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POTENTIAL OF A MEDICINAL PLANT *URTICA DIOICA* (STINGING NETTLE) AS A FEED ADDITIVE FOR ANIMALS AND BIRDS: A REVIEW

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ABSTRACT

Urtica dioica (stinging nettle) has been in feed in the past in many countries, and mainly, its leaves were used as a food source for birds and animals to enhance productivity and accelerate their metabolism. It also enhances the carcass percentage of meat animals, particularly broilers. It can potentially be used as a soya bean replacer as it will lower the feed cost. Its leaves can boost the immune system, particularly enhancing the chicken's ability to fight against gram-positive and gram-negative bacteria. Its antioxidant capability prevents free radical generation, reducing the chances of free radicle injuries. In ruminants, its use as a feed additive can lead to an increase in milk production. In animals, any kind of stress during the raising stage deteriorates the meat quality, so this herb prevents the carcass meat from deteriorating and has a better percentage of crude protein, crude fiber, and metabolizable energy, which results in an economic perspective. Supplementation of *Urtica dioica* in feed can enhance carcass output and provide the potential to counteract bacterial and viral diseases.

***Keywords*:** *Urtica dioica*, Immunomodulatory, Antioxidant, Feed additive, Potential

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1. INTRODUCTION

People all over the world rely on herbal remedies which include phytochemicals for their healthcare needs because they have fewer negative side effects than synthetic drugs and have significant positive effects on human health, including lowering the risk of developing some chronic diseases. These plants contain a variety of phytochemicals, including flavonoids, curcumin, carotenoids, organosulfur compounds and phytosterols. These phytochemicals have a broad range of medicinal applications and a wide range of biological properties, including pro-vitamin, antioxidant, antiviral, antibacterial, and anti-inflammatory properties. Furthermore, these naturally occurring substances are present in economical and widely accessible grains as well as fruits, vegetables, nuts, and tea (Almodaifer et al. 2017).

Plants synthesize phytochemicals to protect themselves from infections. They are used in traditional medicine around the world to treat a variety of neurological, immunological, and metabolic conditions in humans and animals. With an expanding population comes an increase in the utilization of native plants in commercial medicine. Demand rose as a result of plant extracts' antibacterial qualities. In contrast, plant tissue culture has shown to be a dependable substitute for extracting bioactive chemicals from plants. Phytosterols, flavonoids, terpenoids, saponins, alkaloids, carotenoids, aromatic and organic acids, essential oils, and protease inhibitors are the main categories of phytochemicals (Bansal and Priyadarsini 2021).

The wild vegetation *Urtica dioica* has long been used. It is a perennial herbaceous plant belonging to the nettle family (Urticaceae) with spiky leaves. Although it can be found almost anywhere, stinging nettle is most common in North America, Europe, North Africa and some parts of Asia. In the hills and highlands of Nepal, it might be spotted in the wild. Little Sishnu, Sishnu, Thulo Sishnu, Ghario Sishnu, Bhangre Sishnu, Lekali Sishnu, or Patle Sishnu are some Nepaliedible names. In locations where vegetables are scarce, the plant is commonly prepared (Bhusal et al. 2022).

The 46 species in the genus include the two most significant species, *Urtica urens* (small nettle) and *Urtica dioica* (stinging nettle), which are native to North America, Europe, Africa, and other temperate regions of the

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world. *Urtica dioica*, commonly known as stinging nettle, is prevalent throughout Pakistan and India. In Pakistan, stinging nettle is primarily found in the northern areas of Azad Kashmir, the Murree Hills, Khyber Pakhtunkhwa, and Gilgit-Baltistan. The Himalayan area of India is home to stinging nettle, particularly in states like Jammu and Kashmir, Uttarakhand, and Himachal Pradesh. It is also present in other regions of India, such as several areas of the Eastern and Western Ghats.

Based on a variety of ethnobotanical studies, stinging nettle slurry is increasingly being used as a fertilizer in organic horticulture crop cultivation throughout the world (Garmendia et al. 2018). Nettle has been used for its therapeutic properties as a natural remedy for over 2000 years. However, until the middle of the century, when the primary chemically active compounds' chemical structures and pharmacological characteristics were discovered, their medical significance remained largely unrealized (Said et al. 2015; Somani et al. 2015). For more than a century, they have been considered an edible item or part of food with therapeutic qualities and are believed to prevent and cure illnesses (Pant 2019). It states that fresh leaves are a nourishing potherb that can be eaten, cooked, and utilized in herbal therapy. Among the substances found in this plant are lignin, alkaloid, sterol, sphingolipid, secolignan, norlignan, sesquiterpenoid, flavonoid and triterpenoid (Singh and Sengar 2019). It is thought that formic acid, histamine, serotonin and acetyl choline are present in nettle trichomes (Fatima et al. 2018).

2. USE IN AGRICULTURE AND LIVESTOCK

In intensive agriculture, one widely recognized species of plant that is regarded as a weed is stinging nettle. Because it uses all parts of the plant (stem, leaves, roots, and seeds) to produce a number of high-value natural substances, this crop has drawn interest from the scientific and commercial communities (Carrubba and Scalenghe 2012). Because nettles are a perennial low-requirement plant, the environmental effects of nettle cultivation may be favorable (Di Virgilio et al. 2015). The utilization of stinging nettle as a textile fiber has a lengthy history. While its cellulose content is approximately 86%, the quality of the fiber varies significantly based on the method of extraction (Said et al. 2015). Many active compounds, including those with derivatives of caffeic acid, ceramides, nine types of carotenoids, vital fatty acids, minerals, vitamins, phytosterols, glycosides and proteins, have also been confirmed by several studies to be present in nettle leaves. These compounds show the greatest promise for use in the food and feed, pharmaceutical, and cosmetic industries (Viotti et al. 2022). Stinging nettle has served as a green vegetable used in soups, pies, salads, and decocted tea for millennia (Shonte and De Kock 2017).

In addition, stinging nettle contains essential fatty acid compounds, which are significant sources of fuel for both birds and animals since they produce enormous amounts of ATP when digested (Kregiel et al. 2018). Adding *Urtica dioica* to chicken feed can enhance vitamin consumption by 60-70% and protein intake by 15-20%, while reducing green feed requirements by 31%. Furthermore, Egg yolk yellow saturation was observed when stinging nettle was added to layer meals; hence, this particular kind of plant might be considered a good natural and cost-effective remedy for the condition without having any negative side effects (Loetscher et al. 2013).

Because they affect the cost of broiler chicken carcass and industrial cuts are significant components of the broiler manufacturing process. Numerous studies have demonstrated the beneficial effects of herbal products on broiler growth, with greater ultimate body weights in broilers resulting from dietary herbal supplementation (Camy et al. 2020). There is a favorable correlation between carcass percentage, ultimate body mass and broiler growth rate (Narinç et al. 2015). Therefore, it makes sense to anticipate that treating broilers with chemicals derived from plants will lead to higher dressing percentages and marketable cuts (Kregiel et al. 2018).

Herbal supplementation increases the accessible amount of essential nutrients for energy and metabolism for development in broilers by increasing their nutritional digestibility (Sugiharto 2021). The later may also increase the amount of dietary protein that is converted to protein in the body, hence increasing broiler carcass percentage. Herbal therapy has been shown to improve protein digestibility which may lead to increased protein deposition in chicken muscle (Sugiharto 2021). The consumption of herbal items has been linked to an increase in phenolic chemicals in birds. Increased expression of genes of insulin-like growth factor-binding molecules has been demonstrated to be correlated with this rise in phenols, which may increase the accumulation of muscle proteins (Johnson and Mejia 2016). Similarly, the ability of herbal items to boost the concentration of polyphenols in meat has been accounted for in terms of meat oxidation prevention. As a result, meat degradation, particularly muscle protein, can be avoided (Easssawy et al. 2016).

Herbal substances have been proposed to prevent lipase activity in broiler chickens to regulate their lipid metabolism. Dietary fat digestibility may be lowered in this way. The amount of fat in broiler breast meat has decreased due to the usage of herbal products in the diet (Giannenas et al. 2018). Stress circumstances during the raising stage are one of the elements that influence the qualities of broiler meat. It has been discovered that using plant-based or herbal items might lessen the negative effects of stress upon the physical conditions and characteristics of birds and animals' meat. Herb's high phenolic content appears to increase oxidative stability, avoiding the

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detrimental effects of nutritional oxidation on animal's meat while they are being stored (Sugiharto 2021).

3. MEDICINAL USE

Numerous phytochemicals found in this plant, including flavonoids, lignans, sterols, fatty acids, alkaloids, terpenoids, and antiviral, antimicrobial, anthelmintic, anticancer, nephroprotective, hepatoprotective, anti-arthritis, antidiabetic, anti-endometriosis, antioxidant, anti-inflammatory and anti-ageing properties, have been widely reported to have excellent pharmacological activities (Dhouibi et al. 2020; Taheri et al. 2022; Rathaur et al. 2023; Zare et al. 2023). Many Urtica species are used to cure a variety of conditions, including gout, fever, eczema, hemorrhoids, nosebleeds, scurvy, snake bites, rheumatism, sciatica, allergies, coughs, dandruff, diarrhea, and dermatitis. Moreover, it has been proven to be very helpful in treating wounds, pulmonary diseases, hypotension, urticaria, allergic rhinitis, prostate disorders, hemorrhoids, cancer, jaundice, stomach illnesses, diabetes, kidney problems, and hypotension. It is also a galactagogue and a diuretic (Taheri et al. 2022; Goswami et al. 2022; Marković et al. 2024). The major antioxidant and anti-inflammatory activity is attributed to flavonoids including quercetin, kaempferol and ruitn, which suppress the lipid peroxidation in hepatocytes and blood cells, due to this its has the potential to be antiviral, antibacterial and hypoglycemic effects (Kumar and Pandey 2013; Milosevic et al. 2021)

Nettle aerial extracts are high in polyphenols, whereas the roots are high in sterols, oleanolic acid and stearyl glycosides. Nettles have significant action against both Gram-positive and Gram-negative bacteria due to the range of phytochemicals and their amounts. Because of these qualities, nettles are appropriate for a variety of uses, including pharmaceutical formulations, functional foods and nutritional supplements (Kregiel et al. 2018; Dhouibi et al. 2020; Taheri et al. 2022; Rathaur et al. 2023).

Stinging nettles are high in nutrients. A thorough proximate examination revealed that obtained up growths comprised up to 4% proteins, 0.7% fat, 2% ash, 6.5% dietary fiber and 7% carbs. Nettle leaf powders, on the other hand, include an average of 30% protein, 4% fat, 41% non-nitrogen components, 12% fiber and 16% ash calcium content in leaves are higher as compared to roots and stems zinc and iron contents are also higher (Rafajlovska et al. 2013; Taheri et al. 2022; Goswami et al. 2022; Marković et al. 2024). Various properties of Stinging nettles and its potential beneficial effects in animals have been showed in Fig.1 & 2.

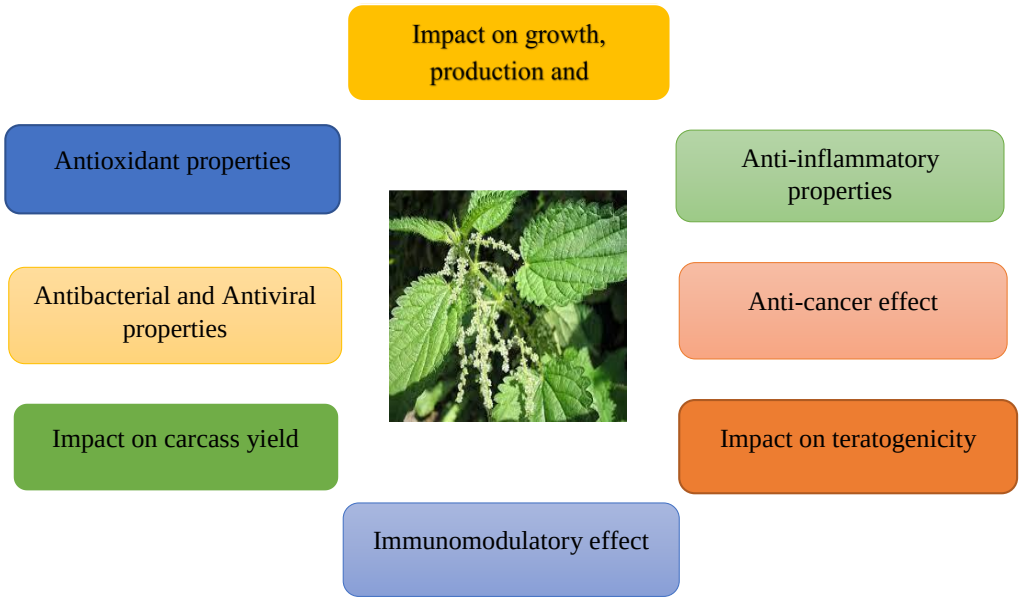

Fig. 1: Medicinal properties of *Urtica dioica* and its effect on various parameters.

3.1. Role as an Antioxidants

A significant problem in the food industry is oxidation. The shelf-life of meat as well as meat products is greatly impacted by lipids and myoglobin oxidation in addition to bacteria that cause meat deterioration. Meat loses nutritional value due to lipid oxidation by deteriorating vital fatty acids, causing an unpleasant taste, producing potentially harmful byproducts, and increasing the oxidation of other critical components such as myoglobin (Papuc et al. 2017; Garcìa et al. 2021; Suli and Papadaki 2024). Despite the availability of synthetic antioxidants, natural antioxidants has surged in recent years, owing mostly to the negative effects of synthetic antioxidants (Shah et al. 2014; Jaiswal and Lee 2022). Heam pigment and ferritin release iron, the most prevalent ion in meat and may play a key role in lipid and protein oxidation. Commercially available polyphenols and polyphenol-rich extracts have been shown in studies to reduce myoglobin oxidation (Inai et al. 2014). Therefore, using stinging nettle as a feed addition

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in animals particularly in broilers, lowers oxidation issues in broiler meat (Forni et al. 2019; Jaiswal and Lee 2022; Khan et al. 2023).

The use of *Urtica spp*. as a food supplement may benefit poultry and cattle health and production. Because of the high concentration of bioactive chemicals in this herb, it may have better antibacterial properties than manufactured antimicrobials. Extracts of *Urtica spp*. have been shown to promote hunger and digestion (Zhang et al. 2005; Flórez et al. 2022).

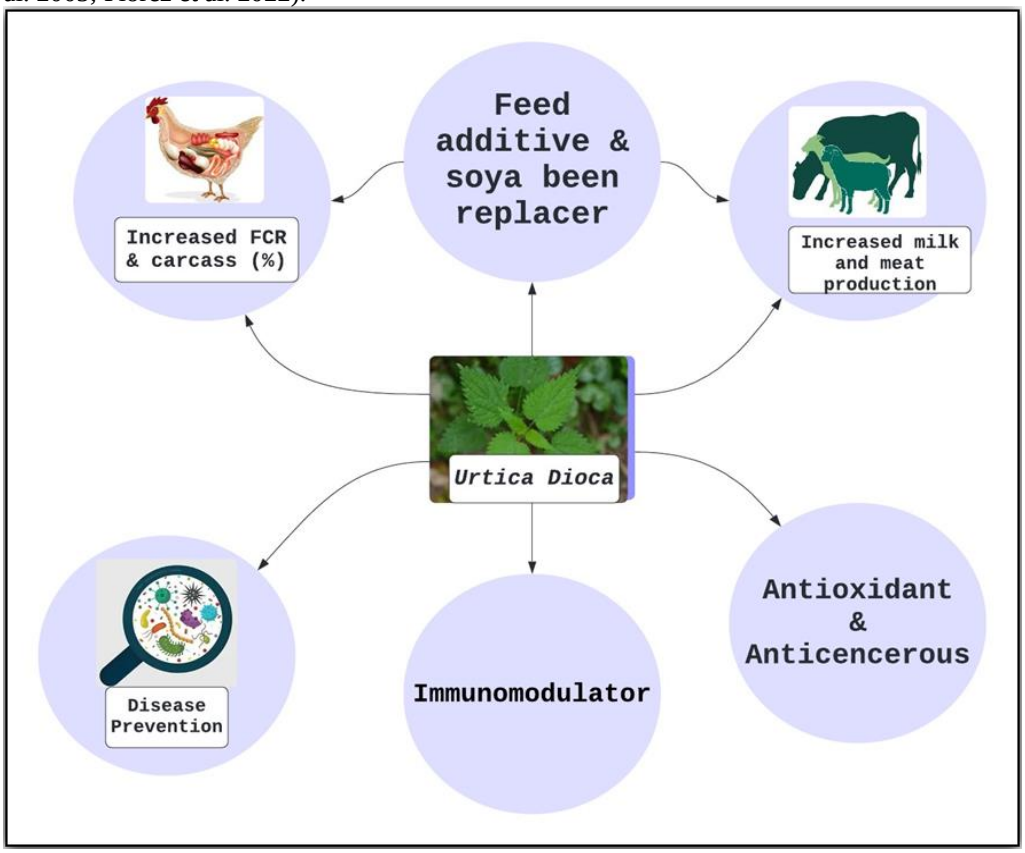

Fig. 2: Potential beneficial effects of *Urtica dioica* in animals.

3.2. Role as an Immune Booster

An ethanolic extract of *Urtica dioica* leaves can improve quality of life, lower platelet counts, inflammatory indicators and boost the activity of the antioxidant enzyme SOD (Nematgorgani et al. 2017; Zare et al. 2023). Frequent administration of alcoholic nettle extract to broiler hens enhances both their weight gain and non-specific cell-mediated immunity. Supplementing with nettles can have a beneficial impact on the immune system, blood lipids, growth, feed utilization and antioxidants in chicken nutrition (Şandru et al. 2016; Zare et al. 2023).

The dietary supplementation of *U. dioica* can potentially activate B cell's secretion of immunoglobulin. Stinging nettle is one immunostimulant that can be used to feed in place of antibiotics to improve sustainable aquaculture. It is concluded that fish development, biochemistry, hematology and nonspecific immunology would all be enhanced by the therapeutic potential of stinging nettle as a dietary supplement. Fish serum lysozyme serves as a marker for the innate immune response. The results of this investigation have shed fresh light on the medicinal plant's ability to stimulate the immune system, which is used in fish diets to avoid bacterial diseases and may even improve fish welfare (Ngugi et al. 2015; Jaiswal and Lee 2022; Khan et al. 2023).

3.3. Role in Carcass Output

In certain parts of Europe, nettles exhibited no impact on the percentage of abdomen, thigh, or breast fat. Fresh leaves were fed to broilers for increased production and immunity (Safamehr et al. 2012). Chickens fed 1% nettles, on the other hand, had the highest carcass output on the other hand, noticed an increase in the carcass output of broilers fed with a mixture of essential fatty acids (Alçiçek et al. 2004). The relative weighing of the majority of the organs remained consistent after nettles were added to the diet. In hens, an alcohol-based extract of *U. dioica* increased the capacity of cell-mediated innate immunity. Total leukocyte counts increased significantly with alcoholic nettle plant extract, rising from 15,400 to 17,125 cells/mm^3 (Şandru et al. 2016).

Similarly, nettle extract administration greatly improved phagocyte in vitro functional capability. This might

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increase disease resistance and enhance broiler post-vaccination response, resulting in lower economic losses. The blood concentrations of triglycerides and cholesterol significantly alter, but the amount of nettle administered has no effect on the hen's level of heterophil, lymphocytes, glucose, or total protein. The effect on lowering serum cholesterol levels may be attributed to the inclusion of plant sterols such stigmasterol and campesterol. They cause the amount of cholesterol in micelles to decrease (Avci et al. 2006). It is believed that phenolic compounds lower serum and meat cholesterol levels. Nevertheless, boiler's total cholesterol did not significantly improve when nettle extract was introduced to their diet (Khosravi et al. 2008).

3.4. Role in Productivity

According to ethnoveterinary medicine *Urtica dioica* used as growth promoter and stimulant in egg laying hens. Nettle leaves are rich in protein, fats, carbohydrates, vitamins, minerals and trace elements. With 30% protein by dry mass, nettle boasts a significantly greater amino acid profile than other green plants. Stinging nettle improves the immune system and modifies metabolic processes in animals and birds (Rutto et al. 2013; Mierlita et al. 2023). Adding stinging nettle leaves in different amounts to broiler meals can increase performance and have a substantial growth-promoting effect on hemoglobin and hematocrit levels. Performance in laying eggs has been improved up to 40%. A diet supplemented with nettles improved growth and carcass quality. Supplementing poultry with stinging nettle powder and pigs with cooked nettle preparation increases productivity (Bekele et al. 2015; Bagno et al. 2023; Mierlita et al. 2023).

3.5. Impact on Teratogenicity

Potential protections offered by *Urtica dioica* against TMX-induced teratogenicity. Reduced CRL, beak and shank size are linked to TMX intoxication, which damages cells and induces oxidative stress by generating free radicals and lipid peroxidation. The mechanism of action of *Urtica dioica* is its ability to scavenge free radicals. Nettle's flavonoid chrysoeriol may be the cause of its antioxidant action, or it could be a result of the flavonoids and phenolic compounds it contains (Raza et al. 2024). *UDE* demonstrates a preventive effect against CPF-induced teratogenicity, which is expressed by a lower morphological deformity rate (Mhalhel et al. 2024).

PCOS reduces fertility by lowering the quantity and quality of the oocytes and embryos and cause oxidative stress in mice. Damage to embryos can result from oxidative stress. However, by raising antioxidant activity, nettle extract given orally both alone and in conjunction enhanced reproductive function. The effect of nettle extract on the reproductive system and metabolic markers in mice with PCOS were observed. The best results were increased antioxidant capacity and improved oocyte and embryo quality. The least amount of MDA was created by nettle combined therapy, which also resulted with considerably greater oocyte counts, oocyte quality, fertilization rates and 2-cell blastocysts (Bandariyan et al. 2021).

3.6. Potential to be a Feed Additive

Leaves from stinging nettle are considered a healthy, convenient source of vitamins, minerals, carbohydrates, and protein. On a dry matter basis, the leaves contain around 22% proteins, and this value is much higher in terms of essential amino acids (Milosevic et al. 2021; Patel et al. 2023). *Urtica simensis* (Samma) native to Ethiopia has a CP content ranging from 25.1 to 26.3%. Compared to alfalfa meal, nettle leaf meal has a higher nutritional density of amino acids. Vitamins A, C, Fe, K, Mn, and Ca are present. Therefore, the leaves are suitable for feeding animals with a single stomach, such as chickens. Improved intake of feed, live body mass, daily gain in weight, slaughter weight, and nutrient retention are among the best results achieved up to 9% inclusion rate. Replacing stinging nettle leaves with soybean up to 12% of the diet for developing broiler chickens had no detrimental effects on performance (Ganai et al. 2022). However, nutritive and chemical composition may be variable among the varieties, genotypic characteristics, climatic and soil conditions, harvesting, storage and post-harvest treatments (Milosevic et al. 2021).

The dressing percentage of poultry and the resistance to oxidation of broiler meat significantly enhanced when the herb *Urtica dioica* was added to broiler meals at varying doses as a feed supplement. The higher percentage of drumstick, thigh and breast meat in broilers is thought to be caused by the phenolic compounds and antioxidants found in nettle (Lee et al. 2004; Milosevic et al. 2021). Although visceral organs did not have variation, however the positive effects on the broiler performance, meat quality and feed efficiency were evident in various research trials (Lee et al. 2004; Milosevic et al. 2021).

Furthermore, the carvacrol found in nettles stimulates pancreatic secretions, which increases the quantity of nutrients that are absorbed and digested in the digestive tract. This increases the proportion of nutrients that are digested. The proportion of organs like the breast has also increased due to these higher levels of absorbed amino acids (Mehboob et al. 2022).

Incorporating nettle supplements to broiler diets at a rate of 1% to 2% can help the birds thrive. Nettle is a

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medicinal plant (Viegi et al. 2003) that has been utilized for its growth-stimulating (Safamehr et al. 2012) and anti-oxidative (Toldy et al. 2005) qualities. Several pathogenic and nonpathogenic bacterial species may be limited in their growth and colonization in the chicks' stomachs by the use of herbs and phytogenic products. This could result in more effective food consumption, which would boost growth and improve the efficiency of feed (Bedford 2000; Safamehr et al. 2012). Thymol and carvacrol, two phenolic chemicals found in nettles, have strong antibacterial and anti-fungicidal properties (Gülçin et al. 2004). Herbs, spices and different plant extracts have antibacterial qualities as well as the ability to stimulate digestion and hunger (Safamehr et al. 2012)

The conclusion that *U. dioica* leaves meal has offered more health and nutritional benefits has been reached due to the general improvement in hen performance, especially for those kept beneath 6 and 9% levels, in addition to their physical attractiveness (Milosevic et al. 2021). With these considerations in mind, using up to 9% stinging nettle leaf meal in grower diets might be an alternate feeding approach for substituting soybean strategies for producing chickens in rural, urban, and per-urban areas that help to improve the bird's nutritional quality and productivity in order to boost their revenue. Use of different doses of UD as a feed additive has been described in Table 1.

Table 1: Different doses of *Urtica dioica* used in poultry or animal feed

Species	Dose rates of *Urtica dioca*	Effect on productivity	References
Layer	5, 10, 15, 20, and 25mg/kg	• Higher egg production • Stimulate appetite and digestion • Feed consumption increase and FCR decrease • Positive effect on growth and egg laying • Improvement in color and taste of egg yolk	Bagno et al. (2023)
Broiler	1.5%	• Increase in feed conversion ratio and body weight gain	Mansoub (2011); Ustundag (2023)
Broiler	Dried leaves 1-2%	• Positive effects on performance, carcass and blood biochemical parameters	Safamehr et al. (2012); Ustundag (2023)
Broiler	1% and 1.5%	• Increase in growth, weight gain and FCR • Breast meat yield increased • Heart, bursa, liver and abdominal fat ratios reduced	Ahmedipour and Khajali (2019)
Broiler	5 and 10g/kg powder	• No effect on performance, carcass and blood biochemical parameters	Keshavarz et al. (2014); Ustundag (2023)
Broiler	0.15, 0.20, and 0.25% nettle leaf extract powder	• Improved performance and strong growth promoting ability	Hashemi et al. (2018); Ganai et al. (2022)
Animals	0.05% nettle root extract	• Increase live weight and feed conversion ratio	Tabari et al. (2016); Meimandipour et al. (2017)
Broiler	9%	• Alternative feeding strategy to soybean meal	Bekele et al. (2015)
Laying hen	0.3% and 0.5%	• No poor effect on performance of laying hens	Grigorova et al. (2022)
Quail	6%	• No negative effect on performance	Moula et al. (2019)
Broiler nutrition	------	• Positive effect regarding production performance	Milosevic et al. (2021); Ganai et al. (2022)
Broiler	2 % and 4% of diet	• Improve the health status and defense mechanism of the birds under stress environment	Farahani and Hosseinian (2022)
Broiler	3%	• Negative impact on the productive performance	Mierlita et al. (2023)

4. CONCLUSION

Nettles include a multitude of physiologically active constituents. For example, the leaves are rich in minerals, terpenoids, carotenoids, fatty acids, certain essential amino acids, vitamins, tannins, carbohydrates, sterols, and polysaccharides. While nettle's roots contain oleanol acid, sterols, and steryl glycosides, nettle extracts are high in polyphenols. Nettles have a considerable effect on both gram-positive and gram-negative bacteria. Most nettle medications are created using the flowers, stems, and leaves, but pharmacology also uses the roots. *Urtica dioica* has been shown to possess antimicrobial, antioxidant, antiviral, analgesic, anti-colitis, anti-inflammatory, anti-cancer, anti-proliferative, anti-ulcer, immunomodulatory, cardiovascular disease prevention, and anti-Alzheimer properties. The use of *Urtica dioica* as a feed additive enhances carcass yield, boosts immunity, and provides protection against various bacterial and viral diseases of birds and animals. Supplementation of *Urtica dioica* in feed has the potential to counteract various issues regarding productive performance, immunity, and teratogenicity.

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