DÜZCE ÜNİVERSİTESİ
Derleme
Düzce Üniversitesi Ziraat Fakültesi Dergisi
(Journal of Agriculture Faculty of Düzce University)
https://dergipark.org.tr/tr/pub/jafdu

Use of medicinal and aromatic plants in poultry nutrition

Yahya Isik[1*], Orkun Babacan[1], Timucin Tas[1]

[1]*Kepsut Vocational School, Balıkesir University, Balıkesir, Türkiye*

**Sorumlu Yazar: yahya.isik@balikesir.edu.tr*

ARTICLE INFO

Article history:
Received 03.01.2025
Accepted 06.03.2025
Available online 20.06.2025

Keywords:
Medicinal and aromatic plants
Herbal extracts
Essential oils
Poultry nutrition

ABSTRACT

Due to the ban on antibiotics as feed additives in the European Union in 2006 and the adverse health effects of synthetic products, medicinal and aromatic plants, as well as the herbal extracts and essential oils derived from them, have gained importance in poultry farming as natural products. In recent years, the production of certain aromatic plants has begun, and market volume has increased, particularly in developed countries, due to the rising use in humans, animals, and plants. These plants exhibit numerous effects such as antioxidant, antifungal, antiviral, anti-inflammatory, antimicrobial, and digestive system stimulation. These effects are mediated through secondary metabolites. Consequently, herbal extracts and essential oils obtained from medicinal and aromatic plants (phytobiotics) have become attractive in poultry nutrition. This review aims to present current information on the importance, physical and chemical properties, modes of action, purposes of use, and significance of using herbal extracts and essential oils derived from medicinal and aromatic plants in poultry nutrition.

Tıbbi ve aromatik bitkilerin kanatlı beslemede kullanımı

MAKALE BİLGİSİ

Makale Geçmişi:
Geliş 03.01.2025
Kabul 06.03.2025
Çevrimiçi mevcut 20.06.2025

Anahtar Kelimeler:
Tıbbi ve aromatik bitkiler
Bitkisel ekstraktlar
Esansiyel yağlar
Kanatlı besleme

ÖZET

Antibiyotiklerin 2006 yılında Avrupa Birliğinde yem katkı maddesi olarak yasaklanmasından ve sentetik ürünlerin sağlığa olumsuz etkilerinin olmasından dolayı tıbbi ve aromatik bitkiler ve bunlardan elde edilen bitkisel ekstraktlar ve esansiyel yağlar doğal ürünler olarak kanatlı yetiştiriciliğinde önem kazanmıştır. Son yıllarda özellikle gelişmiş ülkelerde insan, hayvan ve bitkilerdeki kullanımın artması sonucu bazı aromatik bitkilerin üretimi yapılmaya başlanmış ve pazar hacmi artmıştır. Bu bitkilerin antioksidan, antifungal, antiviral, antiinflamatuar, antimikrobiyal ve sindirim sistemini uyarıcı gibi pek çok etkisi bulunmaktadır. Bu etkilerini sekonder metabolitler ile oluştururlar. Bu etkilerinden dolayı tıbbi ve aromatik bitkilerden (fitobiyotikler) elde edilen bitkisel ekstraktlar ve esansiyel yağlar kanatlı beslenmesinde çekici hale gelmişlerdir. Bu derlemede tıbbi ve aromatik bitkilerden elde edilen bitkisel ekstraktlar ve esansiyel yağların önemi, fiziksel ve kimyasal özellikleri, etki şekilleri, kullanım amaçları ve kanatlı beslemede kullanımının önemi hakkında güncel bilgilerin sunulmasını amaçlanmıştır.

1. Introduction

Plants have been fundamental elements of life throughout human history and have formed the basis of modern medicine (Yeşilbağ, 2007; Arslan et al., 2021). Due to the residues left by antibiotics in milk and meat products, which lead to antibiotic resistance and pose health threats, the use of antibiotics as feed additives (FAs) in animal nutrition was banned in Sweden in 1986, in Denmark and Switzerland in 1998, and in the European Union and Turkey in 2006 (Güven, 2021; Urban et al., 2024). However, the ban on antibiotics has led to the intensification of bacterial infections and a decrease in

poultry productivity during this period (Abd El-Hack et al., 2017; Abd El-Hack et al., 2022; Rahman et al., 2022). Following these bans, considering the harmful effects of synthetic substances, the use of alternative natural FAs, such as medicinal and aromatic plants (MAPs) containing phytochemical compounds, also known as phytobiotics (phytogenic feed additives, PFAs), has become promising (Gürsoy, 2021; Rafeeq et al., 2023; Alem, 2024).

Medicinal and aromatic plants which are phytochemical plants, producing various metabolites to sustain their lives and protect themselves, have been used in human medicine since ancient times, and exhibit pharmacological effects (Yeşilbağ, 2007; Rafeeq et al., 2023). When referring to medicinal and aromatic plants, the plant itself, its extracts, and essential oils come to mind (Okey, 2023; Alem, 2024). These plants stand out with their aromatic activities. Since the active ingredient ratios of extracts obtained from aromatic plants are variable, the direct use of plants is generally not preferred (Aydın, 2023). The various physical and chemical properties of plants are derived from active substances (secondary metabolites) that are not necessary for the normal growth, development, or reproduction of plants but are beneficial (Irchhaiya et al., 2015). In the last twenty years, phytobiotics have shown a wide range of effects, including antioxidant, anti-inflammatory, antimicrobial, antiviral, antilipidemic, antimycotic, and metabolic regulatory properties, in addition to their aromatic effects (Kikusato, 2021; Rafeeq et al., 2022; Öztürk Aydın & Cengiz, 2023). Additionally, they are widely used in poultry production to stimulate the immune system and prevent and control various bacterial, viral, and protozoal diseases (Greene et al., 2021; El-Shall et al., 2022). This review aims to present current information on the use of MAPs, which are important and increasingly used as feed additives, in poultry nutrition.

2. Importance of Medicinal and Aromatic Plants

Plants synthesize secondary metabolites to protect against pathogens such as viruses, bacteria, and fungi. These substances protect the plant's DNA and photosynthetic apparatus from oxidative damage caused by ultraviolet radiation (Kikusato, 2021). Medicinal and aromatic plants are widely used due to their anti-inflammatory, antioxidant, and antimicrobial effects. In fact, these plants have long been used in disease control (Tundis et al., 2017). Using these plants aim to improve the feed conversion ratio (FCR) in poultry nutrition (Spernakova et al., 2007). Plants such as cumin, mint, rosemary, thyme, and cinnamon have been used in poultry nutrition for their antioxidant, anti-inflammatory, antiseptic, antimicrobial, and digestive stimulant effects (Önenç & Turgud, 2019). While many medicinal and aromatic plants are collected from nature, some plants, such as thyme, are also cultivated (Aslan and Karakuş, 2019). Türkiye is rich in medicinal and aromatic plants due to its climate, plant diversity, and geographical location. There are over 12,000 plant species in Türkiye, 3,600 of which are endemic (Anonim, 2019). Plants commonly found and produced in Türkiye, such as sage, linden, licorice, and cumin, are known for their antioxidant, anti-inflammatory, and antimicrobial properties (Şahin-Nadeem et al., 2013). Additionally, these plants are used in various sectors for different purposes (Erten et al., 2023).

3. Properties and Effect Types of Medicinal and Aromatic Plants

Plants experience stress and produce secondary metabolites when the optimal tolerance level of at least one environmental factor, such as temperature, salinity, drought, or high light, is exceeded (Yang et al., 2018; Isah, 2019). These metabolites are found in the roots, leaves, fruits, or seeds of medicinal and aromatic plants (MAPs). Secondary metabolites include essential oils, flavonoids, alkaloids, saponins, tannins, and resins. These metabolites are known as beneficial organic compounds that are not essential for the organism's normal development or reproduction but are advantageous (Irchhaiya et al., 2015). They provide the taste and aroma of plants and also possess bioactive properties. Most MAPs, rich in secondary metabolites, exhibit high antioxidant activity. Plants containing flavonoids demonstrate higher antioxidant activity (Mohammed et al., 2018; Yakoub et al., 2018). Commercially, they are also becoming increasingly important. For example, flavonoids in licorice root are reported to have 100 times more antioxidant effect than vitamin E (Erten et al., 2023).

In addition to their antifungal, antimicrobial, antiviral, antioxidant, and antilipidemic effects, medicinal and aromatic plants (MAPs) are reported to have properties that stimulate the digestive system, strengthen the immune system, and enhance performance and vitality. The composition and effects of herbal extracts obtained from phytobiotics vary depending on the part of the plant used, harvest time, geological origin, processing method, and storage conditions, as well as the species and age of the animals (Adıyaman & Ayhan, 2010; Gürsoy, 2021; Dilbato Dinbiso et al., 2022; Rafeeq et al., 2023).

3.1. Properties and Effect Types of Herbal Extracts

Herbal extracts have been traditionally used for centuries in the treatment of various diseases (Güven, 2021). These extracts contain nutrients in their chemical structures, such as small amounts of fatty acids, proteins, essential amino acids, peptides, oligosaccharides, vitamins, and trace minerals (Aydın, 2023). These extracts improve the sensory properties of feed, enhance animal performance, and increase the quality of products obtained from these animals. They have antimicrobial, antioxidant, anti-stress, and growth-promoting effects (Çetin, 2012; Öztürk Aydın & Cengiz, 2023). Table 1 presents the parts used, active ingredients, and effect of types of some extracts used in poultry nutrition (Tipu et al., 2006; Adıyaman & Ayhan, 2010; Aydın, 2023).

Several theories have been proposed to explain the antibacterial effects of herbal extracts. According to these theories, the active substances in the extracts interact with electron transport, ion gradients, protein translocation, phosphorylation, and enzyme-dependent reactions in the bacterial cell membrane, exhibiting antibacterial activity (Yanar & Aktaş, 2021). Some herbal extracts (thyme, cinnamon, rosemary, garlic) have been reported to have positive effects on performance parameters by inhibiting the growth of microorganisms such as *Salmonella sp.*, *Escherichia coli* (*E. coli*), and *Clostridium sp.* (Öztürk Aydın & Cengiz, 2023).

The diversity of active metabolites in plant species also alters the effects of herbal extracts on the digestive system. Many herbal extracts stimulate saliva secretion, while

some (ginger, turmeric, mint, anise, and cumin) increase the synthesis and release of bile acids in the liver. Additionally, herbal extracts have been reported to stimulate pancreatic enzymes (such as amylases and lipases) and increase the activities of digestive enzymes in the stomach mucosa (Adıyaman & Ayhan, 2010). Herbal extracts play an important role in maintaining the pH balance necessary for the maximum activity of digestive enzymes in the digestive system (Aydın, 2023).

Table 1. Used parts, active ingredients and effect types of some aromatic plants

Aromatic plant	Part used	Active ingredient	Mode of action
Sage	Leaf	Eucalyptol	Digestive stimulant, antiseptic, flatulence
Rosemary	Leaf	Cineole	Digestive stimulant, antiseptic, antioxidant
Bay	Leaf	Eucalyptol	Appetite stimulant, digestive stimulant, antiseptic
Clove	Flower	Eugenol	Appetite stimulant, digestive stimulant, antiseptic
Cumin	Seed	Cuminaldehyde	Digestive stimulant, carminative
Thyme	Whole plant	Thymol, carvacrol	Digestive stimulant, antiseptic, antioxidant
Mint	Leaf	Menthol	Appetite stimulant, digestive stimulant, antiseptic
Garlic	Bulb	Allicin	Digestive stimulant, antiseptic
Cinnamon	Bark	Cinnamaldehyde	Appetite stimulant, digestive stimulant, antiseptic
Ginger	Rhizoma	Zingerone	Digestive stimulant

3.2. Properties and Effects of Essential Oils

Essential (volatile) oils are compounds obtained from medicinal and aromatic plants, typically found in liquid form, which can crystallize at room temperature and are volatile with strong odors. Essential oils have a highly dense and complex structure. They are mostly colorless or light yellow, and the characteristic scent of many plants originates from these oils (Yeşilbağ, 2007; Güven, 2021; Okey, 2023). These oils are obtained from the flowers, buds, leaves, branches, wood, fruits, and roots of plants through distillation and extraction methods. They possess antiseptic, antioxidant, digestive stimulant, antimicrobial, enzymatic, anti-rheumatic, diuretic, anti-inflammatory, and disinfectant properties. The primary effects attributed to essential oils include the increased release of digestive enzymes and the reduced availability of nutrients for pathogenic gut bacteria (Okey, 2023). It is reported that approximately one-third of the 300 plant families in nature contain essential oils (Yeşilbağ, 2007; Güven, 2021). The antimicrobial mechanisms or properties of essential oils are not fully determined, but it is suggested that they increase the lipid solubility of the bacterial cell membrane surface, leading to the rupture and disintegration of the bacterial outer membrane (Dorman & Deans, 2000; Kırkpınar et al., 2011). Some volatile oils, such as terpenoids and phenylpropanoids, are reported to have strong antimicrobial effects against *Clostridium perfringens* and *E. coli* by penetrating bacterial cells using their lipolytic and chemical properties (Okey, 2023).

4. Purposes of Use and Effects of Medicinal and Aromatic Plants

In high-income countries, the use of medicinal and aromatic plants (MAPs) in humans has increased again, bringing their use in the form of natural herbal medicines to the forefront. MAPs have become industrial products in fields such as phytotherapy, medical and veterinary applications, aromatherapy, nutraceuticals, cosmeceuticals, and animal welfare. These innovative applications, which add value, have enabled the use of MAPs in functional foods, livestock, and agriculture (plant protection). Additionally, considering that more than half of the existing medical drugs are derived from plants,

even though the pharmaceutical industry focuses on developing new drugs, natural products will continue to be an important source for new compounds (Arslan et al., 2021).

MAPs contain secondary metabolites such as tannins, saponins, flavonoids, and essential oils, and therefore have found wide usage in sectors such as cosmetics, perfumes, food, and medicine, in addition to adding flavor, aroma, and color to foods since ancient times (Arslan et al., 2021; Alem, 2024). In poultry farming, herbal extracts and essential oils are used to prevent physiological stress in organs and cells due to various stress factors such as stocking density and heat stress (Okey, 2023; Öztürk Aydın & Cengiz, 2023). Moreover, in recent years, they have been widely used in poultry nutrition to enhance flavor, increase efficiency, prevent lipid oxidation, stimulate digestive secretions, improve nutrient digestibility and absorption, promote gastrointestinal microorganisms, strengthen the immune system, and for their antibacterial, coccidiostatic, anthelmintic, antiviral, anti-inflammatory, antioxidant effects, and growth-promoting potential (Aydın, 2023; Alem, 2024).

4.1. Effects of Antibacterial, Antiparasitic and Antifungal

Many researchers have reported that plant extracts or essential oils have strong antimicrobial effects and can be used as alternatives to antibiotics both as feed additives (FAs) and for therapeutic purposes in studies conducted with various animal species (Dorman & Deans, 2000; Çimrin & Demirel, 2016). Many medicinal and aromatic plants (MAPs) contain flavonoid additives with antimicrobial effects, such as baicalein, limonene, cinnamaldehyde, carvacrol, or eugenol, and are effective against microorganisms such as *Salmonella* sp., *E. coli*, *Streptococcus* sp., and *Staphylococcus* sp., as well as having antifungal properties against *Candida albicans* (Alem, 2024). Basmacıoğlu-Malayoğlu et al. (2011) reported in their study that essential oils obtained from cumin, bay leaf, clove, rosemary, anise, and thyme have antimicrobial effects on *Staphylococcus aureus*, *Salmonella typhimurium*, and *E. coli*. Aloe vera has been reported to be a plant with antibacterial and antiprotozoal properties, particularly aiding in the control of coccidiosis in poultry, and contains flavonoids and genes with anti-edema effects in acute irritation (Misra et al., 2018). Another study reported that aloe vera herbal products help combat bacteria and viruses and increase antibody titers against Newcastle disease and coccidiosis in broilers (Akram et al., 2019). Babacan et al. (2012) reported that in the first protocol, disc diffusion method included antibiograms discs with different concentrations of oregano extract were used. Zone diameters were measured in 1/10 oregano concentrations to be 15, 19 and 16 mm for *Salmonella gallinarum, Salmonella enteritidis* and *Salmonella typhimurium*, respectively. This study declared that in the second protocol oregano extract with different concentrations (20 and 30 µl/ml) were added into medium content and bacterial growth were evaluated. Colony counts for S. tyhphimurium and S. enteriditis were 952; 536 and 1600; 440 in 20 and 30 µl/ml concentrations of oregano extract, respectively. Babacan et al. (2012) reported that oregano extract had antibacterial effect on *Salmonella* serotypes according to their results.

4.2. Antioxidant Effects

Antioxidants are substances that delay and prevent lipid oxidation, and when added to food, they reduce spoilage, prevent the formation of unsafe oxidation products, and preserve nutritional quality (Alem, 2024). They also play a role in preventing oxidative stress in both animals and plants (Sordillo, 2013; Zahrazadeh et al., 2018; Öner, 2023). A study (Huang et al., 2021) reported that natural extracts exhibit antioxidant effects by increasing the expression of antioxidant proteins heme oxygenase-1, superoxide dismutase (SOD), and catalase.

4.3. Effects of Anti-inflammatory and Immune-Stimulant

The composition of nutrients can directly affect the immune responses of chicks. The systemic immune system is strongly regulated by gut-associated lymphoid tissue (Rafeeq et al., 2023). Essential oils can strengthen the immune system and positively affect animals by regulating the duodenal mucosa. Natural plants that regulate the immune system can be used as alternatives to standard chemotherapy for disorders such as immunodeficiency (Güven, 2021). Phenols, terpenoids, and flavonoids are the main anti-inflammatory secondary metabolites. Extracts of red pepper, cinnamon, black pepper, ginger, clove, nutmeg, turmeric, mint, and cumin were reported to have anti-inflammatory properties (Jalal et al., 2019). Plants such as echinacea, licorice, garlic, and cat's claw contain chemical substances that stimulate the immune system. These plants can increase the number of lymphocytes and macrophages, stimulate phagocytosis, and promote interferon production (Güven, 2021).

4.4. Effects on Growth Performance

Flavors can make feeds more attractive. It is reported that feed intake is encouraged not only by the taste of the feed but also by its smell, texture, color, and the balance of the compound feed content (Alem, 2024). A study on broilers (Kumar et al., 2014) found that black pepper improved the feed conversion ratio (FCR). Capsaicin has been found to increase the amount of pancreatic and intestinal enzymes in non-ruminant animals by increasing saliva secretion (producing amylase) (Costa et al., 2013). It has been reported that increasing amounts of garlic powder supplementation in compound feed increased the FCR in laying hens (Asrat et al., 2018).

In broilers, growth promotion, live weight gain (LWG), and FCR can be achieved through improved feed intake (FI) and feed utilization, inhibition of bacterial pathogens, and modulation of gut microflora that improves gut health. Moreover, improvements in nutrient digestion and absorption through enhanced gut functions, direct and indirect anabolic activity in target tissues, and activation of endocrine and antioxidative defense systems may be other principles of growth promotion by phytobiotics. However, the mechanisms underlying the effects of phytobiotics are not fully explained (Rafeeq et al., 2023).

The gut is an organ responsible for performing vital functions, including digestion and host defense. Any disruption in gut function can affect nutrient digestion, which can negatively impact the health and growth performance of chickens (Mishra & Jha, 2019; Abdul Basit et al., 2020). Intestinal crypts are thought to be the basis for the

differentiation of epithelial cells of intestinal villi. Additionally, the depth of the crypts is directly related to the rotation of epithelial cells. Deeper crypts reflect increased cell turnover and require more energy to maintain normal gut function in broilers (Abdul Basit et al., 2020). Current research results show that phytobiotics have beneficial effects on intestinal crypts, making them shallower, which indicates a healthy gut. The presence of shallow crypts means reduced cell turnover and, consequently, reduced energy use, which can instead be used for the growth processes of broilers (Abdul Basit et al., 2020). Increased height of intestinal villi and decreased depth of intestinal crypts enhanced the absorption capacity of the small intestine. Longer intestinal villi prevent faster passage of food and increase nutrient intake, leading to increased poultry productivity and FCR (Ortatatlı et al., 2005; Tavangar et al., 2021). Studies have shown that the use of ginger and green tea in the compound feed of chickens increases the size of villi, leading to increased surface area for nutrient absorption and cell division in various parts of the intestine, and reduced risk of pathogenic microbiota (Gadang et al., 2008; Gilani et al., 2021).

5. Use in Poultry Nutrition

In the last few decades, medicinal and aromatic plants (MAPs) have been widely used in poultry compound feeds in many countries (Yeşilbağ, 2007). The use of herbal extracts and essential oils in poultry helps animals cope with stress factors such as stocking density and heat stress, increases the number of beneficial microorganisms in the digestive tract, and improves feed conversion ratio (FCR) (Gürsoy, 2021; Aydın, 2023; Okey, 2023). Additionally, it is reported that the phenolic compounds in herbal extracts enhance oxidative stability and prevent the adverse effects of stress (Aydın, 2023).

Since the immune systems of chicks hatched from eggs are not fully developed, proper nutrition in the early stages is extremely important. Therefore, it has been reported that adding herbal extracts and essential oils to poultry rations during the early development stage is more beneficial (Kahraman, 2009). This can promote feed intake (FI), improve live weight (LW), live weight gain (LWG), and FCR, and activate digestive enzymes (Gürsoy, 2021). Additionally, this can lead to improvements in carcass quality and a reduction in mortality rates (Yeşilbağ, 2007). There are numerous studies on the use of MAPs in poultry.

In a study by Şahin et al. (2012), echinacea (1 and 5 g/kg) was added to quail feeds. They reported that these additions had no effect on LW, LWG, FI, FCR, and carcass yield. In a study on Japanese quails exposed to cold stress (İflazoğlu et al., 2015), the effects of saponin-enriched soapwort extract added to the ration on performance, some carcass characteristics, blood parameters, and mortality rate were examined. No differences were found between the groups in terms of performance, carcass characteristics, mortality rate, low-density lipoprotein (LDL), total cholesterol, alanine aminotransferase (ALT), and aspartate aminotransferase (AST) levels.

In a study on quails using juniper oil as a natural antioxidant (Yeşilbağ, 2018), the effects of this oil on growth performance were investigated. It was reported that live weight gain and carcass weight increased, and juniper oil could be considered a natural

antioxidant to improve performance. In a study by Saraç (2019), it was reported that thyme (*Origanum onites*) essential oil (0, 100, 200, and 400 ppm) did not affect performance parameters, serum biochemical and antioxidant values, and carcass yield in broiler compound feeds. In a study by Jobe et al. (2019) to determine the effects of different stocking densities (5, 10, 20 m^2/animal) and different ratios of senna extract (0, 50, 200, 500 mg/kg) on performance and oxidative stress in chickens, it was reported that FI was lower in the group with high stocking density. In the group with 500 mg/kg senna extract, growth performance decreased, and oxidative stress was reduced.

In a study by Daş et al. (2020), the effects of adding mint oil (0%, 0.1%, 0.2%, and 0.3%) to quail compound feeds on meat quality, fattening performance, carcass composition, and oxidative stress parameters were investigated. It was reported that performance parameters (LW, LWG, FI, FCR), carcass composition, and meat quality parameters (carcass color-pH) were not affected, and there were no differences between the groups ($P>0.05$). In a study by Reda et al. (2021) on quails, the effects of licorice (Glycyrrhiza glabra) (0, 250, 500, 750, and 1000 mg/kg) on performance parameters (LW, LWG, FI, FCR), oxidative status, immunity, and lipid profile were examined. It was found that performance values were best in the groups with 750 and 1000 mg/kg licorice. Additionally, the group with 750 mg/kg licorice had higher total protein and globulin levels, while LDH, total cholesterol, triglyceride, and LDL values were lower. Compared to the control group, serum malondialdehyde (MDA) levels decreased, while superoxide dismutase (SOD), tricarboxylic acid (TAC), immunoglobulin G, and M increased.

6. Conclusion

Projections for poultry meat and egg consumption indicate that demand will continue to increase daily. The conscious consumer is interested in purchasing the highest quality products. Production conditions, including feed quality, naturalness, and welfare levels, are expressed as important criteria for this consumer group. Consequently, the use of medicinal and aromatic plants and the extracts and essential oils derived from them will become an increasingly widespread trend in societies, and animal nutrition will also take its necessary share from this change. After the ban on the use of antibiotics as feed additives in animals, it will be inevitable to permanently add essential oils and plant extracts to poultry compound feeds as natural and health-enhancing additives. Today, the popularity of medicinal and aromatic plants is also increasing due to their antimicrobial, antioxidant, growth-promoting, immunostimulant, flavoring, and preservative effects. It is also inevitable that these plants will provide new perspectives in the nutrition of both humans and animals due to their positive effects on poultry health and their many functional properties. However, there are still some gaps in the mechanisms related to the beneficial effects of herbal extract or essential oil supplements in poultry farming and in determining effective doses. Therefore, future studies should investigate all the mechanisms of action of effective extracts and oils obtained from medicinal and aromatic plants in poultry and develop these products.

Acknowledgments

This study was not supported by any institution.

Author Contribution

Y.I.: Writing the article and literature research.
T.T.: Literature research and writing the article.
O.B.: Literature research and writing the article
The authors declare that they have made equal contributions to the study on the above-mentioned topics.

Conflict of Interest Declaration Information

There is no conflict of interest.

References

Abd El-Hack, M. E., El-Shall, N. A., El-Kasrawy, N. I., El-Saadony, M. T., Shafi, M. E., Zabermawi, N. M., Alshilawi, M. S., Alagawany, M., Khafaga, A. F., Bilal, R. M., Elnesr, S. S., Aleya, L., AbuQamar, S. F., & El-Tarabily, K. A. (2022). The use of black pepper (*Piper guineense*) as an ecofriendly antimicrobial agent to fight foodborne microorganisms. *Environmental Science and Pollution Research International*, *29*(8): 10894–10907. https://doi.org/10.1007/s11356-021-17806-7

Abd El-Hack, M. E., Mahgoub, S. A., Alagawany, M., & Ashour, E. A. (2017). Improving productive performance and mitigating harmful emissions from laying hen excreta via feeding on graded levels of corn DDGS with or without *Bacillus subtilis* probiotic. *Journal of Animal Physiology and Animal Nutrition*, *101*(5): 904–913. https://doi.org/10.1111/jpn.12522

Abdul Basit, M., Abdul Kadir, A., Loh, T. C., Abdul Aziz, S., Salleh, A., Kaka, U., & Banke Idris, S. (2020). Effects of Inclusion of Different Doses of *Persicaria odorata* Leaf Meal (POLM) in Broiler Chicken Feed on Biochemical and Haematological Blood Indicators and Liver Histomorphological Changes. *Animals : an open access journal from MDPI*, *10*(7): 1209. https://doi.org/10.3390/ani10071209

Adıyaman, E., & Ayhan, V. (2010). Etlik Piliçlerin Beslenmesinde Aromatik Bitkilerin Kullanımı. *Journal of Animal Production*, *51*(1).

Akram, M. Z., Salman, M., Jalal, H., Asghar, U., Ali Z., Javed M. H., & Khan M. (2019). Evaluation of dietary supplementation of Aloe vera as an alternative to antibiotic growth promoters in broiler production. *Turkish Journal of Veterinary Research, 3*(1): 21-26.

Alem W. T. (2024). Effect of herbal extracts in animal nutrition as feed additives. *Heliyon*, *10*(3): e24973. https://doi.org/10.1016/j.heliyon.2024.e24973

Anonim. (2019). *Tıbbi ve aromatik bitki çeşitliliğinin korunmasında, bunların üretiminde ve pazarlanmasında karşılaşılan sorunlar ile alınması gereken tedbirlerin belirlenmesi amacıyla kurulan meclis araştırması komisyonu raporu*. https://acikerisim.tbmm.gov.tr/server/api/core/bitstreams/55c24001-21fd-43b1-83e5-8ece5e650098/content.

Arslan, D., Aydın, M., & Türker, S. (2021). Extraction Methods of Medicinal and Aromatic Plants, Its Use in Foods and Evaluation in Food Supplement Field. *Turkish Journal of Agriculture- Food Science and Technology*, *9*(5): 926–936. https://doi.org/10.24925/turjaf.v9i5.926-936.4399

Aslan, R., & Karakuş, Z. (2019). Gelenekten günümüze tıbbi ve aromatik bitkiler. *Göller Bölgesi Aylık Hakemli Ekonomi ve Kültür Dergisi*, *6*(73): 60-66.

Asrat, M., Zeryehun, T., Amha, N., & Urge, M. (2018). Effects of supplementation of different levels of garlic (*Allium sativum*) on egg production, egg quality and hatchability of White Leghorn chicken, *Livestock Research for Rural Development, 30*(3). http://www.lrrd.org/lrrd30/3/tesf30037.html

Aydın, M. Ö. (2023, Aralık). *Farklı yerleşim sıklığında yetiştirilen bıldırcınların rasyonlarına bitkisel ekstrakt karışımı katılmasının performans, et kalitesi ve bazı oksidatif stres parametreleri üzerine etkisi* [Doktora tezi, Aydın Adnan Menderes Üniversitesi Sağlık Bilimleri Enstitüsü]. Adnan Menderes Üniversitesi Açık Erişim Sistemi.http://adudspace.adu.edu.tr:8080/xmlui/bitstream/handle/11607/4910/meltem%20%c3%b6zt%c3%bcrk%20ayd%c4%b1n%20pdf%20tez.pdf?sequence=1&isAllowed=y

Babacan, O., Cengiz, S., & Akan, M. (2012). Detection of antibacterial effect of oregano plant on various *Salmonella* serotypes. *Ankara Üniversitesi Veteriner Fakültesi Dergisi, 59*(2): 103-106. https://doi.org/10.1501/Vetfak_0000002510

Basmacıoğlu-malayoğlu, H., Özdemir, P., & Hameş-kocabaş, E. E. (2011). Chemical compositions and antibacterial activity of the essential oils from some plant species. *Journal of Agriculture Faculty of Ege University*, *48*(1): 11-18.

Costa, L. B., Luciano, F. B., Miyada, V. S., & Gois, F. D. (2013). Herbal extracts and organic acids as natural feed additives in pig diets. *South African Journal of Animal Science*, *43*(2):181–193.

Çetin, M. (2012). Hayvan beslemede antibiyotik ve antiparaziterlere alternatif olarak bitkisel ekstraklar ve Pelinotu'nun (Artemisia Absinthium) kullanılması. *KSÜ Doğa Bilimleri Dergisi*, *15*(4): 58-63. https://doi.org/10.18016/ksujns.75907

Çimrin, T., & Demirel, M. (2016). Influences of rosemary essential oil on some blood parameters and small intestine microflora laying hens. *Türk Tarım - Gıda Bilim ve Teknoloji Dergisi* , *4*(9): 769-775.

Daş, B., Daş, A., Koyuncu, İ., Bilal, O., Çetin, M., Kırar, N., Tufan, T., & Şengül, A. Y. (2020). Bıldırcın rasyonlarına nane yağı ilavesinin besi performansı, et kalitesi, karkas kompozisyonu ve oksidadif stres belirleyicileri üzerine etkisi. *Türk Tarım ve Doğa Bilimleri Dergisi*, *7*(1): 186-194. https://doi.org/10.30910/turkjans.680061

Dilbato Dinbiso, T., Deressa, F. B., Legesse, D. T., Shumi Gebisa, E., Choramo Diko, A., & Tolosa Fulasa, T. (2022). Antimicrobial activity of selected ethnoveterinary medicinal plants of southern region, Ethiopia. *Infection and Drug Resistance*, *15*: 6225–6235. https://doi.org/10.2147/IDR.S366063

Dorman, H. J., & Deans, S. G. (2000). Antimicrobial agents from plants: antibacterial activity of plant volatile oils. *Journal of Applied Microbiology*, *88*(2): 308–316. https://doi.org/10.1046/j.1365-2672.2000.00969.x

El-Shall, N. A., Abd El-Hack, M. E., Albaqami, N. M., Khafaga, A. F., Taha, A. E., Swelum, A. A., El-Saadony, M. T., Salem, H. M., El-Tahan, A. M., AbuQamar, S. F., El-Tarabily, K. A., & Elbestawy, A. R. (2022). Phytochemical control of poultry coccidiosis: a review. *Poultry Science*, *101*(1): 101542. https://doi.org/10.1016/j.psj.2021.101542

Erten, K., Coskuntuna, L., & Koc, F. (2023). Toplam karışım rasyonuna bitki ekstraktları katkısının in vitro gaz üretim parametreleri üzerine etkisi. *Journal of Agriculture Faculty of Ege University*, *60*(2): 317-329. https://doi.org/10.20289/zfdergi.1232824

Gadang, V. P., Hettiarachchy, N. S., Johnson, M. G., & Owens, C. (2008). Evaluation of antibacterial activity of whey protein isolate coating incorporated with nisin, grape seed extract, malic acid, and EDTA on a Turkey frankfurter system. *Journal of Food Science*, *73*(8): M389–M394. https://doi.org/10.1111/j.1750-3841.2008.00899.x

Gilani, S. M. H., Rashid, Z., Galani, S., Ilyas, S., Sahar, S., Zahoor-Ul-Hassan, Al-Ghanim, K., Zehra, S., Azhar, A., Al-Misned, F., Ahmed, Z., Al-Mulham, N., & Mahboob, S. (2021). Growth performance, intestinal histomorphology, gut microflora and ghrelin gene expression analysis of broiler by supplementing natural growth promoters: A nutrigenomics approach. *Saudi Journal of Biological Sciences*, *28*(6): 3438–3447. https://doi.org/10.1016/j.sjbs.2021.03.008

Greene, E. S., Maynard, C., Owens, C. M., Meullenet, J. F., & Dridi, S. (2021). Effects of herbal adaptogen feed-additive on growth performance, carcass parameters, and muscle amino acid profile in heat-stressed modern broilers. *Frontiers in Physiology*, *12:* 784952. https://doi.org/10.3389/fphys.2021.784952

Gürsoy, E. (2021). Bitkisel ekstraktların hayvan beslemede kullanımı. *Kadirli Uygulamalı Bilimler Fakültesi Dergisi, 1*(1): 71–79.

Güven, Ş. (2021, Ocak). *Tam yağlı süte organik asit, bitkisel ekstrakt ve prebiyotik karışımı ilave edilmesinin süt emme dönemindeki siyah alaca buzağılarda performans, dışkı ve kan parametreleri üzerine etkileri* [Yüksek Lisans tezi, Hatay Mustafa Kemal Üniversitesi Fen Bilimleri Enstitüsü]. Hatay Mustafa Kemal

Üniversitesi Kurumsal Akademik Arşiv. https://openaccess.mku.edu.tr/server/api/core/bitstreams/8663893f-2c2b-4593-981e-94da772c42d3/content

Huang, M. H., Lin, Y. H., Lyu, P. C., Liu, Y. C., Chang, Y. S., Chung, J. G., Lin, W. Y., & Hsieh, W. T. (2021). Imperatorin interferes with LPS binding to the TLR4 co-receptor and activates the Nrf2 antioxidative pathway in RAW264.7 murine macrophage cells. *Antioxidants (Basel, Switzerland)*, *10*(3): 362. https://doi.org/10.3390/antiox10030362

Irchhaiya R, Kumar A, Yadav A, Gupta N, Kumar S, Gupta N, Kumar S, Yadav V, Prakash A, Gurjar H. (2015). Metabolites in plants and its classification. *World Journal of Pharmacy and Pharmaceutical Sciences (WJPPS), 4*(1): 287-305.

Isah T. (2019). Stress and defense responses in plant secondary metabolites production. *Biological Research*, *52*(1): 39. https://doi.org/10.1186/s40659-019-0246-3

İflazoğlu Mutlu, S., Çelik, Ö., Bayrak, O., Emreoğlu, L., Terlemez, F., Azman, M. A., Şişek, Ü. G., Özçelik, M., Çerçi, İ. H., Kenar, M., Çiftçi, M. (2015). Soğuk stres koşulları altında bıldırcın karma yemlerine ilave edilen saponin bakımından zenginleştirilmiş çöven ekstraktının performans ve kan parametreleri üzerine etkileri. *Fırat Üniversitesi Sağlık Bilimleri Veteriner Dergisi*, *29*(2): 103-109. https://doi.org/10.33988/auvfd.717013

Jalal, H., Akram, M. Z., Canoğulları Doğan, S., Yaman Fırıncıoğlu, S., Irshad, N., & Khan, M. (2019). Role of aloe vera as a natural feed additive in broiler production. *Turkish Journal of Agriculture - Food Science and Technology*, *7*(sp1): 163–166. https://doi.org/10.24925/turjaf.v7isp1.163-166.2800

Jobe, M. C., Ncobela, C. N., Kunene, N. W., & Opoku, A. R. (2019). Effects of *Cassia abbreviata* extract and stocking density on growth performance, oxidative stress and liver function of indigenous chickens. *Tropical Animal Health and Production*, *51*(8): 2567–2574. https://doi.org/10.1007/s11250-019-01979-y

Kahraman, Z. (2009). Bitkisel yem katkı maddelerinin yumurta tavuğu yemlerinde kullanımı. *Tavukçuluk Araştırma Dergisi, 8*(1): 34–41.

Kırkpınar, F., Ünlü, H. B., & Özdemir, G. (2011). Effects of oregano and garlic essential oils on performance, carcase, organ and blood characteristics and intestinal microflora of broilers. *Livestock Science, 137*: 219-225.

Kikusato, M. (2021). Phytobiotics to improve health and production of broiler chickens: functions beyond the antioxidant activity. *Animal Bioscience*, *34*(3): 345–353. https://doi.org/10.5713/ab.20.0842

Kumar, M., Kumar, V., Roy, D., Kushwaha, R. B., & Vaswani, S. (2014). Application of Herbal Feed Additives in Animal Nutrition - A Review -. *International Journal of Livestock Research, 4*: 1-8.

Mishra, B., & Jha, R. (2019). Oxidative stress in the poultry gut: Potential challenges and interventions. *Frontiers in Veterinary Science*, *6:* 60. https://doi.org/10.3389/fvets.2019.00060

Misra, A. K., Varma, S. K., & Kumar, R. (2018). Anti-inflammatory effect of an extract of *agave americana* on experimental animals. *Pharmacognosy Research*, *10*(1): 104–108. https://doi.org/10.4103/pr.pr_64_17

Mohammed, F. S., Akgül, H., Sevindik, M., & Khaled, B. M. T. (2018). Phenolic content and biological activities of *Rhus coriaria* var. *zebaria*. *Fresenius Environmental Bulletin, 27*(8): 5694-5702.

Okey, S. N. (2023). Alternative feed additives to antibiotics in improving health and performance in poultry and for the prevention of antimicrobials: A review. *Nigerian Journal of Animal Science and Technology (NJAST), 6*(1): 65-76.

Ortatatlı, M., Oğuz, H., Hatipoğlu, F., & Karaman, M. (2005). Evaluation of pathological changes in broilers during chronic aflatoxin (50 and 100 ppb) and clinoptilolite exposure. *Research in Veterinary Science*, *78*(1): 61–68. https://doi.org/10.1016/j.rvsc.2004.06.006

Öner, M. (2023, Temmuz). *Mısır (Zea mays. L.) bitkisinin çimlenme ve fide dönemlerinde uygulanan kitosanın fizyolojik ve morfolojik özellikler üzerine etkisi* [Yüksek Lisans Tezi. Sakarya Uygulamalı Bilimler Üniversitesi Lisansüstü Eğitim Enstitüsü]. Sakarya Uygulamalı Bilimler Üniversitesi Kurumsal Akademik Arşiv. https://acikerisim.subu.edu.tr/xmlui/bitstream/handle/20.500.14002/2403/816812.pdf?sequence=1&isAllowed=y

Öztürk Aydın, M., & Cengiz, Ö. (2023). Farklı yerleşim sıklığında yetiştirilen bıldırcınların rasyonlarına bitkisel ekstrakt karışımı katılmasının performans, et kalitesi ve bazı oksidatif stres parametreleri üzerine etkisi. *Kocatepe Veterinary Journal, 16*(4): 481-490. https://doi.org/10.30607/kvj.1261555

Rafeeq, M., Bilal, R. M., Alagawany, M., Batool, F., Yameen, K., Farag, M. R., Ali, S., Elnesr, S. S., & El-Shall. N. A. (2022). The use of some herbal plants as effective alternatives to antibiotic growth enhancers in poultry nutrition. *World's Poultry Science Journal*. *78*(4): 1067–1085. https://doi.org/10.1080/00439339.2022.2108362

Rafeeq, M., Bilal, R. M., Batool, F., Yameen, K., Farag, M. R., Madkour, M., Elnesr, S. S., El-Shall, N. A., Dhama, K., & Alagawany, M. (2023). Application of herbs and their derivatives in broiler chickens: a review. *World's Poultry Science Journal, 79*(1): 95–117. https://doi.org/10.1080/00439339.2022.2151395

Rahman, M. R. T., Fliss, I., & Biron, E. (2022). Insights in the development and uses of alternatives to antibiotic growth promoters in poultry and swine production. *Antibiotics (Basel, Switzerland)*, *11*(6): 766. https://doi.org/10.3390/antibiotics11060766

Reda, F. M., El-Saadony, M. T., El-Rayes, T. K., Farahat, M., Attia, G., & Alagawany, M. (2021). Dietary effect of licorice (*Glycyrrhiza glabra*) on quail performance, carcass, blood metabolites and intestinal microbiota. *Poultry Science*, *100*(8): 101266. https://doi.org/10.1016/j.psj.2021.101266

Saraç, H. G. (2019, Temmuz). Kekik (Origanum onites) uçucu yağının etlik piliç rasyonlarında besi performansı, jejenal villus uzunluğu ve bazı kan parametreleri üzerine etkisi [Doktora Tezi, Atatürk Üniversitesi Sağlık Bilimleri Enstitüsü]. Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=6fQ79O1NPYmOqmN_uvEIKw&no=Klfup3314VenYfYR2csUSA

Sordillo L. M. (2013). Selenium-dependent regulation of oxidative stress and immunity in periparturient dairy cattle. *Veterinary Medicine International*, *2013*: 154045. https://doi.org/10.1155/2013/154045

Soycan Önenç, S., & Korkmaz Turgud, F. (2019). Effect of oregano, cumin and cinnamon essential oils on fermentation quality in alfalfa silages. *Journal of Agriculture Faculty of Ege University, 56*(3): 367-373. https://doi.org/10.20289/zfdergi.516234

Spernakova, D., Mate, D., Rozanska, H., & Kovac, G. (2007). Effects of dietary rosemary extract and alpha-tocopherol on the performance of chickens, meat quality, and lipid oxidation in meat storaged under chilling conditions. *Bulletin of the Veterinary Institute in Puławy, 51*(4): 585-589.

Şahin, T., Kaya, Ö., Sarı, M. (2012). Effects of ground echinacea (*Echinacea purpurea*) supplementation quail diets on growth performance and carcass traits. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi. 18*(1): 15-19.

Şahin-Nadeem, H., Dinçer, C., Torun, M., Topuz A., & Özdemir, F. (2013). Influence of inlet air temperature and carrier material on the production of instant soluble sage (*Salvia fruticosa* Miller) by spray drying. *LWT-Food Science and Technology, 52*(1): 31-38.

Tavangar, P., Gharahveysi, S., Rezaeipour, V., & Irani, M. (2021). Efficacy of phytobiotic and toxin binder feed additives individually or in combination on the growth performance, blood biochemical parameters, intestinal morphology, and microbial population in broiler chickens exposed to aflatoxin B_1. *Tropical Animal Health and Production*, *53*(3): 335. https://doi.org/10.1007/s11250-021-02778-0

Tipu, M. A., Akhtar, M. S., Anjum, M. I., & Raja, M. L. (2006). New dimension of medicinal plants as animal feed. *Pakistan Veterinary Journal, 26*(3): 144-148.

Tundis, R., Iacopetta, D., Sinicropi, M. S., Bonesi, M., Leporini, M., Passalacqua, N. G., Ceramella, J., Menichini, F., & Loizzo, M. R. (2017). Assessment of antioxidant, antitumor and pro-apoptotic effects of *Salvia fruticosa* Mill. subsp. *thomasii* (Lacaita) Brullo, Guglielmo, Pavone & Terrasi (Lamiaceae). *Food and Chemical Toxicology : an International Journal Published for The British Industrial Biological Research Association*, *106*(Pt A): 155–164. https://doi.org/10.1016/j.fct.2017.05.040

Urban, J., Kareem, K. Y., Matuszewski, A., Bień, D., Ciborowska, P., Lutostański, K., & Michalczuk, M. (2024). Enhancing broiler chicken health and performance: the impact of phytobiotics on growth, gut microbiota, antioxidants, and immunity. *Phytochemistry Reviews*, 1-15. https://doi.org/10.1007/s11101-024-09994-0

Yakoub, A. R., Abdehedic, O., Jridi, M., Elfalleh, W., Nasri, M., & Ferchichi, A. (2018). Flavonoids, phenols, antioxidant, and antimicrobial activities in various extracts from Tossa jute leave (*Corchorus olitorus* L.). *Industrial Crops and Products, 118*: 206–213. https://doi.org/10.1016/j.indcrop.2018.03.047

Yanar, K. E., & Aktaş, M. S. (2021). Ruminantlarda Fitoterapi Uygulamaları. *Bahri Dağdaş Hayvancılık Araştırma Dergisi, 10*(1): 76-86.

Yang, L., Wen, K. S., Ruan, X., Zhao, Y. X., Wei, F., & Wang, Q. (2018). Response of Plant Secondary Metabolites to Environmental Factors. *Molecules (Basel, Switzerland)*, *23*(4): 762. https://doi.org/10.3390/molecules23040762

Yeşilbağ, D. (2007). Fitobiyotikler. *Uludağ Üniversitesi Veteriner Fakültesi Dergisi*, *26*(1-2): 33-39.

Yeşilbağ, D. (2018). Yumurtacı bıldırcın rasyonlarına biberiye ve rezene uçucu yağı ilavesinin performans ve yumurta kalite parametreleri üzerine etkisi. *Ankara Üniversitesi Veteriner Fakültesi Dergisi, 65*(4): 413-418. https://doi.org/10.1501/Vetfak_0000002875

Zahrazadeh, M., Riasi, A., Farhangfar, H., & Mahyari, S. A. (2018). Effects of close-up body condition score and selenium-vitamin E injection on lactation performance, blood metabolites, and oxidative status in high-producing dairy cows. *Journal of Dairy Science*, *101*(11): 10495–10504. https://doi.org/10.3168/jds.2017-14196

To cite: Işık, Y., Babacan, O., & Taş, T. 2025. Use of medicinal and aromatic plants in poultry nutrition, *Journal of Agriculture Faculty of Düzce University, 3*(1):54-66.

Alıntı için: *Işık, Y., Babacan, O., & Taş, T.* 2025. Tıbbi ve aromatic bitkilerin kanatlı beslemede kullanımı, *Düzce Üniversitesi Ziraat Fakültesi Dergisi, 3*(1): 54-66.