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# Turmeric on Poultry Production: A Review

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## Abstract

In the commercial poultry chain, a great diversity of production systems is found to meet the needs of the market, since the consumer has become increasingly aware of the importance of the relationship between diet and health, which has encouraged researchers and the food industry to develop products enriched with nutrients capable of producing beneficial effects on health. There has been increasing progress in research aimed at including viable alternative products, such as plant extracts, in poultry diets, which have been shown to have an antimicrobial and antioxidant action and to promote improvements in animal performance. Turmeric (*Curcuma longa* L.) is a popular medicinal herb, which shows a wide range of pharmacological properties, such as antioxidant, antiangiogenic, antitumor, antivenom, antinflammatory, antimicrobial, antiproliferative, antiprotozoal, and antiaging. The use of turmeric in poultry production has been reported by many researchers. The aim of this review is to describe and report the most recent research on the use of turmeric as feed supplement for birds and so its effect on animal health and welfare.

## Keywords

Plant Extracts, Phytogenic Additives, Curcumin, Poultry Farming

## 1. Introduction

Due to the high rates of productivity, the Brazilian poultry industry stands out in the world economic scenario. This result came through studies in the areas of health, nutrition, genetic improvement, environment and animal welfare. Among

the main causes of growth and consolidation in the poultry sector, the use of growth-promoting antibiotics (PCA) in feed intended for poultry feed stands out. Antibiotics were used in animal diets in the United States and other countries for more than 50 years and, in the absence of the disease challenge, they acted as growth promoters, improving poultry performance. However, with growing concern about the potential development of bacterial resistance to antibiotics, the European Commission, by the precautionary principle, decided to restrict and finally ban the inclusion of PCA in animal feed (EC Regulation No. 1831/2 003). With the banning of these drugs, the chicken meat production companies had to adapt, improving management and biosecurity practices, genetic selection, environmental control of facilities and changes in the composition of the diet and in the poultry feeding program [1]. In order to reduce losses in productivity, alternative additives such as exogenous enzymes, prebiotics, probiotics, synbiotics, organic acids and phytogenic compounds are constantly being studied in order to determine to what extent they can or cannot be used, and under what conditions they are viable. In view of the above, the aim of this study was to carry out a review on the use of turmeric in poultry farming.

Classified as a seasoning plant, turmeric (*Curcuma longa* L.) is a monocotilêdonea belonging to the Zingiberaceae family, popularly known in Brazil as saffron, safflower, turmeric, Indian saffron, yellow potato, golden ginger and mangrove [2]. It is a perennial shrub, native to South and South-West Asia and extensively cultivated in India, as well as in China, Japan, Burma, Indonesia, and the African continent [3]. In Brazil, the culture was introduced in the colonial period, but with production of more expressive from the 60's on, currently resulting in good productivity [4]. It consists of the rhizome, which is freshly cut and has a pleasant smell, a spicy taste and a slightly bitter taste. Its main chemical constituent is the volatile oil, composed of monoterpenes and sesquiterpenes. The main pharmacological activities attributed to this plant species are antimicrobial, anti-inflammatory, antiparasitic, antioxidant, [5] hepatoprotective, immunostimulant, and anticancer activities [6]. The quality of rhizomes is characterized and evaluated by the presence of curcumin dye and essential oils [7]. It is chemically variable and until the year 2014, about 235 compounds, mainly phenolic compounds and terpenoids, were identified [8].

## 2. Antioxidative Capacity

Plant extracts and essential oils have been reported as important sources of natural antioxidants [9] [10] [11]. Some plant sources rich in compounds with antioxidant activity have been used in the feeding of layers, in the search for improved performance of birds and quality of eggs [11]. [12] found that the inclusion in the feed of 1% of herbs—oregano (*Origanum* sp.), rosemary (*Rosmarinus officinalis* L.) or thyme (Thymus vulgaris)—or 0.5% of turmeric (*Curcuma longa* L.) can improve the productive performance of chickens, benefit the oxidative stability of eggs and reduce the oxidation of yolk lipids during storage.

Ginger has an antioxidant capacity that reduces oxidative stress, inhibiting carcinogenesis [13]. Active ingredients such as tetrahydrocurcuminoids were found in turmeric, according to studies [14]; curcumin, demethoxycurcumin, and bisdemethoxycutcumin have also been found in turmeric [15]. Some studies have been carried out to find out the effects of curcumin on the performance of broilers [16] [17] and laying hens [18] [19]. The antioxidant effect of turmeric has already been reported in the case of broilers [17]. This effect is closely related to the increase of catalase, hepatic superoxide dismutase, and glutathione peroxidase enzymes [20].

## 3. Egg Production and Quality

There were no significant differences in egg production and egg weight in egg quality [18] [21] [22] [23]. Contrary, [24] indicated that egg production increased ($P < 0.05$), but egg weight decreased insignificantly by addition of turmeric rhizome powder to laying hen diets. According to the authors, turmeric might enhance digestive tract performance in laying hens resulting in the improvement of egg production. [25] were able to observe that turmeric powder extract improved the production performance of Ac "Black bone" hens with better egg mass production and feed: egg conversion from 28 to 34 weeks of age and no change in egg mass. [19] showed that turmeric powder affected egg production significantly, but not egg weight. [12] indicated that production and mass of egg increased by addition of turmeric due to the fact that uterus media could have been improved (especially the site of calcium deposit) and result in enhanced shell weight and thickness.

Recent research has indicated that there are no differences in the internal quality of eggs from hens fed turmeric [18], [21] and [25]. However [26] reported that albumen height and egg protein significantly increased by addition of turmeric. According to [26], increase in albumen showed that active substances in turmeric powder stimulated the growth of the epithelial cells and tubular gland cells in the magnum to synthesize and secrete albumen.

The ingredients that make up the diet of laying hens directly affect the pigmentation of egg yolks [27]. Some food additives such as dried carrot flour [28], urucum [18]; [29]; [30] and canthaxanthin [27] have been used to change the color of egg yolk. Similarly, turmeric and sumac are used in food as colorants and flavorings [17]. However [21] observed that Haugh unit, and yolk color parameters were not affected by dietary supplementation de 0.5% of turmeric. [12], who reported that addition of turmeric to hen ration did not affect yolk color and Haugh unit, but it significantly increased yolk index. At the fourth week, addition of 0.5% turmeric powder increased yolk color by 17% compared with the control diet, which is in accordance with [31], who reported that the effect of dietary addition of turmeric rhizome powder is remarkable ($P < 0.05$) on yolk color rate after four weeks of study. According to the authors, enhancement of yolk color could result from the yellowish pigment of turmeric (curcuminoids,

curcumin, and its related compounds). At the sixth week, yolk color was lower about 4% in laying hens fed 0.5% turmeric compared with the control group ($P > 0.05$). On the other hand, [19] observed that yolk color increased significantly by the addition of 0.5% dietary turmeric powder. Dietary treatments contend 0.5% of turmeric do not significantly affect blood serum cholesterol, alanine aminotransferase (ALT), and aspartate aminotransferase (AST) levels [21].

## 4. Intestinal Morphology

The development of the intestinal mucosa depends on both endogenous and exogenous factors. The intestinal mucosa is continuously growing and is affected not only by metabolic hormones, but also by other food-related factors, such as physical and chemical characteristics of nutrients and intestinal microbiot [32] [33]. In a study carried out to determine the effect of the herb mixture (fenugreek and turmeric), [34] observed greater depth of crypts in birds that received the herb mixture composed of turmeric powder and fenugreek compared to birds that did not receive, indicating through the crypt depth the body's attempt to recover the villus structure. Studies with broilers have revealed that a lower vilo: crypt ratio may indicate the presence of destroyed villi and increased cell proliferation in crypts, resulting from attempts to restore damaged intestinal epithelium, in the occurrence of microbiological challenges in the intestine [35].

[36] reported that turmeric in the feed is able to prevent intestinal colonization of inoculated bacteria, indicating that 1% turmeric is able to express its antimicrobial activities, promoting an imbalance in the population of bacteria components of the microbiot and especially against inoculated bacteria.

## 5. Feed Intake and Feed Conversion Ratio

[12] reported that feed intake was 1% higher for laying hens fed turmeric-supplemented diets. Because of increased incretion of enzymes such as amylase, trypsin, chymotrypsin, and lipase, feed conversion ratio (FCR) might be improved by turmeric-supplemented diets of laying hens [17]. Moreover, the reason of feed intake increment might be due to turmeric special aroma. [17] indicated that daily feed intake increased by addition of 100 and 200 mg/kg turmeric rhizome extract to broilers; but daily feed intake decreased by addition of 300 mg/kg. These differences are consistent with the results of [37] and [24], who added 3% turmeric rhizome powder to laying hen diet. In another study [18], feed intake and FCR were reduced by addition of 2% turmeric rhizome powder to laying hen diet.

[38] used turmeric powder as a food additive and found a significant increase in the percentage of edible parts, including 0.5%, 1.0% and 1.5% of turmeric powder in the diet, respectively. However, the highest percentage of cuts was 57% [39]. The improvement in carcass weight and edible carcass weight in these experiments is attributed to the antioxidant activity of saffron, as it contains beneficial phytochemicals such as curcumin, AR-turmerones and curlone.

[40], who used 1%, 2% and 3% of turmeric inclusion as a growth promoter and observed better feed intake, weight gain and anticoccidial action in birds that received 3% turmeric. However, [21] observed that addition of 0.5% turmeric increased egg production and egg weight, but reduced the feed conversion ratio compared with the control group.

[41] reported that birds supplemented with levels of 0.2% to 0.3% of turmeric in the feed had greater weight gain. According to the studies of [42] dosages less than 2% incorporated into the feed provide the action of its active components with antioxidant activity, which would stimulate protein synthesis by the bird, the authors also reported that when supplemented the broilers with 0.5%, 1.0% and 1.5% of turmeric in the diet they had greater feed conversion.

## 6. Carcass Yield

[43], who indicated a higher percentage of dressings, as well as the weight of broiler breasts, fed a diet containing 5 g kg of turmeric powder.

[44] recorded the highest drained weight, and muscle weight of breast meat in poultry fed with diet containing 3% turmeric powder. Breast weight gain may be due to optimal antioxidant activity of turmeric (curcumin a phenolic group, thetrahydro curcumin, cinnamic acid, curlone and niacin) [25], which stimulates protein synthesis by the enzymatic system of birds [43]. Supplementing with turmeric can increase the amount of lean meat and reduce the risk of hyperlipidaemia in consumers.

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The study also reported that turmeric supplementation inhibited hepatic fatty acid synthase (HGS) activity and increased beta oxidation of fatty acids. Curcumin has been shown to specifically deregulate FAS [45], leading to an effective reduction in fat storage. However, the effect of turmeric on FAS activity is not well established [46]. According to [47], turmeric can be included as an additive in animal feed at a level of 1 and 2% in the total to obtain better and positive results in carcass yield and lean meat production (breast meat), which could reduce the risk of hyperlipidemia and increase consumer acceptability.

## 7. Biochemical Parameters/Blood Profiles

[19] and [21] reported that serum total cholesterol concentration of layers was not significantly affected by the addition of turmeric, however in a study carried out with turmeric for laying hens, it was reported that cholesterol decreased significantly [48]; the authors reported that turmeric could be useful in the man-

agement of arteriosclerosis. [49] reported that turmeric decreased lipid peroxidation due to its antioxidant effects and increased plasma vitamin E in rabbits.

Concerning plasma lipids, the use of pure curcumin at low doses in feed reduces cholesterol level in broilers [50] while the same effect of TRP is possible when it is used at high amounts, up to 1 $g \cdot kg^{-1}$ feed.

According to [51], in a study to evaluate the effect of turmeric (rhizome powder) in broilers supplemented with 0.00%, 0.25%, 0.50% and 0.75% turmeric, no difference was observed in the levels of total protein at 35 and 42 days of age. However, [52], in a study evaluating two natural dyes norbixin (20 mg) and turmeric (20 mg), observed that both caused significant reductions in total cholesterol levels, although the best results were observed in the group treated with turmeric, whose percentages of reduction were 28% at 21 days and 57% at 28 days of age.

## 8. Conclusion

Many studies have been carried out with the inclusion of turmeric powder in the diet of broilers and laying hens, however the results have been quite different. The variation of results obtained in studies with long turmeric in broiler performance can be explained by the variability in the amount of phytochemicals in the plant, since factors such as the age and stage of development of the plant, as well as the time when the harvest was performed, temperature, water availability, UV radiation, soil nutrients, altitude and atmospheric composition directly influence the relative proportions of these compounds in the plant.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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