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The Impact of Herbal Supplements on Animal Health and Feed Efficiency

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Abstract: *The significance of herbal feed additives in animal production is increasing as a result of the prohibition of the use of specific antibiotics, the cost-effectiveness, and the potential for detrimental residual effects. The production of animals has been positively impacted by a variety of feed additives, including probiotics, prebiotics, organic acids, and plant extracts. The properties of medical botanicals that enhance digestibility, antimicrobial, anti-inflammatory, anti-oxidant, and immune-stimulant activity must be utilized in the production of safe food products for humans and animals. Additionally, it is imperative to conduct research on the standardization of appropriate dosages of botanical feed additives for specific purposes.*

Keywords: Antimicrobial, Anti-Oxidant, Immune-Stimulant, Feed Additive, Herb, Spices

I. INTRODUCTION

Initially, the development of microbial resistance to antibiotic drugs and its impact on human health has led to an increasing interest in herbal feed additives in livestock production. The second is a reaction to consumer pressures to eliminate the use of all non-plant xenobiotic agents from the diets of animals. Health and nutrition are significantly influenced by herbal feed additives. The following are the definitions of herbal feed additives: herbs, seasonings, and botanicals (Webster's Encyclopedic Unabridged Dictionary of the English Language, 1989):

Herb: A perennial floral plant that maintains its persistent and fibrous stem above ground. A plant that is regarded for its medicinal properties, aroma, fragrance, or similar attributes.

Spices: A class of pungent or aromatic substances of vegetable origin, such as pepper, cinnamon, and cloves, that are employed as preservatives, seasonings, and the like.

Botanical: A medication that is derived from a plant's root, leaves, bark, or other components. Essential oils are a type of volatile oil that are extracted from plants. They are primarily used in the production of pharmaceuticals, fragrances, and perfumes, and they possess the plant's characteristic properties and odor.

Table 1: Different herbal feed additives, its active components and functions

Plant	Used parts	Active component	Function
Nutmeg (Myristica fragrans)	Seed	Sabinene	Digestion stimulant, antidiarrhoeic
Cinnamon (Cinnamomum zeylanicum)	Bark	Cimetaldehyde	Appetite and digestion stimulant, antiseptic
Cloves (Syzygium aromaticum)	Cloves	Eugenol	Appetite and digestion stimulant, antiseptic
Cardmom (Amomum subulatum)	Seed	Cineol	Appetite and digestion stimulant
Coriander (Coriandrum sativum)	Leaves and seed	Linalol	Digestion stimulant
Cumin (Cuminum cyminum)	Seed	Cuminaldehyde	Digestive, carminative, galactogogue
Anise	Fruit	Anethol	Digestion stimulant, galactogogue

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(Pimpinella anisum)			
Celery (Apium graveolens)	Fruit, leaves	Phtalides	Appetite and digestion stimulant
Parsley (Petroselinum crispum)	Leaves	Apiol	Appetite and digestion stimulant, antiseptic
Fenugreek (Trigonella foenum-graecum)	Seed	Trigonelline	Appetite stimulant
Capscicum (Capsicum annuum)	Fruit	Capsaicin	Digestion stimulant
Pepper (Piper nigrum)	Fruit	Piperine	Digestion stimulant
Horsradish (Armoracia rusticana)	Root	Allyl izotiocianat	Appetite stimulant
Mustard (Brassica Nigra)	Seed	Allyl izotiocianat	Digestion stimulant
Ginger (Zingiber officinale)	Rizom	Zingerone	Gastric stimulant
Garlic (Allium sativum)	Bulb	Alkin	Digestion stimulant, antiseptic
Rosemary Rosmarinus officinalis	Leaves	Cineol	Digestion stimulant, antiseptic
Thyme (Thymus vulgaris)	Whole plant	Thymol	Digestion stimulant, antiseptic, antioxidant
Mint (Mentha piperita)	leaves	Menthol	Appetite and digestion stimulant, antiseptic
Shatavari (Asparagus racemosus)	Root	Sapogenins, flavonoids and saponin	Prevention and treatment of gastric ulcers, dyspepsia and as a galactogogue.
Jivanti (Leptadenia reticulata)	Leaves and twigs	Stigmasterol, β – itosterol, flavonoids, pregnane glycosides	Galactogogue, antimicrobial and anti-inflammatory activity
Shatavari (Asparagus racemosus)	Root	Shatavarin-I-IV, qucertin, rutin, hyperoside	Galactogogue

(Source: Mirzaei-Aghsaghali, 2012)

Modes of Action and Beneficial Effects of Herbal Feed Additives

A diverse array of low molecular weight secondary metabolites has been developed by plants. In general, these compounds facilitate the interaction between plants and the environment, and they may function as a defense mechanism against physiological and environmental duress, as well as predators or parasites. In addition to compounds with toxic properties, several of these secondary plant metabolites have been reported to exhibit beneficial effects on animal metabolism and food products. Many of these compounds have been proposed to function as antioxidants or antibiotics (Rhodes, 1996; Hirasa and Takemasa, 1998). The majority of these active secondary plant metabolites are classified as flavonoides, glucosinolates, and isoprene derivatives. In the feed of farm animals, herbs initially develop their activity as flavor. Consequently, they can affect the feeding pattern, secretion of digestive fluids, and total feed ingestion. Microorganisms can be selectively influenced by herbs or phytochemicals through an antimicrobial activity or a favorable stimulation of the eubiosis of the microflora. The antibacterial effect of the majority of herbal feed additives is achieved by denaturing and coagulating proteins in the bacterial cell wall structure. The cytoplasmic

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membrane's permeability to H+ and K+ ions is influenced by the essential oils. This alteration results in the disruption of critical cellular processes, including electron transport, protein translocation, oxidative phosphorylation, and other enzyme-dependent reactions. Consequently, chemiosmotic control is lost, leading to bacterial mortality (Dorman & Deans, 2000). The lipophilic nature of essential oils that accumulate in the membranes is the cause of the disruption of the bacterial cytoplasmic membrane. Additional actions may be associated with the inhibition of nutrient assimilation, enzymatic inhibition, DNA, RNA, and protein synthesis by bacterial cells. The antioxidant activity of essential oils is primarily attributed to the presence of phenolic compounds, flavonoids, and terpenoids, which protect food, tissues, and cells from the detrimental effects of oxidation reactions.

The immune system is stimulated or nutrient utilization and absorption are enhanced by herbal feed additives. Changes in the intestinal microbiota, increased digestibility and nutrient absorption, enhanced nitrogen absorption, enhancement of the immune response, morphological and histological modifications of the gastrointestinal tract, and antioxidant activity are all potential mechanisms of action of the herb in the animal for growth promotion. Lastly, botanicals can contribute to the nutrient requirements of the animals and stimulate the endocrine system and intermediate nutrient metabolism.

The beneficial effects of herbs or botanicals on farm animals may result from the activation of feed ingestion and the secretion of digestive secretions, immune stimulation, antibacterial, coccidiostatic, anthelmintic, antiviral, or anti-inflammatory activity, and antioxidant properties. The beneficial effects of the herbal feed additives are achieved through the following mechanisms:

Influence of herbal feed additives on feed intake, digestibility of nutrients and animal performance: Following the prohibition of antibiotics, an increased number of botanicals are employed as feed additives to enhance growth conditions. The varying effects of various herbs and seasonings on digestion processes are a result of the broad variety of active components. The majority of them induce salivation. The digestion and absorption of lipids are positively impacted by the synthesis of bile acids in the liver and their excretion in bile, which is facilitated by curcuma, cayenne pepper, ginger, anis, mint, scallions, fenugreek, and cumin. The majority of the spices enumerated above promote the activity of pancreatic enzymes (lipases, amylases, and proteases); a few also enhance the activity of digestive enzymes in the gastric mucosa. In addition to their impact on enzyme activity and bile synthesis, extracts from botanicals and spices expedite the digestion process and reduce the duration of feed/food passage through the digestive tract (Frankic et al., 2009). In tropical regions, plant herbs such as peppermint (Mentha piperita), lemongrass (Cymbopogon citrates, DC. Stapf.), and garlic (Allium sativum) are extensively employed as antibacterial agents and to preserve the microbial ecosystem of the gastrointestinal tract (Shin and Kim, 2004). Kongmun et al. (2011) reported that the growth rate, digestibility, and carcass traits of livestock were enhanced when garlic was used as an alternative growth promoter. Yang et al. (2007) have reported that lemongrass and peppermint have been used as feed additives to enhance the production performance of beef and dairy cattle. In recent years, menthol (Mentha arvensis) has been documented to enhance the digestibility of ileal protein and amino acids, thereby increasing the efficacy of feed in weaned piglets (Maenner et al., 2011). Additionally, black paper has been shown to enhance the performance of broiler chickens (Tazi et al., 2014).

Herbal feed additives as antimicrobial supplements

The antimicrobial activity of specific plant extracts against Gram− and Gram+ microorganisms was demonstrated in numerous investigations. Plants are capable of producing substances that serve as defense mechanisms against microorganisms, herbivores, and insects. Additionally, they may generate secondary antimicrobial metabolites as a consequence of duress or as part of their typical growth and development. The antimicrobiol effect of oriental herbs, such as Allium sativum, Angelica dahurica, Anguisorba officinalis, Artemisia argyi, Coptis chinensis, Dictamnus dasycarpus, Fraxinus rhynchophylla, Geranium thunbergii, Hydrastis canadensis, Phellodenron amurense, Polygonum cuspidatum, Scutellria baicalensis, and Sophora flavesens, has been the subject of numerous studies. Baicalin, baicalein, limonene, cinnamaldehyde, carvacrol, or eugenol are the primary flavonoid components in these herbs, and they collectively exert an antimicrobial effect in conjunction with other supportive herbs. These botanicals exhibit an antibacterial effect against Salmonella spp. or E. coli, as well as gram-positive microorganisms Staphylococcus spp.

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and Streptococcus spp. The fatty acid composition of herbal feed additives is altered by active principles, which can impact the surviving ability of microorganisms by increasing hydrophobicity. It is confirmed that herbs and spices function as antimicrobial agents by altering the characteristics of cell membranes and causing ion leakage, thereby reducing the virulence of microorganisms. Phytobiotics, which are plant extracts, have been utilized for their antimicrobial, anti-inflammatory, anti-oxidative, and anti-parasitic properties. The composition of phytobiotics is subject to significant variations as a result of biological factors (plant species, growing location, and harvest conditions), manufacturing processes (extraction/distillation and stabilization), and storage conditions (light, temperature, oxygen tension, and time; Huyghebaert et al., 2011).

Herbal feed additives as anti-inflammatory

Curcuma, red pepper, black pepper, cumin, cloves, nutmeg, cinnamon, mint, and ginger extracts exhibited an anti-inflammatory effect. Phenols, terpenoids, and flavonoids are the primary active molecules that exhibit anti-inflammatory properties. The metabolism of inflammatory prostaglandins is inhibited by these molecules. Plant phenolic compounds are hydroxylated derivatives of benzoic acid and cinnamic acids and have been reported to exhibit anti-inflammatory properties. Anti-inflammatory, anti-allergic, antiviral, and antiproliferative properties have been acknowledged for a long time in flavonoids (Muanda et al., 2011). Chamomile, marigold, liquorice, and anis are the most well-known botanicals and seasonings with anti-inflammatory properties (Frankic et al., 2009). Mint and other plants from the Labiatae family have garnered significant attention. Phenolic terpenes are responsible for their antioxidant properties (Cuppett and Hall, 1998). Thymol and carvacrol are prominent monoterpenes in oregano and thyme (Rahim et al., 2011.). Flavonoids-rich plants, including green tea and other Chinese botanicals, have been identified as natural antioxidants (Wei and Shibamoto, 2007). A number of antioxidant compounds are also present in black pepper (Piper nigrum), red pepper (Capsicum annuum L), and chili (Capsicum fretuscene) (Nakatani, 1994). However, the active substances in the portions of many of these plants are highly fragrant and/or peppery, which has resulted in their restriction for use in animal feed. Recently, the anti-bacterial, anti-viral, anti-fungal, anti-tumor, anti-inflammatory, immunomodulatory, wound-healing, anti-oxidant, and anti-diabetic properties of Aloe vera have been reviewed for poultry (Babak and Nahashon, 2014).

Herbal feed additives as antioxidants

Antioxidants are compounds that aid in the delay and inhibition of lipid oxidation. When introduced to food, they reduce rancidity, delay the formation of deleterious oxidation products, and contribute to the preservation of nutritional quality (Muanda et al., 2011). Antioxidants from vegetation are believed to have a health-promoting effect by counteracting reactive oxygen species. Numerous studies have indicated that plants that are abundant in antioxidants have a protective effect on health and disease, and that their consumption reduces the risk of cancer, heart disease, hypertension, and stroke. The antioxidant potential of medicinal plants may be correlated with the concentration of phenolic substances (flavonoids, hydrolysable tannins, proanthocianidins, phenolic acids, phenolic terpenes) and certain vitamins (E, C, and A). The sulfur-containing active principle of garlic and onion is responsible for their biological action products, which have been reported to have lipid-lowering effects and inhibit the oxidation of low-density lipoproteins (Ahmed and Bassuony, 2009). Rosemary, thyme, oregano, sage, green tea, chamomile, ginko, dandelion, and marigold are frequently employed herbs that are high in phenolics. The feed can be safeguarded from oxidative deterioration during stowage by the use of herbs and seasonings.

Herbal feed additives as immunostimulant

Herbs and spices that are abundant in flavonoids, vitamin C, and carotenoids are generally advantageous to the immune system. The plants that contain molecules that exhibit immunostimulatory properties are cat's claw, garlic, liquorice, and echinacea. These botanicals have the potential to enhance the activity of lymphocytes, macrophages, and NK cells by increasing phagocytosis or stimulating interpheron synthesis (Frankic et al., 2009). Lavinia et al. (2009) have demonstrated that the immune response is enhanced by essential oils extracted from medicinal plants, and they are also capable of causing changes in the duodenal mucosa that are beneficial for the animal (Lavinia et al., 2009). Recently,

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the immunomodulatory properties of β-glucan and cow urine distillate have been emphasized in broiler chicken (Ganguly, 2013).

Herbal feed additives as coccidiostat

Certain plant extracts have been shown to be effective against certain chicken parasites, particularly coccidian (Naidoo et al., 2008; Arczewska-Wlosek and Swiatkiewicz, 2012). Betaine, a byproduct of the sugar beet industry, has recently been noted to have a beneficial effect on the prevention of coccidiosis. It facilitates the normal metabolic activity of cells and safeguards against osmotic stress that is associated with dehydration. Nevertheless, the protective effects of betaine on intestinal cells are also felt by parasitic cells. Curcumin, a phenolic compound derived from the rhizome of Curcuma longa, is the active component. Its anticoccidial properties are mediated by its antioxidant activity on the immune system (Allen et al., 1998). Galla rhois and Nectaroscordum tripedale extracts have demonstrated promising results in the treatment of coccidial infections (Lee et al., 2012; Habibi et al., 2014).

Advantages of Herbal Feed Additives

Selection and feeding of herbal feed additives over other feed additives is due to:
Natural constituent of feeds.
Absence of residual effects.
Non-hazardous eco-friendly.
Minimum problem of drug resistance.

Limitations of Herbal Feed Additives

Not easily quantifiable and standardized due to their complex composition.

The composition of plants may be influenced by the location, soil type, atmospheric conditions, altitude, season of growth, harvesting procedure, and storage situation.

While the majority of herbals are stable, there are a number of constituents that are thermolabile and photolabile, resulting in a lower level of stability.

Factors such as the extraction method, the method and duration of conservation and storage, the variety and environmental growth conditions, the harvesting time and state of maturity, and potential synergistic or antagonistic effects, anti-nutritional factors, or microbial contamination may significantly influence the use of herbal feed additives.

II. CONCLUSION

Maintaining the welfare of farm animals is essential for the production of wholesome animal products. The utilization of compounds of natural origin in the diets of both humans and animals has been promoted over the past decade. There have been numerous studies that have examined the biochemical structures and physiological functions of a variety of feed additives, including probiotics, prebiotics, organic acids, and plant extracts. Herbs and seasonings may be incorporated into feed as desiccated plants, plant portions, or extracts to achieve their beneficial effects. However, there is a necessity for research to be conducted on the various properties of a specific herb in order to enhance its digestibility, antimicrobial, anti-inflammatory, anti-oxidant, and immunostimulant effects, as well as the appropriate dosages.

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