Rocz. Nauk. Zoot., T. 53., z. 1 (2026): 91–100 *DOI: 10.58146/7tjg-tz22*

HERBS AND PHYTOBIOTICS IN POULTRY NUTRITION

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Abstract

Phytobiotics used in poultry nutrition act as natural feed additives and health-promoting substances, beneficially affecting digestion, intestinal microbiota, animal welfare, and meat quality. Their effectiveness depends on the species and age of the birds, the type and form of feed, husbandry conditions, and the composition and dose of bioactive ingredients. Plant mixtures may exhibit synergistic effects, enhancing beneficial metabolic and immunological responses; however, potential antagonistic interactions between herbal components should also be taken into account. An optimal combination of phytobiotics maximizes production and health benefits, highlighting the need for further research into their mechanisms of action, chemical composition, and dosage for individual poultry species, with consideration of production needs and animal welfare.

Keywords: phytobiotics, poultry nutrition, gut microbiota, digestion, gut health

Introduction

The growing interest in safe and efficient poultry nutrition promotes the search for natural feed additives as alternatives to chemotherapeutic agents that can beneficially affect bird growth, condition, and immunity. Among the most frequently studied, and already used in practice, are probiotics, synbiotics, enzymes, organic and inorganic acids, eubiotics, postbiotics, and phytobiotics (Fig. 1). The term “phytobiotics” encompasses plant-derived substances also referred to as phytogenic additives, phytochemicals, or phytotherapeutics. This class includes four major subgroups: herbs, botanical substances, essential oils, and oleoresins. The aim of this publication was to analyze current literature describing the potential for replacing antibiotic growth promoters in the nutrition of growing and laying poultry.

Phytobiotics are an increasingly used group of natural feed additives in poultry production and breeding because of their diverse effects on growth, modification of the gastrointestinal microbiome, bird health, feed conversion ratio (FCR), and laying performance (Abdelli et al., 2021; Wang et al., 2024). Herbs in their natural form, as dried material, oils, or extracts contain numerous bioactive substances and their metabolites, such as flavonoids, alkaloids, terpenoids, and phenols, which exhibit diverse therapeutic properties. Oleoresins are natural plant extracts containing essential oils and a resin fraction rich in bioactive compounds, obtained by solvent extraction followed by solvent removal. In poultry nutrition, oleoresins may influence digestive

processes, oxidative status, and gastrointestinal function. The effectiveness of these additives depends on many factors, including the composition and activity of biologically active substances, inclusion level in the feed, bird genotype, and diet composition (Kuralkar and Kuralkar, 2021). They are attributed immunostimulatory effects (e.g. Echinacea, ginger, turmeric, garlic, oregano, hop cones, licorice), anti-inflammatory effects (turmeric, ginger, nettle), antioxidant effects (purple coneflower, thyme, green tea), adaptogenic effects (ginseng), antibacterial and antiviral effects (garlic, Echinacea), regulation of body homeostasis (turmeric, ginger, saffron), and support of digestive processes (peppermint, caraway, anise, turmeric, ginger, chamomile) (Wang et al., 2024; Makała, 2023). The health-promoting effects of phytobiotics and their regulation of metabolic processes directly translate into improved production outcomes. These include increased laying productivity, improved broiler meat quality, and favorable changes in feed conversion ratio (FCR), as confirmed by numerous studies and practical observations in poultry production (Aarti and Khusro, 2020; Shahrajabian et al., 2022; Wang et al., 2024; Yang et al., 2025), including in laying hen nutrition (Grela et al., 2026a; Grela et al., 2026b).

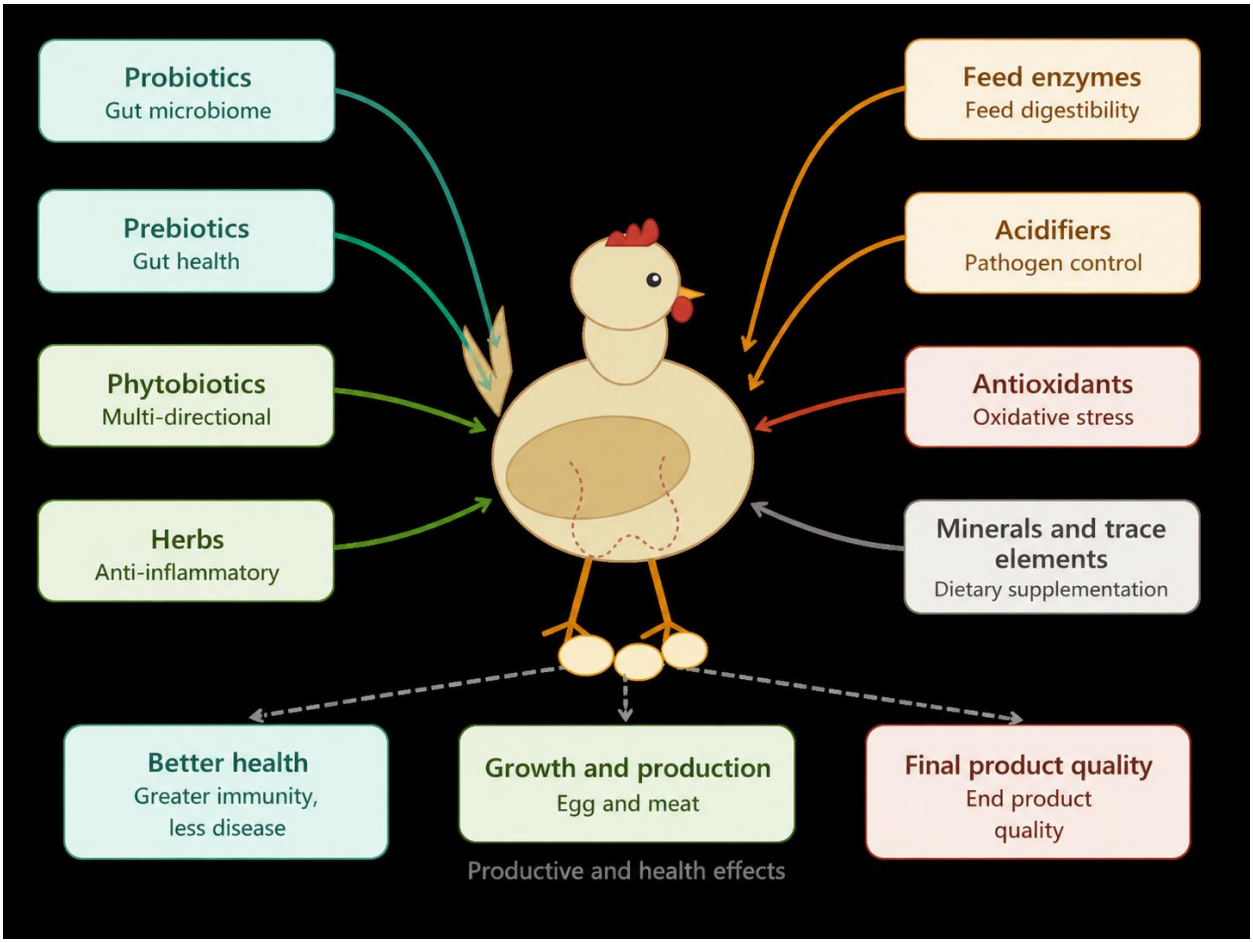

Fig. 1. The effect of feed additives on poultry health and productivity (own figure)

Effects of phytobiotics on poultry production performance

Many studies have demonstrated positive effects of phytobiotics on body weight gain, feed utilization, and laying performance. A feed mixture containing dried oregano, bay leaves, sage and myrtle, fennel seeds, and citrus peel significantly improved feed utilization. Sampath et al.

(2025), among others, reported a significant improvement in body weight gain (by approximately 5%) and feed efficiency (a reduction in FCR by approximately 3%) in broilers fed a diet containing 25 g/tonne of a mixture of carvacrol, cinnamaldehyde, and paprika oleoresin. In addition to their effects on production performance in meat-type poultry, phytobiotic additives also significantly influence egg production and egg quality parameters in laying hens. Sharma et al. (2020) demonstrated a beneficial effect on laying performance (an increase of more than 10%) and selected egg quality traits, including an approximately 24% increase in yolk weight, using a phytobiotic mixture containing ellagic acid, cymenol, and alliin isolated from *Punica granatum*, *Thymus vulgaris*, and *Allium sativum*, respectively, administered at 0.5 mL/L in drinking water. The authors attributed these effects to the antioxidant and immunomodulatory properties of these bioactive compounds (Aarti and Khusro, 2020). In turn, Zhang et al. (2020) showed that inclusion of 15% hemp nettle (*Urtica cannabina*) in laying-hen diets beneficially affected laying rate (an increase of more than 2%) and the content of selected vitamins, including vitamin A (by approximately 17%) and vitamin B2 (by approximately 50%). These findings suggest that phytobiotics can effectively modulate lipid metabolism, mineral balance, and antioxidant status in layers, thereby improving both quantitative and qualitative characteristics of egg production. The use of marigold or red pepper extracts in the nutrition of laying hens and broilers can produce an intense color of egg yolks and bird skin (Matache et al., 2024). Natural pigments such as lutein and zeaxanthin may replace synthetic colorants, providing an alternative for organic production.

The beneficial effects of phytobiotics on production performance are attributable to the presence of numerous bioactive compounds, including polyphenols, saponins, sulfur compounds, flavonoids, and essential oils, as well as vitamins and minerals (Abdelli et al., 2021). Dietary supplementation with phytobiotics containing 20% carvacrol and 25% thymol as active ingredients, 35% silicon dioxide as an anti-caking agent, and 12% glycerides as stabilizers (400 mg/kg) was shown to promote broiler growth (an increase of approximately 5%) and improve feed utilization (a reduction in FCR of approximately 12%) (Zhu et al., 2019). These compounds may improve feed palatability, stimulate digestive enzyme secretion, modulate intestinal microbiota, and inhibit pathogen growth, which directly contributes to improved production results (Niknia et al., 2025). Supplementing broiler diets with a mixture containing 25% thymol and carvacrol (1:1) at 60 mg/kg increased the activity of pancreatic enzymes such as trypsin (by approximately 20%), lipase (by approximately 13%), and amylase (by approximately 10%), particularly during the early rearing period. Studies also confirmed beneficial effects of these compounds on intestinal morphology, including increased villus height and villus-to-crypt ratio ($p<0.05$), which promoted better nutrient absorption and more efficient feed utilization (by approximately 2%) (Yang et al., 2025).

Effects of phytobiotics on poultry health and physiological functions

The use of phytobiotics in poultry affects not only production parameters but also bird health and physiological function. These effects include modulation of the immune response, reduction of oxidative stress, improvement of gastrointestinal function, and reduction of intestinal pathogen pressure (Kikusato, 2021; Zhu et al., 2019). These effects have been demonstrated in laying hens, broiler chickens, and turkeys, and their mechanisms have been associated with bioactive compounds affecting metabolic, immune, and barrier processes. Phytobiotics may support immune function by improving the blood biochemical profile and reducing metabolic burden. In broilers, supplementation with powdered Tulasi (*Ocimum sanctum*) leaves at 0.5–1% improved the lipid profile, including an increase in the HDL fraction (20–30%), which was interpreted as a factor conducive to a more efficient immune response (Bhagwat et al., 2021; Lanjewar et al., 2009). The same plant material administered at 0.1% alleviated the effects of

heavy-metal toxicity, including lead, by reducing liver enzyme activity (ALT — alanine aminotransferase — by nearly 50%), thereby limiting hepatocyte damage and supporting the body's defense mechanisms (Bhagwat et al., 2021; Bharavi et al., 2010).
A similar hepatoprotective effect was demonstrated after the use of turmeric (0.05% of the diet) in poultry receiving feed contaminated with aflatoxin B_1 (3 ppm). Turmeric supplementation reduced the activity of liver enzymes, i.e. alanine aminotransferase (ALT) from 17.2 U/L to 11.4 U/L and aspartate aminotransferase (AST) from 283 U/L to 228 U/L. The reduction in these enzyme activities indicated limited hepatocyte damage, which could indirectly support maintenance of normal immune function under conditions of metabolic and infectious stress (Gholami-Ahangaran et al., 2016).

One of the key mechanisms of phytobiotic action is the reduction of oxidative stress. In broiler chickens fed diets containing powdered Tulasi leaves (0.5%) and organic selenium (0.3 ppm), a significant reduction in lipid peroxidation and an approximately 22% increase in plasma glutathione concentration were observed, indicating activation of endogenous antioxidant mechanisms (Reddy et al., 2009). Likewise, addition of essential-oil mixtures (a blend of clove and eucalyptus essential oils at 25 g/100 kg or a blend of oregano, cinnamon, citrus-peel essential oils and fructooligosaccharides at 10 g/100 kg) to broilers under heat stress reduced lipid peroxidation by approximately 12% and cortisol concentration by approximately 19%, confirming their role in stabilizing oxidative homeostasis (Mounika et al., 2025).
An important effect of phytobiotics is their influence on intestinal microbiota and the integrity of the intestinal barrier. Saponins present in *Yucca schidigera* extract stabilized the intestinal microflora and reduced the abundance of pathogens such as *Clostridium perfringens* and *Escherichia coli* in both broilers and turkeys (Khaskheli et al., 2020; Chepete et al., 2012). In addition, this extract administered at 100 ppm reduced ammonia concentration (from 44 to 28%) and biogenic amines in the intestine, thereby supporting intestinal health and nutrient utilization. A direct effect of phytobiotics on intestinal barrier integrity has also been confirmed at the molecular level. In Arbor Acres broilers, dietary supplementation with resveratrol at 400 mg/kg feed counteracted LPS-induced intestinal barrier disruption, as reflected by increased expression of ZO-1, occludin, claudin-1, and MUC2, as well as reduced serum D-lactate concentration and DAO activity (Zhang et al., 2023). Moreover, supplementation of broiler diets with the phytobiotic Anta®Phyt, containing hop-derived bioactive ingredients, did not adversely affect bird performance. At the same time, favorable changes in intestinal morphostructure were observed, including improvements in intestinal wall thickness, crypt depth, and the villus-height-to-crypt-depth ratio, indicating improved functional status of the broiler intestine. Similarly, Ząbek et al. (2020) showed that supplementation with Anta®Phyt (from 0.04 to 0.03%), containing hop-derived bioactive compounds, did not negatively affect broiler performance and simultaneously improved intestinal morphostructure, as evidenced by an approximately 6% increase in intestinal wall thickness, an approximately 6% reduction in crypt depth, and a favorable approximately 5% increase in the villus-height-to-crypt-depth ratio, indicating improved functional status of the gastrointestinal tract. These findings are consistent with observations by Arczewska-Włosek et al. (2023), who demonstrated that supplementation with dried dandelion (*Taraxacum officinale*) extract at 2 g/kg diet in broilers challenged with *Eimeria spp.* improved gastrointestinal function and immune parameters (an increase of more than 40% in IgM titer and more than 13% in IgA titer), which was manifested, among other things, by improved growth indices, increased body weight gain, reduced oocyst shedding (by more than 26%), and favorable changes in intestinal morphology and barrier integrity.

Phytobiotics, especially essential oils, exhibit strong antimicrobial activity resulting from the presence of terpenoids and phenolic compounds. These substances disrupt bacterial cell membrane integrity, leading to leakage of ions and cellular constituents and consequently inhibiting the growth of intestinal pathogens.

Herbal extracts containing carvacrol, cinnamaldehyde, and paprika oleoresin promoted formation of a protective mucus layer on the intestinal surface, limiting pathogen adhesion and reducing the abundance of *E. coli* and *Clostridium perfringens*. In vivo studies in Cobb 500 broilers additionally showed that dietary administration of 0.05% basil, thyme, or sage essential oils reduced ($p<0.05$) the abundance of potentially pathogenic bacteria while increasing ($p<0.0001$) the proportion of *Lactobacillus spp.* in the intestine (Vlaicu et al., 2023).
Improved intestinal health is associated with enhanced digestive processes. Phytogenic feed additives increased the activity of digestive enzymes such as trypsin, lipase, and amylase and improved intestinal morphometry, including villus height and the villus-to-crypt ratio. These effects were confirmed in studies using 100 mg/kg of a microencapsulated essential-oil blend (carvacrol, thymol, and limonene), in which increases in the digestibility of protein (by approximately 3%), phosphorus (by approximately 9%), and cysteine (by approximately 4%) and enhanced expression of intestinal nutrient-transporter genes were observed (Hafeez et al., 2016; Elolimy et al., 2025). These results fit within a growing body of research suggesting that phytobiotics may act as epigenetic modulators, regulating gene expression without changing the nucleotide sequence of DNA. Despite promising reports, the mechanisms underlying these effects remain incompletely understood and require further research.

Synergistic and antagonistic effects of phytobiotics

The use of phytobiotics in poultry nutrition is associated with complex and multidirectional effects resulting from the presence of numerous bioactive substances and secondary plant metabolites. Depending on their type, dose, and combination, these substances may exert synergistic effects, mutually enhancing their beneficial properties, as well as antagonistic effects that weaken or modify the action of other components.
Synergistic effects are observed mainly in mixtures of plant extracts, where combining different essential oils or plant bioactive ingredients increases antimicrobial, immunomodulatory, and metabolic efficacy. An example is a mixture of oregano and garlic essential oils (a premix at 1 g/kg feed containing 50 g/kg oregano oil and 5 g/kg garlic oil), which improved production performance in broilers challenged with *Eimeria spp.*, as shown by increased final body weight (1833.9 vs 1685.9 g; $p<0.01$) and improved feed utilization (1489 vs 1569; $p<0.01$), together with a significant reduction in oocyst shedding (day 28: 3672 vs 3989 log oocysts/g; $p<0.01$; day 37: 3475 vs 4007 log oocysts/g; $p<0.001$) and favorable modulation of the intestinal microbiota (Sidiropoulou et al., 2020). Such combinations may stimulate digestive enzyme activity, increase nutrient absorption, and improve overall production efficiency, as emphasized in studies of phytobiotics containing polyphenols, flavonoids, and carotenoids (Wang et al., 2024). At the same time, antagonistic effects are also encountered. One example is the interaction between carvacrol, present in thyme and caraway, and eugenol, present in clove oil, which under some conditions may weaken antimicrobial or growth-promoting effects (Abdelli et al., 2021; Makała, 2023; Wang et al., 2024).

The complexity of interactions among phytobiotic components also results from their effects on the intestinal microbiota. On the one hand, synergistic action may stabilize the intestinal microflora, inhibit pathogen development, and support digestive processes (Hafeez et al., 2016; Zhu et al., 2019). On the other hand, certain combinations may antagonistically modulate enzyme secretion or the metabolism of specific nutrients, requiring precise selection of ingredients in feed mixtures. Properly selected combinations may improve nutrient absorption and digestive efficiency, whereas inappropriate combinations may limit the effectiveness of phytobiotics in improving body weight gain and FCR (Wang et al., 2024).

Preparations and forms of herbs for poultry

The use of phytobiotics in poultry nutrition is highly diverse in terms of both technological forms and routes of administration, which is an important factor determining their biological efficacy. Phytobiotics may be administered to birds in feed or water and are available as dried and ground herbs, plant extracts, essential oils, and standardized herbal preparations containing aqueous, alcoholic, or hydroalcoholic extracts. In feeding practice, infusions, decoctions, and herbal brews are also used, and the plants themselves may be offered in either fresh or dried form (Makała, 2022). Under free-range conditions, poultry additionally have continuous access to diverse vegetation, which they may select and consume according to their own nutritional and behavioral needs.

Herbs and their derivatives may be used as single components or as multi-ingredient mixtures. Studies have shown that combining different plant species or their extracts often results in a stronger biological effect than using individual raw materials, which is attributed to synergistic interactions among their bioactive compounds (Hristakieva et al., 2025). At the same time, available data indicate that individual phytobiotics may be particularly effective in influencing selected metabolic or health parameters. Moreover, the use of individual herbs such as turmeric or garlic has been associated with improvements in the amino acid profile and fatty acid composition of broiler meat, indicating their potential importance in shaping final product quality (Khaskheli et al., 2020; Ren et al., 2025; Sharma et al., 2020).

One of the basic and most commonly used forms of phytobiotics is dried and ground herbs, including oregano, thyme, basil, and mint. Their phenolic compounds and terpenoids exhibit antibacterial activity and may support stabilization of the intestinal microbiota by limiting the growth of pathogenic microorganisms. Plant extracts are an alternative characterized by a higher concentration of active substances, enabling more precise dosing and greater repeatability of biological effects. Essential oils are assigned a particular role in poultry nutrition because their lipophilic and volatile structure confers high bioavailability and antiseptic activity, stimulates secretion of digestive juices, and improves nutrient utilization (Aarti and Khusro, 2020; Ren et al., 2025; Zhu et al., 2019).

However, the effectiveness of phytobiotics in poultry nutrition varies considerably and depends on bird species, production group, and the technological form of the additive. The highest effectiveness (2.1–5%) was reported for dried herbs, dried extracts, and essential oils in broiler nutrition, as well as dried herbs and essential oils in laying hens. In geese, beneficial effects were observed mainly with fresh herbs, whereas in turkeys all forms of phytobiotics—fresh, dried, and essential oils—were effective. Low effectiveness (0–2%) was reported for fresh herbs and dried extracts in laying-hen nutrition, dried extracts in turkeys, and fresh herbs in duck diets. Inconclusive effects or a lack of literature data concerned fresh herbs used in broilers, as well as dried herbs, dried extracts, and essential oils in geese and ducks (Makała, 2023).

Many phytobiotic preparations intended for poultry production are commercially available. One example is Digestarom® Poultry, which contains a blend of essential oils and plant extracts that support intestinal health and improve feed digestibility. The recommended dose ranges from 150 to as much as 300 g per tonne of feed. Biostrong® 510 has similar properties; its composition is based on herbal extracts supporting respiratory and digestive functions, at a dosage of 150 g per tonne of feed. AviPlus®, a combination of essential oils and organic acids, effectively limits the development of pathogenic bacteria in the poultry gastrointestinal tract, and its recommended dose is 1–2 kg per tonne of feed. An increasing number of herbal-mineral-aromatic preparations are appearing on the market, including BioStrong, Dominal, and Digestarom, which contains essential oils of peppermint, marjoram, clove, anise, and fennel on an

inorganic carrier (Makała, 2022). Another interesting product is Garlin Plus, based on concentrated extracts of garlic, purple coneflower, and lovage. The dosage of phytobiotics depends on the type of preparation, its concentration, and specific production needs. It is essential to adjust the amount of additive to the production stage and health status of the flock in order to achieve optimal effects without the risk of excessive stimulation or undesirable interactions among feed components.

El-Sabrout et al. (2023) emphasize the need for research and development of practical solutions for using these additives in poultry nutrition. It is important to develop effective multi-herb preparations with targeted effects, for example hepatoprotective, choleretic, bactericidal, or counteracting fishy odors in products.

When phytobiotic additives are used, economic and environmental aspects should also be considered, including reducing the use of antibiotic growth promoters (Acharya and Barsila, 2025; Wang et al., 2024; Zhu et al., 2019).

Summary

Phytobiotics represent a promising alternative to antibiotic growth promoters in poultry nutrition because of their broad, multidirectional effects, including improvement of gastrointestinal function, modulation of intestinal microbiota, support of immunity, and reduction of oxidative stress. Consequently, they contribute to more favorable production parameters such as improved feed utilization, higher body weight gains, improved laying performance, and better meat and egg quality. At the same time, analysis of the available literature clearly indicates that their effectiveness is not universal and depends on many interacting factors, including bird species and age, diet composition and quality, technological form of the additive, dose, and the profile of bioactive compounds. An additional factor determining biological effects is the interaction among components of plant mixtures, which may act synergistically, strengthening desirable effects, or antagonistically, reducing their efficacy.

Therefore, despite the growing importance of phytobiotics in modern poultry production, their full utilization requires further well-designed studies. Particularly important is a deeper understanding of their mechanisms of action at physiological, biochemical, and epigenetic levels, the development of standardized and reproducible preparations, and the precise determination of optimal doses and combinations for different species and production systems. At the same time, their long-term effects on animal health, product quality, and the economic and environmental aspects that determine their practical use in animal production must be taken into account.

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Approved for publication: 1 June 2026

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