The potential of botanical products in animal nutrition

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Abstract

Plants produce a huge variety of secondary compounds as natural protection against microbial and insect attack. Many have been used in the form of whole plants or plant extracts for food or medical application in man. The potential use of those products as beneficial feed additives in animal production are discussed in this paper.

Introduction

The way in which human food is produced today is intensively discussed and questioned by the modern society. We expect to have enough food of good quality, at an acceptable price for everybody in the world. But we are also increasingly concerned about environmental and health matters. Sustainable agriculture with low, renewable energy input in the production of food is an important target in our society.

According to IFPRI (1999) world production of pigs and chickens will grow by about 2% p.a. in the next 20 years the meet the expectation to produce enough food for the growing world population (more then 7.5 billion in 2020, FAOSTAT, 2002). We expect to achieve this growth in world food production without increasing the environmental waste

load.

The worldwide agricultural productivity must be increased. The efficient use of all available resources, including feed additives, is a prerequisite to reach these goals (Wenk, 2003).

Consumers and health authorities, particularly in Europe, increasingly dictate that the use of chemical feed additives, including ionophores and antibiotics, should be phased out and, where possible, replaced by alternative products.

Thus, to increase agricultural productivity under increasing constraints, new methods must be found that will enable farmers to reach those goals. Among such new methods, the great diversity of plant secondary metabolites offers tremendous opportunities for development.

In this paper we present selected recent examples of the potential and problems encountered when using botanical products in animal production.

Definitions

In the last years the Modern Western World has been learning what many Asian and Native American (Bye and Linares, 1999) knew since centuries, namely that plant extracts and spices can play a significant role in health and nutrition.

The American Heritage Dictionary of the English Language (1980) defines as follows:

Herb: 1. A plant that has a fleshy stem as distinguished from the woody tissue of shrubs and trees, and that generally dies back at the end of each growing season. 2. Any of various, often aromatic, plants used especially in medicine or as seasoning.

Spices: 1. Any of various aromatic and pungent vegetable substances, such as cinnamon or nutmeg, used to flavor foods or beverages.

Botanicals: A drug, medicinal preparation, or similar substance obtained

from a plant or plants. (Essential oils are any of a class of volatile oils obtained from plants, possessing the odor and other characteristic properties of the plant, used chiefly in the manufacture of perfumes flavors and pharmaceuticals (extracts after steam distillation)).

Quality

Often the desired activity of herbs is not repeatedly the same (Wenk *et al.,* 1998). Conflicting results may arise from the natural variability of the composition of plant secondary metabolites. The main factors influencing the composition are: variety and environmental growth conditions, harvesting time and state of maturity, method and duration of conservation and storage, extraction method of the plant, as well as possible synergistic (Ute *et al.,* 2000) and antagonistic (Lee *et al.,* 2002) effects. Botanical products are generally perceived by consumers as more secure then their chemical counterparts. However the purity of the different botanical products may vary and the absence of undesirable substances like heavy metals, pesticides, etc. must be assured.

Mode of action

The positive effects of herbs or botanical in animal production may arise from stimulation of feed intake and increase of digestive secretions, immune stimulation, anti-microbial, coccidiostatic, anthelmitic, anti-viral or anti-inflammatory activity and inhibition or anti-oxidant properties.

Synergism and antagonism

Some combinations of compounds of essential oils have been shown to have synergistic or antagonistic properties. For example Utlee *et al.* (2002) studied the antimicrobial activity of carvacrol, a compound found in the essential oils of oregano and

thyme, towards the food borne pathogen *Bacillus cereus*. A synergistic effect was observed when 0.30 mg/g carvacrol was combined with 0.27 mg/g cymene, a compound with very similar structure. It was hypothesized that the destabilization of the cytoplasmatic membrane and the action as proton exchanger of carvacrol is reinforced by the action of cymene (Utlee *et al.*, 2000).

On the other hand studies done by Lee *et al.* (2002) suggest that a combination of 100 ppm of cinnamaldehyde, a compound of the essential oil of cinnamon, with 100 ppm of carvacrol can impair growth performance of chickens when birds are fed a diet containing the soluble fiber, carboxymethylcellulose.

Selected properties and effects on animals

Feed intake

Among others Gebert *et al.* (1999) reported a partly significant effect on piglet feed intake of seven different herbs and herbs mixtures. Type of herbs and inclusion level were the decisive factors. Similar observations were also made by Wenk and Messikommer (2002) with laying hens when fed turmeric, the powder of the rhizome of Curcuma longa, a spice frequently used in the south Asian kitchen.

Stimulation of digestive enzymes

The mechanism of hot spices activating sensory nerve fibers is through an ion channel (for review see Clapham, 1997). Platel and Srinivasan (2000) reported that the dietary consumption of the active principle of certain spices like capsaicin, piperin and curcumin, stimulated pancreatic enzymes production in rats without affecting feed intake. More recently Lee *et al.* (2003) showed that thymol was able to increase the trypsin activity in digesta of 40 days old female broiler chickens when fed at 100 ppm. A com-

mercial preparation of essential oil compounds gave similar results on the amylase activity on 21 days old birds. A concentration dependent stimulation of the duodenal amylase activity in broilers was also reported (Williams and Losa, 2001).

Antimicrobial effect

The antimicrobial properties of essential oils are well known and a huge amount of literature is available (for selected literature overview see S. Wesslen, 1998). Simms *et al.* (2003) as well as Kamel and McKay (2003) reported that 2 different commercial blends of essential oils and essential oil compounds could alleviate the growth depression induced by a challenge with the pathogenic bacterium *Clostridium perfringens* in broiler chickens. In both cases a dose dependent effect was shown.

Ruminal fermentation

Wallace et al. (2002) reported the effects of saponins and blends of essential oil compounds, both are types of plant secondary compounds, used as manipulators of rumen fermen-tation. Dietary essential oils caused rates of NH3 production to decrease, yet proteinase and peptidase activities were unchanged (Losa *et al.*, 2002) Hyper-ammonia producing bacteria and anaerobic fungi (McIntosh *et al.*, 2003) were the most sensitive ruminal bacteria to essential oils in pure culture. Essential oils also slowed colonization and digestion of some feedstuff. *Ruminobacter amylophylus* may be a key organism in mediating such effects. A reduction of the ruminal degradation of the crude protein of some raw materials when animals were fed a commercial blend of essential oil compounds was also reported (Molero *et al.*, 2003).

Saponins-containing plants and their extracts appear to be useful to suppress the bacteriolytic activities of rumen ciliate protozoa and thereby enhancing total microbial protein flow from the rumen. The effect of some

saponins seems to be transient. Saponins also have a selective antibacterial effect.

Antioxidant

Antioxidant may be used to preserve feed and food as well as to optimize the antioxidative status of the animals. The hexane extract of the leaves of rosemary (*Rosmarinus officinalis* L.) contains four effective antioxidants; carnosol, rosmanol, isorosmanol and rosmaridiphenol, is probably the best known botanical product used for its antioxidative properties. Rosemary is one of the very few spices commercially available for use as antioxidant in the US and EU. Using a Racimat system Scheeder (2000) found the antioxidative capacity of different botanicals to be at least 4 times smaller when compared to that of rosemary.

Conclusions

In efficient and productive animal nutrition the highest emphasis must be given to the supply of an adequate amount of all the essential nutrients, energy and water to the animals. Optimal management and housing conditions must also be basics in every strategic consideration. In such a context, feed additives in general and botanicals (e.g. essential oils) in particular will be able to express their full potential in terms of improving the well being, growth performances and nutrient/energy utilization.

In the future, only the best combinations among all the possible alternatives will be good enough the reach the goals expected from agricultural production.

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