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PHYSIOLOGICAL EFFECTS AND USES OF SOME PHYTOBIOTIC COMPOUNDS - A REVIEW

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Phytobiotics have been used to supplement ingredients in poultry feeds for the last few years. A great deal of research has been conducted on this topic. Researchers highlight the multifaceted benefits of phytobiotics, underscoring their antimicrobial, antioxidant, and anti-inflammatory properties, in addition to their capacity to stimulate growth. Most of the phytobiotics currently in use are seamlessly incorporated into animal diets, with no reported palatability issues. In fact, there have been instances of enhanced feed intake when these additives are included.
The objective of this review is to comprehensively examine the utilization of phytogenic feed additives in poultry diets, alongside a detailed exploration of the latest insights into their potential mechanisms of action.

Key words: *botanical, herb, physiological impact, phytobiotics, poultry*.

INTRODUCTION

Exogenous stress factors disrupt the mucosal immune response against other pathogens, leading to intestinal damage and poor growth performance.
Therefore, to mitigate the adverse effects of environmental stress factors, to enhance growth performance, and to improve existing flora, various feed additives, such as antibiotics, probiotics, prebiotics, and phytogenics, are added to animal diets.
In poultry production, antibiotics have been used at subtherapeutic levels since the 1950s to further improve growth and health (Barreto et al., 2008; Diaz-Sanchez et al., 2015; Oso et al., 2019).
However, due to concerns about residue risks in poultry products and the potential development of antibiotic-resistant bacteria in humans (Windisch et al., 2008; Oso et al., 2019), coupled with increasing public awareness of environmental issues (Gheisar and Kim, 2017), the European Union decided to ban the use of antibiotics as growth promoters.
Probiotics or plant extracts can be used as alternatives to antibiotics in poultry nutrition due to their beneficial effects on intestinal microflora (Sarica et al., 2005). The "pro-" and "prebiotic" approach is continually evolving to enhance animals' immune responses and increase resistance to diseases using feed additives that pose no food safety risks (Kovacs et al., 2016).
The chemical composition of phytobiotics and the content of active components vary depending on factors such as the part of the plant used (leaves, seeds, roots, etc.), harvest season, and geographic origin (Windisch et al., 2008; Oso et al., 2019).
These substances have low levels of weight and are produced in plant secondary metabolism, including glycosides, alkaloids, phenolic and polyphenolic molecules, terpenoids, saponins, gums, flavonoids and soluble oils. These plants have been bred for defense against external factors such as traits, stress factors, protection against predators and pathogens (Barreto et al., 2008). Numerous studies have shown that phytobiotics have antimicrobial, antioxidant and anti-inflammatory activities, as well as growth-promoting effects.
However, most studies have focused on the effects of active compounds used in terms of production performance rather than their physiological impact. This review aims to provide a general overview of the use of phytogenic feed additives in poultry diets and the latest information on their potential modes of action.

GROWTH PROMOTING EFFECTS

The stimulatory effect of adding plant-based products to poultry diets on growth has been reported in many studies (Gheisar and Kim, 2017). Antibiotics are commonly used in animal production facilities to maintain herd health, support growth, and increase productivity (Al-Kassie, 2009).

However, their use has been restricted in many countries, including the European Union, due to concerns about microbial resistance and residues in products (Haashemipour et al., 2013). As the poultry industry is one of the most common sectors for antibiotic use, research into alternatives to antibiotics is increasing in this field.
Among the alternative methods for antibiotics in poultry, the use of plant-based products is prominent. In this context, the use of medicinal plants or extracts derived from these plants, known as phytobiotics, is becoming more widespread (Ghasemi et al., 2010; Zhao et al., 2011; Bölükbaşı et al., 2008; Zyla et al., 2012).

ANTIOXIDADIVE EFFECTS

The antioxidant properties of spices and herbs are well-defined. It is believed that many phytochemical compounds with antioxidant properties contribute to the protection of dietary lipids from oxidative damage, similar to added antioxidants in diets (e.g., α-tocopherol acetate or butylated hydroxytoluene) (Windisch et al., 2008).
Among the leading causes of harmful consequences of stress in poultry, there is an excessive production of free radicals, particularly perilous, and the resulting effects of antioxidant defenses and oxidative stress.
Some studies have successfully used essential oils and dried powders from plants, especially from the Labiatae plant family, as natural antioxidants in animal diets (Botsoglou et al., 2002; Bolukbası et al., 2006; Abd El-Hack and Alagawany, 2015; Giesar and Kim, 2018).
Researchers have investigated the potential effects of phytobiotics derived from the Labiatae plant family, which contains phenolic compounds, on poultry (Botsoglou et al., 2003; Bolukbasi et al., 2006; Abd El-Hack and Alagawany, 2015). They have reported that a wide range of plants from the Labiatae family, especially rosemary, oregano, and thyme, and their extracts, have potential antioxidant functions.
In their broiler study, Abd El-Hack and Alagawany (2015) observed that the group fed with thyme-enriched diets showed significantly increased serum superoxide dismutase activity and decreased glutathione concentration. They also noted that the concentration of malondialdehyde (MDA) decreased in experimental groups compared to the control. Placha et al. (2010) similarly found that supplementing broiler chicken diets with thymol significantly reduced MDA concentration, and suggested that thyme oil concentration was sufficient to control the irregular release of reactive oxygen species (ROS).
Various plant species, such as ginger, resveratrol, rosemary, sage, curcuma, anise, coriander, among others, have demonstrated antioxidant activities (Sahin et al., 2010; Windisch et al., 2008; Gheisar and Kim, 2017).
Evidence exists to support the antioxidant activities of black pepper (Piper nigrum), red pepper (Capsicum annuum L.), and tomatoes (Akdemir et al., 2012; Puvaca et al., 2015).
Similarly, there is information indicating that the antioxidant activities of plants, such as ginger root, thyme, and resveratrol, are transferred to eggs along with the body (Sahin et al., 2010; Zhao et al., 2011). Sahin et al. (2016) reported that dietary supplementation of lycopene in broilers exposed to heat stress increased serum and muscle malondialdehyde (MDA) levels.

ANTIMICROBIAL EFFECTS

It is well-known that herbs and many spice varieties exhibit in vitro antimicrobial effects against significant pathogens (Dorman and Deans, 2000; Barreto et al., 2008). This antimicrobial activity is reported to originate from the essential oil fractions found in spice and plant extracts (Nychas, 1995).
Furthermore, citrus essential oils exhibit antimicrobial effects against foodborne bacteria and molds (Nychas, 1995). Additionally, the antibacterial and antifungal effects of thyme (Bolukbasi et al., 2008; Abd El-Hack et al., 2016; Gholijani and Anirghofran, 2016), and othe natural product are well-documented (Abd El-Hack et al., 2022).
The antimicrobial action of hydrophobic essential oils is thought to arise from their potential to enter bacterial cell membranes, disrupt membrane structures, and induce ion leakage (Burt, 2004).
In their study, Bolukbasi et al. (2008) applied thyme, rosemary, and sage oil to the diets of laying hens. They found that the concentration of E. coli in fecal samples significantly decreased when thyme oil and rosemary oil were used ($P < 0.05$). Additionally, they reported that thyme oil and rosemary oil exhibited higher antimicrobial activity than sage oil.

PALATABILITY AND EFFECTS ON INTESTINAL FUNCTION

Phytogenic feed additives are generally reported to enhance the palatability of feed and, consequently, improve production performance (Windisch et al., 2004). However, studies evaluating their palatability in terms of specific effects on the diet have remained limited.

In addition to the beneficial effects of a wide variety of spices and herbs, it has been reported that they also have positive effects on the digestive system, such as preventing spasms and bloating (Chrubasik et al., 2005). Furthermore, it is suggested that phytogenic additives stimulate digestion by increasing saliva, bile, and mucus production along with enzyme activity. Many spices have been reported to trigger increased secretion of bile acids, which play a vital role in fat digestion and absorption, and significantly stimulate pancreatic enzymes.

These effects, in conjunction, lead to an acceleration of digestion and a reduction in the transit time of food in the gastrointestinal tract (Platel and Srinivasan, 2004). In a different study, it was reported that the sharp flavors of rosemary and sage herbs resulted in chickens showing a preference for additive-free diets (Loetscher et al., 2014).

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CONCLUSION

In recent years, some of the functions investigated regarding phytobiotics include their growth-promoting effects, antimicrobial activity, antioxidant activity, and anti-inflammatory activity.

According to the literature, phytobiotics have positive effects on improving poultry performance.

Some researchers have even suggested that phytobiotics used as dietary supplements are consumed without any taste issues and may, in fact, lead to increased feed consumption, possibly due to improved palatability.

REFERENCES

1. Abd El-Hack M.E. and M. Alagawany (2015). Performance, egg quality, blood profile, immüne function, and antioxidant enzyme activities in laying hens fed diets with thyme powder. J. Anim. Feed Sci. 24:127-133.

2. Abd El-Hack M.E., M. Alagawany, M.R. Farag, R. Tiwari, K. Karthik, K. Dhama, J. Zorriehzahraf and M. Adel (2016). Beneficial impacts of thymol essential oil on health and production of animals, fish and poultry: a review. J. Essent. Oil Res. 28(5): 365–382.

3. Abd El-Hack ME, El-Saadony MT, Salem HM, El-Tahan AM, Soliman MM, Youssef GBA, Taha AE, Soliman SM, Ahmed AE, El-Kott AF, Al Syaad KM, Swelum AA. (2022). Alternatives to antibiotics for organic poultry production: types, modes of action and impacts on bird's health and production. Poult Sci. Apr;101(4):101696.

4. Abdel-Latif H.M.R., Abdel-Tawwab M., Khafaga A.F., Dawood M.A.O. (2020). Dietary oregano essential oil improved the growth performance via enhancing the intestinal morphometry and hepato-renal functions of common carp (Cyprinus carpio L.) fingerlings. Aquaculture.;526

5. Aich, P., Heather, L., Wilson, Radley, S., Kaushik, T., Andy, A., Potter Lorne, A., & Griebel P. (2007). Comparative analysis of innate immune responses following infection of newborn calves with bovine rotavirus and coronavirus. Journal of General Virology, 88, 2749-2761.

6. Akdemır, F., C. Orhan, N. Sahın, K. Sahın, A. Hayırlı. (2012). Tomato powder in laying hen diets: effects on concentrations of yolk carotenoids and lipid peroxidation. Br. Poult. Sci. 53, 675-680.

7. Al-Kassıe, G.A.M., Mamdooh, A.M.A., Saba, J.A. (2011). The effects of using hot red pepper as a diet supplement on some performance traits in broiler. Pakistan J. Nutr. 9, 842-845.

8. Barreto, M.S.R., Menten, J.F.M., Racanicci, A.M.C., Pereria, P.W.Z., Razzo, P.V. (2008). Plant extracts used as growth promoters in broilers. Brazilian J. Poult. Sci.;10:109–115.

9. Bölükbaşı, Ş.C., Erhan, M.K., Özkan, A. (2006). Effect of dietary thyme oil and vitamin E on growth, lipid oxidation, meat fatty acid composition and serum lipoproteins of broilers. S Afr J Anim Sci, 36 (3): 189-196.

10. Bölükbaşı, Ş.C, Erhan, M.K., Kaynar, Ö. (2008). The effect of feeding thyme, sage and rosemary oil on laying hen performance, cholesterol and some proteins ratio of egg yolk and Escherichia Coli count in feces. Arch Geflügelk, 72 (5): 231–237.

11. Botsoglou, N.A., P. Florou-Panerı, E. Chrıstakı, D.J. Fletourıs, A.B. Spaıs. (2002). Effect of dietary oregano essential oil on performance of chickens and on iron-induced lipid oxidation of breast, thigh and abdominal fat tissues. Br Poult Sci 43, 223-230.

12. Burt S. (2004). Essential oils: Their antibacterial properties and potential applications in foods – a review. Int. J. Food Microbiol.;94:223–253.
13. Chrubasik S, Pittler MH, Roufogalis BD. (2005). Zingiberis rhizoma: a comprehensive review on the ginger effect and efficacy profiles. Phytomedicine. 12:684–701.
14. Diaz-Sanchez S., S. Moscoso, F. Solís De Los Santos, A. Andino and I. Hanning. (2015). Antibiotic use in poultry: A driving force for organic poultry production. Food Prot. Trends, 35(6), 440–447.
15. Dorman H.J.D. and S.G. Deans (2000). Antimicrobial agents from plants: antibacterial activity of plant volatile oils. J Appl Microbiol. 88: 308–316.
16. Ghasemi R., M. Zarei and M. Torki .(2010). Adding medicinal herbs including garlic (allium sativum) and thyme (Thymus vulgaris) to diet of laying hens and evaluating productive performance and egg quality characteristics. Am J Anim Vet Sci. 5(2): 151.
17. Gheisar M.M., and Kim, I.H. (2018). Phytobiotics in poultry and swine nutrition–a review. Ital J Anim Sci. 17:92–9.
18. Gholijani N. and Amirghofran. Z. (2016). Effects of thymol and carvacrol on T-helper cell subset cytokines and their main transcription factors in ovalbuminimmunized mice. J Immunotoxicol. 13(5): 729–737.
19. Hashemipour H., Kermanshahi,,H., Golian, A. and Veldkamp, T. (2013). Effect ofthymol and carvacrol feed supplementation on performance, antioxidant enzyme activities, fatty acid composition, digestive enzyme activities, and immune response in broiler chickens. Poultry Sci. 92: 2059-2069.
20. Huang, C.M., Lee, T.T. (2018). Immunomodulatory effects of phytogenics in chickens and pigs. Asian-Australas. J. Anim. Sci. 31, 617-627.
21. Kim, J.D., Sherwin, J.A., Shim, KS. (2010). Effects of feed additive as an alternative for antibiotics on growth performancenand feed cost in growing-finishing pigs. Korean J Org Agric. 18:233–244.
22. Kovacs M., Tuboly T., Mézes M., Balogh K., Gerencsér Z., Matics Z., Bosco, A.D., Szendrő, Z., Tornyos, G., Hafner, D., Milisits, G., Balogh - Zándoki , E. and Zotte, A.D. (2016). Effect of dietary supplementation of spirulina arthrospira platensis) and thyme (Thymus vulgaris) on serum biochemistry, immune response and antioxidant status of rabbits. Ann Anim Sci. 19(1): 181-195.
23. Loetscher, Y., Kreuzer, M. , Messıkommer, R.E. (2014). Late laying hens deposit dietary antioxidants preferentially in the egg and not in the body. J. Appl. Poultry Res.,00973.
24. Nychas, G.J.E. (1995). Natural Antimicrobials from Plants. In: Gould, G.W., Ed., New Methods of Foods Preservation, Blackie Academic Chapman & Hall, Glasgow, 53-83, 3-2, 87-108.
25. Oso, A.O, Suganthi, R.U. Reddy, G.B.M., Malik, P.K., Thirumalaisamy, G., Awachat ,V.B., Selvaraju, S., Arangasamy, A., Bhatta, R. (2019). Effect of dietary supplementation with phytogenic blend on growth performance, apparent ileal digestibility of nutrients, intestinal morphology, and cecal microflora of broiler chickens. Poult Sci. Oct 1;98(10):4755-4766.
26. Placha, I., Simonova, M.P., Cobanova, K., Laukova, A. and Faix S. (2010). Effect of Enterococcus faecium AL41 and Thymus vulgaris essential oil on small intestine integrity and antioxidative status of laying hens. Res in Vety Sci, 89(2):257-261.
27. Platel K.and Srinivasan K. (2004). Digestive stimulant action of spices: a myth or reality? Indian J Med Res. 119:167–179.
28. Puvaca, N., L. Kostadınovıc, S. Popovıc, J. Levıc, D. Ljubojevıc, V. Tufarellı, R. Jovanovıc, T. Tasıc, P. Ikonıc, D. Lukac, (2015). Proximate composition, cholesterol concentration and lipid oxidation of meat from chickens fed dietary spice addition (Allium sativum, Piper nigrum, Capsicum annuum). Anim. Prod. Sci. 56, 1920-1927.
29. Sahin, K., Orhan, C., Tuzcu, M., Sahin, N., Hayirli, A., Bilgili, S., Kucuk, O. (2016). Lycopene activates antioxidant enzymes and nuclear transcription factor systems in heat-stressed broilers. Poult Sci. 95(5):1088-95.
30. Sahin, K., Akdemir, F., Orhan, C., Tuzcu, M., Hayirli, A., Sahin, N. (2010). Effects of dietary resveratrol supplementation on egg production and antioxidant status. Poult Sci. Jun;89(6):1190-8.
31. Sarica, S., Ciftci, A., Demir, E., Kilinc, K., Yildirim, Y., (2005). Use ofan antibiotic growth promoter and two herbal natural feed additives with and without exogenous enzymes in wheat based broiler diets. South African Journal of Animal Science 35, 61–72.
32. Surai, P.F., Kochish, I.I., Fisinin, VI., & Kidd, M.T. (2019). Antioxidant defence systems and oxidative stress in poultry biology: An update. Antioxidants, 8, 1–36.
33. Windisch, W., Schedle, K., Plitzner, C., Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. J Anim Sci. 86:140–148.

34. Zhao, X., Yang, Z.B., Yang, W.R., Wang, Y., Jiang, S Z, Zhang, G .G .(2011) .Effects of ginger root (Zingiber officinale) on laying performance and antioxidant status of laying hens and on dietary oxidation stability. Poult Sci, 90: 1720–1727.
35. Żyła, K., Mika, M., Duliński R., Świątkiewicz, S., Koreleski., J., Pustkowiak H., and Piironen J. (2012) .Effects of inositol, inositol-generating phytase B applied alone, and in combination with 6-phytase A to phosphorus-deficient dietson laying performance, eggshell quality, yolk cholesterol, and fatty acid deposition in laying hens. Poult Sci. 91(8):1915-27.

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