشاب وقد تم استخدامه لعلاج العديد من المشاكل الصحية في الدواجن ، كمضاد للبكتيريا والفطريات ، مما يعزز النمو ويحسن البيئة المعوية والمناعة. الهدف من هذه المقالة هو مراجعة الأبحاث التي تركز على استخدام الكركم (كركما لونجا) في تغذية فروج اللحم ودجاج البيض على الأداء وخصائص الذبيحة ومعايير الدم وإنتاج البيض والصفات النوعية للبيض . تشير معظم الأبحاث إلى أن إضافة الكركم إلى علائق التسمين أدت إلى تحسين الصفات الإنتاجية (وزن الجسم ، الزيادة الوزنية ، استهلاك العلف ، ومعامل التحويل الغذائي) ، والحيوية ، ولم يكن لها تأثير معنوي على صفات الذبيحة (نسبة التصافي ، نسب قطع الذبيحة). دهون البطن ، الاحشاء المأكولة ، نسبة الفقد أثناء الطبخ ، نسبة الاحتفاظ بالماء). كانت هناك نتائج مختلفة لإضافة الكركم على صفات الدم. أشار البعض إلى آثاره الإيجابية ، والبعض الآخر أشار إلى آثار سلبية ، في حين وجد البعض الآخر آثارًاغير معنوية على خصائص الدم. وجد معظم الباحثين انخفاضًا في استهلاك العلف عند إضافة الكركم إلى علائق البياض ، بينما كانت هناك نتائج مختلفة في صفات وضع البيض والصفات النوعية للبيض.

الكلمات المفتاحية: الكركم ، الاداء ، فروج اللحم ، دجاج البيض ، صفات الدم

Introduction

Medicinal plants and herbs have been used to treat many health problems in poultry, which reflects in their health, due to their antibacterial and antifungal effects, and these natural medicinal plants can also promote growth, improve the intestinal environment and immunity. The crude protein content of dried turmeric is 6.3%, ether extract 5.1%, ash 3.5%, carbohydrate 69.5%, moisture 13.1%, essential oils 5%, and tetrahydrocurcuminoids 5%. Curcumin, dimethoxy curcumin and bismethoxy curcumin are the active compounds of turmeric (Eevuri and Putturu, 2013; Li et al., 2011). *Curcuma longa*, also known as turmeric, is a tropical medicinal plant and used for its antifungal, immunomodulatory, antioxidative, and antimutagenic effects (Nisar et al., 2015). Linnaeus classified Turmeric C. longa, and it belongs to the following taxonomic group: Order Zingiberales, Family Zingiberaceae, Class Liliopsida, Subclass Commelinids, Genus Curcuma Species Curcuma longa, also known as turmeric. Protein, lipid, mineral, carbohydrate, and moisture content of turmeric is 6.3%, 5.1%, 3.5%, and 69% and 13.1%, respectively. Rhizome steam distillation yields 5.8 % essential oil that contains 1 % α-phellandrene, 1% cineol, 0.6 % sabinene, 25% zingiberene, 1% borneol and 53% sesquiterpines. The yellow colour comes from curcumin (diferuloylmethane), which is 3–4 % (Sotiboldieva et al., 2020).

The chemical components of turmeric (Curcuma longa L.) tissues has been widely researched (Li et al., 2011). It has been found that the species contains at least 235 compounds, including 22 diarylheptanoids and diarylpentanoids, 8 phenolic compounds, 68 monoterpenes, and 109 sesquiterpenes, 5 diterpenes, 3 triterpenes, 4 sterols, and 2 alkaloids, as well as 14 other compounds. According to Fascina et al (2012), use of phytogenic additions increases the secretion of pancreatic and intestinal enzymes, synthesis of bile salts, and activity of pancreatic and intestinal lipase, all contribute to improve nutrient metabolism. Al-Asmary et al. (2014) mentioned that *Curcuma longa* used in traditional medicine in Saudi for loss of appetite, liver problems, jaundice, arthritis, and gall bladder disorders. It is due to its active components, like Curcumin, demethoxycurcumin, and bis-demethoxycurcumin. Curcuma extracts showed an-

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tidiabetic qualities similar to commercial drugs and may even be more effective in people in some instances (Priyangga et al., 2021).

Broiler Performance

Abd Al-Jaleel (2012) studied the effect of turmeric addition to Ross broiler ration at ratios of 0, 0.25, 1.0, and 1.5 %. He found that 0.25, 0.5%, additions had a significant (P≤0.05) improvement in final body weight at 42 days. Ration of 0.5% was significantly higher than 0.25, 1 and 1.5%. Abd El-Hakim (2009) found insignificant effect of 0.2% curcuma longa addition to the Cobb broiler's low protein diet (i.e. 18%) on the weight gain, feed conversion ratio, dressing percentage, liver, gizzard, abdominal fat, total edible parts, and edible giblets percentages. The nitrogen content of feces and nitrogen retention were insignificantly different between curcuma longa treatment and control. Mehala and Moorthy (2008) indicated that 0.1 or 0.2% tumeric addition to control ration did not affect body weight, weight gain, feed intake, feed conversion ratio and livability. Ürüşan and Bölükbaş (2017) studied the effect of turmeric addition by 0, 2, 4, 6 ,8 ,10 g/kg showed significantly lower weight gain compared to 0, 2, 6, 10 treatments, 10 g/kg treatment was highest feed intake and 2 g/kg showed best feed conversion.

Nayaka et al. (2013) did not find a significant effect when the addition of 0.2% turmeric to the control ration on live body weight at 6 weeks or feed conversion and livability. Widodo et al. (2021) found insignificant effect of adding 1, 2, or 3% white curcuma (Curcuma zedoaria) to broiler basal diet on digestibility (i.e. dry matter, crude fat, protein biological value, and nitrogen retention). Hussein (2013) found that 7 g/kg addition of turmeric powder to the starter and finisher rations of broilers improved body weight and weight gain, feed conversion, and decreased feed intake significantly (P≤0.05). He attributed this effect to turmeric's active compounds (i.e. curcuminoids and curcumin) and it improved feed utilization efficiency leading to better growth. Turmeric's antimicrobial properties inhibited chicken pathogens. Another study conducted by Rajbit et al. (2012) on broilers used 0, 100, 150, and 200 mg/kg of turmeric.Their results showed a significantly increased body weight at 42 days of age for the 3rd and 4th treatments (i.e. 150 and 200 mg/kg) and in feed conversion for the 200 mg/kg treatment, but there was an insignificant difference in feed intake between all treatments.

Islam (2018) found that adding 0.25, 0.5, and 0.75 gm/kg turmeric to broiler rations improved body weight significantly (P≤0.05) in the 0.5 and 0.75 treatments, but there was an insignificant difference in feed consumption and feed conversion between all treatments. Wang et al. (2015) studied the effect of turmeric rhizome extract at levels of 0, 100, 200, and 300 mg/kg during 2–12 weeks of Wenchang broiler age. The results indicated that there was an insignificant difference between treatments in final body weight at 12 weeks. Control was significantly less weight gain during 9–12 weeks. Addition of 300 mg/kg showed a significant decrease in feed intake compared to other treatments in the total period of 2–12. Addition of 100 and 300 mg/kg showed better feed conversion than control. Urusan and Bolukbasi (2017) studied the effects of adding 2, 4, 6, 8, 10 g/kg of turmeric powder on broiler performance to 42 days of age and found that turmeric addition had an insignificant effect on final body weight at 42 days of age, a significant increase in weight gain, a significant decrease in feed intake in the 10 g/kg treatment, and a significant improvement in feed conversion in the 2 g/kg treatment. Hussien (2013) found that 7 g/kg turmeric addition showed a significant improvement in body weight, weight gain, feed conversion and a significant decrease in feed intake when compared to 0 and 9 g/kg treatments. Arslan et al. (2017) found that adding 1 to 1.5% turmeric powder improved body weight and weight gain (P≤ 0.05), decreased feed consumption, and improved feed conversion. Adding 0.5% turmeric improved (P≤ 0.05) body weight, weight gain, and feed conversion. Ahmed et al. (2018) found that the addition of 1 g/kg turmeric powder to broiler diets led to improvement in body weight, feed consumption, and feed conversion. Widjastuti et al. (2020) found that adding red ginger and turmeric mixture (1/1) to broiler ration decreased protein consumption, increased body weight gain, and improved protein conversion and meat protein conversion.

Choudhury et al. (2018) found that a 0.75% addition of turmeric powder in the broiler ration showed a significant increase in final body weight at 6 weeks compared to 0 and 0.25% levels but did not differ with 0.5% turmeric, and this treatment showed the best feed efficiency and broiler performance efficiency index. Olabode et al. (2018) found that adding 1.5% turmeric to broiler ration reduced significantly final body weight, weight gain, and feed intake at 42 days old. Sadeghi et al. (2012) compared the effect of replacing drinking water (control) with cinnamon, thyme, and turmeric infusions on broiler performance. The control group showed significantly better body weight at 21 days of age, which did not affect weight gain, feed intake, or feed conversion significantly, adding red ginger and turmeric mixture (1/1) to the broiler ration at 0.5 and 1.5% decreased protein consumption significantly, and that 0.5 and 1.5% treatments increased body weight gain and improved protein conversion and meat protein conversion significantly.

Carcass Characteristics

Widjastuti and Andriani (2010) did not find a significant effect of 3.5, 4.5, and 5.5% addition of Turmeric Zedora to the control diet of broiler on the percentage of abdominal fat, while significantly decreased broiler meat cholesterol in 3.5, 4.5, and 5.0% treatments. Pur-

wanti et al. (2018) did not find a significant effect of 2.5% turmeric extract addition to the basal diet on the pH, % cooking loss, tenderness, juiciness, and acceptability of broiler meat, while there was a significant decrease in water holding capacity from 22.65 to 18.88%, which was comparable to control. Negari and Nurwantoro (2014) studied the effect of administration of turmeric exctract to the broiler diet by 100, 200, 300, and 400 mg/kg of body weight on the carcass characteristics of the broiler, where they found that there was an insignificant decrease in water holding capacity, tenderness of meat, and a significant decrease in pH for the 100, 300, 400 treatments as 6.04, 6.08, and 5.98 compared to control (6.46). Ashayerizadeh et al. (2009) compared the effects of supplemented broiler ration with 0.2% prebiotic, 0.1% garlic, and 0.1% turmeric powder on the internal organs of broiler. There was an insignificant difference in heart, liver, and gizzard weight, but abdominal fat was decreased significantly in prebiotic and garlic treatments compared to turmeric and control treatments. Al-Noori et al. (2011) found that turmeric powder addition by 0.5 and 1% to the broiler ration did not affect dressing percentage, heart, liver, gizzards, or spleen percentage significantly. Singh et al. (2018) investigated 3 levels of turmeric in broiler rations (0.5, 1, and 1.5%), and he found that treatments did not affect carcass parameters such as dressing yield, giblet weight, cooking loss, pH, shear force, or proximate composition, although separable fat and meat cholesterol levels were reduced ($P \leq 0.05$) in broiler chickens fed a ration supplemented with 1.0 or 1.5% turmeric powder. The sensory qualities of the carcass were unaffected by dietary treatments. Mondal et al. (2015) found that using turmeric powder by 0.5, 1, and 1.5% in broiler chick rations increased carcass characteristics such as average weight of liver, heart, and gizzard, but the effects were not significant. In chickens fed turmeric-supplemented diets, there was a substantial decrease ($P<0.01$) in abdominal fat pad and a significant rise ($P \leq 0.05$) in dressing percentage. Al-Mashhadani (2015) did not find a significant effect by the addition of 0.2, 0.4, 0.6% in dressing percentage, breast, thigh, wing, back, neck, heart, liver, spleen, bursa of fabricius percentages. Wang et al. (2015) found that the addition of 100, 200, 300 mg/kg turmeric rhizome extract to the Wenchang chicken ration did not affect the dressing percentage, thigh weight, or percentage, while significantly increased breast muscle weight and decreasing abdominal fat percentage. Sadeghi et al. (2012) studied the effect of replacement drinking water (control) with cinnamon, thyme, and turmeric infusions on broiler performance. There was an insignificant difference in relative weight of carcass, heart, liver, pancrease, bursa, and abdominal fat, but gizzard and proventiculus in the thyme treatment were significantly heavier than others.

Blood Parameters

Riasi et al. (2012) indicated that addition of 0.5, 1, 1.5, and 2 g/kg of turmeric powder to layers' diet decreased triglycerides, total cholesterol, LDL-cholestrol, compared to control, and increased HDL-cholestrol significantly except for 2 g/kg treatments. We did not find a significant effect when we added 1 g/kg turmeric powder to the broiler ration on blood total protein, albumen, globulin, glucose, cholesterol, triglycerides, HDL, LDL, and VLDL.

Akbarian et al. (2012) found that the 0.5 g addition of turmeric powder to the diet reduced alanine aminotransferase (ALT) activity but had no effect on aspartate aminotransferase (AST) or lactate dehydrogenase (LDH) activity, or serum concentrations of low density lipoproteins (LDL), high density lipoproteins (HDL), cholesterol, or triglycerides. The addition of turmeric rhizome powder lowered serum chloride and overall electrolyte balance, but sodium and potassium concentrations remained stable. Muliani (2015) found that turmeric extract given to Arbor Acres males at 200, 300, or 400 mg/kg/day had no effect on blood cholesterol levels. Qasem et al. (2016) studied the effect of 10, 12, 14, 16, 18, 20 gm/kg of turmeric powder in the broiler ration affected significantly: serum glucose concentration (mg/dL), serum albumin concentration (g/dL), serum globulin concentration (g/dL), blood urea nitrogen (BUN), serum total bilirubin concentration (mg/dL), serum ALT enzyme activity (IU/L), serum lactic dehydrogenase concentration activity (IU/L), but serum total protein concentration (g/dL) and serum creatine kinase activity (U/L) did not differ significantly. Olabode et al. (2018) stated that addition of 1% turmeric lead to a significant decrease in packed cell volume (%), hemoglobin (g/d), red blood cell (×1012/l), white blood cell (×10 9/l) and packed cell volume (%), compared to control and 0.5, 1.5% turmeric treatments. Wang et al. (2018) found that turmeric rhizome extract increased superoxide dismutase and glutathione peroxidase enzyme activities and decreased malondiadehyde levels compared to the control group. Widhowati et al. (2017) indicated that turmeric as a feed supplement enhanced the number of heterophil and basophil cells, as well as had an immunostimulatory impact against the Avian Influenza vaccination in layer chickens. Sadeghi et al. (2012) discovered that replacing drinking water (control) with cinnamon, thyme, and turmeric infusions had no effect on hemocrit percent, but cinnamon had a significantly higher antibody titer than other treatments, implying that cinnamon significantly improved birds' immune response to the NDV vaccine.

Ramadan et al. (2021) investigated the effect of 0.5% turmeric addition to broiler ration under heat stress and discovered that turmeric addition resulted in a significant decrease in HGB, PCV, albumin, serum T3 and T4, RBCs, total protein, whereas increased H/L, triglycerides, uric acid, cholesterol, AST, ALT , LDL-cholesterol, ALP, TBIL, DBIL, and creatinine significantly.

Layers

Riasi et al. (2012) found that the addition of 1.5 and 2 g/kg tumeic powder to layers' diet at the age of 100 weeks in the second production cycle for four weeks had decreased feed intake significantly (P≤0.05). Treatment of 2 g/kg increased egg mass significantly compared to 1.5, 1, 0 g/kg treatments and improved feed conversion significantly compared to 0 and 1.5 g/kg treatments. There was an insignificant difference in egg quality traits including specific gravity, egg shell thickness (mm), egg shell weight (g), and egg shell weight/egg weight between all treatments (egg weight) between all treatments (egg weight), while yolk color improved significantly when 2 g/kg added compared to 0 and 1 g/kg. Samia et al. (2018) indicated that the addition of 6 g/kg turmeric poweder to golden Montazah layers' basal diet during 29–40 weeks of age improved significantly (P<0.01): egg number, egg weight, egg mass, decreased feed intake, improved feed conversion, increased shell weight, decreased albumin weight, while it did not affect body weight gain, yolk weight, yolk index, or shell thickness. Azouz et al. (2019) discovered that adding 0.25% turmeric powder to Sinai layers aged 59-74 weeks had no significant effect on egg number/hen, laying rate (%), egg weight (g), egg mass (g/hen), feed intake, feed conversion ratio, yolk index, yolk (%), albumen (%), shell (%), haugh unit, net return, or economic efficiency. Gumus et al. (2018) found insignificant effect of adding 0.5% turmeric powder to the basal diet on final body weight, feed consumption, feed conversion ratio, egg production, albumen index, yolk index, haugh unit, or yolk color in his study of Lohman brown layers at 30-36 weeks of age.

Chauhan et al. (2018) studied the effect of 1.5, 3, 4.5, and 6% turmeric powder inclusion in layer rations from 32–40 weeks of age and indicated that the addition of 4.5 g turmeric powder/kg feed improved the performance of birds by 53.60% as compared to the initial value of egg production (P≤0.05), but feed intake, egg weight, and egg shell quality did not differ between treatments. Malekizadeh et al. (2012) did not find a significant effect of turmeric rhizome powder (i.e. 0, 1 or 3%) on egg production, egg mass, egg weight and feed efficiency, but 1% turmeric showed a significant decrease in feed consumption compared to control (0 and 3%).

Park et al. (2012) looked at the effects of adding 0, 0.10, 0.25, or 0.50 percent to the feed of laying hens for seven weeks on egg production. They found that there was no significant difference in egg production or feed intake, but adding 0.5% increased egg weight significantly. They also found that the daily egg mass of the turmeric treatments was significantly higher than that of the control group. There was no difference in shell strength, shell thickness, or haugh unit, but the 0.5% treatment shaowed a significant increased.

Conclusion

The addition of turmeric to the broiler rations led to an improvement in the performance, and had insignificant effect on carcass traits. There were different results of adding turmeric to blood traits. Add liitle more on blood traits? Most researchers found a reduction in feed consumption when turmeric was added to egg-laying rations, while there were varied results in egg-laying and egg-specific qualities.

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