

Phytogenic Substances and Their Use as Livestock Feed

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ABSTRACT

Antibiotic growth promoters (AGPs) have traditionally been incorporated into livestock diets to improve growth and feed utilization, through their effects on the microbial population of the gastrointestinal tract. However, their prolonged and routine use has contributed to the emergence and spread of antimicrobial resistance. Consequently, current efforts are focused not only towards finding suitable substitutes for AGPs but also towards minimizing the dependence on antibiotics in animal production. Plant-based products have received considerable attention as potential alternatives. Phytogenic feed additives (PFAs) include herbs, spices, essential oils and various plant extracts containing biologically active compounds. Research conducted in different animal species indicates that these substances may exhibit antimicrobial, antiviral, antioxidant and anti-inflammatory properties and may also influence feed palatability, intestinal health and gut development. But the precise biological mechanisms responsible for many of these effects are not yet completely understood.

INTRODUCTION:

Antibiotics have historically been included at sub-therapeutic concentrations in the diets of pigs,

poultry, fish and ruminants to support growth and production efficiency. But, continuous exposure to antibiotic growth promoters has

been associated with the emergence of resistance among bacteria (Marshall and Levy, 2011). At the same time, the growing requirement for animal-derived protein, together with increasing attention to animal welfare and environmental sustainability, has created a need for improved production practices. These circumstances have encouraged extensive research into alternatives that can provide beneficial effects similar to antibiotics while minimizing the risk of antimicrobial resistance and undesirable effects in animals.

Phytogenic substances represent a diverse category of plant-origin feed ingredients. They may be obtained from herbs, spices, fruits, seeds, leaves, roots and other plant materials. Depending on their chemical composition, these substances may possess antimicrobial, anthelmintic and antioxidant activities (Alagawamy *et al.*, 2016), besides having growth-promoting (Sun and Kim, 2020) and immunomodulatory effects. Some phytogenic products may additionally influence voluntary feed intake and stimulate the secretion of endogenous digestive enzymes. Increasing research evidence suggests that incorporating plant-derived additives into animal diets can positively affect several indicators of animal health and production, highlighting their potential role in modern animal nutrition.

CHARACTERISTICS OF PHYTOGENIC SUBSTANCES

Phytogenic substances are obtained from plant materials and are considered as natural feed ingredients that can be used in place of synthetic growth-promoting compounds. Because of their plant origin, they are often regarded as suitable components for food and feed applications and have attracted interest as potential alternatives to conventional antibiotic growth promoters (Varel, 2002).

The biological activity of herbs and plant extracts is largely associated with the wide range of compounds they contain. These include active principles such as alkaloids, bitters, flavonoids, glycosides, mucilage, saponins, tannins, phenolic compounds, polyphenols, terpenoids and polypeptides. Important individual constituents reported in phytogenic products include thymol, cineole, linalool, anethole, allicin, capsaicin, allyl isothiocyanate and piperine (Windisch *et al.*, 2008). Since different plants contain different combinations and concentrations of these compounds, their biological effects can also vary considerably.

The chemical profile of a PFA is not constant and may be affected by several factors. These include the plant species used, geographical origin, climatic conditions, harvesting practices and storage conditions (Huyghebaert *et al.*, 2011). The plant part selected, its physical characteristics, genetic variation, stage of maturity, inclusion level, extraction procedure, harvesting time and compatibility with other dietary ingredients can also influence the final efficacy of the additive (Yang *et al.*, 2015). Furthermore, the response obtained after supplementation depends on the nutritional condition of the animal, existing infections, overall diet composition and environmental conditions (Giannenas *et al.*, 2003).

PFAs can be supplied in different physical forms, including powders, granules and liquids. Powdered or granular preparations are generally mixed with premixes or incorporated directly into complete feeds. Liquid preparations can be administered through drinking water or milk replacers. They may also be applied by spraying onto feeds that undergo hydrothermal processing, including pelleted and extruded diets.

TABLE 1. Phytogetic substances and their parts used in feed additives (Steiner and Syed, 2015)

Common name	Latin name	Parts utilized*
Anise	<i>Pimpinella anisum</i>	Seeds
Black cumin	<i>Nigella sativa</i>	Seeds
Cinnamon	<i>Cinnamomum verum</i>	Bark
Chamomile	<i>Matricaria recutita</i>	Flowers
Citrus	<i>Citrus</i> sp.	Peel
Clove	<i>Syzygium aromaticum</i>	Buds
Cumin	<i>Cuminum cyminum</i>	Seeds
Fennel	<i>Foeniculum vulgare</i>	Seeds
Garlic	<i>Allium sativum</i>	Bulb
Ginger	<i>Zingiber officinale</i>	Rhizome
Onion	<i>Allium cepa</i>	Bulb
Oregano	<i>Origanum vulgare</i>	Leaves
Peppermint	<i>Mentha piperita</i>	Leaves
Rosemary	<i>Rosmarinus officinalis</i>	Leaves
Thyme	<i>Thymus vulgaris</i>	Leaves

*Parts may be used in their whole, ground form or as a source for extracts.

LIMITATIONS AND CHALLENGES OF USING PHYTOGENIC SUBSTANCES IN ANIMAL FEED

The complex and variable nature of phytogetic products makes it difficult to establish their efficacy and safety in a uniform manner. The presence of several active compounds within a single product can make it challenging to determine which component is responsible for a particular response. Other concerns include possible toxicity, undesirable taste or odour, regulatory requirements and interactions between phytogetic compounds and other feed ingredients. In addition, standardized analytical procedures for detecting, identifying and quantifying these substances in feeds and animal tissues are still lacking. Although many plant-derived compounds are considered natural alternatives to antibiotics and several are recognized as generally safe (GRAS) by the United States Food and Drug Administration, more

comprehensive investigations on their toxicity and long-term safety are required before their widespread application in animal feeding. Such evaluations are also important under Indian production conditions.

A clearer understanding of the biological basis of antibiotic-mediated growth promotion is necessary for the development of reliable alternatives. Several possible mechanisms have been proposed to explain the action of phytogetic substances; however, available evidence is not sufficient to provide a complete explanation of their effects. This limited understanding of their mode of action remains one of the major barriers to the development and optimization of phytogetic alternatives.

Although phytogetic compounds have been extensively investigated as substitutes for antibiotics, experimental findings have not always been consistent. Several factors may account for this variation. First, the composition of phytogetic products can change according to the location in which plants are grown, processing or manufacturing techniques and storage conditions. Second, the quantity supplied may differ between studies and may sometimes be below the level required to produce a measurable response. Third, individual phytogetic products may differ in their inherent biological effectiveness. Finally, experimental conditions such as animal age, genetic background, health status, diet and environmental conditions can strongly influence the observed response.

Another concern is the volatility of certain phytogetic constituents. Some compounds may evaporate readily, resulting in differences between the intended and actual concentration present in the final feed product. Their stability during feed manufacture and processing therefore requires careful consideration. Preserving the biological activity of phytogetic compounds during production and

storage is also challenging. Their chemical stability and functional activity may be affected by factors such as temperature, exposure to light, contact with metals, moisture and the availability of oxygen. These factors may alter the properties of the compounds and consequently influence their effectiveness after incorporation into animal feeds.

CONCLUSION

The European Union has prohibited the use of antibiotic growth promoters in food-animal production since 2006, and this removal of AGPs from animal feeds has created a need for effective alternatives such as Phytogetic compounds which contain a broad spectrum of biologically active constituents and may provide several beneficial effects. However, their widespread application in livestock production is still restricted by variation in efficacy and by incomplete knowledge of their mechanisms of action. Future research should therefore focus on understanding the interactions of phytogetic compounds with the gut microbiota, intestinal physiology and immune system. A better understanding of these relationships will help in the development of more consistent and effective phytogetic feed strategies and may support their use in economically viable and environmentally sustainable animal production.

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