PHYTOBIOTICS IN POULTRY PRODUCTION: APPLICATIONS, BENEFITS, AND PERSPECTIVES

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Abstract

The aim of this paper was to synthesize current knowledge on the applications, benefits, and prospects of phytobiotics in poultry production. A literature-based analysis was conducted to assess the effects of medicinal and aromatic plants, plant extracts, essential oils, and other plant-derived bioactive compounds used as feed or water additives. The reviewed evidence indicates that phytobiotics may support digestive function, intestinal microbiota balance, immune response, antioxidant protection, and productive performance in poultry. In broilers, their supplementation has been associated with improved growth and feed utilization, while in laying hens, beneficial effects on egg production and quality have been reported. However, their efficacy depends on plant source, chemical composition, dosage, and administration conditions.

The originality of the paper lies in the integrated synthesis of the applications, biological benefits, limitations, and research perspectives of phytobiotics in poultry production. Their rational selection, standardization, and dosage are essential for safe and effective application in sustainable poultry farming.

Key words**:** *phytobiotics, poultry production, feed additives, productive performance, sustainability.*

INTRODUCTION

The poultry industry plays an important role in animal protein production, while feed composition and bioactive compounds significantly influence bird health and productive performance [1].

One of the main challenges in modern poultry farming is reducing antibiotic use due to the risk of antimicrobial resistance and its consequences for animal and public health [2]. In this context, phytobiotics, including plant extracts, essential oils, and medicinal plants, are considered promising alternatives because of their antioxidant, antimicrobial, and immunomodulatory properties.

Phytobiotics may improve nutrient digestibility, maintain intestinal microbiota balance, support immunity, and reduce stress effects. However, their efficacy depends on chemical composition, dosage, administration method, and bird physiology. Deminicis et al. (2021) [3] highlighted their potential in broiler nutrition, while determining optimal doses and combinations remains an important research priority [4,5].

The aim of this paper is to analyse the use of phytobiotics in poultry production, focusing on their mechanisms of action and effects on bird health and productive performance.

The main objectives are to examine phytobiotic categories, evaluate their effects on digestive function, intestinal microbiota, immunity, and antioxidant status, assess their influence on productivity, and identify the factors, limitations, and prospects of their use in sustainable poultry production.

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MATERIAL AND METHODS

The study was based on an analysis of scientific literature on the use of phytobiotics in poultry nutrition and production. The literature review was conducted using the PubMed, Web of Science, Scopus, and Google Scholar databases, focusing on publications from the last five years. Studies concerning medicinal and aromatic plants, plant extracts, essential oils, and other bioactive compounds administered through feed or drinking water were analysed.

Study selection focused on evaluating the effects of phytobiotics on gastrointestinal tract health, intestinal microbiota, immune response, antioxidant status, growth performance, and feed-use efficiency. Findings related to egg production and quality, carcass characteristics, and meat quality were also examined.

The analysis also addressed the selection of plant sources, identification of bioactive compounds, determination of optimal doses, and possible adverse effects associated with the inappropriate use of phytobiotics.

RESULTS AND DISCUSSION

Characterization and classification of phytobiotics

Phytobiotics are natural plant-derived bioactive compounds used as feed additives to support animal health and productivity [6, 7, 8, 9]. They are available as dried or ground plant materials, extracts, and concentrated preparations. The main categories include herbs, spices, essential oils, and plant extracts, each possessing specific biological properties (Figure 1) [10].

Aromatic plants (herbs) are rich in secondary metabolites, including flavonoids, essential oils, and phenolic compounds. Common examples include garlic (*Allium sativum*), ginger (*Zingiber officinale*), oregano (*Origanum vulgare*), rosemary (*Rosmarinus officinalis*), and thyme (*Thymus vulgaris*). Their bioactive compounds exhibit antimicrobial, antioxidant, and anti-inflammatory properties. In particular, thymol and carvacrol have antibacterial activity, while allicin contributes to the antimicrobial effects of garlic. These plants may support gastrointestinal health and broiler performance, although their effectiveness depends on composition, dosage, and administration method [11].

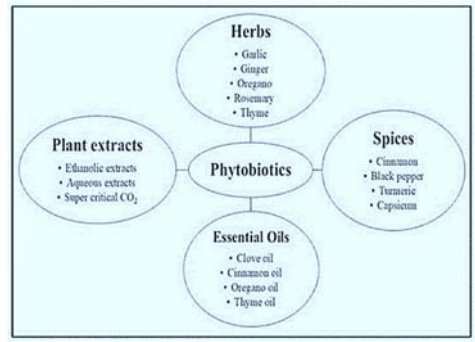


Figure 1. Classification of the main categories of phytobiotics [10]

Spices are plant-derived products obtained from fruits, seeds, roots, or bark and used to improve feed palatability and support physiological functions. Important examples include chilli pepper (*Capsicum annuum*), cinnamon (*Cinnamomum verum*), black pepper (*Piper nigrum*), and turmeric (*Curcuma longa*). Cinnamon possesses antimicrobial and antioxidant properties [12], while black pepper may stimulate digestive enzyme secretion and improve nutrient utilization [13]. Curcuminoids in turmeric also demonstrate antioxidant and anti-inflammatory activity, potentially protecting cells against oxidative stress [14].

Essential oils (EOs) are volatile mixtures extracted from different plant parts, mainly through steam distillation. Their antimicrobial activity is associated with interactions between active compounds and microbial cell membranes,

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leading to increased permeability and disruption of cellular functions. In addition to antimicrobial effects, some essential oils possess antioxidant and anti-inflammatory properties, making them valuable natural feed additives in broiler nutrition [15,16]. However, their effectiveness depends on chemical composition and dosage, as excessive concentrations may negatively affect beneficial intestinal microbiota [15, 16].

Plant extracts are concentrated preparations obtained using aqueous, ethanolic, or supercritical CO_2 extraction. They contain various bioactive compounds, including flavonoids, tannins, saponins, alkaloids, and glycosides. Examples include grape-seed, green-tea, chestnut, and *Yucca schidigera* extracts. Their biological effects depend on phytochemical composition and active-compound concentration. Flavonoids provide antioxidant and anti-inflammatory effects [17], while tannins may exert antimicrobial and astringent activities and support intestinal barrier integrity [18]. Saponins from *Yucca schidigera* may also contribute to reducing ammonia emissions and influencing intestinal structure and function [19].

Effects of phytobiotics on growth performance

Phytobiotics are considered promising alternatives to antibiotic growth promoters due to their antioxidant, antimicrobial, and anti-inflammatory properties, which may support intestinal health and productive performance. Windisch et al. [20] highlighted their potential to stimulate digestion and improve animal health through the use of plant extracts, essential oils, and spices.

Certain bioactive compounds may positively influence broiler growth and meat quality. For example, 1,8-cineole (eucalyptol), found in rosemary and eucalyptus essential oils, has been associated with increased body weight, daily weight gain, and improved feed conversion [21]. Similarly, [22] reported higher daily weight gains in broilers supplemented with turmeric and ginger compared with the control group and birds receiving cinnamon or garlic.

The effectiveness of phytobiotics depends on plant species, bioactive-compound composition, dosage, and administration period. Moreover, interactions between different plant compounds may produce complementary or synergistic effects, potentially exceeding the activity of individual substances [3]. Their biological properties are associated with various compounds, including terpenoids, flavonoids, alkaloids, phenols, tannins, glycosides, and glucosinolates [23, 34, 25]. These compounds contribute to antimicrobial, antioxidant, anti-inflammatory, and digestive effects [4, 5].

However, the mechanisms of action of phytobiotics remain incompletely understood. Their chemical composition varies according to plant species, plant part, geographical origin, and harvesting season, complicating the standardization and evaluation of their effects [26, 27].

Essential oils have also demonstrated beneficial effects on broiler performance. Studies investigating cinnamon-bark, clove-bud, and ajwain-seed oils, as well as combinations of cinnamaldehyde and formic acid, have highlighted their potential in poultry nutrition. Galal et al. (2016) [28] reported positive effects of oregano essential oil, containing 60.2% carvacrol and 4% thymol, on growth performance, humoral immune response, and interferon-alpha signalling.

Overall, phytobiotics may improve broiler growth and feed conversion by supporting digestion, nutrient absorption, and intestinal microbiota balance. They may also contribute to carcass quality and support egg production and quality, although their effects depend on the composition and conditions of supplementation.

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Effects on intestinal health and microbiota

Intestinal health is essential for broiler productivity and depends on intestinal barrier integrity, immune function, villus morphology, and microbiota balance. Phytobiotics can positively modulate intestinal microbiota, although their effects depend on composition and dosage. Mountzouris et al. (2011) [29] and Cross et al. (2007) [30] investigated the effects of phytogenic additives and medicinal plants on broiler performance and intestinal microflora. Kirkpinar et al. (2011) [31] studied oregano and garlic essential oils. Paraskeuas and Mountzouris (2019) [32] reported their potential to modulate intestinal microbiota and genes associated with immune response and barrier integrity. Similarly, [33] observed changes in intestinal microbiome and immune response following L-theanine supplementation.

Antioxidant effects and effects on the immune response

Phytobiotics possess antioxidant and immunomodulatory properties due to their bioactive compounds. Echinacea, liquorice, garlic, and essential oils may influence immune cell activity, phagocytosis, and interferon synthesis [34,35,36]. Sadeghi and Moghaddam [22] demonstrated the effects of turmeric, cinnamon, ginger, and garlic supplementation on antioxidant enzymes and metabolic hormones in broilers exposed to heat stress.

Overall, phytobiotics may support intestinal health, immune function, and antioxidant capacity, contributing to improved broiler performance. However, their effectiveness depends on composition, dosage, and feeding conditions.

CONCLUSIONS

Phytobiotics are a promising alternative for improving poultry health and productivity through their beneficial effects on digestion, intestinal microbiota, and antioxidant status. Their effectiveness depends on chemical composition, bioactive compound concentration, dosage, and bird physiology. Further research is needed to standardize products, establish optimal inclusion levels, and clarify their long-term effects, contributing to sustainable poultry production and reduced antibiotic use.

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