

# Turmeric (*Curcuma longa*): an alternative to antibiotics in poultry nutrition

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## Abstract

Turmeric, a common spice in many countries has been used for centuries in traditional medicine for its antimicrobial properties. Recent research has shown that turmeric can be a viable alternative to antibiotics in poultry production. Antibiotic overuse in poultry has led to the development of antibiotic-resistant bacteria, which poses a threat to both animal and human health. Turmeric contains curcumin, a compound that has been shown to have antimicrobial activity against a wide range of bacteria, including those resistant to antibiotics. In addition, turmeric has anti-inflammatory and immunomodulatory properties, which can help boost the immune system of poultry and reduce the need for antibiotics. Studies have shown that turmeric can improve growth performance, and gut health, and reduce the incidence of disease in poultry. Therefore, the use of turmeric as an alternative to antibiotics in poultry production has the potential to not only improve animal health and welfare but also contribute to the fight against antibiotic resistance. This review aims to provide an overview of the recent knowledge on the use of these plant extracts in poultry feeds as feed additives and their effects on poultry performance.

## Lay Summary

Continuous antibiotics in poultry production are no longer desirable because of the resultant effects on animal and human health. Prolonged use of antibiotics either as growth promoters or for managing bacterial diseases has led to antimicrobial resistance strains which has also necessitated the need for safer and readily available alternatives. Many organic products have been identified and tested in poultry production and among them is turmeric. The active component of turmeric is known as curcumin which has been shown to have a broad-spectrum antibacterial property. It can also assist in enhancing the immune system of poultry. Turmeric also possesses anti-inflammatory properties. It has been confirmed through studies that it can enhance feed intake, improve growth rate and gut health of poultry and therefore, turmeric is a very good organic product that can easily replace the use of antibiotics in poultry production hence this review work is showcasing an overview of the recent knowledge on importance of turmeric as feed additive.

**Key words:** antibiotics, health, immunity, nutrition, poultry, turmeric

## Introduction

Overuse of antibiotics in poultry production has led to the emergence of antibiotic-resistant bacteria, which poses a threat to both animal and human health. Therefore, there is a growing interest in finding alternatives to antibiotics that can promote animal health and welfare without contributing to the development of antibiotic resistance (Aderemi et al., 2017; Reulas et al., 2023; Soisuwan et al., 2023). Many spices and foliar meals of plant origin have been reported to have positive effects on the performance and health status of egg and meat-type chickens (Aderemi et al., 2018; Alabi Olufemi et al., 2021; Lim et al., 2023; Ramachandraiah and Hong, 2022; Ruelas et al., 2023). Turmeric, a commonly used spice in many cultures, has been found to have potential as an alternative to antibiotics in poultry production due to its antimicrobial, anti-inflammatory, and immunomodulatory properties (Lagua and Ampode, 2021).

Turmeric (*Curcuma longa*) is a perennial herbaceous plant belonging to the *Zingiberaceae* family, widely used as a spice and traditional medicine in many countries, in-

cluding India, China, and Southeast Asia. Turmeric contains several bioactive compounds, such as curcuminoids, volatile oils, and polysaccharides, which have been shown to have various health benefits, including hypocholesterolemic and hepatoprotective effects. Turmeric contains curcumin, a compound that has been shown to have antimicrobial activity against a wide range of bacteria, including those resistant to antibiotics (Kim et al., 2013). In addition, curcumin has been shown to have anti-inflammatory properties, which can help reduce inflammation in the gut and improve gut health in poultry. Furthermore, turmeric has been found to have immunomodulatory effects, which can help boost the immune system of poultry and reduce the need for antibiotics (Akbarian et al., 2016).

Studies have shown that turmeric can improve growth performance, and feed efficiency, and reduce the incidence of disease in poultry (Ürüsan and Bölükbaşı (2017) Sayed et al., 2023). In a study conducted by Ürüsan and Bölükbaşı (2017), using turmeric extract as a feed additive improved broiler chickens' growth performance and gut health. In another study, Sayed et al. (2023) found that the use of turmeric

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powder in feed reduced the incidence of necrotic enteritis in broiler chickens.

This review work therefore aims at showing the antibiotic properties of turmeric and its usefulness in poultry nutrition as may be reflected in improved laying abilities of egg-type chickens; also, its effect on blood cholesterol regulations, effect on immune system of chickens, anti-inflammatory effect, antioxidant, anti-stimulant, and anticancer properties which are all desirable.

### Effect on Performance of Broiler

Curcumin, also known as diferuloylmethane ( $C_{21}H_{20}O_6$ ), is a hydrophobic polyphenolic phytochemical present in the rhizomes of the turmeric (*Curcuma* spp.) belonging to the family of *Zingiberaceae* which is commonly found in Asian countries. which has been found to have a range of health benefits, including anti-inflammatory, antioxidant, and antimicrobial properties. Recently, there has been increasing interest in using turmeric as a feed additive in the poultry industry to improve the performance of broiler chickens as reported by [Sureshbabu et al. \(2023\)](#).

Several studies have investigated the effects of turmeric on the performance of broilers, with promising results. For example, a study conducted by [Wang et al. \(2015\)](#) found that the inclusion of turmeric powder in the diet of broiler chickens improved their growth rate, feed conversion ratio, and carcass traits. [Xie et al. \(2019\)](#) reported that dietary curcumin supplementation significantly improved body weight gain and feed conversion ratio in broilers. Similar findings were observed by [Zhang et al. \(2018\)](#), who reported enhanced growth performance parameters with curcumin supplementation. In another study by [Abd El-Hack et al. \(2020\)](#) it was reported that the addition of turmeric powder to the diet of broiler chickens resulted in improved feed intake, weight gain, and feed conversion ratio. Curcumin supplementation reduces absolute and abdominal fat weights by regulating lipid metabolism in broiler chickens [Xie et al. \(2019\)](#). [Liu et al. \(2020\)](#) reported improved color stability and reduced lipid oxidation in broiler breast meat with curcumin supplementation. These results highlight the potential of curcumin to enhance meat quality parameters, thus contributing to the market value of broiler products.

The positive effects of turmeric on the performance of broilers have been attributed to its ability to improve nutrient absorption and utilization, enhance immune function, and reduce oxidative stress. Curcumin has been shown to improve the activity of digestive enzymes in the gut, which can lead to better nutrient absorption and utilization. Additionally, curcumin has been found to have immunomodulatory effects, which can enhance the immune response of broilers and help to prevent infections. Finally, curcumin has been shown to have antioxidant properties, which can reduce oxidative stress and improve overall health [Scazzocchio et al. \(2020\)](#).

Furthermore, the use of turmeric as a feed additive in the poultry industry has shown promise for improving the performance of broiler chickens. Studies have demonstrated that the inclusion of turmeric powder in the diet of broilers can lead to improved growth rates, feed conversion ratios, and carcass traits. These effects are likely due to the ability of curcumin to improve nutrient absorption and utilization, enhance immune function, and reduce oxidative stress ([Ahmadi, 2010](#); [Abou-Elkhair, 2014](#)).

### Effect on Laying Birds

Curcumin in turmeric has been reported to possess various pharmacological activities, including anti-inflammatory, antioxidant, and anticancer effects. Recent studies have also investigated the potential use of curcumin as a feed additive in laying birds to improve their productivity and health ([Zacaria and Ampode, 2021](#); [Samantaray et al., 2022](#)).

One study conducted by [Singh et al. \(2019\)](#) investigated the effects of black cumin garlic and turmeric supplementation on egg production, egg quality, and antioxidant capacity in laying hens. It was reported that the supplementation significantly increased egg production, weight, and shell thickness while reducing cholesterol levels. In addition, curcumin supplementation increased the antioxidant capacity of the hens, as evidenced by increased levels of superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) in the serum. [Kosti et al. \(2020\)](#) evaluated the effects of curcumin on the gut microbiota of laying hens. The study found that curcumin supplementation significantly altered the composition of the gut microbiota in the hens, increasing the abundance of beneficial bacteria such as *Lactobacillus* and *Bifidobacterium*, while decreasing the abundance of harmful bacteria such as *Escherichia coli* and *Salmonella*. [Galli et al. \(2020\)](#) demonstrated curcumin (30 and 50 mg/kg) alone can reduce lipid peroxidation and increase the antioxidant level in eggs of laying hens or curcumin combined with microencapsulated phytochemicals (carvacrol, thymol, and cinnamaldehyde improve the growth, flesh quality, and unsaturated fatty acids in broiler chicks). Supplementing turmeric in the poultry diet at a 1% to 5% concentration improves feed intake and significantly lowers cholesterol in poultry products. In laying hens, dietary supplementation of turmeric at 1% and 4% reduced eggs' cholesterol by 16% and 25%, respectively, [Kosti et al. \(2020\)](#). Compared to a control group, birds fed a high carbohydrate content supplemented with turmeric for a month before sexual maturity produced higher eggs (20%). It stimulates bile production, which is necessary for lipid emulsification. It was also reported to improve liver function and vitellogenin production. It enhances liver function by reducing serum levels of glutamic pyruvic transaminase/alanine aminotransferase and glutamic oxaloacetic transaminase/aspartate aminotransferase [Kosti et al. \(2020\)](#).

Additionally, it was found that curcumin supplementation significantly increased the expression of immune-related genes in the hens, as well as their resistance to infection with *Salmonella enteritidis*. Overall, these studies suggest that curcumin has the potential to improve egg production, egg quality, antioxidant capacity, gut health, and disease resistance in laying birds. However, further research is needed to determine the optimal dosage and duration of curcumin supplementation and its long-term effects on bird health and productivity.

### Hypocholesterolemic and Hepatoprotective Actions

In poultry, high levels of cholesterol and liver damage are common problems that can affect the birds' health and productivity. Several studies have investigated the potential of turmeric to improve cholesterol levels and protect the liver in poultry.

A study conducted by [Mondal et al. \(2015\)](#) investigated the effects of dietary supplementation with turmeric on the serum lipid profile and liver function of broiler chickens. The

study showed that turmeric supplementation significantly reduced the serum levels of total cholesterol, triglycerides, and low-density lipoprotein cholesterol while increasing the levels of high-density lipoprotein cholesterol. In addition, turmeric supplementation improved liver function parameters, such as serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels.

Another study by [Fan et al. \(2021\)](#) evaluated the hepatoprotective effects of turmeric polysaccharides in broiler chickens exposed to aflatoxin B1 (AFB1), a toxic fungal metabolite that can cause liver damage. The study showed that dietary supplementation with turmeric polysaccharides significantly reduced AFB1-induced liver damage and oxidative stress in the birds. The researchers attributed these effects to the antioxidant and anti-inflammatory properties of turmeric polysaccharides. Similarly, a study by [Rahmani et al. \(2018\)](#) investigated the hepatoprotective effects of curcumin, the main active compound in turmeric, in broiler chickens exposed to lipopolysaccharide (LPS), a bacterial endotoxin that can cause liver damage. The study showed that curcumin supplementation significantly reduced LPS-induced liver damage and inflammation in the birds. The researchers suggested that curcumin exerts its hepatoprotective effects by modulating the expression of genes involved in inflammation and oxidative stress.

Additionally, turmeric has been shown to have hypocholesterolemic and hepatoprotective effects in poultry. These effects are likely due to the presence of bioactive compounds, such as curcuminoids and polysaccharides, that have antioxidant, anti-inflammatory, and hepatoprotective properties ([Laganá et al., 2019](#); [Al-Otaibi et al., 2022](#)). Therefore, the inclusion of turmeric or its extracts in poultry feed may be a potential strategy to improve the birds' health and productivity.

### Antibacterial and Immunomodulating Effects

Curcumin, a natural polyphenolic compound found in turmeric, has been studied for its antibacterial and immunomodulating effects in poultry. Curcumin, a bioactive compound found in turmeric, has been extensively studied for its potential health benefits in both humans and animals. Among its various effects, curcumin has been shown to possess antibacterial and immunomodulating properties in poultry.

In terms of antibacterial effects, curcumin has been found to inhibit the growth of various bacterial strains, including *Salmonella* and *E. coli* in poultry. In a study by [Hafez et al. \(2022\)](#), it was reported that dietary supplementation of curcumin at a concentration of 100 mg/kg significantly reduced the growth of *Salmonella enteritidis* in broiler chickens. Similarly, in another study curcumin was found to inhibit the growth of *E. coli* in vitro and in vivo in broiler chickens.

In addition to its antibacterial effects, curcumin has also been shown to modulate the immune system in poultry. For instance, curcumin has been found to enhance the production of cytokines, which are signaling molecules that play a crucial role in the regulation of immune responses. In a study, it was reported that dietary supplementation of curcumin at a concentration of 100 mg/kg significantly increased the production of interleukin-2 (IL-2) and interferon-gamma (IFN- $\gamma$ ) in broiler chickens. These cytokines are known to enhance cellular immunity and promote the activation of immune cells.

*Curcuma longa* has been widely used in the poultry industry as an anticoccidial, anti-inflammatory, immunomodulatory, antimicrobial, antioxidant, and to promote growth performance ([Paolino et al., 2016](#)).

Furthermore, curcumin has also been found to modulate the expression of genes involved in the immune response. In a study by [Upadhaya et al. \(2016\)](#), it was reported that dietary supplementation of curcumin at a concentration of 200 mg/kg upregulated the expression of genes involved in the toll-like receptor signaling pathway in broiler chickens. This pathway plays a crucial role in the recognition of pathogenic microorganisms and the activation of immune responses.

Overall, the antibacterial and immunomodulating effects of curcumin make it a promising dietary supplement for improving the health and performance of poultry. However, further research is needed to determine the optimal dosage and duration of curcumin supplementation in poultry.

### Antimicrobial and Anti-inflammatory Effects

Turmeric is a well-known spice that has been used for its medicinal properties for centuries. It contains a bioactive compound called curcumin, which has been found to have a range of health benefits, including anti-inflammatory, antioxidant, and antimicrobial properties. Recently, there has been increasing interest in using turmeric as a feed additive in the poultry industry to improve the performance of broiler chickens.

Several studies have investigated the effects of turmeric on the performance of broilers, with promising results. For example, a study conducted by [Wang et al. \(2015\)](#) found that the inclusion of turmeric powder in the diet of broiler chickens improved their growth rate, feed conversion ratio, and carcass traits. Similarly, another study by [Abd El-Hack et al. \(2020\)](#) reported that the addition of turmeric powder to the diet of broiler chickens resulted in improved feed intake, weight gain, and feed conversion ratio.

The positive effects of turmeric on the performance of broilers have been attributed to its ability to improve nutrient absorption and utilization, enhance immune function, and reduce oxidative stress. Curcumin has been shown to improve the activity of digestive enzymes in the gut, which can lead to better nutrient absorption and utilization. Additionally, curcumin has been found to have immunomodulatory effects, which can enhance the immune response of broilers and help to prevent infections. However, it was reported that curcumin's active compound in turmeric still has a deficiency related to its minimal systemic bioavailability (absorption) in digestion in other words its poor aqueous solubility and intestinal permeability according to [Paolino et al. \(2016\)](#). The researcher, therefore, suggested that other compounds need to be added to turmeric extract to optimize the function of curcumin. The researcher went further to show that adding the compounds chitosan and sodium tripolyphosphate (STPP) is known to be able to cover the weaknesses of curcumin in the digestion process. Chitosan functions to improve the solubility and bioavailability of curcumin, while STPP acts to stabilize turmeric extract and chitosan by performing as a cross-linker. Finally, curcumin has been shown to have antioxidant properties, which can reduce oxidative stress and improve overall health. In conclusion, the use of turmeric as a feed additive in the poultry industry has shown promise for improving the performance of broiler chickens. Studies have demonstrated that the inclusion of turmeric powder in the diet of broilers can lead

to improved growth rates, feed conversion ratios, and carcass traits. These effects are likely due to the ability of curcumin to improve nutrient absorption and utilization, enhance immune function, and reduce oxidative stress.

### Antiparasitic and Antioxidant Actions

Turmeric (*Curcuma longa*) is a widely used spice that has been reported to possess various pharmacological properties including antiparasitic and antioxidant effects. In poultry production, turmeric has gained attention as a natural alternative to synthetic drugs for the prevention and treatment of parasitic infections. This is particularly important in the context of increasing concerns about the development of drug resistance among parasites.

The antiparasitic effect of turmeric has been demonstrated in several studies. For instance, a study by Khan et al. (2012) investigated the efficacy of turmeric in the prevention of coccidiosis in broiler chickens. The study reported that dietary supplementation of turmeric significantly reduced the oocyst count in the feces of infected birds, indicating a reduction in the severity of the infection. Another study by Kim et al. (2013) investigated the efficacy of turmeric in the treatment of experimentally induced *Eimeria tenella* infection in broiler chickens. The study reported that turmeric supplementation significantly reduced the mortality rate, improved the feed conversion ratio, and reduced the histopathological lesions in the infected birds. A study conducted by Jin et al. (2021) investigated the effect of dietary curcumin supplementation on the antioxidant capacity and meat quality of duck. The researchers found that curcumin supplementation increased the total antioxidant capacity and reduced lipid peroxidation in the breast muscle of broiler chickens, which improved the meat quality. Badran (2020) examined the effects of curcumin on the growth performance, immune response, and intestinal health of broiler chickens. The researcher found that dietary curcumin supplementation improved the growth performance and immune response of broiler chickens and reduced the incidence of intestinal inflammation. Scazzocchio et al. (2020) in understanding the health effect of curcumin made an assertion that curcumin supplementation improved the antioxidant status and meat quality of laying hens by reducing lipid peroxidation and improving the total antioxidant capacity. This study showed that curcumin supplementation improved growth performance and immune function in broiler chickens challenged with *Escherichia coli* K88, a common bacterial pathogen in poultry.

### Effects on Gastrointestinal Tract

Curcumin, a natural polyphenol extracted from the turmeric plant, has been reported to possess anticancer properties via its immunomodulatory potency (Sureshbabu et al., 2023). Below are some references that provide evidence of the immunostimulant and anticancer effects of curcumin in poultry. Huang and Lee (2018) investigated the immunomodulatory effects of curcumin in chickens infected with avian coccidiosis, a protozoal disease that causes enteritis. The results showed that curcumin treatment improved immune responses and reduced the severity of the infection. However, another study reported curcumin supplementation did not completely mitigate the negative effects of coccidiosis on growth performance but improved the capacity against *Eimeria* infection by increasing antioxidant activities, mostly GSH synthesis to scavenge reactive oxygen species, decreasing lesion score

of the ceca when included at 200 mg/kg and significantly decreasing oocyst shedding of *E. maxima*, as well as *E. tenella* to some extent (Yadav et al., 2020).

While Dai et al. (2022) in a write-up on curcumin as an antibacterial agent; current achievements and problems reported that nanoformulation of curcumin improved immune responses, reduced inflammation, and improved gut health in the chickens.

In another, study the anticancer effects of curcumin in chickens infected with the chicken leukemia virus were evaluated. The results showed that curcumin treatment inhibited the growth of chicken leukemia virus-induced lymphomas and improved the survival rate of the infected chicken (Xie et al., 2019).

Curcumin was found to modulate the cecal microbiota, leading to a reduction in harmful bacteria and an increase in beneficial bacteria. This study showed that curcumin supplementation reduced hepatic lipids and serum cholesterol levels in chickens. This effect is important for poultry health, as high cholesterol levels can lead to fatty liver disease and other metabolic disorders. Coles et al. (2023), however, suggested the use of curcumin in combination with essential oils to promote the health status of broiler chicken.

### Conclusion

This review article summarizes the various pharmacological properties of curcumin in veterinary medicine, including antibacterial, and immunomodulating effects. The authors suggest that curcumin could be a useful natural alternative to antibiotics in poultry production. Curcumin has potential as a dietary supplement for improving the health and meat quality of poultry. Although phytochemical feed additives have been perceived as relatively low risk compared with synthetic growth promoters, even when a product or compound is natural, it is not necessarily safer than other products, and it can equally produce toxicity or other adverse effects needed for better understanding of the mechanisms and optimal dosages of curcumin supplementation for poultry, the mode of administration for maximum efficacy as well as its potential side effects.

Therefore, the use of turmeric as an alternative to antibiotics in poultry production has the potential to not only improve animal health and welfare but also contribute to the fight against antibiotic resistance.

### Conflict of interest statement

The authors report that there are no competing interests to declare.

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