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IMPLICATIONS OF USING SOME PHYTOADDITIVES IN BROILER NUTRITION - A REVIEW

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Abstract

This study aims to discuss the various applications of phytoadditives (basil, thyme, sage) in broiler nutrition. Nowadays, commercial development of plants as natural sources of antioxidants or antimicrobials both to enhance animal health, performance and nutrient digestibility is of current interest. Plants as basil, thyme and sage have been studied countless times for their chemical composition, being rich in bioactive compounds, vitamins, minerals, etc. Consequently, in recent years, these plants have gained attention in their use in the diet of animals, including birds. This review showed that plants as basil, thyme and sage are valuable feed supplements for broilers that can improve the performance, nutrient digestibility, carcass and meat quality, gut health and overall health.

Key words*: basil, thyme, sage, broiler, diet.*

INTRODUCTION

Among the livestock sectors, poultry production systems have the most intense development, especially in the fields of nutrition, disease control, breeding, management and organization of nutritional requirements, together with the pressure of increasing demand for poultry products and the risk of exposure to pathogens. Therefore, this sector is in great need of research in the field of nutrition and sustainable production, based mainly on plants, due to advantages such as low costs, increased bioavailability, no residual effect, without causing antibiotic resistance, etc.

Moreover, highlighting plants with an important role in increasing production performance in the context of banning antibiotics as growth promoters is a strategy that will attract the attention of poultry specialists. The information will be useful to increase production in the poultry sector and to protect the health of birds in a more effective way than traditional ways and to promote and popularize the use of plants among poultry producers.

Many plants have been identified as excellent feed additives for poultry, including basil (*Ocinum* spp.) rosemary (*Rosmarinus officinalis*), thyme (*Thymus vulgaris*), marjoram (*Origanum majorana*), sage (*Salvia officinalis*), oregano (*Origanum vulgare*), mulberry (*Morus alba*), sweet wormwood (*Artemisia annua*), etc (Botsoglou et al., 2013; Rahal et al., 2014; Olteanu et al., 2015; Criste et al., 2017; Panaite et al., 2018; Saracila et al., 2018).

Basil (*Ocimum spp., Lamiaceae*) contains a wide range of essential oils rich in phenolic compounds (Simon et al. 1990; Phippen and Simon 2000) and a higher capacity to inhibit DPPH radicals than that of essential oils (Ahmed et al., 2019).

Thyme (*Thymus vulgaris* L.) contains minerals and vitamins that are essential for health. Its leaves are one of the richest sources of potassium, iron, calcium, manganese, magnesium and selenium (Sharangi et al., 2013). Thymol is the main phenolic component that is primarily responsible for its antioxidant activity (Alireza et al., 2015).

Sage (*Salvia officinalis*) is also a natural source of flavonoids and polyphenolic compounds (e.g., carnosic acid, rosmarinic acid, and caffeic acid) that possess strong antioxidant, radical, and antibacterial activities (Baranauskiene et al., 2011; Hamidpour et al., 2014). Based on

the evidence available in the literature, this plant has anticancer, anti-inflammatory, antioxidant, antimicrobial, hypoglycemic, hypolipidemic effects (Ghorbani and Esmaeilizadeh, 2017).
The present review aims to discuss the effects of phytoadditives (basil, thyme, sage) in the broiler diet on maintaining or improving performance, nutrient digestibility, carcass quality and animal by-products obtained from them.

1. The use of basil in the diet of broiler chickens

There are currently a number of studies focused on the effects of using basil in the diet of broiler chickens. In this regard, Gurbuz and Ismael (2016) reported that the inclusion of 0.5%, 1.0% and 1.5% basil in Ross 308 diet improved the performance and feed conversion rate. The level of inclusion of 3 g/kg basil seeds in the diet of broiler chickens led to a significantly higher body weight ($p < 0.05$) than those who were fed with a conventional diet (Abbas, 2010). The carcass characteristics did not differ significantly but a significant reduction in serum cholesterol was reported compared to the control diet. However, the results of the study led by Sheoran et al. (2017) support the premise that adding basil powder to a level higher than 1% in chicken feed can improve the growth performance and immune status of chickens, by increasing the immune response mediated by T cells and thus protecting them from disease.
Osman et al. (2010) reported that the inclusion in the diet of chickens of 1.0 g./kg sweet basil in the growing and finishing periods led to a better ratio of protein efficiency and performance index values. The use of sweet basil levels (0.5 or 1.0 g/kg diet) in broiler diets can improve productivity, immunological status and carcass characteristics.
On the contrary, Ulupi et al. (2015) showed that the addition of 1, 2 and 3% basil flour in the chick feed did not have an effect on feed consumption, body weight and feed conversion rate, but the production of NH_3 and H_2S detected in manure was well below the safe level recommended for the health of the chicks and the environment. This result is important in the context of a currently growing interest in finding nutritional solutions for chickens in order to reduce the negative effects of N resulting from the decomposition of manure on the environment (Dragotoiu et al., 2010). Air polluted with NH_3 and H_2S can cause health problems for chicks, especially respiratory disorders leading to CRD (Chronic Respiratory Disease). It also increases the activity of the virus that causes Newcastle disease. This contaminated air also pollutes the society around the farm. If the concentration of NH_3 and H_2S in the hall exceeds 0.05%, it can cause the death of the chicks, according to Rahmawati (2000).
On the other hand, Saleh et al. (2020) showed that the addition of basil leaf flour to broiler diets by up to 9% did not significantly increase the weight and length of the digestive organs of the chicks. Thus, the substances contained in the basil leaf flour added to the commercial diets for broilers have not been effective in the growth and development of the digestive organs to a maximum capacity.
Dietary basil seeds had also beneficial effects on broiler health. Thus, Kadhim (2016) reported an improvement in biochemical parameters of the blood, especially total proteins and a decrease in liver enzymes (ALT, AST and ALP) and cholesterol when broilers fed diets including 0.3% and 0.6% basil seeds. The explanation found by Crowell, (1999) was that the active ingredient of plant oil extract inhibits the activity of hepatic 3-hydroxy-3-methylglutaryl coenzyme A (HMG- CoA) reductase, considered a key enzyme in cholesterol synthesis.
It has also been shown that basil supplementation had beneficial effect on broiler even under heat stress conditions. Thus, Jahejo et al. (2019) reported that basil supplementation at 5 g/kg feed, promotes the growth, improves the intestinal villus size, feed efficiency and immunity of heat stressed broiler chicken.

2. The use of thyme in the diet of broiler chickens

Thyme has been known as a strong growth stimulant and as a good alternative for chemical materials in poultry industry (Alcicek et al., 2004). Thyme as a supplement in the diet of

chickens as a growth promoter or for any other use has beneficial activity on feed use, nutrient absorption, antioxidant status, immune function, carcass quality, performance parameters and odor attenuation and ammonia emission in animal halls (Abd El-Hack et al., 2016). Moreover, it has been found that thymol as an antioxidant potential, protects against cell destruction by decreasing/preventing the loss of mitochondrial membrane potential and inhibiting ROS overproduction due to oxidative stress in liver cells. Exploring the modes of action of thymol, such as pharmacological, nutritional, health and biological benefits can play a vital role in its uses in poultry farms and animal husbandry systems to improve performance parameters (Abd El-Hack et al., 2016).

Cross et al. (2007) reported antibacterial, anticoccidial and antifungal activities of thyme, thus lead to improve the general health of the chicks. The active principles of essential oils, among them also thymol, act as a stimulant of digestibility, balancing the intestinal microbial ecosystem and stimulating the secretion of endogenous digestive enzymes, thus improving the growth performance of birds (Ayoub et al., 2011; Barakat et al., 2016; El-Far et al., 2016). Consequently, thyme can be used as a readily available source of natural antioxidants and antibiotics in food and medicine. In this regard, several studies have been conducted to investigate the antioxidant and immunostimulatory potential of thyme that reflects the health and performance of broilers (Abdel-Ghaney et al., 2017).

The results obtained by Toghyani et al. (2010) suggest that dietary supplementation with 5 g/kg thyme had favourable influences on performance without having negative effects on immune system responses and blood parameters. Similarly, Ahangaran et al. (2019) showed that supplementing the diet of broiler chickens with 0.5 and 1% thyme led to a higher weight gain and decreased feed conversion rate. Thymol and carvacrol concentrations from 100 to 1000 ppm have been shown to have a positive effect on broiler production performance (Hosseini et al., 2013; Pourmahmoud et al., 2013) and on blood metabolites and immune responses (Fallah and Mirzaet, 2016). The difference in results cited in the literature on the effect of thyme on chicken performance may be due to different forms used in tests (oil, powder or various extracts) or different doses, emphasizing the need for further research (Attia et al., 2017).

Shabaan (2012) showed that chickens that were fed a low-energy diet supplemented with a mixture of 0.15% thyme and 0.15% cumin had lower values of total plasma protein, albumin and uric acid and values higher carcass percentage, total edible parts and plasma antioxidant capacity. Hashemipour et al. (2013) reported that supplementing the diet of broilers with mixture of thymol and carvacrol led to improved growth performance, increased activity of antioxidant enzymes and inhibition of lipid oxidation of meat, improved digestive enzyme activity and immune responses. Diet supplementation with thyme essential oil (300 mg/kg) led to an increase in the digestibility of crude protein, and those fed diets without the addition of antioxidants showed an increase in apparent metabolizable energy (Abbasi et al., 2019). Significantly higher ileal digestibility ($P < 0.05$) of crude ash, crude protein, crude fat, calcium and phosphorus was observed in chickens that included in the diet thyme and anise essential oils (150, 750 or 1500 mg/kg), increase directly dependent on the inclusion dose (Amad et al., 2011).

Cho et al. (2014) reported a improved growth performance, reduction of total blood cholesterol levels and also inhibition of *C. perfringens* and *E. coli* proliferation in the small and large intestine have been reported in the diet fed with the addition of phytoadditives compared to the control group and with the batch with the addition of antibiotics after exposure to *Clostridium perfringens.* Moreover, the addition of 0.5 and 1% thyme in the diet decreased the pathogenic microbial population in cecal and meat content (Ahangaran et al., 2019). Thus, the addition of thyme in the diet of broilers can improve the growth rate and hygienic parameters of chicken, essential in terms of food safety. On the contrary, Cross et al. (2007) have reported that mixtures of essential oil of 10 g/kg thyme in the diet of chickens had no effect on the microbial population and its composition in the digestive tract or in their feces (Cross et al., 2007). It was notable that supplementing a

mixture of 0.15% thyme and 0.15% cumin in the low-energy diet improved economic efficiency by 5.79% compared to the control diet (Shabaan, 2012).

Additional studies should also evaluate the safety and toxicity of thyme extracts and essential oils for a new approach in considering their use as a supplement in poultry diets.

3. The use of sage in the diet of broiler chickens

The literature is rich in studies evaluating the effect of using sage in broiler diet. An important idea is that the use of higher doses of sage is not recommended because its essential oil contains tannins, toxic stems and eugenol compounds (Dogan, 2004; Lima et al., 2004). However, the dietary level at which sage extract becomes toxic to poultry has not been established (Yurtseven et al., 2008).

Many researchers have shown that the inclusion of sage in broiler diet improved the performance parameters. For example, Traesel et al. (2011) evaluated performance data following diet broilers supplemented with antibiotics or essential oils of oregano, sage, rosemary and raw pepper extract. The dose of essential oils at the level of 100 mg/kg is suitable for recording a weight gain similar to those observed in broilers fed diets supplemented with antibiotics as growth promoters. Moreover, Hernández et al. (2004) did not observe any difference in feed consumption or feed conversion after administration of 5000 ppm essential oil extract from *Labiatae* plants (sage, thyme, rosemary) in the diet of broilers for 42 days. However, the growth of the broilers was faster than that of the control group. Similarly, Lenuta and Leonte (2011) showed that the addition of sage oil in the broiler chick diet improved body weight by about 1% (diet with 0.5% sage oil), 2% (diet with 1% sage oil) and 8% (diet with 2% sage oil) compared to those fed a conventional diet. The same authors state that sage essential oil is considered to be a potential natural promoter of chick growth.

The results obtained by El-Garhy (2018) showed that supplementing the diet of chickens with sage powder at a level of 8 and 12 g/kg diet led to an increase in body weight of chickens, improved growth rate, consumption and feed conversion, blood parameters, economic efficiency, carcass yield and decreased mortality rate.

Hernandez et al. (2004) proved that supplementation with plant extract of diets for broiler chickens improved the digestibility of nutrients throughout the gastrointestinal and ileal tract. Improvements in the apparent fecal digestibility of dry matter and crude fat were significant after the intake of 5000 ppm of essential oil of sage, thyme and rosemary essential oil in the starter phase, but no effect was detected on the digestibility of crude protein. The extracts led to an improvement in the apparent fecal digestibility of the dry matter and the crude protein in the finishing phase. Faixová et al. (2009) observed that chickens fed diets supplemented with sage essential oil had a reduction in plasma calcium concentrations. Marcin et al. (2016) conducted a 42-day study on 70 one-day Ross 308 puppies. This study aimed to compare the effects of including in the diet of chicks the essential oil of sage (*Salvia officinalis* L.) at a dose of 2.306 g/kg diet on digestive enzymatic activities in jejunum, digestive characteristics and bacterial microflora selected in caecum. The main volatile compounds in sage oil were: eucalyptol 85, alpha-thujon 148, betathujon 72, camphor 149 and borneol 37 g/kg. Supplementing the diet of Ross 308 chickens with sage essential oil (2.306 g/kg diet) led to increased digestibility of crude cellulose and amylolytic and cellulolytic activities in the jejunum chem and decreased number of *E. coli* in cecum (Marcin et al., 2016). The mucus in the digestive tract and the mucus produced could influence the antibacterial protection of the gastrointestinal tract of broiler chickens against *E. coli.* Rasouli et al. (2019) showed in a study performed on Ross 308 broiler chickens fed diet supplemented with different levels of sage extracts (100, 200, 300 and 400 ppm), a decrease ($p < 0.05$) in the levels of total plasma cholesterol, triglycerides and LDL and increases in HDL.

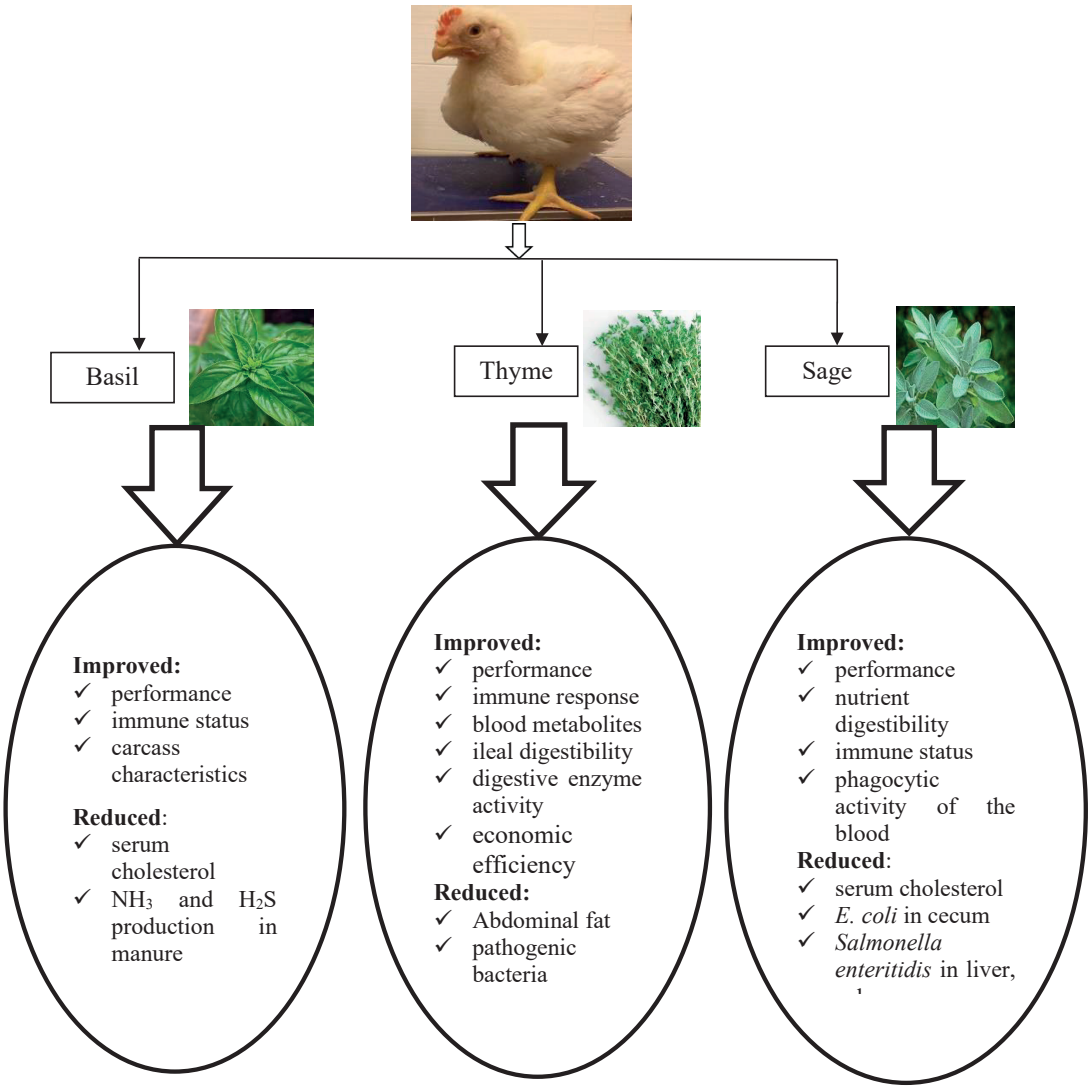

Figure 1. An overview of the effects of basil, thyme and sage inclusion in broiler diet

At the same time, a significant improvement ($p<0.05$) of the broilers' immune response was observed when the concentration of sage extract in the diet increased. The results of the study conducted by Al-Sherify and Al-Alwany, (2016) showed that the addition of 1 and 2% of *Salvia officinalis* leaf powder in the diet of broiler chickens Ross 308 led to a significant improvement ($p < 0.05$) of red blood cell count, PCV concentration and hemoglobin. Piesova et al. (2012) investigated the effects of adding sage extract to the diet on biochemical parameters, the weight of some organs and changes in the number of *Salmonella enteritidis* PT4 (SE) in infected chickens. Compared to the SE group, the sage extract from the SSE group decreased ALP and ALT activities and glucose and bilirubin concentrations on the 4th day after inoculation (p.i.). However, on day 18 p.i., only lower levels of bilirubin and ALT activity were detected. The addition of sage extract to diets decreased the number of *Salmonella* in the liver, spleen and caecum at both sampling periods, along with lower mucus production in the intestines of the chicks. The results of Piesova et al (2012) suggest that adding sage

extract to the diet could be effective in protecting SE-infected chicks. *Salvia officinalis* essential oils (0.05% concentration) were used in a study by Ryzner et al. (2013) in broiler chickens in order to study their effect on antioxidant status and phagocyte activity in the blood. The same authors concluded that sage is an important source of antioxidants that significantly improves the phagocytic activity of the blood. Furthermore, a significant bactericidal effect ($p < 0.05$) of sage extract was detected for *E. coli,* while it was moderate for *Lactobacillus*. Therefore, Rasouli et al. (2019) found that sage extract with positive effects on the parameters of immunity of chicks and antibacterial activity, being strictly related to the level of inclusion in the diet.

CONCLUSIONS

Based on the evidence available in the literature, it can be concluded that phytoadditives such as basil, thyme and sage can be used in broiler nutrition to increase performance, nutrient digestibility, carcass and meat quality, intestinal health and improve overall health. As presented in this review, the results on the applications of phytoadditives (basil, thyme, sage) in the broiler diet varied depending on several factors such as plant variety, form of use (dry plant, essential oil, plant extract), dose of inclusion, bird genetics or diet composition.

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