Review Article

The Use of Ginger and Cinnamon as Feed Supplements for Broilers

Shawky S. Ibraheim, Khaled M. Ali, Ahmed H. M. Elanwar, Nermen A. Helmy, and Salah H. Salah

Physiology Department, Faculty of Veterinary Medicine, Beni Suef University, Beni-Suef 62511, Egypt

salahhosny75@gmail.com

Abstract

Recently, in Egypt, poultry production has become an industry, rather than an agricultural activity. Increasing consumer demand for affordable animal protein has led to a rise in broiler meat production. However, there are many Challenges facing the poultry industry. To face these Challenges, we will need to increase the efficiency of primary production of higher food quality and quantity. Using some herbal plants, such as ginger or cinnamon, has been rapidly progressing in different scientific areas, particularly in poultry breeding, in order to increase performance and production. Studies showed that medicinal herbal supplements, ginger, and cinnamon have favorable effects on both human and animal health due to their active components, medicinal and antioxidant ingredients. It can be concluded that using ginger or cinnamon as ration supplements for broilers with various levels will have an excellent impact on growth performance, especially in terms of body weight gain, feed consumption, and feed conversion ratio, and also the overall performance of broilers.

Keywords: Cinnamon, Ginger, Broilers, Performance, Feed supplements

Citation. Ibraheim, S. S., Ali, K. M., Elanwar, A. H. M., Helmy, N. A., Salah, S. H. The use of ginger and cinnamon as feed supplements for broilers. J Vet Med Res., 2025; In press https://doi.org/10.21608/jvmr.2025.398770.1134

Article History: **Received**: 28-Jun-2025 **Revised**: 10-Jul-2025 **Accepted**: 17-Jul-2025

1. Introduction

In Egypt, poultry production has become an industry, rather than an agricultural activity. The increasing consumer demand for affordable animal protein has led to an increase in broiler meat production. Chicken meat is popular on most Egyptian tables because of its reasonable price, especially when compared to other types of animal meat. According to the report of the Central Agency of Public Mobilization and Statistics (CAPMAS), 10.1 kg of poultry is produced for each individual in Egypt. Moreover, the State Information Service (SIS) mentioned that the total volume of poultry produced in Egypt is nearly 1.4 billion birds.

The investment volume in the poultry industry in Egypt reaches nearly 100 billion Egyptian pounds, and it employs about 3 million employees. There are about 38,000 poultry facilities, which include farms, feed factories, slaughterhouses, and vet shops for selling veterinary medicines and vaccines, according to SIS.

There are many challenges facing the poultry industry in Egypt. Despite its improved self-sufficiency in the broiler meat sector, the country will remain dependent on imports of feed ingredients, vet drugs, and vaccines. The threat of grain price increases or the decrease in imported tariffs puts pressure on poultry producers to become highly competitive. Feed prices witnessed an unprecedented increase due to some world problems, which have disrupted the international trade of grains. All these conditions have direct effects on the poultry production in Egypt. The challenge starts from the absence of local alternatives to imported feed components. There are not many alternatives to cover our needs.

To face these challenges, we will need to increase the efficiency of the primary production of higher food quality and quantity. Using some herbal plants, such as ginger or cinnamon, has been rapidly progressing in different scientific areas, particularly in poultry breeding, in order to increase performance and production.

2. Herbal plants as feed additives

The demand of the consumer for valuable, safe, and nutritious food from animal origin is considered a challenge for animal nutrition. Increasing consumer need for components of natural origin has resulted in the use of herbal plants as ingredients in the industry of feed and food production

(Sacchetti et al., 2005). There is a great interest in many herbs, as they are considered an unexploited reservoir of beneficial substances that can be used to accomplish such demands.

One of the primary aims of supplementation of feed additives to broiler feed is to promote the nutritive value of ingredients and improve performance by increasing growth and feed conversion efficiency. European Union Health Organization has placed a ban on to use of antibiotics as growth promoters in broilers due to their antibacterial resistance in the birds, which may have a negative effect on human health. This gave a chance to use plant-derived additives in animal feed to improve production and maintain animals' health (Castanon, 2007).

Previous studies have shown that herbal plants, ginger or cinnamon, have favorable effects on human and animal health due to their active components, medicinal and antioxidant ingredients (Valadi et al., 2010).

2.1. Ginger (*Zingiber officinale*)

Zingiber officinale, which is related to the *Zingiberaceae* family, is commonly known as ginger. It is a rhizome, a monocotyledonous herb, and is considered one of the most popular feed flavoring additives worldwide. Recently, numerous pharmacological properties of ginger have been recognized, including analgesic, anti-inflammatory, gastrointestinal modulator, antimicrobial, and antioxidant characteristics. Ginger has recently been used as a substitute for antibiotic growth promoters, as it is more palatable and it increases appetite stimulation and feed utilization in broilers (Khan et al., 2019).

2.2. Cinnamon (*Cinnamomum zeylanicum*)

Cinnamomum zeylanicum, which is known as cinnamon. It is one of the oldest herbal plants that is still used all over the world. Cinnamon is used in the aroma industries because of its fragrance, which is incorporated into numerous feedstuffs, perfumes, and also medicinal products (Huang et al., 2007).

Cinnamon's principal chemical constituents are cinnamaldehyde, transcinnamaldehyde, and eugenol. These constituents are present in the essential oil and contribute mainly to the fragrance and multiple biological activities. The presence of other essential oils such as cinnamyl acetate, Lbornol, Caryophylene oxide, b-caryophylene, Lbornol acetate, E-nerolideol, and thujene has also been reported (Chang et al., 2008).

3. Birds performance

The basic aim of any feed supplements to broiler feed is to see effects on their performance. This performance includes growth performance referring to body weight, feed intake, and feed conversion (FCR). Several studies reported the performance of broilers after the supplementation of cinnamon or ginger to the ration.

3.1. Growth performance

Growth performance refers to the process or act of growing following assimilation of feed and is expressed by the gain in body weight.

3.1.1. Effect of ginger supplementation

Ademola et al. (2006) reported that growth performance in broilers has been slightly improved by the supplementation of ginger with a level of 15, 10, or 5 g/kg in the ration. Growth performance of broiler supplemented with graded levels of ginger induced significant differences in feed consumption, body weight, and feed conversion (George et al., 2015).

Similarly, Kur et al. (2013) have studied the effect of ginger supplementation on broiler ration, and the results of this study showed higher body weight in ginger-treated groups. In another study, ginger in the form of aqueous extract that was given through drinking water to broilers increased body weight gain (Javed et al., 2009).

On the contrary, some previous experiments showed non-significant effects with ginger supplementation to broiler ration on the body weight gain (Fakhim et al., 2013; Khan et al., 2019).

3.1.2. Effect of cinnamon supplementation

Park (2008), Sang-Oh et al. (2013) and Ebrahimi et al. (2013) reported that the bodyweight of the broilers fed a ration containing cinnamon powder was significantly higher when compared to those fed a basic ration. In addition, Toghyani et al. (2011) found that dietary supplementation with cinnamon at a level of 2 g/kg ration led to improved body weight gain and suggested that it could be used as an alternative to antibiotics growth promoters for broilers.

However, Koochaksaraie et al. (2011) and Sampath and Atapattu (2013) found that supple-

mentation of broiler rations with cinnamon did not affect broilers' growth performance.

3.2. Feed intake

Feed intake means the average quantity of ration consumed by a bird throughout the rearing cycle. Feed intake is affected by several factors such as the strain of the broilers, energy content of the ration, temperature, density of broilers in the shed, hygienic measures, and housing environment.

3.2.1. Effect of ginger supplementation

Valiollahi et al. (2014) and Singh et al. (2016) in their experiments on the effect of ginger supplementation to broilers' ration on feed consumption found that more feed consumption was observed in the ginger-treated group in comparison to the untreated control one. However, Zomrawi et al. (2012) found that total feed consumption in broilers fed on ginger-supplemented ration was reduced, especially in groups with higher levels of supplementation.

On the other hand, some previous studies showed non-significant effects of ginger supplementation to broiler ration on feed consumption Patel (2012); Kur et al. (2013).

3.2.2. Effect of cinnamon supplementation

Some previous research was carried out to reveal the influence of dietary cinnamon as a feed supplement on the growth performance and feed consumption of broilers. AL-Kassie (2009) and Sampath and Atapattu (2013) showed that supplementation of cinnamon powder to broilers' ration improved significantly feed consumption and feed conversion in comparison to those fed with a basal ration. In addition, Shirzadegan (2014) reported that the addition of cinnamon to the ration had better effects on body weight, feed consumption, and feed conversion of broilers.

3.3. Feed conversion ratio

Feed conversion ratio is a conventional measure of birds' production efficiency: the weight of feed consumed divided by the weight gained by the bird. A lower feed conversion ratio indicates better efficiency.

3.3.1. Effect of ginger supplementation

Mohamed et al. (2012), Ebrahimi et al. (2013) found that supplementation of ginger in broilers' ration had a positive effect on the feed conversion ratio. However, some previous studies reported that supplementation of ginger to broilers' ration had no effect on feed conversion (Zomrawi et al., 2012; Fakhim et al., 2013).

3.3.2. Effect of cinnamon supplementation

AL-Kassie (2009) and Sampath and Atapattu (2013) reported that the cinnamon supplementation for broilers significantly improved feed conversion in comparison to those fed a basal ration. In addition, Habibi et al. (2014) found significantly better FCR with supplementation of 1% cinnamon to the broiler ration. On the other hand, Toghyani et al. (2011) reported no difference in feed consumption and FCR of broilers after the supplementation with cinnamon.

4. Effect of supplementation of ginger or cinnamon on some blood Parameters in broilers

It is well established that cellular and biochemical values of blood are related to the physiological state of the animals. Blood profile is a vital tool that is used to measure the effect of environmental, nutritional, and therapeutic interventions in both veterinary and human health.

4.1. Thyroid hormones; Triodothyronine (T3) and thyroxine (T4)

Thyroid hormones regulate a range of natural biological processes, such as development, reproduction, growth, and metabolism. The specific processes that are regulated differ among species, tissues, and developmental phases Laurberg (2009). However, studies on the effect of supplementation of ginger or cinnamon on thyroid hormones of broilers seem to be scant.

4.2. Liver enzymes

Several liver enzymes can reflect liver function. The most important and well-known are alanine transaminase (ALT) and aspartate transaminase (AST). ALT is found at high levels in the cytoplasm of hepatocytes. It catalyses the transamination reaction in the cytoplasm of hepatic cells. It also helps in energy production from proteins in liver cells. Most inflammatory conditions or stress may be accompanied by different degrees of hepatic cell destruction, resulting in the release of ALT from hepatic cells and consequently a rise in the enzyme level in the blood. Moderate rise of

ALT is not specific solely to the liver, but it may be due to the damage of some cells of other organs, such as the kidneys and the muscles. Higher levels of ALT, 500 IU/L or more, reflect liver affections. Persistent ALT elevation, 6 months or longer, indicates the incidence of chronic hepatitis. Rise of ALT level is usually associated with decreased insulin response, decreased glucose tolerance, as well as increased concentration of free fatty acids and triglycerides (Gowda et al., 2009).

AST helps in amino acid metabolism and exists in the form of two isoenzymes, namely mitochondrial and cytoplasmic forms. It is found at a high level in liver cells, followed by the heart, muscles, kidneys, brain, pancreas, and lungs (Masters, 2012). This wide range of organs that contain AST makes it a less specific indicator of liver damage when compared to ALT (Gowda et al., 2009).

4.2.1. Effect of ginger supplementation

Some previous studies were carried out to declare the effect of ginger supplementation on liver enzyme levels in broiler blood. The result of these studies showed no marked variations in serum ALT and AST levels due to ginger supplementation (Dieumou et al., 2009; Shanoon et al., 2012). However, Rehman et al. (2000) studied the effect of ginger supplementation for broilers, which resulted in a decrease in serum ALT and AST concentrations. In addition, Herve et al. (2018) reported that serum contents of ALT and AST lowered in quails supplemented with ginger as a feed additive.

4.2.2. Effect of cinnamon supplementation

Kanani et al. (2016) reported the effect of cinnamon supplementation on some blood parameters of broilers under heat stress and reported that there was no effect on serum AST levels. Furthermore, Toghyani et al. (2011) found that serum AST levels were not changed by cinnamon supplementation to broilers' ration, whereas serum ALT levels were reduced.

4.3. Serum bilirubin

Bilirubin (BR) is considered the main bile pigment. Within the available literature, studies dealing with the effect of supplementation of ginger or cinnamon on BR levels in broilers seem to be scanty.

4.3.1. Serum total proteins, albumins, and globulins

Several proteins are dissolved mainly in plasma. The concentration of those proteins can give some information about the state of many different organs. Albumins represent more than half of the total proteins present in the blood (Rothschild and Oratz, 1976). Globulins are found in four main forms, $\alpha 1$, $\alpha 2$, β, and γ. Most of these globulins are synthesized in the liver, but immunoglobulins are synthesized by the plasma cells McPherson and Pincus (2021).

4.3.2. Effect of ginger supplementation

Herve et al. (2018) reported that total proteins and globulins were elevated in birds supplemented with ginger as a feed additive. Moreover, Tchoffo et al. (2017) have reported that values of serum total proteins were improved in a dose-related pattern in birds supplemented with ginger. On the contrary, Saleh et al. (2019) in their study on the effect of feed supplementation with ginger basic oils on some hematological, biochemical, and immunological characters of broilers found an obvious decrease in total proteins and globulins.

4.3.3. Effect of cinnamon supplementation

Toghyani et al. (2011) found that serum total protein and albumin did not change in broilers supplemented with cinnamon. Furthermore, recently, Rashid et al. (2020) confirmed this result, where there were no significant interactions for serum total proteins, globulins, and albumins in groups supplemented with cinnamon. In contrast, a study carried out by AL-Kassie (2009) reported that broilers fed on 200 ppm dietary cinnamon powder had increased total protein concentration. Another observation was reported by Gaikwad et al. (2019) who confirmed that 0.8% supplementation with cinnamon reduced plasma total protein concentration.

4.4. Serum creatinine

Creatinine is a waste product produced by muscles and protein metabolism from the breakdown of creatine phosphate. Creatinine is eliminated from the body by the kidneys, which filter nearly all of it from the blood to be released in urine (Allen, 2012). Diagnostic serum creatinine studies are used to determine renal function Taylor (1989).

4.4.1. Effect of ginger supplementation

Dieumou et al. (2009) reported that there were no clear variations recorded in the serum creatinine level due to supplementation of ginger in broilers. These results agreed with Shanoon et al. (2012) who mentioned that there were no obvious differences in serum creatinine levels between treated groups with ginger as a feed additive and control one.

4.4.2. Effect of cinnamon supplementation

AL-Kassie (2009) and Kanani et al. (2016) reported the influence of cinnamon supplementation on some blood parameters of broilers and found that there were no significant differences in serum creatinine level in treated and control groups.

4.5. Serum total cholesterol

Cholesterol is a fat-like waxy substance that helps the body to make cell membranes, many hormones, and also vitamin D. The Liver makes all the cholesterol that your body needs. Cholesterol and other fats are carried within the bloodstream as spherical particles called lipoproteins. The most commonly known two lipoproteins are low-density lipoproteins (LDL) and high-density lipoproteins (HDL).

4.5.1. Effect of ginger supplementation

Several investigations have been conducted to investigate the effect of ginger supplementation on broiler rations on total serum cholesterol levels. The results of these studies showed that serum total cholesterol levels decreased due to supplementation of ginger (Ghasemi and Taherpour, 2015; Herve et al., 2018).

4.5.2. Effect of cinnamon supplementation

It was reported that cinnamon supplementation played a vital role in decreasing cholesterol concentration, which is very desirable for consumers. However, it should be noted that the effect of cinnamon supplementation on blood profile and immune system status in broilers has not been constant. A possible source of this alternation may be related to the health status (Rashid et al., 2020). AL-Kassie (2009) showed that broilers supplemented with 200 ppm cinnamon had lower cholesterol concentration. This agreed with Ciftci et al. (2010), who found that the serum level of cholesterol was reduced in broilers supplemented with cinnamon.

4.6. Serum glucose

Glucose is the main type of sugar in blood and is the major source of energy for body cells. Glucose comes from feed, or the body can make it from other substances. Glucose is carried to cells through the bloodstream. Several important hormones, including insulin, control glucose levels in the blood.

4.6.1. Effect of ginger supplementation

Tekeli et al. (2011) reported that blood glucose levels increased by ginger dietary supplementation for birds. In contrast, Shewita and Taha (2019) in their study about supplementation of ginger to broiler ration showed a decrease in the serum glucose level.

On the other hand, Zomrawi et al. (2012) found that supplementation of ginger to broilers' ration has no effect on serum glucose level.

4.7. Effect of cinnamon supplementation

Previous studies showed that the addition of cinnamon to broiler rations led to lowered blood glucose levels in blood (Habibi et al., 2014; Shirzadegan, 2014).

4.7.1. Malondialdehyde (MDA)

Malondialdehyde is a marker for oxidative stress. MDA is produced from lipid peroxidation of unsaturated fatty acids, as well as it is produced in the process of prostaglandin synthesis (Davey et al., 2005). Therefore, the production of this aldehyde is used as a biomarker for measuring the level of oxidative stress, due to reactive oxygen species (ROS), in tissues, seminal plasma, and blood (Hsieh et al., 2006).

4.7.2. Effect of ginger supplementation

Herve et al. (2018) reported that the serum MDA decreased in quails supplemented with ginger as a feed additive. This result agreed with previous results of Habibi et al. (2014) and An et al. (2019), who also demonstrated lowered serum MDA levels in broilers supplemented with ginger as a feed additive.

4.7.3. Effect of cinnamon supplementation

Ciftci et al. (2010) found that the serum levels of MDA were decreased in broilers supplemented with cinnamon. These authors concluded that cinnamon has strong antioxidant activity. A similar result was confirmed by Yang et al. (2019) who found that MDA levels decreased on the 21st day after supplementation with cinnamon in broilers.

4.8. Cortisol

Cortisol is one of the main glucocorticoids which synthesized in the *zona fasciculata* of the adrenal cortex. Cortisol secretion is affected by hypothalamic hormone, CRH, and the pituitary hormone, ACTH, in the hypothalamic pituitary adrenal axis. Cortisol is known as the stress hormone which involved in the response to physical stress. Cortisol also shares in various homeostatic maintenance actions such as blood pressure, immune system response, anti-inflammatory actions, and metabolism of protein, carbohydrate, and fat (Dickstein et al., 1991). Within the available literature, studies on the effect of supplementation of ginger or cinnamon on the cortisol levels of broilers seem to be scant.

Article Information
Ethical Approval. Not applicable.
Funding. The research received no external funding.
Conflict of Interest. The authors declare no conflict of interest.

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