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REVIEW ARTICLE
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Herbal Medicine: A Natural Alternative Treatment of Avian Coccidiosis

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ABSTRACT

This review explores the increasing interest in using herbal medicine to treat avian coccidiosis, either in addition to or instead of traditional treatments. In the chicken industry, coccidiosis results in large financial losses because it impairs development, makes it more difficult for nutrients to be absorbed, and raises mortality. Despite the efficacy of traditional anticoccidial drugs, research into herbal medicine as a safer and more natural alternative has been spurred by consumer demand for organic products, drug resistance, and environmental consequences. Many natural herbs were found to treat coccidiosis, the most recent studies on garlic (*Allium sativum*), ginger (*Zingiber officinale*), and turmeric (*Curcuma longa*), which include immunomodulatory, antibacterial, antioxidant, and anti-inflammatory qualities, were assessed in this review. Studies have shown that garlic supplements can improve avian health and reduce coccidiosis symptoms without having major negative consequences. Ginger reduces the severity of coccidiosis by boosting gut health, reducing parasite growth, and fortifying the immune system. It also reduces oxidative damage and intestinal lesions caused by Eimeria infections. Curcumin, the key ingredient in turmeric, has anti-inflammatory and antioxidant properties that reduce intestinal lesions, stop Eimeria from growing, improve gut health in general, and boost nutrition metabolism and weight gain in poultry. Combining these herbs may help them work in concert to address various aspects of coccidiosis control. More studies are required to improve their use in poultry diets to maximize their therapeutic potential and minimize side effects.

Keywords: Coccidiosis, Herbal medicine, Garlic, Ginger, Turmeric, Poultry.

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INTRODUCTION

Avian coccidiosis, a common health issue in the poultry industry that gradually causes chronic harm, is caused by a number of Eimeria parasites (Hansen et al., 2021). These deficits can cause symptoms including dehydration, intestinal bleeding, decreased skin pigmentation, and increased susceptibility to numerous diseases by interfering with the nutritional process, digestive processes, and nutrient absorption (Hafeez et al., 2020). Significant economic losses can result from coccidiosis in a number of ways, including lower growth rates, decreased feed conversion efficiency, poor absorption of digestible minerals, and high mortality rates (Muthamilselvan et al., 2016; Gómez-Osorio et al., 2021). The chicken industry spends between £7.7 to £13.0 billion a year on avian coccidiosis vaccination, treatment, and productivity losses, according to Blake et al. (2020). These losses are caused by seven species of Eimeria, which are known to be detrimental to chickens. They infect different sections of the intestines and have varying degrees of virulence (Yu and Heo, 2021; Adjei-Mensah and Atuahene, 2023). The species of Eimeria are *Eimeria brunetti*, *Eimeria praecox*, *Eimeria acervulina*, *Eimeria mitis*, *Eimeria necatrix*, *Eimeria tenella*, and *Eimeria maxima*.

Coccidiosis has been managed with various anti-coccidiosis medications, including coccidiostats and ionophores (Lee et al., 2022). Concerns regarding drug resistance, environmental effects, poultry ionophore toxicity, the recent "no antibiotics ever" movement in response to growing consumer demands to limit the use of antibiotics in poultry and consumer preference for organic egg and meat products have all been raised by the widespread and prolonged use of anti-coccidiosis

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medications (Abbas et al., 2011, 2012; Lillehoj et al., 2018; Raza et al., 2024). Alternative therapy approaches are becoming more popular as a result of these worries (Lillehoj et al., 2018; Tonda et al., 2018; Abbas et al., 2020, 2023; Rani et al., 2021; Mohsin et al., 2021a, b; Mustafa et al., 2024; Hussain et al., 2024; Raza et al., 2024; Ali et al., 2025).

Herbal therapy has demonstrated significant potential in the treatment and prevention of coccidiosis in chicken (Zaman et al., 2012; Khater et al., 2020; Alsayeqh and Abbas, 2023; Javanmiri et al., 2024; Mohsin et al., 2024; Shahininejad et al., 2024). More than 1200 plants have been revealed to possess antiprotozoal properties (Muthamilselvan et al., 2016). Natural compounds have been used in chicken feed to alter the formation of the oocyst's wall or eradicate sporozoites, with promising outcomes in terms of parasite control (Fatemi et al., 2015).

Recent studies have shown that hens can be protected and treated against artificially produced coccidiosis using phytogenic extracts (Abbas et al., 2020, 2023; Mohsin et al., 2021b). These extracts boost productivity and overall performance while having a direct and indirect effect on parasites through their beneficial effects, which include immunomodulation, antioxidative, and anti-inflammatory processes to guard against coccidian (Pop et al., 2019).

Interest in employing herbal products as safe substitutes to treat a variety of disorders with a decreased chance of acquiring resistance has grown throughout the last ten years (Abd El-Hack et al., 2020a, c; Ashour et al., 2020; Raza et al., 2024). Poultry diets are supplemented with certain herbal remedies to boost the natural immune system and encourage growth (Hafeez et al., 2020; Qureshi, 2021). Additionally, the antibacterial, antioxidant, and anti-parasitic qualities of herbal medical supplements have led to their use (Rony et al., 2021; Elmahallawy et al., 2022; Jamil et al., 2022; Rizwan et al., 2022).

Recent studies on popular herbal treatments for chicken coccidiosis, including those involving garlic (*Allium sativum*), ginger (*Zingiber officinale*), and turmeric (*Curcuma longa*) will be highlighted in this review. It will highlight how these treatments function, offer proof for study results, and go over how they could aid in the management of coccidiosis.

Herbal Medicine: A Natural Alternative

Overview of Herbal Treatments

Compounds derived from plants are used in phytotherapy, also referred to as herbal medicine, to treat a variety of diseases and conditions (Rehman et al., 2023; Jamil et al., 2024; Wang et al., 2024). Many plants include bioactive compounds called alkaloids, flavonoids, and tannins that have antibacterial, anti-inflammatory, and immunomodulatory properties (Nahed et al., 2022; Rizwan et al., 2022). Recent years have seen an increase in the usage of herbal therapies to treat coccidiosis in poultry, either in place of or in addition to conventional medications (Wang et al., 2024).

Among other elements of animal performance, feed producers discovered that herbs enhanced body weight, feed conversion ratio, and meat quality (Yang et al., 2015). Later, researchers found that the beneficial effects of herbs were caused by their antibacterial, antiviral, antifungal, antioxidant, and anti-inflammatory properties (Idris et al., 2017; de Andrade et al., 2022). As extraction techniques and active ingredients have improved, there is more research being done on substituting phytogenic extracts or chemicals for antibiotics in animal diets (Wang et al., 2024).

Commonly used Herbs to Treat Coccidiosis

The most common herbs used to treat coccidiosis—garlic (*Allium sativum*), ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*)—as well as the way their extracts work to cure coccidiosis in chicken will be covered in detail in this review.

Garlic (*Allium sativum*)

Garlic has long been known to have broad-spectrum antibacterial properties, and investigations conducted both *in vitro* and *in vivo* have demonstrated that it can stop the growth of Eimeria species (Elmahallawy et al., 2022). The most common bioactive ingredient believed to provide garlic its medicinal properties is allicin, a sulfur-containing compound that is created when garlic is chopped or crushed (Adjei-Mensah et al., 2022).

Several processed extract forms of garlic have been the subject of several *in vitro* and *in vivo* studies. Garlic products include things like essential oil, aqueous garlic extract, powder and other commercial goods (Adjei-Mensah and Atuahene, 2023). These garlic products may be derivatives of one or more garlic components. The *in vitro* and *in vivo* effect of garlic products on *Eimeria* spp. are compiled in Table 1.

Table 1: Garlic processed forms *in vitro* and *in vivo* and their effects on *Eimeria* spp.*

Garlic Type (Dosage)	Specific functions	Effects on *Eimeria* spp.	Literature
Garlic powder (0.8-10g/L *in vitro*)	Antioxidant, anti-inflammatory properties	Reduce sporulation of oocysts	Dese et al. (2018); Waqas et al. (2018); Ali et al. (2019)
Aqueous extract (2.5-10mL/L *in vitro*)	Antioxidant, alter cytoplasmic membrane's permeability	Inhibit sporulation of oocysts, antimicrobial agent	Jang et al. (2018); Waqas et al. (2018); Liu et al. (2021)
Essential oil (5.0-100µg/mL *in vitro*)	Antiviral, anti-inflammatory properties	Inhibit sporulation of oocysts in vitro	Sidiropoulou et al. (2020); Ezeorba et al. (2022)
Essential oil (2.0-10mL/L *in vivo*)	Immunomodulatory and anti-proliferative properties	Reduce the number of oocytes in vivo	Chang et al. (2021)
Herbal formula (10mL /L *in vivo*)	Anti-aging, antioxidant and anti-fungal properties	Increase oocytes output	Pop et al. (2019)
Methanol garlic extract (2-4g/kg *in vivo*)	Antioxidant, alter cytoplasmic membrane's permeability	Inhibit sporulation of oocysts	Jang et al. (2018); Waqas et al. (2018)
Garlic tincture (100ppm *in vivo*)	Antioxidant, anti-bacterial properties and stimulate the cytokines production	Decrease oocytes output	Kumar et al. (2022)

* Adapted from Adjei-Mensah & Atuahene (2023).

By weakening the parasite's cell membrane, allicin stops coccidians from proliferating and maturing. By blocking the parasite's ability to adhere to and penetrate the host's intestinal epithelium, it ends its life cycle. Garlic also improves digestion, boosts immunity and reduces oxidative stress, all of which can aid in the recovery of chickens suffering from coccidian (Dese et al., 2018).

Numerous research has examined the efficacy of garlic in treating and preventing chicken coccidiosis. Chang et al. (2021) investigated the effects of natural garlic essential oil on the proliferation of Eimeria oocysts. The results showed that, in comparison to the infected group, the number of oocysts, cecal lesions, and clinical symptoms could be significantly reduced by continuously administering different quantities of natural garlic essential oil. But it could also effectively improve digestive processes and increase the weight of sick chickens (Chang et al., 2021). Garlic extract inhibited *Eimeria tenella in vivo*, according to earlier studies (Jang et al., 2018; Waqas et al., 2018). According to the study, garlic extract can reduce the quantity of oocysts in fecal samples and improve the overall health of sick hens.

In a field trial, Dese et al. (2018) fed garlic powder to commercial poultry as part of a complete coccidiosis management plan. The study found that supplementing garlic reduced the incidence of coccidiosis and improved overall bird health, including improved growth performance and feed efficiency. The use of garlic was well received by the birds, who displayed no signs of toxicity or adverse effects. Garlic was added to broiler chicken feed, according to research by Atuahene et al. (2018). The results demonstrated improved gut health and immunity as well as a significant reduction in the clinical manifestations of coccidiosis, including diarrhea and bloody stools.

By increasing the production of lymphocytes and macrophages, which are critical in the fight against parasitic diseases, garlic has been shown to strengthen the immune response in hens (Ezeorba et al., 2022). Garlic can help the bird build a successful immune response against Eimeria by increasing the production of cytokines, which facilitate communication between immune cells (Kumar et al., 2022).

Although garlic is generally regarded as safe for poultry, it is important to use the proper doses to avoid any negative effects. Liver enzyme levels in the blood are measured to detect liver damage and infections. It is well known that eating too much garlic might damage a woman's liver (Adjei-Mensah et al., 2022). Excessive garlic consumption can lead to gastrointestinal irritation and, in extreme cases, poisoning. Depending on whether the garlic is powdered, dried, or fresh, the recommended dosage in chicken diets varies from 0.5 to 2%. Ali et al. (2019) introduced 0.5% garlic into the diet. These dosages are effective without causing negative side effects. Garlic should be added to the birds' diet gradually to prevent upset stomachs and keep an eye out for adverse reactions (Ali et al., 2019).

Ginger (*Zingiber officinale*)

Ginger is another herb that has several therapeutic uses (Bodagh et al., 2019; Aljedaie and Al-Malki, 2020). It contains compounds with antibacterial, antioxidant and anti-inflammatory properties, as gingerol and shogaol (Raza et al., 2016). Its potential use in chicken health, particularly in the treatment of coccidiosis, is therefore gaining attention (Rehman et al., 2018). Ginger extracts have been shown to improve gut health, increase immunity, and directly stop Eimeria from growing, which may reduce the severity of coccidiosis (Raza et al., 2016).

Numerous studies have examined ginger's antimicrobial properties (Bodagh et al., 2019). Its two most powerful ingredients, shogaol and gingerol, interfere with the cellular integrity of parasites (Li et al., 2019). *In vitro* studies have shown that ginger extract can directly stop the generation of Eimeria oocysts, reducing the overall parasite load in afflicted birds (Abd El-Hack et al., 2020b).

Ginger has been shown to inhibit the production of cytokines and pro-inflammatory enzymes such as cyclooxygenase-2 and lipoxygenase (Pázmándi et al., 2024). The bioactive ingredients in ginger help to neutralize free radicals and reduce oxidative stress, two key elements in the pathophysiology of coccidiosis (Ley-Martínez et al., 2022). Furthermore, it has been demonstrated to enhance immunological function by encouraging the production of white blood cells and antibodies, which fortifies the host's resistance to parasite infections (Pázmándi et al., 2024).

Coccidiosis results in intestinal tissue damage, poor nutrient absorption, and loss of gut integrity. By inhibiting the production of pro-inflammatory cytokines and enzymes, gingerol helps control the inflammatory response (Morvaridzadeh et al., 2020). Ginger also reduces intestinal lesions and tissue damage from an Eimeria infection. It improves intestinal health and aids in the recovery and general performance of sick chickens (Raza et al., 2016).

Reactive oxygen species (ROS) are increased by Eimeria infection, causing damage to cells and tissues (Bischoff-Kont & Fürst, 2021; Ley-Martínez et al., 2022). The strong antioxidant properties of ginger, which scavenge free radicals, mitigate oxidative damage in the intestines. Recent studies (Pázmándi et al., 2024; Velayati et al., 2024) highlighted the potential of ginger in modulating immune responses and counteracting reactive oxygen species (ROS). Pázmándi et al. (2024) emphasized that ginger's bioactive compounds exhibit strong antioxidant properties by activating the Nrf2 signaling pathway. This activation leads to the upregulation of antioxidant enzymes like superoxide dismutase, catalase, and glutathione peroxidase, which play crucial roles in neutralizing ROS and maintaining cellular redox balance (Pázmándi et al., 2024).

Ginger has been shown to enhance immunological function by increasing the production of neutrophils, lymphocytes, and macrophages—all vital components of the immune system (Abd El-Hack et al., 2020b). Additionally, ginger's anti-inflammatory effects are mediated through the inhibition of the NF-κB (nuclear factor kappa B) pathway, resulting in decreased

production of pro-inflammatory cytokines like tumor necrosis factor (TNF), interleukin (IL)-6 and IL-1ß, thereby reducing oxidative stress and inflammation (Velayati et al., 2024).

Tufarelli et al. (2015) investigated the anticoccidial effect of ginger essential oil on the development of Eimeria oocysts. They found that ginger essential oil significantly inhibited the sporulation of Eimeria oocysts by preventing them from developing into infectious stages, hence reducing the transmission of parasites in chicken flocks. In *in vitro* study, Kousar et al. (2024) found the same results. Ginger extract suppressed oocyst sporulation in a dose-dependent manner, suggesting that ginger could help reduce the environmental viability of the parasite (Kousar et al., 2024).

In an *in vivo* investigation, Shewita and Taha (2018) examined the effects of ginger powder on hens infected with Eimeria. They found that giving diseased chickens ginger supplements significantly reduced the severity of coccidiosis, as seen by fewer intestinal lesions, less oocyst shedding, and increased weight gain. Furthermore, ginger-treated pigeons showed higher white blood cell and serum immunoglobulin counts, suggesting enhanced immunity and improved feed conversion ratios (Aljedaie and Al-Malki, 2020). When administered *Z. officinale* herbal extracts, birds exhibited reduced oocyst formation, improved cecum histology, and a lower cecum lesion score (Aljedaie and Al-Malki, 2020).

Turmeric (*Curcuma longa*)

Curcumin, which is produced by the herbal turmeric (*Curcuma longa*), gives it its distinctive yellow color and a number of therapeutic advantages, including anti-inflammatory, anti-cancer, and antioxidant properties (Abbas et al., 2010; Kocaadam and Sanlier, 2017). It eliminates free radicals and protects cells from lipid peroxidation (Galli et al., 2020). Curcumin (0.05%) effectively reduced upper- and mid-small intestine infections caused by *E. acervulina* and *E. maxima* (Yadav et al., 2020). Furthermore, research has shown that the antibacterial and anticoccidial properties of curcumin improved the quality and performance of poultry meat (Nm et al., 2018).

Curcumin improved antioxidant and anti-inflammatory qualities at 50mg/kg of feed, but when paired with a stimulant, zootechnical performance improved. A recent study by Nm et al. (2018) found that adding 1% curcumin to broiler feed increased weight gain by 10% while decreasing feed conversion by 7.6%. One way that these additions improve performance may be through the increased production of gram-positive facultative and non-pathogenic anaerobic bacteria that aid in digestion and nutrition utilization (Kocaadam and Sanlier, 2017).

By inhibiting the activity of pro-inflammatory enzymes and cytokines, curcumin lowers inflammation of the gut epithelium. This reduction in inflammation is necessary to alleviate the symptoms of coccidiosis (Teng et al., 2020b). Teng et al. (2020b) found that adding turmeric to poultry feed enhanced intestinal health and reduced the incidence and severity of coccidiosis. According to their hypothesis, curcumin may have a direct effect on the survivability of Eimeria oocysts, inhibiting their proliferation and reducing the overall parasite load in infected birds both *in vitro* and *in vivo* (Teng et al., 2020a).

By addressing multiple aspects of coccidiosis control, inhibiting oocyst production, strengthening the immune system, reducing intestinal inflammation and enhancing overall gut health, combining herbs with complementary actions may work in concert (Pirgozliev et al., 2019). Curcumin, along with other herbal feed additives like *Curcuma longa* (Yadav et al., 2020), *Spinacia oleracea* (Ewais et al., 2023), oregano, and essential oil derived from citrus species (Gordillo Jaramillo et al., 2021), can help reduce oxidative stress in the intestines during coccidiosis infections, which is beneficial for birds infected with the disease.

Combining ginger and turmeric can significantly improve the health of hens by reducing mortality rates, increasing weight gain, and diminishing the severity of coccidiosis symptoms (Aljedaie and Al-Malki, 2020). Another study (Santos et al., 2020) found that when curcumin was coupled with inorganic Zn and Cu, it improved nutritional metabolism by increasing bile acid synthesis and stomach enzyme activity to speed up digestion and absorption. Furthermore, curcumin has been shown to reduce intestinal ulcers, oocyst discharge, and *E. tenella* sporozoites (Teng et al., 2020a).

Birds fed 200mg/kg curcumin showed a decrease ($P<0.05$) in lesion ratings and oocyst shedding when compared to those fed 100mg/kg curcumin or control (Yadav et al., 2020). Curcumin and other feed additives may be employed as a dietary strategy to improve broiler gut health, as demonstrated by the current study's positive results on antioxidant capacity, lesion score, and oocyst shedding (Yadav et al., 2020).

Conclusion

Herbal remedies or plant-based therapies offer a lot of promise as a component of an all-encompassing approach to managing avian coccidiosis. These plants and/or their extracts include a variety of bioactive compounds that have antibacterial, anti-inflammatory, antioxidant, and immunomodulatory properties. Because they improve immune responses, reduce oocyst shedding, and support gut health—especially in organic or sustainable poultry production—they could be useful alternatives to synthetic anticoccidials.

Feed additives including herb extracts like garlic, ginger, or turmeric have reduced the severity of avian coccidiosis by inhibiting parasite growth, enhancing the immune system, fostering gut health, and increasing nutrition metabolism and weight gain in poultry. Combining these herbs may have synergistic benefits that address various aspects of coccidiosis control. To fully understand the optimal dosages, formulation, and long-term efficacy of these herbal treatments in order to maximize their therapeutic potential while avoiding adverse effects, more research—including comprehensive field trials-is needed.

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