ARTICLES
Archives of Veterinary Science
https://www.ufpr.br/

Phytobiotics incorporation in feed: Case of ruminants and monogastric animals

Submitted: *08/03/2025*
Accepted: *26/10/2025*

Mouffok Assia[1], Saidj Dahia[2;3], Mefti Korteby Hakim[1]

[1]*Plant Biotechnology Research Laboratory, Department of Biotechnology and Agroecology, Faculty of Natural and Life Sciences, Saad Dahleb University, Blida1.*
[2]*Institute of Veterinary Sciences, Saad Dahleb University, Blida1.*
[3]*Health and Animal Production Laboratory SPA, High National Veterinary School, Oued Smar, Algiers, Algeria*

Author for correspondence: Mouffok Assia - assia18mouffok@gmail.com

Abstract: The ban on growth-promoting antibiotics (GPAs) in livestock feed in 2006 was primarily driven by growing concerns over antibiotic resistance, which poses a threat to both human and animal health. The widespread use of antibiotics in agriculture led to the development of resistant bacterial strains, reducing their effectiveness in treating infections. Additionally, the presence of antibiotic residues in animal products raised significant concerns regarding food safety and consumer health. These challenges prompted the search for alternative solutions that could maintain or even improve animal health and productivity without contributing to these issues. Phytobiotics have emerged as a promising alternative to antibiotics. These natural compounds, derived from various herbs, spices, and plants, have long been recognized for their health benefits. Historically appreciated for their antimicrobial, anti-inflammatory, and digestive properties, they are now being explored for similar uses in animal nutrition. The renewed interest in phytobiotics reflects their potential to address growing concerns about antibiotic resistance and chemical contamination in livestock products. This study aims to review the progress of research on the use of phytobiotics as an alternative to antibiotics in both monogastric species (e.g., poultry) and ruminants (e.g., cattle, sheep, and goats). It also aims to evaluate their impact on key factors, including animal performance, welfare, and the environmental footprint of farming practices. Previous studies have demonstrated that phytobiotics enhance animal performance by improving growth rates, feed conversion efficiency, and overall productivity. They also play a crucial role in maintaining animal health by boosting immune responses and gut health. Additionally, the use of phytobiotics has been linked to reduced environmental impact from farming, particularly by lowering methane emissions from ruminants and reducing the need for synthetic chemical additives in animal feed. These benefits highlight the potential of phytobiotics as a sustainable, health-conscious alternative to conventional antibiotics in livestock farming.
Keywords: Additives, phytobiotics, antibiotics, monogastric, environment, farming, performance, ruminants.

1. Introduction

The use of antibiotics in animal production has long been a common practice to prevent and treat infectious diseases and enhance growth performance. However, their intensive and uncontrolled use has led to the emergence of resistant microbial strains, compromising treatment efficacy and posing a risk to public health (Marazuela, Bogialli, 2009; Nisha, 2008). Chronic exposure to antibiotic residues in animal-derived products can lead to direct toxic effects and alter the human microbiota, thereby promoting the development of resistance (Anadón, 2006).

In response to these concerns, the European Union banned the use of antibiotics as growth promoters (AGPs) in 2006, after more than 50 years of use in livestock farming (Greathead, 2003; Rochfort et al., 2008; Mohammadi Gheisar, Kim, 2018). However, this ban led to a resurgence of animal infections, compromising livestock productivity and health. At the same time, increasing demand for sustainable and environmentally friendly farming has promoted the development of alternative methods to synthetic antibiotics, particularly in organic farming, where their use is strictly limited (Bourgoin et al., 2017; Nagarajan et al., 2017).

In this context, research has intensified to identify efficient substitutes for AGPs. Among the studied solutions, feed additives play a prominent role. According to the American Feed Control Officials (AFCO), a feed additive is a substance added to animal feed to meet a specific need, usually in small quantities and requiring careful incorporation (AFCO). These additives can be of plant, animal, or mineral origin and are widely used to improve digestion, stimulate growth, and enhance animal health (World Health Organization, 2018).

Among the most studied additives are probiotics (live microorganisms), prebiotics (substrates that promote the growth of specific bacteria in the digestive microbiota and are indigestible by the host animal), enzymes, organic acids, and natural phytobiotics. The latter, also known as phytogenic additives, refer to a group of bioactive compounds extracted from plants and incorporated into animal feed for their beneficial effects on growth and health (Windisch et al., 2008).

Phytobiotics, or phytogenics, are derived from a wide variety of herbs, spices, and plant extracts and are known for their distinctive aromas and pharmacological properties. They contain secondary plant metabolites—such as essential oils, alkaloids, flavonoids, and phenolic compounds—which are responsible for a range of biological activities, including antimicrobial, antioxidant, anti-inflammatory, and immunomodulatory effects (Bakkali et al., 2008; Schwab et al., 2008). These substances are typically classified as herbs (non-woody, non-perennial plants), plant parts (leaves, roots, bark), essential oils (volatile compounds obtained by distillation), and oleoresins (solvent-extracted compounds).

When incorporated into animal feed, phytobiotics have been reported to enhance digestive function, stimulate gastric and bile secretions, improve nutrient absorption, reduce gut pathogen load, and support the immune system (Kamel, 2001; Athanasiadou et al., 2007; Brenes & Roura, 2010). Their application, however, requires strict regulation and evaluation regarding dosage, composition, efficacy, and safety for animals, humans, and the environment (Anonymous, 2009).

Since ancient times, medicinal plants have been used to prevent and treat diseases in both humans and livestock (Radkowska, 2013). Advances in biochemistry have enabled the identification and characterization of numerous plant-derived active compounds, although their use was gradually abandoned in favor of synthetic antibiotics (Greathead, 2003; Rochfort et al., 2008). However, due to the health and environmental risks associated with antibiotics, phytobiotics have regained interest as natural alternatives (Ndomou et al., 2021).

These plant-based compounds, extracted from herbs, spices, and essential oils, exhibit antibacterial, anti-inflammatory, antioxidant, and immunostimulatory properties (Qin & Hou, 2017; Pandey et al., 2019; Martel et al., 2020; Kikusato, 2021). More than 5,000 phytobiotic molecules have been identified in various plant sources, including rosemary (α-pinene), oregano (carvacrol), thyme (thymol), cinnamon (cinnamaldehyde), and citrus fruits (limonoids) (Tsao & Deng, 2004; Liu, 2004; Mountzouris, 2016; Abd El-Hack et al., 2022).

2. Materials e Methods

This synthesis was developed based on a rigorous selection of scientific publications addressing the incorporation of phytobiotics into animal feed. The studies consulted focused mainly on the use of plants such as garlic, cloves, rosemary, peppermint, cumin, and fenugreek, evaluating their effects on digestive health, growth performance, feed efficiency, and immune status in both ruminants and monogastric animals.

The selected sources were drawn from specialized scientific journals, with particular attention to methodological quality, the relevance of the results, and the diversity of animal species studied. The publications reviewed describe experimental trials (*in vivo* and *in vitro*) conducted with phytobiotics in various forms (powders, extracts, essential oils), at different dosages and durations.

3. Results

3.1. Effectiveness of some spices used in poultry feed

The ban on antibiotics as growth promoters in broiler chicken feed underscores the need for thorough research into natural alternatives, such as phytobiotics. These are often added to feed, but can also be added to drinking water. They are widely used in broilers to improve growth performance, meat quality, and preservation (Windisch et al., 2008; Brenes and Roura, 2010).

Here are some commonly used phytobiotics in broiler diets, along with their beneficial effects. Various studies have investigated the impact of these substances on various zootechnical and immunological parameters, as well as their antimicrobial and antiparasitic efficacy. The results of these studies on the main spices and plant extracts used are summarized in Table 1, highlighting their applications and the beneficial effects observed in poultry.

Phytobiotics	Scientific Name	Effectiveness
Cinnamon	*Cinnamomum cassia / Cinnamomum zeylanicum*	Used to treat diarrhea and stimulate appetite in Chinese medicine. Cinnamon extract is effective against various bacteria (Smith-Palmer et al., 1998).
Oregano, Thyme, Red pepper	*Origanum vulgare, Thymus vulgaris, Capsicum annuum*	phytobiotic additives, such as oregano (5 g/kg), thyme (1.0 g/kg), and red pepper (1.0 g/kg), have been shown to have a stimulating effect on the intestines of chickens, particularly by promoting mucus secretion. This effect could inhibit the adhesion of pathogens, thereby helping to stabilize the microbial balance in the animals' intestines (Jamroz et al., 2006).
Garlic	*Allium sativum*	Srivastava et al. (1993) and Kumar and Berwal (1998) demonstrated that garlic oil (Allium sativum) possesses anti-tumour and antioxidant properties. In this context, an English study revealed a beneficial effect of garlic (1.0 g/kg) on growth and feed efficiency in chickens (Lewis et al., 2003). These authors concluded that garlic is likely to have a beneficial effect on the intestinal flora by reducing pathogenic bacteria, which would explain the improved performance in chickens.
Garlic, Fenugreek	*Allium sativum, Trigonella foenum-graecum*	A dietary supplement consisting of 1% garlic powder and 1% fenugreek powder showed a favourable response, particularly by improving blood parameters and the immune system (Seyed, 2014). Most studies show that gram-negative bacteria require higher doses of plant extracts for optimal antimicrobial efficacy (Shelef, 1983; Zaika, 1988; Smith-Palmer et al., 1998; Ceylan and Fung, 2004).
Oregano, Thyme essential oils	*Origanum vulgare, Thymus vulgaris*	Burt and Reinders (2003) observed an antibacterial effect of oregano and thyme essential oils against E. coli (gram-negative) at a dose of 0.6 ml/l. Moreover, some plant extracts are effective against parasites, particularly chicken coccidia (genus Eimeria), which are responsible for significant economic losses in the poultry industry worldwide (Sharkey, 1978; Christaki et al., 2004; Giannenas et al., 2005; Naidoo et al., 2008)
Turmeric (Curcumin)	*Curcuma longa*	At a dietary level of 1%, turmeric improved weight gain and reduced intestinal lesions in chickens infected with E. maxima. Its active compound, curcumin (1–5%), has antioxidant, anti-inflammatory, and anti-tumour properties (Allen et al., 1998).
Mix of essential oils: oregano, laurel, sage, anise, citrus	*Origanum vulgare, Laurus nobilis, Salvia officinalis, Pimpinella anisum, Citrus* spp.	Supplementation of 24 mg/kg of this essential oil blend significantly improved feed conversion ratio in broilers. (Cabuk et al., 2006).
fenugreek	*Trigonella foenum-graecum*	The inclusion of fenugreek at levels ranging from 0.01% to 4.0% in broiler diets improves zootechnical performance and immune response. Its extract, rich in steroids, stimulates digestive enzymes, enhances digestion, and protects the intestinal mucosa (Oueslati, 2015; Seyed, 2014). It also contains compounds that stimulate appetite and lower blood cholesterol, helping to prevent atherosclerosis (Adil, 2015).
Green anise	*Pimpinella anisum*	At doses between 0.5 g/kg and 1.5%, green anise improved all zootechnical parameters in broilers and enhanced liver and kidney function. Its essential oil showed in vitro antibacterial activity against B. cereus, S. aureus, and E. coli (0.98 mg/ml), and promoted both humoral and cellular immunity (Mahmood, 2014; Al-Kassie, 2008; El-Deek et al., 2002; Al-Shammari, 2017; Barakat, 2016.)

Table 1 – Summary of the main phytobiotics used in poultry feed and their beneficial effects.

3.2. Phytobiotics commonly used in layer diets, and their beneficial effects:

Laying hens benefit from various dietary supplements that help improve their health, production performance, and egg quality. Among these supplements, phytobiotics are gaining increasing interest due to their beneficial effects. The main impacts of some phytobiotics used in laying hens are summarized in Table 2.

Phytobiotics	Scientific Name	Effectiveness
Cinnamon	*Cinnamomum zeylanicum*	Immunostimulant properties likely linked to antioxidant activity; increased antibody levels in eggs (Lee et al., 1999).
Ginger	*Zingiber officinale*	Increased egg weight, improved egg quality, reduced yolk cholesterol, antioxidant and immunomodulatory effects, and stimulation of growth hormone (El-Hack et al., 2020; Kafi et al., 2017; Wen et al., 2019).
Turmeric	*Curcuma longa*	Improved production performance, egg quality, intestinal morphology, immune response, and economic efficiency (Azouz, 2020; Kinati et al., 2021; Kosti et al., 2020; Mousa et al., 2019; Rahman et al., 2021).

Table 2 – Effects of selected phytobiotics on performance, egg quality, and health parameters in laying hens.

3.3. Efficacy of some phytobiotics used in ruminant nutrition

Phytobiotics, additives classified as growth-promoting factors, are emerging as a promising solution (Hashemi S.R., Davoodi H., 2010). This category of additives has proven its advantage in stimulating animal growth by inducing significant changes in the dynamics of the ruminal ecosystem and the microbiota that thrive. Improved production performance, egg quality, intestinal morphology, immune response, and economic efficiency (Azouz, 2020; Kinati et al., 2021; Kosti et al., 2020; Mousa et al., 2019; Rahman et al., 2021). They improve the metabolism of the animal organism by improving digestion and nutrient absorption, stimulating immune activity and antioxidant activity, and consequently improving animal performance and well-being (Zeweil et al., 2016).

3.3.1. Effect of phytobiotics on the digestive process

The effect of phytobiotics on digestion is briefly illustrated in Figure 1.

3.3.2. Effect of phytobiotics and animal welfare

In the literature, medicinal plants are reported to be effectively used to treat a wide range of disorders and diseases, such as bloating (*Brassica campestris* L.), ectoparasites (*Azadirachta indica A*.), infertility (*Phoenix dactylifera* L.), milk production problems (*Cuminum cyminum* L.), diarrhea (Plantago lanceolata L.), retained placenta (*Allium sativum* L.), etc. This is also supported by the findings of Meena et al. (2015), who aimed to quantify the extent of ethno-veterinary practices in India. Their study revealed that a wide range of local herbs and plants (turmeric, lemon, neem, mustard, ajowan, etc.) were used appropriately to treat diarrhea, bloating, endo- and ectoparasites, mastitis, retained placentas, foot-and-mouth disease, and lameness.

Even in newborns, medicinal plants also retain their immunomodulatory properties. Shokrollahi et al. (2015) reported that the addition of garlic extract significantly improved immunity in goat kids, resulting in a significant increase in defence cells in the blood. This *in vivo* study aimed to visualize the effect of adding different doses (100 and 200 mg/kg body weight per day) of aqueous rosemary extract to newborn milk. The results showed that adding rosemary to the kids' milk significantly improved their immunity by increasing the number of leukocytes, which are heavily involved in the body's defence.

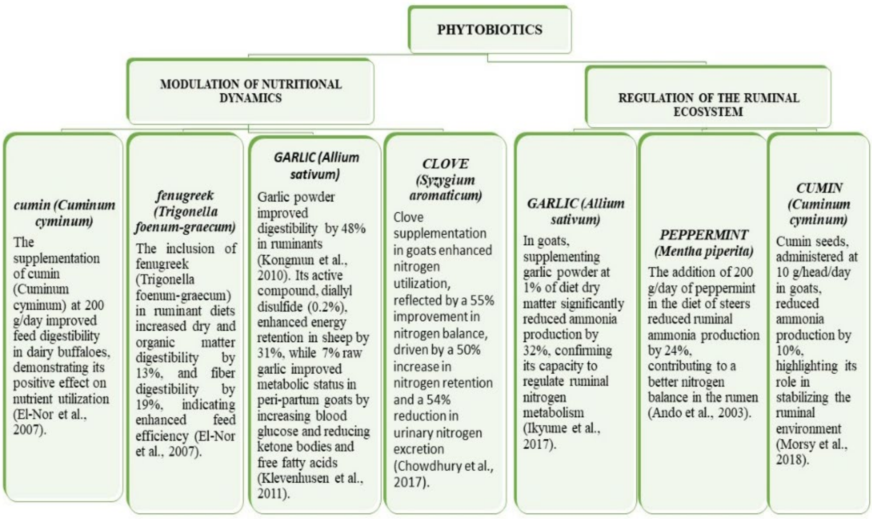

Figure 1 – Effect of phytobiotics on the digestive process.

3.3.3. Effect of phytobiotics on livestock performance

Phytobiotics have notable effects on zootechnical performance, particularly on growth and production.

Effect on growth:

In sheep, a study showed a significant improvement in the growth performance of lambs born to ewes supplemented with chamomile flowers (*Chamaemelum nobile*) and black cumin seeds (2 g per animal per day), with a higher average daily gain (ADG),

https://doi.org/10.5380/avs.v30i4.98837

attributed to better quality of maternal milk, especially in terms of protein content (EL-Ghousein, 2010). Furthermore, adding cumin to lambs' diets (7% and 14% of the basal diet) improves their growth (Jami et al., 2015).

In goats, supplementing kids' milk with aqueous garlic extract (250 mg/kg body weight) for 42 days significantly increases their ADG (Shokrollahi et al., 2016). Adding clay (3%) and thyme (3%) to the diet of growing goats significantly improves voluntary dry matter intake (Okali-Usur, 2019).

In cattle, garlic extract (250 mg/kg body weight) significantly improves growth in calves (Ghosh et al., 2010). In dairy cows, supplementation with a complex of essential oils (eucalyptus oil (*Eucalyptus globulus*) and menthol crystals, and peppermint essential oil) at increasing doses (16 and 32 mg/l in drinking water) improves growth parameters (Soltan et al., 2009).

Effect on production:

In sheep, the addition of 10 g/day of chamomile or black cumin flowers improves milk quality and quantity during lactation, with higher protein (PC) and mineral content (EL-Ghousein, 2010). The addition of rosemary extract (1200 mg per animal per day) also significantly increases milk production (Chiofalo et al.,2010).

In goats, a methanolic cumin extract (1.27% of dry matter intake) significantly improves milk yield (+13%) (Miri et al., 2013). Milk production increases by 11% to 15% in goats receiving dry lemongrass (*Cymbopogon citratus*) and rosemary leaves (10 g/head/day) in the concentrate (Kholif et al., 2017).

In dairy cows, the use of phytobiotics affects milk quantity and quality. Thus, a complex of essential oils (mint, eucalyptus, and menthol crystals) administered at 32 mg/l of drinking water to Holstein cows increases PC (Soltan et al., 2009). Similarly, supplementation with cumin seeds (200 g/day) in the diet of these cows significantly improves milk production, both in quantity and quality (Ghafari et al., 2015).

3.3.4. Ecological impacts of phytobiotics

The development of livestock farming has been the subject of debate, focusing on its impact on climate change and environmental protection. Methanogenesis is a metabolic process that eliminates hydrogen released during ruminal fermentation (Rizzoli D.J., Baxter R., & Reeve J.L., 1976; McDonald P., 2002; Claude J-B., 2002; Reyaud J.L. et al., 2014). Through this mechanism, ruminants produce significant amounts of methane (CH_4), a greenhouse gas, accounting for about 33% of global emissions of this gas, and contributing significantly to global warming by generating 4% of total greenhouse gas emissions (FAO, 2010, cited by Cobellis et al.; Shokrollahi et al., 2015). Several studies have examined the effectiveness of phytobiotics in reducing the environmental impact of ruminant farming. Kongmun et al. (2010) observed significant reductions of about 22% in methanogenic activity ($p < 0.001$) and about 5% in ammoniogenesis ($p < 0.05$) in an in vitro test using garlic powder. This reduction helps to reduce energy losses in the form of methane and nitrogen losses in the form of urea. Similarly, Cobellis et al. (2015) reported a similar effect in an *in vitro* test using 2 g/L of oregano and rosemary essential oils, reducing methanogenesis by 70% and 9% ($p<0.01$), respectively, and ammoniogenesis by 78% and 70% ($p<0.001$), respectively. There was also a remarkable reduction in CO2 emissions. Galindo et al. (2016) reported a significant decrease in ammoniogenesis of around 42% ($p<0.05$) in sheep fed a diet containing 12% dry matter concentrate in the form of coconut essential oil.

4. Discussion

The results obtained from various studies clearly highlight the promising potential of phytobiotics as natural alternatives to conventional antibiotics in animal nutrition. Whether used in poultry or ruminants, these plant-derived compounds have demonstrated beneficial effects on growth performance, immune function, digestive efficiency, product quality, animal welfare, and even environmental sustainability.

In poultry, particularly broilers and laying hens, the incorporation of phytobiotics such as garlic, oregano, thyme, turmeric, and fenugreek has improved feed conversion ratio, body weight gain, egg quality, and immune response. Several studies confirm their antimicrobial and antiparasitic properties, especially against Gram-negative bacteria and coccidia, which enhance intestinal health and zootechnical performance. Essential oils and spice-derived compounds (e.g., curcumin from turmeric, allicin from garlic, and thymol and carvacrol from thyme and oregano) contribute to these effects by modulating the gut microbiota, stimulating enzyme secretion, and exerting antioxidant and anti-inflammatory activities. These benefits also translate into economic advantages through improved feed efficiency and reduced disease incidence. In ruminants, phytobiotics exhibit an even broader spectrum of action. On the digestive level, additives such as cumin, fenugreek, garlic, and clove have significantly improved dry matter digestibility, energy retention, and nitrogen utilization. These effects suggest enhanced microbial fermentation and nutrient absorption, which are essential for optimal ruminal function. Moreover, certain phytobiotics help stabilize the ruminal ecosystem by reducing ammonia production, as observed with garlic, peppermint, and cumin supplementation. Such reductions not only improve nitrogen use efficiency but also reduce nitrogen excretion and the potential for environmental pollution. Animal welfare is also positively influenced by phytobiotic supplementation. Various medicinal plants have traditionally been used to treat digestive and reproductive disorders in livestock, and recent studies have confirmed their immunomodulatory potential. For example, garlic and rosemary extracts have been shown to enhance neonatal immunity by stimulating leukocyte production, thereby strengthening early-life defense mechanisms.

Livestock performance has also been favorably affected, particularly regarding growth and milk production. Phytobiotics such as chamomile, black cumin, lemongrass, and rosemary have been shown to improve daily weight gain and enhance milk yield and composition in various species, including kids, lambs, and dairy cows. These improvements are often attributed to better nutrient availability, enhanced metabolic activity, and, in some cases, hormonal modulation.

Finally, the ecological dimension of phytobiotics is attracting growing interest. Several in vitro and in vivo studies have reported a significant reduction in methane and ammonia emissions following the administration of garlic, oregano, rosemary, or coconut oil. This contributes to improved energy efficiency in ruminants and positions phytobiotics as a sustainable strategy for reducing the environmental footprint of livestock farming.

5. Conclusion

Phytobiotics represent a promising alternative to antibiotics, particularly for their ability to promote sustainable, environmentally friendly animal production. They help reduce dependence on conventional chemical products and veterinary medications, thereby contributing to more ethical farming practices and better ecosystem health. The use of phytobiotics as feed additives can be optimized by combining them with other beneficial compounds, such as prebiotics, which nourish beneficial gut bacteria, or probiotics, which support microbial balance. This synergy can enhance the positive impact of phytobiotics on digestive health and animal production performance, particularly by improving feed conversion, growth, and the quality of animal products. However, while phytobiotics offer clear benefits, further research is needed to precisely determine the optimal dosage, as it may vary across animal species and production conditions.

Additionally, it is essential to gain a deeper understanding of the cellular mechanisms of action of these substances to ensure more targeted and practical use. This includes studying their interactions with biological receptors and their effects on physiological processes, such as the immune response and anti-inflammatory mechanisms. Moreover, the formulation of additive blends combining several spices or plants with complementary effects could offer even more effective solutions to improve the nutritional efficiency of animal diets. Such an approach could maximize the benefits of phytobiotics by promoting digestive health, disease prevention, and optimizing zootechnical performance.

Finally, although phytobiotics are promising, their integration into farming practices requires close monitoring by manufacturers and regulatory authorities to ensure their safe use. It is essential to ensure the safety of the products, particularly the dosage and purity of the compounds, as well as their traceability throughout the production chain. Manufacturers must also ensure compliance with legal standards and health requirements to ensure the effectiveness of their products while protecting the health of both animals and consumers.

6. References

ABD EL-HACK, Mohamed E., EL-SAADONY, Mohamed T., SALEM, Heba M., et al. Alternatives to antibiotics for organic poultry production: types, modes of action and impacts on birds' health and production. Poultry science, 2022, vol. 101, no 4, p. 101696.ADIL, S., QURESHI, Saim, et PATTOO, R. A.,2015. A review on positive effects of fenugreek as feed additive in poultry production. International Journal of Poultry Science. vol. 14, no 12, p. 664.

ADIL, A. Effets de la curcumine : stimulation de l'appétit, réduction du cholestérol et prévention de l'athérosclérose. Journal of Nutritional Therapeutics, 2015, vol. 7, no 2, p. 45–52.

AL-KASSIE, Ghalib Alwan Mohammed. The effect of anise and rosemary on broiler performance. International Journal of Poultry Science, 2008, vol. 7, no 3, p. 243-245.ALLEN, Patricia C., DANFORTH, Harry D., et AUGUSTINE, Patricia C.,1998. Dietary modulation of avian coccidiosis. International journal for parasitology. vol. 28, no 7, p. 1131-1140.

ALLEN, Patricia C., DANFORTH, Hugh D., et AUGUSTINE, Patricia C. Dietary modulation of avian coccidiosis. International Journal of Parasitology, 1998, vol. 28, no 7, p. 1131–1140.

AL-SHAMMARI, K. I. A., BATKOWSKA, J., et GRYZIŃSKA, M. M. Effect of various concentrations of an anise seed powder (Pimpinella Anisum L.) supplement on selected hematological and biochemical parameters of broiler chickens. Revista Brasileira de Ciência Avícola, 2017, vol. 19, no 01, p. 41-46.

ANADÓN, A. WS14 The EU ban of antibiotics as feed additives (2006): alternatives and consumer safety. Journal of Veterinary Pharmacology and Therapeutics, 2006, vol. 29, p. 41-44.

ANDO, Sada, NISHIDA, T., ISHIDA, M., et al. Effect of peppermint feeding on the digestibility, ruminal fermentation and protozoa. Livestock Production Science, 2003, vol. 82, no 2-3, p. 245-248.

ANONYME. Food Additives in the EU, 2009. http://www.reading.ac.uk/foodlaw/additive.htm

ATHANASIADOU, S., GITHIORI, J., et KYRIAZAKIS, Ilias. Medicinal plants for helminth parasite control: facts and fiction. Animal, 2007, vol. 1, no 9, p. 1392-1400.

AZOUZ, Hesham Mahmoud. Effects of dietary turmeric and fenugreek powder supplementation on productive performance of local laying hens. Egyptian Poultry Science Journal, 2020, vol. 40, no 1, p. 243-258.

BAKKALI, Fadil, AVERBECK, Simone, AVERBECK, Dietrich, et al. Biological effects of essential oils–a review. Food and chemical toxicology, 2008, vol. 46, no 2, p. 446-475.

BARAKAT, D., EL-FAR, A., SADEK, K., et al. Anise (Pimpinella anisum) enhances the growth performance, immunity and antioxidant activities in broilers. International Journal of Pharmaceutical Sciences Review and Research, 2016, vol. 37, no 24, p. 134-140.

BOURGOIN, M A., GRAZA, G., PHILIPPE, G., et al. Study of the Antimicrobial Properties of Garlic Extract. Allium sativum, 2017, p. 1-5.

BRENES, Agustín et ROURA, E. Essential oils in poultry nutrition: Main effects and modes of action. Animal feed science and technology, 2010, vol. 158, no 1-2, p. 1-14.

BURT, Sara A. et REINDERS, Robert D. Antibacterial activity of selected plant essential oils against

Escherichia coli O157: H7. Letters in applied microbiology, 2003, vol. 36, no 3, p. 162-167.
CABUK, M., BOZKURT, M., ALCICEK, AHMET, et al. Effect of a herbal essential oil mixture on growth and internal organ weight of broilers from young and old breeder flocks. South African Journal of Animal Science, 2006, vol. 36, no 2, p. 135-141.
CEYLAN, Erdogan et FUNG, Daniel YC. Antimicrobial activity of spices 1. Journal of Rapid Methods & Automation in Microbiology, 2004, vol. 12, no 1, p. 1-55.
CHIOFALO, Biagina, RIOLO, E. B., FASCIANA, G., et al. Organic management of dietary rosemary extract in dairy sheep: effects on milk quality and clotting properties. Veterinary Research Communications, 2010, vol. 34, p. 197-201.
CHOWDHURY, M. R., KHAN, M. M. H., MAHFUZ, S. U., et al. Effects of dietary supplementation of spices on forage degradability, ruminal fermentation, in vivo digestibility, growth performance and nitrogen balance in Black Bengal goat. Journal of animal physiology and animal nutrition, 2018, vol. 102, no 2, p. e591-e598.
CHRISTAKI, Efterpi, FLOROU-PANERI, Panagiota, GIANNENAS, Ilias, et al. Effect of a mixture of herbal extracts on broiler chickens infected with Eimeria tenella. Animal Research, 2004, vol. 53, no 2, p. 137-144.
CLAUDE, J. B. Introduction à la nutrition des animaux domestiques. Technique et Documentation. 2002.
COBELLIS, Gabriella, ACUTI, Gabriele, FORTE, Claudio, et al. Use of Rosmarinus officinalis in sheep diet formulations: Effects on ruminal fermentation, microbial numbers and in situ degradability. Small Ruminant Research, 2015, vol. 126, p. 10-18.
EL-DEEK, A. A., ATTIA, Y. A., et HANNFY, Maysa M. Effect of anise (Pimpinella anisum), ginger (Zingiber officinale Roscoe) and fennel (Foeniculum vulgare) and their mixture on performance of broilers. 2003.
EL-GHOUSEIN, Safaa S. Effect of some medicinal plants as feed additives on lactating Awassi ewe performance, milk composition, lamb growth, and relevant blood items. Egyptian Journal of Animal Production, 2010, vol. 47, no 1, p. 37-49.
EL-HACK, Mohamed E., ALAGAWANY, Mahmoud, SHAHEEN, Hazem, et al. Ginger and its derivatives as promising alternatives to antibiotics in poultry feed. Animals, 2020, vol. 10, no 3, p. 452.
EL-NOR, SAH Abo, KHATTAB, H. M., AL-ALAMY, H. A., et al. Effect of some medicinal plant seeds in the rations on the productive performance of lactating buffaloes. 2007.
GALINDO, Juana, GONZÁLEZ, Niurca, DELGADO, Denia, et al. Effect of a regulator product of the fermentation with coconut oil on the methanogenic population and other microbial of the sheep rumen Pelibuey. Cuban Journal of Agricultural Science, 2016, vol. 48, no 4.
GHAFARI, M., SHAHRAKI, A. D. Foroozandeh, NASROLLAHI, S. M., et al. Cumin seed improves nutrient intake and milk production by dairy cows. Animal Feed Science and Technology, 2015, vol. 210, p. 276-280.
GHOSH, Sudipta, MEHLA, Ram K., SIROHI, S. K., et al. The effect of dietary garlic supplementation on body weight gain, feed intake, feed conversion efficiency, faecal score, faecal coliform count and feeding cost in crossbred dairy calves. Tropical Animal Health and Production, 2010, vol. 42, p. 961-968.
GIANNENAS, I. A., FLOROU-PANERI, P., BOTSOGLOU, N. A., et al. Effect of supplementing feed with oregano and/or alpha-tocopheryl acetate on growth of broiler chickens and oxidative stability of meat. Journal of Animal and Feed Sciences, 2005, vol. 14, no 3, p. 521.
GREATHEAD, Henry. Plants and plant extracts for improving animal productivity. Proceedings of the Nutrition Society, 2003, vol. 62, no 2, p. 279-290.
HASHEMI, S.R., DAVOODI. Phytogenics as new class of feed additive in poultry industry. J. Anim. Vet. Adv, 2010, vol. 9, p. 2295-2304.
IKYUME, Timothy Tertsegha, SOWANDE, O. S., DELE, P. A., et al. Effect of varying levels of garlic (Allium sativum) powder on growth, apparent nutrient digestibility, rumen ecology, blood profile and cost analysis of feeding West African Dwarf goats. Malaysian Journal of Animal Science, 2017, vol. 20, no 2.
JAMI, Younes Esmaeil, FOROUGHI, Alireza, SOLEIMANI, Akbar, et al. The effect of substituting wheat straw with different levels of cumin (Cuminum cyminum) crop residues on growth, blood metabolites and hematological values of Moghani male lambs. 2015.
JAMROZ, Dariusz, WERTELECKI, Tomasz, HOUSZKA, Maciej, et KAMEL, Charles. Influence of diet type on the inclusion of plant origin active substances on morphological and histochemical characteristics of the stomach and jejunum walls in chicken. Journal of Animal Physiology and Animal Nutrition, 2006, vol. 90, no 5-6, p. 255–268.
KAFI, Abdullahel, UDDIN, M. N., UDDIN, M. J., et al. Effect of dietary supplementation of turmeric (Curcuma longa), ginger (Zingiber officinale) and their combination as feed additives on feed intake, growth performance and economics of broiler. 2017.
KAMEL, C. Natural plant extracts: Classical remedies bring modern animal production solutions. Cahiers options méditerranéennes, 2001, vol. 54, no 3, p. 31-38.
KHOLIF, A. E., MATLOUP, O. H., MORSY, T. A., et al. Rosemary and lemongrass herbs as phytogenic feed additives to improve efficient feed utilization, manipulate rumen fermentation and elevate milk production of Damascus goats. Livestock science, 2017, vol. 204, p. 39-46.
KIKUSATO, Motoi. Phytobiotics to improve health and production of broiler chickens: functions beyond the antioxidant activity. Animal Bioscience, 2021, vol. 34, no 3, p. 345.

KINATI, Chala, AMEHA, Negasi, GIRMA, Meseret, et al. Effective microorganisms, turmeric (Curcuma longa) as feed additives on production performance and sensory evaluation of eggs from White Leghorn hens. Livestock Research for Rural Development, 2021, vol. 33, no 1.
KLEVENHUSEN, F., ZEITZ, J. O., DUVAL, S., et al. Garlic oil and its principal component, diallyl disulfide, fail to mitigate methane production but improve digestibility in sheep. Animal Feed Science and Technology, 2011, vol. 166, p. 356-363.
KONGMUN, P., WANAPAT, M., PAKDEE, P., et al. Effect of coconut oil and garlic powder on in vitro fermentation using gas production technique. Livestock science, 2010, vol. 127, no 1, p. 38-44.
KOSTI, Devvrat, DAHIYA, D. S., DALAL, Rajesh, et al. Role of turmeric supplementation on production, physical and biochemical parameters in laying hens. World's Poultry Science Journal, 2020, vol. 76, no 3, p. 625-637.
KUMAR, X., et BERWAL, Y. Garlic oil: anti-tumour and antioxidant effects. Journal of Food Science and Technology, 1998, vol. 35, no 5, p. 428–431.
LEE, Chang Woo, HONG, Dong Ho, HAN, Sang Bae, et al. Inhibition of human tumor growth by 2′-Hydroxy-and 2′-benzoyl-oxycinnamaldehydes. Planta Medica, 1999, vol. 65, no. 03, p. 263-266.
LEWIS, M. R., ROSE, S. P., MACKENZIE, A. M., et al. Dietary inclusion of plant extracts, including garlic, in male broiler diets improves growth performance. British Poultry Science, 2003, vol. 44, p. 43–44.
LIU, Rui Hai. Potential synergy of phytochemicals in cancer prevention: mechanism of action. The Journal of Nutrition, 2004, vol. 134, no 12, p. 3479S-3485S.
MAHMOOD, M., et AL-KASSIE, G. A. M. Effet de l'anis vert (Pimpinella anisum) sur les performances zootécnico-nutritionnelles, la fonction hépatique et rénale chez les poulets de chair. International Journal of Poultry Science, 2014, vol. 13.
MARAZUELA, M. D. et BOGIALLI, Sara. A review of novel strategies of sample preparation for the determination of antibacterial residues in foodstuffs using liquid chromatography-based analytical methods. Analytica Chimica Acta, 2009, vol. 645, no 1-2, p. 5-17.
MARTEL, Jan, OJCIUS, David M., KO, Yun-Fei, et al. Phytochemicals as prebiotics and biological stress inducers. Trends in biochemical sciences, 2020, vol. 45, no 6, p. 462-471.
MCDONALD, P., EDWARDS, R.A., GREENHALGH, J.F.D., MORGAN, C.A., SINCLAIR, L.A., WILKINSON, R.G. Animal nutrition. 7ème édition. Pearson Education, 2002, p. 692.
MEENA, M. L., SHARMA, N. K., et SINGH, Dheeraj. Ethnoveterinary treatment of sheep in Marwar region of Rajasthan, India. Indian Journal of Animal Research, 2015, vol. 49, no 5, p. 662-670.
MIRI, Vahideh Heidarian, TYAGI, Amrish Kumar, EBRAHIMI, Seyed Hadi, et al. Effect of cumin (Cuminum cyminum) seed extract on milk fatty acid profile and methane emission in lactating goat. Small Ruminant Research, 2013, vol. 113, no 1, p. 66-72.
MOHAMMADI GHEISAR, M. et KIM, I. H. Phytobiotics in poultry and swine nutrition – a review. Italian Journal of Animal Science, 2018, vol. 17, no 1, p. 92–99. https://doi.org/10.1080/1828051X.2017.1350120
MORSY, Tarek A., KHOLIF, Ahmed E., MATLOUP, Osama H., et al. Mustard and cumin seeds improve feed utilisation, milk production and milk fatty acids of Damascus goats. Journal of Dairy Research, 2018, vol. 85, no 2, p. 142-151.
MOUNTZOURIS, K. C. Phytogenic and probiotic feed additives for broilers: Evidence for growth performance links with gut performance indices. In: Proceedings of the 2016 World Nutrition Forum. Erber Ag, Austria. 2016. p. 107-116.
MOUSA, Baraa H., AWAD, Ahlam M., ALHAMDANI, H. A. A., et al. Inclusion of Garlic (Allium Sativum) and Turmeric (Curcuma longa L.) powder to laying hens' diets on egg quality traits, bacterial population and intestinal histomorphology. Annals of Tropical Medicine and Public Health, 2019, vol. 22, p. 231-240.
NAGARAJAN, Prabha, PREVOST, Christopher T., STEIN, Alexis, et al. Roles for the Rad27 flap endonuclease in mitochondrial mutagenesis and double-strand break repair in Saccharomyces cerevisiae. Genetics, 2017, vol. 206, no 2, p. 843-857.
NAIDOO, V., MCGAW, L. J., BISSCHOP, S. P. R., et al. The value of plant extracts with antioxidant activity in attenuating coccidiosis in broiler chickens. Veterinary parasitology, 2008, vol. 153, no 3-4, p. 214-219.
NAKATANI, Nobuji. Phenolic antioxidants from herbs and spices. Biofactors, 2000, vol. 13, no 1-4, p. 141-146.
NDOMOU, Serge Cyrille Houketchang, DJIKENG, Fabrice Tonfack, TEBOUKEU, Gires Boungo, et al. Nutritional value, phytochemical content, and antioxidant activity of three phytobiotic plants from West Cameroon. Journal of Agriculture and Food Research, 2021, vol. 3, p. 100105.
NISHA, A. R. Antibiotic residues: a global health hazard. Veterinary world, 2008, vol. 1, no 12, p. 375.
OKALI, USUR, J. Effects of thyme and garlic on growth and biochemical traits in goats. Development, 20019, vol. 31, no 3.
OUESLATI, H. -A. et GHÉDIRA, K. Notes ethnobotanique et phytopharmacologique sur Trigonella foenum-graecum. Phytothérapie, 2015, vol. 13, p. 234-238.
PANDEY, Amit Kumar, KUMAR, Prafulla, et SAXENA, M. J. Feed additives in animal health. Nutraceuticals in veterinary medicine, 2019, p. 345-362.
QIN, Si et HOU, De-Xing. The biofunctions of phytochemicals and their applications in farm animals: The Nrf2/Keap1 system as a target. Engineering, 2017, vol. 3, no 5, p. 738-752.
RADKOWSKA, Iwona. Wykorzystanie ziół i fitogenicznych dodatków paszowych w żywieniu zwierząt gospodarskich. Wiadomości Zootechniczne, 2013, vol. 51, no 4, p. 117-124.
RAHMAN, M. A., RAY, D., REDOY, M. R., et al. Dose titration of herbs mixture powder supplementation on

laying performance and egg quality in commercial layer chicken. Livest Res Rural Dev, 2021, vol. 33, p. 1.
REYAUD J.L. COLLECTIVE, Expertise Scientifique. Réduire les pertes d'azote dans l'élevage. Quae. 2014.
RIZZOLI, D. J., BAXTER, R., REEVE, J. L., et al. Proceedings: Effect of lupin grain supplementation on ovulation rate in Border Leicester X Merino ewes. Journal of Reproduction and Fertility, 1976, vol. 46, no 2, pp. 518-519.
ROCHFORT, Simone, PARKER, Anthony J., et DUNSHEA, Frank R. Plant bioactives for ruminant health and productivity. Phytochemistry, 2008, vol. 69, no 2, p. 299-322.
SCHWAB, Wilfried, DAVIDOVICH-RIKANATI, Rachel, et LEWINSOHN, Efraim. Biosynthesis of plant-derived flavor compounds. The Plant Journal, 2008, vol. 54, no 4, pp. 712-732.
SEYED MOHAMMAD, MOTAMEDI, et al., SEYED MOZAFAR MEHDIZADE. Investigating the effect of fenugreek seed powder and garlic powder in the diet on the immune response of commercial laying hens' eggs. Indian J. Sci. Res, 2014, vol. 3, no 1, p. 277-283.
SHARKEY, David Lee. Evaluation of coccidiosis in the presence of a mold inhibitor. 1978.
SHELEF, L. A. Antimicrobial effects of spices 1. Journal of Food Safety, 1984, vol. 6, no 1, pp. 29-44.
SHOKROLLAHI, Borhan, AMINI, Fardin, FAKOUR, Shahin, et al. Effect of rosemary (Rosmarinus officinalis) extract on weight, hematology and cell-mediated immune response of newborn goat kids. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 2015, vol. 116, no 1, p. 91-97.
SHOKROLLAHI, Borhan, HESAMI, Sayed Madeh, et al. BANEH, Hasan. The effect of garlic extract on growth, haematology and cell-mediated immune response of newborn goat kids. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 2016, vol. 117, no 2, p. 225-232.
SMITH-PALMER, A., STEWART, J, and FYFE, L. Antimicrobial properties of plant essential oils and essences against five important food-borne pathogens. Letters in applied microbiology, 1998, vol. 26, no 2, p. 118-122.
SOLTAN, M. A. E., SHEWITA, R. S., et AL-SULTAN, S. I. Influence of essential oils supplementation on digestion, rumen fermentation, rumen microbial populations and productive performance of dairy cows. 2009.
SRIVASTAVA, K. C., et MUSTAFA, T. Spices: Antiplatelet activity and prostanoid metabolism. Prostaglandins, Leukotrienes and Essential Fatty Acids, 1993, vol. 38, p. 255–266.
TSAO, Rong et DENG, Zeyuan. Separation procedures for naturally occurring antioxidant phytochemicals. Journal of chromatography B, 2004, vol. 812, no 1-2, p. 85-99.
WEN, Chao, GU, Yunfeng, TAO, Zhengguo, et al. Effects of ginger extract on laying performance, egg quality, and antioxidant status of laying hens. Animals, 2019, vol. 9, no 11, p. 857.
WHO. Food additives. 2018. http://www.who.int/en/news-room/fact-sheets/detail/ food-additives.
WINDISCH, W., SCHEDLE, K., PLITZNER, Ch, et al. Use of phytogenic products as feed additives for swine and poultry. Journal of animal science, 2008, vol. 86, no suppl_14, p. E140-E148.
ZAIKA, Laura L. Spices and herbs: their antimicrobial activity and its determination 1. Journal of Food Safety, 1988, vol. 9, no 2, p. 97-118.
ZEWEIL, H. S., ZAHRAN, S. M., AHMED, M. H., et al. Effect of organic selenium and ginger supplementation of a diet enriched with linseed oil on performance, carcass, blood lipid profile, with its traits in the meat and antioxidant property of growing rabbits. Egyptian Poultry Science Journal, 2016, vol. 36, no 4.