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Review Article

PHYTOGENIC COMPOUNDS USED AS A FEED ADDITIVES IN POULTRY PRODUCTION

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Abstract: Antibiotic growth promoters enhance growth performance and stabilize an animal's health status (Gustafsonand Bowen, 1997). Since the ban in 2006 of antibiotic growth promoters in the European Union, the search for suitable natural alternative to antibiotic growth promoters with similar beneficial effects has been intensified. Among possible alternatives are phytogenic feed additives (**PFA**) which may positively affect poultry health and productivity. Many non-therapeutic substitutes (prebiotics, probiotics and symbiotics), especially plants extracts from a wide variety of herbs, spices and derivatives, have already been used as a feed additive in poultry. Recent studies on these compounds have shown some positive effects (antimicrobial, antioxidant and regulator of the gut flora) in poultry production. This indicates that plant extracts can be considered as feed additives in poultry production.

Keywords: Phytogenics, Antioxidant, Herbs, Spices, plant extracts.

Introduction

Herbs and plant extracts used in animal feed is called phytogenics feed additives (also called phytobiotics or botanicals), are defined as 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 (Kamel, 2001; Balunas and Kinghorn, 2005; Athanasiadou *et al*., 2007). They are incorporated into diets to improve production performance, and the quality of food derived from those animals (Windisch *et al.* 2007). The large variety of plant compounds used as PFA are assembled according to their origin and treatment, such as herbs and spices (eg: garlic, anise, cinnamon, coriander, oregano, chili, pepper, rosemary and thyme) but also essential oils or oleoresins (Kamel, 2000). Another category of compounds are extracted exclusively from fruits. They are represented by water soluble polyphenols (flavonoids) which can also be used in animal feed (Lopez-Bote, 2004). The content of active substances in these products can vary greatly depending on what part of the plant is used (grains, leaves, roots, bark, flowers, or buds), the

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harvest season and geographical origin. This review critically analyses the use of phytogenic feed additives in poultry.

Antioxidant action of PFA

The antioxidant properties of herbs and spices have been largely described by Craig (1999), Nakatani (2000), Lambert *et al*., (2001); Ruberto *et al*., (2002); Wei and Shibamoto (2007). Among the varieties of plants with antioxidant constituents, plants of the *Labiatae* families (like mint) have attracted due to phenolic terpenes (Cuppett and Hall, 1998) which improve oxidative stability of poultry products (meat) by decreasing lipid per-oxidation during refrigerated storage of fresh and cooked meat (Botsoglou *et al*., 2003). The oxidative stability was also demonstrated with other PFA (Botsoglou *et al*., 2004; Govaris *et al*., 2004; and Schiavone *et al*., 2007). Other herbs species with antioxidative properties such as thyme and oregano contain large amounts of monoterpenes, thymol and carvacrol (Ruberto *et al*., 2002; Rahim *et al*., 2011). Nakatani, (2000); and Wei and Shibamoto, (2007) reported that 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 anthocyans (e.g., many fruits), are exerting antioxidative properties.

The antioxidant property of many phytogenic compounds assumed to contribute to protection of feed lipids from oxidative damage, such as the antioxidants usually added to diets (e.g., α tocopheryl acetate or butylated hydroxytoluene). Although this aspect has not been investigated for poultry feeds, there is a wide practice of successfully using essential oils, especially those from the Labiatae plant family, as natural antioxidants in human food (Cuppett and Hall, 1998), as well as in the feed of companion animals. Nevertheless, it remains unclear whether these phytogenic antioxidants are able to replace the antioxidants usually added to the feeds (e.g., α-tocopherols) to a quantitatively relevant extent under conditions of common feeding practice.

Actions on palatability and digestion of PFA

The inclusion of phytogenic compounds in poultry feed reduce palatability of diet due to pungent odour, which depress the feed intake without changes in body weight gain, leading to an improved FCR (Windisch et al.,2008; Brenes and Roura, 2010).

A wide range of spices, herbs, and their extracts are exert beneficial actions on the digestive tract, such as laxative and spasmolytic effects and prevention from flatulence (Chrubasiket al., 2005). Phytogenic feed additives increase the output of digestive enzymes from the pancreas, gut mucosa,and increased bile flow (Platel and Srinivasan, 2004; Jamroz

et al., 2005; Jang et al., 2007). Further increase the absorption surface of intestine there by it increase the Apparent Ileal Digestibility (AID) of nutrients favours the growth of broilers. The essential oils improve the activity of trypsin, amylase and increase intestinal mucus production. This effect is assumed to influence the adhesion of pathogens and help to stabilize the microbial equilibrium in the chicken gut (Lee *et al*., 2003; Jang *et al*., 2004; Jamroz *et al*., 2005; Jamroz *et al*., 2006). Dietary supplementation of garlic increased feed intake and growth rate in chickens (Lewis *et al*., 2003). Essential oils used as feed additives for broilers were shown to enhance the activities of trypsin and amylase (Lee et al., 2003; Jang et al., 2004). Glucose absorption from the small intestine was accelerated in rats fed with anise oil (Kreydiyyeh et al., 2003).

Saponins (e.g., from *Yucca schidigera*) reduce intestinal ammonia formation by lower intestinal and fecal urease enzyme involved in urea metabolism in broilers (Nazeer et al., 2002; Francis et al., 2002; Killeen et al., 1998; Duffy et al., 2001). However, yucca extracts were reported to contain subfractions with partially antagonistic properties on intestinal urease activity and ammonia formation (Killeen et al., 1998).

Antimicrobial actions of PFA

Sari *et al*., (2006) reported that antimicrobial action of PFA is depends on the physico-chemical characteristics of plant compounds. Most of the studies showed plant extracts are highly active against Gram positive bacteria compared to Gram negative (Shelef, 1983; Zaika, 1988; Smith -Palmer *et al*., 1998; Ceylan and Fung, 2004). This does not mean that the plant extracts are not active on Gram - bacteria, but the dosage should be higher. Ayachi *et al*., (2009) stated that extracts of berries, dates and thyme effective against *Salmonella*. Cosentino *et al*., (1999) stated that active compounds (thymol and carvacrol) of Thyme is highly active against *Candida albicans.* Walnut leaves (*Juglandaceae*) reduce the proliferation of *Clostridium perfrengens* in chickens (Lovland and Kaldhusdal, 2001 ; Engberg *et al*., 2007; Mathis *et al*., 2007). The essential oil of oregano contains about 60% carvacrol and 10% thymol active against salmonella in chicken (Koscova *et al*., 2006).

Anticoccidial actions of PFA

Phytogenic feed additives active against *Eimeria* species (Giannenas et al., 2003, 2004; Hume et al., 2006; Oviedo-Rondon et al., 2006). Betaine is a byproduct of the sugar beet industry. Waldenstedt *et al*., (1999) showed that the addition of betaine in the poultry feed, reduced weight loss during coccidial infection by different *Eimeria* species in poultry. It

protects cells against osmotic stress associated with dehydration and permits normal metabolic activity of cells.

Production performance of PFA

Cabuk *et al*., (2006) reported that the mixture of essential oils of oregano, bay leaf, sage, anise and citrus significantly improved feed conversion by changes in the intestinal ecosystem. Lippens *et al*., (2005) compared extracts of cinnamon, oregano, thyme, cayenne pepper, citrus and organic acids with avilamicine in chicken. The plant extracts supplemented group reduced feed conversion ratio (0.4% lower than avilamicine group and 2.9% lower than the organic acids group). Fenugreek seeds (*Trigonella foenum-graecum*) supplementation significantly improved feed conversion ratio of broiler chickens due to morphological changes in the gastrointestinal tissues (Srinivasan, 2006; Alloui *et al*., 2012; Mamoun *et al*., 2014). The inclusion of anise seeds at a level of 0.5-0.75/kg of diet to broilers, improved body weight gain and relative growth rate. In contrast, a higher inclusion level of anise seeds (1.5 g/kg diet) reduced growth performance (Soltan *et al*., 2008). Garlic (*Allium sativum*), thyme (*Thymus vulgarus*) and conflower (*Echinacea purpurea*) as feed supplements have recently reported that increase the production performance (weight gain, feed conversion, egg production and quality) of broilers and laying hens (Aji *et al*., 2011; Rahimi *et al*., 2011; Khan *et al*., 2012). Bolukbasi and Erhan, (2007) studied the effect of dietary supplementation of thyme at the level of 0.1-0.5% improved feed conversion and egg production associated to a decline of *E.coli* concentration in feces.

Conclusion

Phytogenic compounds is 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 nonantibiotic growth promoters, such as organic acids and probiotics.

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