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Review Article

PHYTO FEED ADDITIVES IN POULTRY NUTRITION – A REVIEW

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Abstract: Phyto feed additives are plant-based feed additives or botanicals that are used in natural substances used in poultry nutrition. These substances are derived from herbs, spices, other plants and their extracts, like essential oils. They are natural, less toxic, residue free and ideal feed additives for poultry when compared to synthetic antibiotics. Most common herbs and spices for phyto feed additives in poultry production are oregano, thyme, garlic, horseradish, chili, cayenne, pepper, peppermint, cinnamon, anise, clove, rosemary and sage. Many beneficial properties of phytogenic compounds derive from their bioactive molecules are carvacrol, thymol, cineole, linalool, anethole, eugenol, allicin, capsaicin, allyl isothiocyanate and piperine. Phyto feed additives have antimicrobial, antifungal, antiviral, antitoxigenic, antiparasitic and insecticidal properties. The benefits of using phyto feed additives in poultry nutrition are increased feed intake, stimulation of digestion, increased growth performance, reduced incidence of disease, improved reproductive parameters, feed efficiency, profitability and reducing poultry house emissions. Phyto feed additives from aromatic plant parts could be included ranged from 0.01-30 g/kg (oregano 10 to 30 g/kg, garlic at 1.5-2 g/ kg feed, rosemary at 5-10 g/kg feed and rosemary powder at 0.5 g/kg feed) whereas essential oils could be included in the feed (rosemary and sage extracts at 500 mg/kg of feed, oregano essential oil at 50-300 mg/kg feed, clove essential oil at 100-600 mg/kg feed, thymol at 100 mg/kg feed). To maximize the overall performance of poultry, phyto feed additives should be used as an alternative feed additives in poultry production because of the absence of side effects, residual effects, non-hazardous and eco-friendly.

Keywords: phytogenic, feed additives, poultry, nutrition, antibiotic alternative.

Introduction

The international feed industry is facing the challenge of the awareness among the consumers of meat on the risk of bringing about antibiotic resistance in pathogenic microbiota through antibiotics used in animal and poultry feeds. It has directed them towards the

non-antibiotic feed additives. Among them, the feed additives of plant origin, called as Phytogenic Feed Additives (PFA) or Phytobiotics or Phytoadditives are considered to be a better alternative as non-antibiotic growth promoters, eventhough there are well established non antibiotic growth promoters such as organic acids and probiotics. The Phytogenic feed

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additives also vary widely in their botanical origin, processing and composition. They have been used in solid, dried and ground forms or as extracts or essential oils (Guo *et al.,* 2003). Phytogenic feed additives usually have considerable variation in their chemical composition, depending on their ingredients and the influences of climatic conditions, location, harvest stage or storage conditions.

Phytogenic Feed Additives

The phytogenic feed additives are defined as "the compounds of plant origin incorporated into animal feed to enhance livestock productivity through the improvement of digestibility, nutrient absorption and elimination of pathogens residents in the animal gut" (Athanasiadou *et al.*, 2007). They are also defined as "plant-derived compounds incorporated into diets to improve the productivity of livestock through amelioration of feed properties, promotion of the animal's production performance and improving the quality of food derived from those animals" (Windisch *et al.*, 2008).

Classification of Phyto additives

Phytogenics comprise a wide range of substances and thus have been further classified according to botanical origin, processing and composition. The phytogenics include a broad range of plant materials such as herbs, spices, essential oils or oleoresins - extracts derived by non-aqueous solvents (Windisch *et al.*, 2008).

Mode of Action

Phytogenic feed additives have been proved to provide antimicrobial, antioxidative, anticoccidial, immunogenic effects on feeding to poultry. They also improve the palatability of the feed; protection from oxidative damage of feed lipids; improve the digestibility of the feed and absorption of the nutrients in the gut. They have shown to enhance the gut health through reduced bacterial colony counts, fewer fermentation products (including ammonia and biogenic amines), less activity of the gut-associated lymphatic system and a greater preceacal nutrient digestion. In addition, some phytogenic compounds seem to promote intestinal mucus production.

Most of these active secondary plant metabolites, which belong to the classes of isoprene derivatives, flavonoids and glucosinolates and a large number of these compounds, act as antibiotics or as antioxidants *in vivo* as well as in food. Several authors have given some overview on physiologically active secondary plant metabolites (Rhodes, 1996) and their principles of antioxidative characteristics (Halliwell *et al.,* 1995).

Phytogenics as valuable feed additives

The phytogenic feed additives may be included among supplements that are aimed to positively affect feed quality, health of animals as well as animal products by means of their specifically efficacious substances. They can be classified into several groups: sensory additives (feed additives affecting the sensory properties of animal products), technological additives (antioxidants, substances decreasing mycotoxin contamination of feeds, etc.), zootechnical additives (immunomodulators, digestive stimulants, growth promoters of non-microbial origin, substances increasing performance or quality of animal products, etc) and nutritional additives (vitamins, minerals, plant enzymes, etc). Phytogenic additives are used mainly in the first three cases, however, a number of phytogenic additives have been demonstrated or are presumed to have more than one positive effect and cannot be strictly classified into the designated groups (Karaskova *et al.*, 2015).

Sensory Additives

Traditional sensory additives include substances affecting food odour, palatability and colourings. Phytogenic additives are commonly used as colourings in laying hens to affect the egg yolk colour. Natural colourings are preferred; the most frequently used ones include carotenoids, the source of which are carrot, *Chlorella* algae, marigold (*Tagetes erecta* L.), or lutein, however, natural carotenoids are unstable and their use is also limited by their price (Englmaierova *et al.*, 2014).

Technological additives

Phytogenic additives are newly studied also in terms of decreasing the production of harmful gases in poultry. Lower ileum ammonia concentration in broiler chickens fed essential oil (125 ppm including the essential oil derived from oregano, anise, and citrus peel) was noted by Hong *et al.* (2012).

Zootechnical Additives

Immunomodulators

Immunomodulation can be defined as a change (stimulating or suppressing) in the indicators of cellular, humoral and non specific defense mechanisms (Bakuridze *et al*, 1993). Typically the immune system is held in homeostatic balance between immune stimulation and immune suppression. Emerging evidences indicate that herbal plants exert their beneficial effects on chicken immune system mostly by plant secondary metabolites (Hashemi *et al.*, 2008). The immune stimulating activities of these components have been most widely studied in chicken by Cao and Lin (2003).

Anti-oxidants

Antioxidant properties are well described for herbs and spices (e. g., Cuppett and Hall, 1998; Craig, 1999; Nakatani, 2000; Wei and Shibamoto, 2007). Plant species from the families of Zingiberaceae (e.g., ginger and curcuma) and Umbelliferae (e.g. anise and coriander), as well as plants rich in flavonoids (e.g. green tea) and anthocyanins (e.g. many fruits), are also described as exerting antioxidative properties (Nakatani, 2000; Wei and Shibamoto, 2007). Furthermore, pepper (*Piper nigrum*), red pepper (*Capsicum annuum L.*), and chili (*Capsicum frutescene*) contain antioxidative components (Nakatani, 1994). In many of these plants, parts of the active substances are highly odorous or may taste hot or pungent, which may restrict their use for animal feeding purposes.

Antimicrobials

Some studies with broilers demonstrated *in vivo* antimicrobial efficacy of essential oils against *Escherichia coli* and *Clostridium perfringens* (Jamroz *et al.*, 2003, 2005; Mitsch *et al.*, 2004). Lee and Ahn (1998) reported that cinnamaldehyde selectively inhibited *Bacteroides* and *C. perfringens*. Mitsch *et al.* (2004) investigated the effects of essential oils in broilers. A blend of thymol, eugenol, curcumin, and piperin significantly reduced the concentrations of *C. perfringens* in the digesta and faeces of the birds, potentially indicating a reduced risk for these birds to develop necrotic enteritis, yet in these field studies, mortality was too low to realize any differences. Reduced levels of *C. perfringens*, *E. coli* and fungi were also obtained in experiments with broilers fed a blend of carvacrol, cinnamaldehyde, and capsaicin (Jamroz *et al.*, 2005).

Gut health promoters

Stimulation of digestive enzymes: Stimulation of digestive secretions (e.g., saliva, bile and mucus) and enhanced enzyme activity are proposed to be a core mode of nutritional action (Platel and Srinivasan, 2004; Rao *et al.*, 2003). Essential oils used as feed additives for broilers were shown to enhance the activities of trypsin, amylase, lipase, amylase or carbohydrates, thus having beneficial effect on nutrient utilization (Lee *et al.*, 2003; Jang *et al.*, 2004 and Williams and Losa, 2001). Phytogenic feed additives were also reported to stimulate intestinal secretion of mucus in broilers, an effect that was assumed to impair adhesion of pathogens and thus to contribute to stabilizing the microbial eubiosis in the gut of the animals (Jamroz *et al.*, 2006).

Modification of Gut morphology: Jamroz *et al.* (2006) reported that, depending on the type of diet, villus height and crypt depth were affected by dietary supplementation with a

phytogenic feed additive derived from carvacrol, cinnamaldehyde and capsaicin. When the birds were fed corn-based diets, phytogenic supplementation significantly reduced crypt depth in the jejunum at 21 d of age. In contrast, the effect was opposite when the birds were fed wheat and barley based diets. In the same trial, the blend of phytogenic ingredients enhanced intestinal mucin secretion and the number of goblet cells on the villi indicating in general a protective effect of these phytogenic compounds. Because these results are not fully conclusive, there is a need for further investigations into the effect of phytogenic compounds on gut morphology in poultry.

Improving digestibility: In a study with broilers, addition of different phytogenic feed supplements, one based on oregano, cinnamon, and pepper and the other based on sage, thyme, and rosemary, enhanced apparent ileal dry matter and starch digestibility at 21 days of age (Hernandez *et al.*, 2004). Moreover, phytogenic supplementation increased total tract apparent dry matter and crude protein retention. Cobb broilers supplemented with a blend of essential oils derived from oregano, anise, and citrus at 125 mg/kg of diet had increased apparent ileal fat digestibility (Mountzouris *et al.*, 2008).

Improving production performance/growth promotion

The growth promotion activity of phyto feed additive in poultry production is due to their effects of improving the digestibility of nutrients, improving the GIT microbiota, antioxidation property contributing to reducing the oxidative stress, immunomodulation, improvements in body weight, body weight gain, feed intake, FCR, carcass characteristics.

Conclusion

Phytogenic compounds are an alternative to antibiotic growth promoters. The mode of action of phytogenics to achieve better performance is not completely clear. Unfortunately, recent experimental results are available only from commercial products containing blends of phytogenic substances. Therefore, systematic approach is needed to explain the efficacy and mode of action for each of type and dose of active compound. Nevertheless, the current experience in feeding such compounds to poultry seems to justify the assumption that phytogenic feed additives may have the potential to promote production performance and productivity and thus add to the set of non antibiotic growth promoters such as organic acids and probiotics.

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