

## THE POTENTIAL USE OF SOME MEMBERS BELONG TO APIACEAE AND ASTERACEAE PLANT FAMILY AS IMMUNE BOOSTERS IN LIVESTOCK PRODUCTION

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### SUMMARY

This review was conducted based on two plant families, which are Apiaceae and Asteraceae, to study on their action as immune boosters in livestock production. The review demonstrated the capabilities of plants belong to these two families to improve health of livestock and immune functions as well as reducing the risks of different animal diseases. These plant family groups are collected based on their effects on the mechanisms that affect the immune system of animal which are antioxidant, anti-inflammatory, and antimicrobial activities. Further studies can be conducted on these plant species by identifying their ability and capability to be developed into a new drug or to be used as a medicinal plant in treating immune-mediated diseases in livestock.

**Keywrd:** *Apiaceae, Asteraceae, immune, livestock production, livestock disease*

### INTRODUCTION

Nature has given its own medicine for animals as well as birds. Since emergence of life, herbs acted as medicine and food (Abd-Alla *et al.*, 2014, 2019; Kuralkar and Kuralkar, 2021). The necessity for investigation and mobilization of ancient medicinal practice to fulfill the primary health care of the animals has been recognized by the world health organization (WHO) (WHO, 2008). It realizes that the traditional system of medicine may play an important role in the development of livestock of the third world countries (Kuralkar and Kuralkar, 2021). The most common immune-mediated diseases in animals are those in which the immune system destroys circulating cells (Mravčáková *et al.*, 2021). The body creates inflammation, but instead of directing the inflammation at a pathogen, it directs this inflammation towards the tissues of the body. Nowadays, the growing need for more natural sources of medicine has driven scientific interest towards the Asteraceae and Apiaceae; the most varied families of flowering plants. Medicinal plants belong to Apiaceae and Asteraceae contain various bioactive compounds, such as terpenoids, flavonoids, lactones, and glycosides that have different modes of therapeutic action. Studies have demonstrated that their extracts have a positive impact on animal health and were attributed to their effect as immunomodulatory, anti-inflammatory, antioxidant, and antimicrobial activities (Abd-Alla *et al.*, 2016; Li *et al.*, 2018; Mravčáková *et al.*, 2021). Many of its species have been used in traditional medicine since ancient times. The influence of plants belong to these families (Asteraceae and Apiaceae) is used for control of infection on the local immune response of abomasal mucosae in gastrointestinal diseases-infected animal (Mravčáková *et al.*, 2021). The

objective was to review the potential benefits of the different medicinal plants belong to these families as immune boosters for efficient management and successful rearing of our animals along with their importance in livestock production. The current review has retrieved articles available in different databases namely, Google, Google scholar, PubMed, EKB, ScienceDirect, and chemical abstracts.

#### ***Immunomodulatory effect of different members of Apiaceae and Asteraceae:***

Natural products have played a significant role in animal disease therapy and prevention. The plant-derived immunomodulators are being considered as safer alternatives as most synthetic immunomodulators pose serious toxicity or other side effects (Nair *et al.*, 2019).

Most members belong to the plant family Apiaceae (formerly Umbelliferae), which is called celery or carrot family and daisy family and Asteraceae (formerly Compositae) have shown several interesting biological activities in animals. The major secondary metabolites isolated from Apiaceae and Asteraceae include triterpenoids, flavonoids, and simple phenolics. The plants with these secondary metabolites were reported to possess antioxidant, anti-inflammatory, and immunomodulating activities.

Apiaceae (formerly Umbelliferae) is a family of mostly aromatic flowering plants named after the type genus *Apium* and commonly known as the celery, carrot family. Several species have long been used as herbal and folk remedies; e.g., *Aegopodium podagraria* (goutweed) and *Dorema ammoniacum* (gum ammoniac). Other species are widely used vegetables, including *Apium graveolens* (celery), *Daucus carota* (carrot), *Foeniculum vulgare*

(fennel), *Petroselinum crispum* (parsley), and *Pastinaca sativa* (parsnip).

The Asteraceae family is one of the largest flowering plant families, including 25,000 species and over 1600 genera worldwide. It includes a number of well-known species, such as coreopsis, sunflower, chicory, lettuce, daisy and dahlias, as well as a number of plants of medicinal significance, such as dandelion, chamomile and wormwood. The majority of Asteraceae family members have therapeutic applications. The plants of Asteraceae family were known as agents in the protection of animals from infectious diseases.

#### **Immune system and botanicals:**

Botanicals are a natural new class of additives based on plants and are highly acceptable among consumers. Botanicals comprise the complex structure of molecules reducing the risk of developing resistance (Khater *et al.*, 2020). They are highly efficient as vaccines and synthetic drugs and help in organic poultry production. Herbal complex of four herbs including the seeds of *Trachyspermum ammi* (Apiaceae) significantly reduced the negative influence and pathogenic effects associated with *Eimeria tenella* challenge (Oviedo-Rondón *et al.*, 2005). *Eimeria* spp. penetrates the intestinal cells of the host at different sites and cause damaging of the intestinal walls resulting in great economic losses.

The influence of medicinal plants used for control of haemonchosis on the local immune response of abomasal mucosae in GIN-infected sheep, however, has been reported by Mravčáková *et al.* (2021). The study aimed to evaluate the effect of diets containing wormwood (*Artemisia absinthium*), mallow (*Malva sylvestris*), or their mix, on antioxidant parameters and local immune responses in the abomasum of lambs infected with *Haemonchus contortus*. Treatment with the medicinal plants affected antioxidant parameters by reducing oxidative stress in the abomasal mucosa and helped trigger local immune responses.

Some plants belong to family of Asteraceae and Apiaceae were used as a feed additive (Kothari *et al.* 2019; Khater *et al.*, 2020). A commercial herbal formula contains plants belong to these two families, effectively controlled experimental coccidiosis in chickens and can be used successfully as a natural anticoccidial drug (Pop *et al.*, 2019; Khater *et al.*, 2020).

Avian coccidiosis is one of the serious infectious diseases of poultry caused by different species of genus *Eimeria*. Coccidial infections are a major public health concern, also responsible for some of the most important veterinary diseases, leading to important economic losses in poultry and cattle industries. The anticoccidial of *Achillea talagonica* (Asteraceae) (aqueous and hydroalcoholic extracts) on the *Eimeria maxima* oocysts *in vitro* was reported (Rajaei *et al.*, 2017).

There is an increased public concern about the use of chemotherapeutics in livestock, since they may

generate unacceptable residues in milk and meat that would avoid their commercialization and consumption (Dubey and Schares, 2011; Sander *et al.*, 2019). Moreover, many anti-coccidial drugs are being banned from use in food animals. Although prophylactic vaccines emerge as the most suitable approach, successful vaccines against coccidial parasites are scarce and limited to the veterinary field (Dubey and Schares, 2011; Sander *et al.*, 2019). The anticoccidial of *Achillea talagonica* (Asteraceae) (aqueous and hydroalcoholic extracts) on the *Eimeria maxima* oocysts *in vitro* was reported (Rajaei *et al.* 2017).

#### **Conventional plant immunomodulators:**

There are several artificial immunomodulators in the market but with some or other side effects (Childs *et al.*, 2019). Conventional plant immunomodulators are safe and cheaper. These plants have immunomodulatory properties, are widely used in poultry industry (Abd El-Hack *et al.*, 2020).

Several commonly known plants like *Angelica sinensis* (Apiaceae), *Centella asiatica* (Apiaceae), *Achillea talagonica* (Asteraceae), *Tridax procumbens* (Asteraceae), are currently being investigated for their immunomodulatory potentials (Shantilal *et al.*, 2018). The majority of the Asteraceae family members are as the medicinal plants which have therapeutic applications. These comprise *Achillea*, *Carthamus*, *Chromolaena*, *Emilia*, and *Pluchea*.

#### **Asteraceae family plants:**

##### ***Achillea talagonica:***

*Achillea talagonica* (Asteraceae) has been shown to possess immunomodulatory activity on humoral immune responses in experimental animals (Rajaei *et al.* 2017).

Avian coccidiosis is one of the serious infectious diseases of poultry caused by different species of genus *Eimeria*. The anticoccidial and the lethal effect of aqueous and hydroalcoholic extracts of *Achillea talagonica* on the *Eimeria maxima* oocysts *in vitro* was reported by Rajaei *et al.* (2017).

Bioactive immunostimulatory compounds were isolated from *Achillea millefolium* (Nair *et al.*, 2019). The aqueous extract of *Achillea cucullata* is known with its antioxidant and antimicrobial activity. *Achillea millefolium* extract has an estrogenic effect, thanks to its content of phytoestrogens such as apigenin and luteolin; these have a stronger binding affinity to  $\beta$  estrogen receptors than estradiol. Topical application of *Achillea kellalensis* flowers demonstrates wound healing properties and antibacterial and antiviral activity. On a wound, it can hasten healing due to its flavonoid content.

##### ***Artemisia species:***

*Artemisia* is a large, diverse genus of plants with between 200 and 400 species belonging to the daisy family Asteraceae. Wormwood (*Artemisia absinthium*) is known as a functional and medical

herbal plant. *Artemisia* species is used to exterminate parasites, aid digestion, and cure constipation, gastroenteric disorders, and neuralgia in many countries (Kim, 1984). Herbs such as immune-promoting agents, essential micronutrients, probiotics, and antioxidants has found belong to Asteraceae members. Also, the oriental *Artemisia absinthium* (wormwood) composes of vitamins (vitamin C, B1, B2 and A) and minerals (Fe, P, and Ca) (Kim *et al.*, 2002; Mravčáková *et al.*, 2021). Mravčáková *et al.* (2021) represented the impact of *Artemisia absinthium* in combination with *Malva sylvestris* on local immune responses of abomasal mucosa and antioxidant parameters of lambs infected with the gastrointestinal nematode parasite; *Haemonchus contortus* (Mravčáková *et al.*, 2021). A study by Kim *et al.* (2002) demonstrated the influence of dietary addition of *Artemisia* sp. (dried wormwood) on the carcass characteristics and the performance of Hanwoo steers and the nutrient digestibility of sheep. The authors concluded that feeding diet containing dried *Artemisia* species substituted for equal weight of rice straw (5 - 10% levels) would be anticipated to provide higher income for beef cattle producer and better quality roughage for beef cattle production.

#### ***Carthamus tinctorius*:**

The genus *Carthamus*, the distaff thistles, includes plants in the thistle family. The group is native to North Africa, Europe, and parts of Asia. *Carthamus tinctorius* is herbaceous, thistle-like, highly branched annual plant in the sunflower family Asteraceae.

Immunomodulatory effects of leaves of *Carthamus tinctorius* on chicken lymphocytes and macrophages has been demonstrated by Lee *et al.*, (2008).

Safflower (*Carthamus tinctorius*) has been used as a traditional medicinal plant to enhance natural immunity. However, limited information exists on the mechanisms responsible for its immune enhancing properties. In this study, the immunostimulatory effects of crude methanol extract of *C. tinctorius* leaf were assessed by stimulating spleen lymphocyte proliferation and nitric oxide production by cultured chicken macrophages. This extract inhibited the viability of tumor cells significantly greater than medium controls. These results demonstrated that *C. tinctorius* leaves contain immunostimulatory components that may be potentially useful as a dietary immunomodulator for poultry.

#### ***Chromolaena odorata*:**

*Chromolaena odorata* (Siam weed) is an invasive plant species in tropical and subtropical areas of the world (Jiwuba *et al.*, 2018). *Chromolaena odorata* has potential medical uses and an infusion of the plant is taken as antipyretic and to treat jaundice and malaria. Traditionally, fresh leaf juice or a decoction of *C. odorata* is used for treatment of skin and

wounds infection and as antihemorrhagic, and astringent. The plant has reported with antifungal, antibacterial, and antiprotozoal effects. A study has demonstrated the immunomodulatory effects of *C. odorata* extract on the enhancement of the innate immune response by employing a number of immune response *Chromolaena odorata* (L.) King utilisation as a livestock feed additive in different countries (Jiwuba *et al.*, 2018). A high susceptibility of birds to diseases as a result of reduced white blood cell concentration- a pathological case of leucopaenia and a compromise of the birds' immune response (Nudo *et al.*, 2018). A 49-day feeding trial was conducted by Jiwuba *et al.* (2018) to determine the effect of this plant leaves meal-based diet on organ, growth, and carcass weight characteristics and economics of production of broilers. This meal is rich in essential nutrients and therefore suitable for inclusion in broiler diets at level not beyond 2% for best final live weight, daily weight gain, and thigh weight (Boudjeko *et al.*, 2015). Also, the polysaccharides from *Chromolaena odorata* have reported with antioxidant and immunomodulatory properties of polysaccharides from *Allanblackia floribunda* Olive stem bark and *Chromolaena odorata* (L.) King.

#### ***Chrysanthemum coronarium* and *C. morifolium*:**

Chrysanthemums sometimes called mums or chrysanthus are flowering plants of the genus *Chrysanthemum* in the family Asteraceae. Royal Chrysanthemum tea promotes immunity (Tao *et al.*, 2017). Our previous studies have demonstrated the immunostimulatory effect of *Chrysanthemum coronarium* in chicks (Abd-Alla *et al.*, 2014). The ability of chrysanthemum in treating various immune-related diseases was proven. *Chrysanthemum morifolium* Ramat has been clinically used as popular anti-inflammatory herbal supplements. It effectively cures some inflammatory and infectious diseases such as stomatitis and colitis, for thousands of years in China and Korea, *Chrysanthemum* polysaccharides have been demonstrated to ameliorate ulcerative colitis by restoring the immune system, modulating the balance of intestinal microecology, and fostering beneficial intestinal flora growth (Tao *et al.*, 2017). Chrysanthemums have established anti-inflammatory effects in a variety of animal colitis models. The response of chrysanthemum plant to addition of broiler manure as a substitute for commercial substrate has been reported (Alonso *et al.*, 2012).

#### ***Cichorium intybus* (chicory):**

The immunomodulatory effect of *Cichorium intybus*, i.e., chicory, extract was demonstrated in *in vivo* studies based on the chicory extract increased production of IL-12 by dendritic cells, i.e., antigen-presenting cells in the immune system (Jafarinia *et al.*, 2019). Chicory (*Cichorium intybus*) also is a valuable source for new health food products and functional food. The roots from chicory are a healthy replacement for white flour and fat in cracker

production, due to a high level of dietary fiber and inulin. The flowers of chicory are used for tea, which, used daily, helps to improve the immune system in the body, provides an energy boost and prevents kidney disorders. Chicory extract has also been found to lower the concentration of certain cytokines, such as the anti-inflammatory interleukin-4 (Jafarinia *et al.*, 2019).

***Cynara scolymus (artichoke):***

*Cynara scolymus*, artichoke, is a plant used both as food as well as medicinal plant worldwide. The plant has been found to demonstrate antioxidant and anti-inflammatory activities (Hueza *et al.*, 2019). Animals were treated with 1, 2 or 4 g/kg body weight of *Cynara scolymus* extract for 28 days. An increase in the basal activity of reactive oxygen species from male's macrophage was observed. There was a suppression of the DTH response in both genders when treated with the highest dose of *C. scolymus* (Hueza *et al.*, 2019). Regular treatment with the extract increased total lymphocyte and leukocyte count, interleukin-12 (IL-12) and phagocyte activity, had an immunostimulant effect, as indicated by hemogram, serum biochemistry, lymphoid organ weight, macrophage and neutrophil oxidative burst, and specific humoral immune response.

***Echinacea purpurea:***

*Echinacea purpurea* (Asteraceae) is a medicinal herb that is used by modern herbalists as an immune system stimulant (Freier *et al.*, 2003; Saeed *et al.*, 2018). *Echinacea* increases the proliferation of phagocytes in spleen and bone marrow, stimulates monocytes to produce cytokines (IL-1, IL-6, TNF), increases the number of PMN, and activates macrophages. Initiation of immune response was recorded by repeated short-time applications of *Echinacea purpurea* juice as feed additive in laying hens (Saeed *et al.*, 2018). The number of lymphocytes was highest in the group receiving ethanolic juice for five consecutive days. *Echinacea* is one of the widely consumed botanicals that purported to be immune stimulants and had immunological adjuvant activity (Saeed *et al.*, 2018). *Echinacea purpurea* is one of the most widely used medicinal herbs that are of interest to animal scientists due to its valuable immuno-stimulatory and anti-inflammatory properties. Chicoric acid is a major active constituent of the roots. The constituent content (16.80-24.30 mg/g) has gained a lot of renown due to its promising bioactivities. This acid has shown to simulate growth promoters and have antioxidant, anti-inflammatory, anti-bacterial, and hepatocyte protective properties. Many studies have included nutritional investigation in the poultry industry and its use in poultry diets (Li *et al.*, 2018). The compound was suggested to improve health status and meat quality in broiler chickens (Saeed *et al.*, 2018). A study showed that to boost the immune system and fight infection, Oregon grape or *Echinacea* teas are given for seven days (Lans *et al.*,

2007). These are made with 1/2 cup coarsely cut dried Oregon grape roots or *Echinacea* simmered in water for 10–15 minutes. One cup of tea is diluted in 1 gallon of water and given as the only drinking water (Lans *et al.*, 2007).

The tincture of *Echinacea* (*Echinacea* species: *E. augustifolia* or *E. purpurea*) is given to animals before shows (Lans *et al.*, 2007). It consists of 4 ounces of dried *E. augustifolia* or *E. purpurea* or root or 1 or 2 fresh *Echinacea* chopped roots. A jar or glass bottle is half-filled with the chopped fresh or dried root. Brandy, rum, or Vodka is added until it covers the root completely. For two to eight weeks, this is stored in a dark place. It is shaken daily (the first week) and weekly (the remaining weeks). Then it is decanted into a tincture bottle. One tsp of *Echinacea* tincture per animal in is added to the feed bowl daily for self-medication (immune stimulant) at least six to ten days before the show. A by-product from processed *Echinacea* can be used instead of a purchased product to reduce costs.

***Emilia sonchifolia:***

The methanol extract from *Emilia sonchifolia* demonstrates anti-inflammatory effects by inhibition of edema induced by carrageenan (Achika *et al.*, 2014). Oleamide isolated from burdock can reduce the production of TNF- $\alpha$  and IL-4.

*Emilia sonchifolia* enhanced bone marrow cellularity, the total white blood cell count, weight of lymphoid organs, and  $\alpha$ -esterase activity (Gilcy and Kuttan, 2015). The effect on humoral immune response was evident from the enhanced hemagglutinating antibody titer and increased number of plaques forming cell. The blastogenic effects of mitogens were also stimulated. Blastogenesis assays of lymphoid organs were done in the presence and absence of various mitogens such as phytohemagglutinin, concanavalin A, pokeweed mitogen, and lipopolysaccharide.

***Matricaria chamomilla (chamomile):***

*Matricaria chamomilla* belongs to Asteraceae family. The immunomodulatory activity of *Matricaria chamomilla* (Chamomile) belongs to Asteraceae family and growing in Egypt was reported and it may have therapeutical implications in prophylactic treatment of opportunistic infections in mice immunosuppressed with cyclophosphamide (Ghonime *et al.*, 2010, 2015).

The immune response to Newcastle disease was higher in MC-0.9 and MC-1.2 groups. The counts of lactobacilli in the intestinal digesta were higher ( $P < 0.05$ ) in broilers receiving MC-0.6 and MC-0.9 diets than those fed on the CD diet. The immunomodulatory activity in chamomile could be attributed to initiation of immunostimulating properties of heavy erythrocytes (macrocytes), activation of immunoregulation cells of peripheral blood, and increased sensitivity of effector cells to helper signals (Uteshev *et al.*, 1999; Akbari *et al.*, 2020). Regarding immune response, significant

differences were found in Newcastle disease titre values indicative of a higher antibody response with *M. chamomilla* supplementation with the exception of chamomile-0.6 group. The supplementation of *M. chamomilla* has exerted positive effect on carcass characteristics, the growth performance and immune system (Akbari *et al.*, 2020).

#### ***Pluchea arabica:***

The methanolic fraction of root extract of *Pluchea arabica* (Asteraceae) was found to possess significant antiulceractivity in different experimental animal models (Sharma and Goyal, 2011). The extract also afforded significant protection to chemically-induced duodenal lesion in guinea pigs. Significant enhancement of healing process in acetic acid-induced chronic gastric lesions was also observed in the *P. indica* extract-treated animals (Pal *et al.*, 1989).

#### ***Pulicaria crispa:***

*Pulicaria* is a genus of flowering plant in the sunflower family, native to Europe, Asia, and Africa. In North America *Pulicaria* is known by the common name false fleabane. The genus *Pulicaria* is in the family Compositae in the major group Angiosperms (Flowering plants). Our previous work reported the immunostimulatory effects of methanolic extract from *Pulicaria crispa* (Maghraby *et al.*, 2010). Animal subjected to a daily intra-peritoneal injection by the extract (33ng/mouse) for 10 successive days followed by infection with 100 *Schistosoma mansoni* cercariae. Treatment with the extract induced significant increase ( $P < 0.05$ ) in sera-IL-2 before and after infection. The detected levels of IgG were significantly ( $P < 0.05$ ) higher in sera from treated-infected mice than untreated extract-infected mice, upon using soluble worm antigen preparation or cancer bladder homogenates as antigens in ELISA. Using crude *Escherichia coli* lysate as an antigen in ELISA, it was detected a significant increase in IgG levels in sera from the *P. crispa*-treated mice before and after infection (Maghraby *et al.*, 2010). Recently, Albrahim *et al.* (2020) and Al-Nasser *et al.* (2021) demonstrated the immunomodulatory effects of *Pulicaria crispa* extract in lipopolysaccharide- (LPS-) stimulated THP-1 monocytes. The extract alone significantly reduced the rate of THP-1 cell apoptosis, while it increased the rate of late apoptosis. The treatment with this extract has significantly upregulated the expression of p-MAPK, ERK1, Bcl2, and P-P38. While the extract significantly reduced the expression of Bax, P-NF- $\kappa$ B, ERK5, NF- $\kappa$ B, CCL-(1,5, and 22) and CXCL-(1, and 10) (Albrahim *et al.*, 2020).

#### ***Santolina species:***

*Santolina* species are widely used in traditional medicine in the Mediterranean region for their antimicrobial, anti-inflammatory, digestive, antispasmodic, and analgesic properties (Alves-Silva, *et al.*, 2019). *S. impressa* is traditionally recognized

for its beneficial anti-inflammatory properties in several gastrointestinal affections.

*Santolina chamaecyparissus* (syn. *S. incana*), known as cotton lavender or lavender-cotton, is a species of flowering plant in the family Asteraceae (Alves-Silva *et al.*, 2019). The aqueous leaves extract and polyphenolic extract portion of *S. chamaecyparissus* exerted anti-inflammatory activity related to neutrophils reactions induced by formyl methionyl-leucyl-phenylalanine/Cytochalasin B (Alves-Silva *et al.*, 2019). Enzyme elastase which released during neutrophil degranulation was inhibited by concentration-dependent manner in concentration of 50 and 10 mg/ml for aqueous and polyphenolic extract, respectively. The neutrophil migratory activity was also inhibited at 100 mg/ml by polyphenolic extract while 200 mg/ml of the aqueous extract executed the same activity. The same concentrations decreased the phagocytosis capacity toward *C. albicans* of both extracts (Alves-Silva *et al.*, 2019).

#### ***Tagetes erecta:***

Carotenoids as feed ingredient in the poultry industry have increased markedly owing to their proactive and health-promoting properties (Nabi *et al.*, 2020). Carotenoids are powerful antioxidant that can alleviate adverse effect of oxidative stress via several mechanisms. They improve the oxidative stability of poultry products such as meat and egg. The flowers of *Tagetes erecta*, commonly known as the Mexican marigold, are often used as food colorants; they are also added to poultry feed to decrease egg cholesterol level and improve egg yolk pigmentation (Gostin and Waisundara, 2019). It contains more biologically useful lutein and lutein/zeaxanthin compounds. Marigold (*Tagetes erecta* L.) contains total carotenoid of 4200 mg/kg and is used in the pigmentation of eggs. Poultry industry uses carotenoids not only for colouration of different body parts but these compounds improve the production performance and health of poultry birds (Nabi *et al.*, 2020). Most of the natural carotenoids that are relevant for poultry pigmentation occur in the free form, but the lutein in *Tagetes* sp. occurs mainly as diesters of palmitic and myristic acids. Poultry cannot synthesize these carotenoids and must obtain carotenoids from their diets. Natural oxycarotenoids have demonstrated that beside the colouration of egg yolk and skin they can enhance the immune function too in Japanese quail (Nabi *et al.*, 2020). An antimicrobial screening assay found ethanol extract from *Tagetes erecta* to demonstrate antimicrobial properties against a broad spectrum of Gram-positive and Gram-negative bacteria (Rolnik and Olas, 2021).

#### ***Tridax procumbens:***

*Tridax procumbens* commonly known as tridax daisy or coatbuttons is a species of flowering plant in the daisy family Asteraceae. Ethanol insoluble fraction of aqueous extract of *Tridax procumbens* (Asteraceae) exerted significant increase in

phagocytic index, leukocyte count and splenic antibody secreting cells (Beck *et al.*, 2018). Stimulation of humoral immune response was further observed with elevation in hemagglutination antibody titer. Heightened delayed type hypersensitivity reaction suggested convincing evidence for activation of cellular immune system. Various tests in mice evaluated the effect of *Tridax* in stimulating the immune system, including the use of Swiss albino mice treated with immunomodulators present in *T. procumbens* and shown to activate the immune system (Beck *et al.*, 2018). Research has shown that *T. procumbens* does possess immunostimulator. It is unclear what constituents are immunostimulators.

#### **Apiaceae family plants:**

The Apiaceae/ Umbelliferae family includes more than 3500 species and Apiaceae plants are full of immunomodulatory chemicals such as essential oils, carotenoids, coumarins, phenols, lignans, monoterpenes, glycosides, organic acids, xanthenes, lipids, and flavonoids (Golubkina *et al.*, 2021). The plants belong to Apiaceae are usually used as a spice or as a vegetable, but their other functional properties are also very important, among which anise, dill, caraway, cumin, coriander, fennel, celery, angelica, parsley, carrot and lovage, which are popular spices and vegetables (Li *et al.*, 2018; Golubkina *et al.*, 2021). High levels of antioxidants in *Apiaceae* plants express powerful antibiotic properties, normalize digestion, and increase immunity (Golubkina *et al.*, 2021).

Apiaceae are a very important source of phytochemicals – chemicals with biological activity. However, phytochemicals are non-nutritive plant chemicals, also called nutraceuticals. They are widely used for prevention, treatment or cure of conditions or diseases (Li *et al.*, 2018). Bioactive compounds with nutraceutical potential are polyphenolic compounds, polyacetylenes and terpenoids. The aim of this review is to represent selected plants of Apiaceae family currently used as nutraceuticals and describe their nutritional benefits.

The benefits that accrue as a consequence are better performance and meat quality of broiler chicks (Lee *et al.*, 2004; Giannenas *et al.*, 2013). The use of antibiotic growth promoters in livestock production within the European Union has been prohibited since 2006. As a result, new commercial additives derived from plants, including aromatic plant extracts and their

The dried ripe fruits of the plants from Apiaceae family are used in folk medicine for treating digestive disorders (Aćimović *et al.*, 2016). Caraway, coriander, fennel, and anise are examples of the common fruits belong to Apiaceae family (Li *et al.*, 2018). Their role in broiler chickens and Japanese quail nutrition and effects on production performance, blood parameters have been reviewed by Aćimović *et al.* (2016). Plants from Apiaceae family can be used in animal production and

veterinary care especially poultry, as immunostimulants. They improve performance parameters of poultry and can be used for prevention of diseases (Golubkina *et al.*, 2021).

#### ***Anethum graveolens (celery):***

Apiaceae is a family of mostly aromatic flowering plants named after the type genus *Apium* and commonly known as the celery and carrot. *Anethum graveolens* L. is a popular plant widely used as a spice. It is an aromatic and annual herb of Apiaceae family used in Africa. *Anethum graveolens* is commonly known as dill. The generic name “Anethum” is derived from the Greek word “anethon” and the name comes from the Old Norse word, dylla or dilla which means “to soothe”. Pregnant and lactating goats and cows are allowed access to fresh nettles or wilted cut nettles. Milking ewes are given a tea of dill seed for milk production (Chandra *et al.*, 2016, 2017). Dill seed (*Anethum graveolens*, Apiaceae) (2 tsp) is steeped in 1 cup of boiling water for 10–15 min. or 1/2 cup dill seeds is steeped in water overnight. This is then boiled until becomes very dark in color and strained. Each animal is given 1 cup of this dill tea per day as the drinking water. Armfuls of comfrey (*Symphytum officinale*) are reputed to increase butterfat and act as a laxative. A handful of fresh or dried leaves of thornless raspberry (*Rubus* sp.) is given free choice (Chandra *et al.*, 2016, 2017).

#### ***Angelica sinensis:***

*Angelica sinensis* (Apiaceae) has been used in traditional Chinese medicine and is Native American medicine for centuries (Wang *et al.*, 2004; Lee *et al.*, 2013). The formula of Sheng Hua Tang consists of five ingredients including *Radix Angelicae sinensis* as the major ingredient of this formula. The effects of this formula on uterine involution and ovarian activity in postpartum dairy cows have been reported. Angelicae polysaccharide, a polysaccharide isolated from *Radix Angelicae Sinensis*, may stimulate the microenvironment within the body, to accelerate the synthesis and secretion of hematopoietic regulation factors. These effects of angelicae polysaccharide had been studied and confirmed at the level of gene and protein expression (Wang *et al.*, 2004). Activation of the immunologic function of rat Kupffer cells by the plant polysaccharides was detected.

#### ***Carum carvi (caraway):***

The uses of plants belong to Apiaceae, or their extracts, for treatment of gastro-intestinal parasites in livestock is considered in many studies (Waller *et al.*, 2001). Preparations derived from Apiaceae plants were the original therapeutic interventions used by man to control diseases, both within livestock and humans. It must be established that biological effects of some formula are directly Apiaceae plants related which helps the animal to rapidly mount an immune response against incoming or resident infections. One

specific strategy is to graze livestock on plants with purported anthelmintic properties (Waller *et al.*, 2001). For example, a survey of Danish organic dairy farmers with 255 respondents, revealed the use of herbs in the leys on 26% of the farms. Of these, *Anethum graveolens* (celery or dill, 14%), *Cichorium intybis* (chicory, 10%), *Anthriscus cerefolium* (chervil, 10%), *Petroselinum crispum* (parsley, 20%), *Carum carvi* (caraway, 56%), used singly or in combination, were the most commonly used plants (Waller *et al.*, 2001).

#### ***Centella asiatica*:**

*Centella asiatica* (Apiaceae) is herbaceous, frost-tender perennial plant. It is a capable agent applied in conventional asiatic medicine, as feed additive and is known to cure animal and human diseases (Roy *et al.*, 2013; Srichaiyo *et al.*, 2020). Nearly 60% of feed ingredients come from agricultural waste and agro-industry which decreased productivity of livestock. In order to overcome anti-nutrient or compensate for these conditions the feed additives need to be added (Caumo *et al.*, 2021). As approved in recent pharmacology, *Centella asiatica* (Apiaceae) displays multiple pharmacological properties, such as an antimicrobial, antitumor, anti-inflammatory, and immunomodulatory potentials (Shantilal *et al.*, 2018; Srichaiyo *et al.*, 2020). For serum immunity, dietary administration of *Centella asiatica* (gotu kola) powder led significantly ( $P < 0.05$ ) to an improved serum lysozyme and serum peroxidase activities compared to control group (Srichaiyo *et al.*, 2020). Highest value was found in fish fed 5 and 10 g kg<sup>-1</sup> the dried extract of *Centella asiatica*, which functions as a hepatoprotective, has been included as feed additive ingredient for livestock (Caumo *et al.*, 2021). Anti-nutrient substances in feed ingredients make up rations, causing disruption of the function of livestock organs (Srichaiyo *et al.*, 2020). Immunochemical examination is investigated in animal organs. The serum glutamic oxaloacetic transaminase, serum glutamic pyruvic transaminase, aspartate transaminase, and aspartate transaminase are usually investigated (Srichaiyo *et al.*, 2020).

A study by Caumo *et al.* (2021) showed that areas grazed by cattle presented an increase in the relative coverage of rosette and prostrate species including *Centella asiatica*. One litre of a maceration or decoction made from the eight medicinal plants including *Centella asiatica* is orally given twice a day. This description was used for the treatment of bloody stool and liquid feces many times a day as the symptom of some livestock diseases as coccidiosis, dysentery and diarrhoea (Caumo *et al.*, 2021). Also, the inclusion of dried *Centella asiatica* leaf meal as an herbal feed additive at 6% enhanced the overall performance of the broiler chicken without causing any deleterious effect on the health of the birds (Caumo *et al.*, 2021).

In the last decades, the scientific community has paid great attention to the use of natural immunostimulants in aquaculture. As alternatives to

antibiotics, natural, environmentally friendly, and cost-effective, medicinal plants have been widely applied in aquaculture. *Centella asiatica* is one of the plants have been widely applied in aquaculture to enhance immune system, and to provide antioxidant effects, due to their biological compounds, such as flavonoids, terpenoids, alkaloids, saponins element (Reverter *et al.*, 2017). Srichaiyo *et al.* (2020) reported the the effects of the *Centella asiatica* powder on serum immunity, skin mucus, and growth performance of *Oreochromis niloticus* (Nile tilapia) fingerlings.

#### ***Coriandrum sativum* (coriander):**

Coriander is an annual, herbaceous plant which originated from the Middle Eastern and Mediterranean regions and known as medicinal plants. Different parts of coriander contain essential oil (0.03±2.6%) (Abou-Elkhair *et al.*, 2014; Li *et al.*, 2018). They contain monoterpenes,  $\alpha$ -pinene, coriandrin, limpnene, *P*-cymene, camphor,  $\gamma$ -terpinene, citronellol, borneol, dihydrocoriandrin, geraniol, and coriandrins A-E. It is used for animal as a spasmolytic, stomachic, and carminative. The plant parts (seeds, flowers, fruits and leaves) possess antioxidant, anti-microbial, anti-mutagenic and antihelmintic activity.

A combination of coriander seeds (*Coriandrum sativum*), as one of Apiaceae plants, has been supplemented with other plants was used as feed additives. Their effects on some blood parameters, carcass traits, growth performance, and humoral immune response of broiler chickens have been reported ((Abou-Elkhair *et al.*, 2014).

#### ***Daucus carota* (carrot):**

Apiaceae family is large, with over 3.000 species worldwide cultivated for many purposes. Some plants in this family such as carrots are common vegetable crops. Usage of these plants is very popular in everyday diet because of their documented health benefits. There is a long tradition of feeding carrots to livestock but their use in animal feeding is marginal nowadays. Cold-press carrot seed oil has ben suggested to be used as a dietary source of natural antioxidant for broilers.

#### ***Foeniculum vulgare*:**

Effect of supplementation poly herbal mixture (consists of six herbs) on post-partum reproductive performance in Murrah buffaloe has been investigated by Chandra *et al.*, (2016). The poly herbal mixture was made by mixing 25 g each of *Zingiber officinale* (Zingiberaceae), *Foeniculum vulgare* (Apiaceae), *Trachyspermum ammi* (Apiaceae), *Trigonella foenum-graecum* (Fenugreek, Fabaceae/ Leguminosae), *Anethum graveolens* (Apiaceae), *Elettaria cardamomum* (ginger family; Zingiberaceae) and 25 g black salt. This mixture was boiled (20-30 min.) till half of water remained, then 250 g of Jaggery was added and heated (5-10 min.), prepared to be mixed with 1.5 kg of concentrate

mixture and fed to the buffaloes of supplemented groups after parturition (7days) in the morning hours, improved the immunity level of Murrah buffaloes. Significantly Low neutrophil and high phagocytic activity and myeloperoxidase activity indicated the better immunity (Chandra *et al.*, 2016, 2017)

#### ***Heracleum species:***

*Heracleum nepalense* (Apiaceae) exhibited a dose-dependent immunostimulant effect, which could be attributed to the flavonoid content (quercetin glycosides) or due to the combination with other component (s) (Eftekhari *et al.*, 2018). Eftekhari *et al.* reported the effect of dietary supplementation of fruit hydroalcoholic extract of angelica (*Heracleum persicum*, Apiaceae family) fruit on immune responses, and haematological characteristics of broiler chickens (Eftekhari *et al.*, 2018).

#### ***Petroselinum crispum (parsley):***

The aqueous extract of *Petroselinum crispum* Mill. (parsley) had bactericidal effects against *Helicobacter pylori* and inhibited adhesion of the bacteria to animal stomach section.

The production of *P. crispum* plant with the highest levels of anthocyanins (0.40 mg CGE g<sup>-1</sup>), has reported that it may has accumulated as stress sensors and defense components. Agro-industrial wastes of animal origin, such as broiler chicken wastes, are particularly rich in nutrients for plant (Li *et al.*, 2018; Mravčáková *et al.*, 2021). Recently (Santos *et al.*, 2021), a study has illustrated for the minerals and phenolic compounds in parsley (*Petroselinum crispum*) that has been affected by composts made from broiler chicken residues and blended with biochar.

#### ***Pimpinella anisum (anise):***

Some members in Apiaceae family like anise, coriander, caraway, cumin, lovage, fennel, dill and angelica are famous for their medicinal and aromatic properties (Li *et al.*, 2018). Anise (*Pimpinella anisum* L.) oil was reported as a natural feed supplement for growth in broiler chicken.

Soltan *et al.* (2008) reported the effect of dietary anise (*Pimpinella anisum*) seeds supplementation on immune response, growth performance, some blood parameters and carcass traits of broiler chickens. While, Yazdi *et al.* (2014) evaluated the effect of inclusion of *P. anisum* (three levels) as an antibiotic growth promoter substitute on immune responses, carcass traits, and growth performance in broiler chickens. At 42 d of age, the body weight of broilers fed basal diet was higher than other groups. Administration of broilers of basal diet had higher feed intake effect compared to broilers receiving different levels of anise seed. In chicks fed diets supplemented with 1 g anise (*P. anisum*)/kg, it was the most efficient feed conversion throughout this study. In the group treated with 10 g *P. anisum*/kg diet, the antibody titer against avian influenza virus increased (P<0.05) compared with other groups.

Many lignin-carbohydrate-protein complexes isolated from a hot water extract of seeds of *Pimpinella anisum* and have been reported with immunostimulating activity.

Another finding has showed that the *P.anisum* fixed oil has anti-inflammatory effect as strong as indomethacin and it showed analgesic effect compared to aspirin (100 mg/kg) and morphine (10 mg/kg) at 30th min.

#### ***Trachyspermum ammi:***

*Trachyspermum ammi* is one of the main plant families possess antiparasitic activity and use in controlling coccidiosis with promising results (Qureshi *et al.*, 2017). Three main plant families possess antiparasitic effect of supplementation poly herbal mixture (consists of six herbs including *Trachyspermum ammi*) on post-partum reproductive performance in Murrah buffalo has been investigated by Chandra *et al.* (2016). The poly herbal mixture was boiled (20-30 min.) till half of water remained, then 250 g of Jaggery was added and heated (5-10 min.), prepared to be mixed with 1.5 kg of concentrate mixture and fed to buffaloes of supplemented groups after parturition (7days) in the morning hours, improved the immunity level of Murrah buffaloes. Significantly low neutrophil and high phagocytic activity and myeloperoxidase activity indicated the better immunity (Chandra *et al.*, 2016, 2017)

#### ***Future perspectives:***

Economical, safe and healthier livestock production can be achieved by using medicinal plant base-feed additives with compromising animal health. Nevertheless, the fundamental relationship of these immune boosters with livestock production will remain a subject matter in the future for elucidative research. The variable mechanisms of Apiaceae and Asteraceae plants have significant impact on livestock health and overall production. The immunomodulatory properties of both plant families in poultry production have gained more interest and needs more exhaustive research in this field. The corresponding methods should be established for analytical quantification of the bioactive compounds of various medicinal plants to track the metabolites in the livestock production. Concrete scientific knowledge about the biological actions of conventional plants and their compounds will make the application of their products more successful in livestock production especially poultry industry. This review mainly illustrates the positive effects of herbal products on the immune system and overall poultry health. More consideration should be given to the chemical composition of non- investigated medicinal plants and their impact on the animal health and productivity. Although numerous reports have demonstrated immune stimulation efficacy *in vitro*, respective experimental *in vivo* evidence is still quite limited. However, further studies of the Asteraceae and Apiaceae families should be



conducted to fully understand the potential uses as prevention for many diseases or in the development of new drugs.

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## الإستخدام المحتمل لبعض عناصر تنتمي إلى الفصيلة النباتية الخيمية و النجمية كمعززات للمناعة في إنتاج الثروة الحيوانية

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قسم كيمياء المركبات الطبيعية- معهد بحوث الصناعات الصيدلانية والدوائية- المركز القومي للبحوث

يعتمد المرجع على مصادر نباتية تنتمي لأثنين من الفصائل النباتية (الخيمية والنجمية) لدراسة تأثيراتها كمعززات مناعية تسهم في الإنتاج الحيواني. وأظهر المرجع قدرة النباتات التي تنتمي إلى هاتين الفصائلتين على تحسين صحة الماشية ووظائف المناعة بالإضافة إلى تقليل مخاطر الإصابة بأمراض الحيوان المختلفة. يتم تقسيم مجموعات الفصيلة النباتية هذه بناءً على تأثيرها على الآليات التي تؤثر على الجهاز المناعي للحيوان والتي تتمثل في الأنشطة المضادة للأكسدة والالتهابات ومضادات الميكروبات. يمكن إجراء مزيد من الدراسات على هذه الأنواع النباتية من خلال تحديد قدرتها وإمكانية تطويرها إلى دواء جديد أو استخدامها كنبات طبي في علاج الأمراض التي تشملها المناعة في الماشية.