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Nutraceuticals In Dairy Cow Nutrition: An Overview

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OBJECTIVES

Microbial ecosystems lend themselves to manipulation by external means, and it has long been clear that feed additives could be used to improve the nutrition of ruminants by manipulating ruminal fermentation.

Ionophores and antibiotics have been used in the past to achieve some nutritional goals, however the recent ban of antimicrobial feed additives in the EU (since January 2006 (Directive 1831/2003/CEE), has lead to renewed interest in plants or their extracts as feed additives, with some success.

This paper reviews recent progress in understanding how plants and their extracts may be used as rumen manipulating agents, with some benefits that were provided by ionophores and others that may improve the health of the animal and the healthiness of ruminant products.

Information on the effect of essential oils on rumen microbial fermentation is very limited.

The objective of the present paper is to review current knowledge and assess the potential benefits of essential oils and their active components as modifiers of rumen microbial fermentation.

INTRODUCTION

One of the key points of safe human and animal nutrition is to replace the not „organism and environment friendly" additives, especially the antibiotics. Functional foods or nutraceuticals has been applied for this purpose.

Their beneficial effects on the organisms can be:

- non-specific (e.g. enhance of vitality),
- influence of organ systems (e.g. stimulation of immune system),
- systemic character (e.g. decrease of fat content of carcass).

For this reason, there is an interest in evaluating other alternatives to modulate rumen fermentation, including the use of

- organic acids,
- plant extracts (garlic, yucca, oregano, mint, cinnemon)
- probiotics (yeast cultures, bacteria; mostly Lactobacilli, spores of bacteria),
- prebiotics (fructose oligo sacchaaride (FOS), e.g. sugar beet pulp, Jerusalem artichoke; mannose oligo saccharide, (MOS), e.g. yeast extract),
- microelements (selenium, zinc, chromium, preferably in organic compound),
- enzymes (beta-glucanase, phytase),
- fat-burning compounds (L-carnitine, organic (trivalent) chromium, omega-3-fatty acids).

Plant extracts have been used for centuries for various purposes (e.g., traditional medicine, industrial applications, food preservatives) and most of them are categorized as GRAS (Generally Recognized as Safe) for human consumption.

The use of plant extracts appears to be one of the most natural alternatives to the antibiotic use in animal nutrition.

RESULTS

Plants produce an extensive variety of organic compounds derived from the secondary metabolism that seem to have no direct function in their growth and development.

They are responsible for the odour and colour of plants and spices, have important ecological functions as chemical messengers between the plant and its environment, and often exhibit antimicrobial activity against a wide range of bacteria, yeasts, and molds.They can generally be structured into 3 groups: saponins, tannins, and essential oils. The effects and mechanisms of action of saponins and tannins on rumen microbial fermentation have been extensively researched.

Targets for manipulation

Breakdown of dietary protein

The low efficiency of nitrogen retention which results represents a major economic loss, causes metabolic stress in the animal, and also places a burden on the environment, in the form of nitrogen-rich wastes.

Breakdown of microbial protein

Protozoa consume large quantities of bacteria in the rumen. If the protozoa could be suppressed, there would be less ammonia formation and less need for dietary protein supplementation.

Methane formation

Ruminants are major contributors to biogenic methane formation, and it has been estimated that preventing methane formation from ruminants would stabilise atmospheric methane concentrations. Decreasing methane emissions would also lead to improved energy retention in the animal.

Digestive disorders

Bloat is a disorder in which the gases formed by fermentation are prevented from escaping because a stable foam forms in the rumen. Lactic acidosis occurs when a rapidly degraded feed is introduced too quickly, or when concentrates form a high proportion of the diet, volatile fatty acid production exceeds the buffering capacity of the rumen, rumen pH falls, and only lactic acid-producing bacteria can grow.

Fatty acid biohydrogenation

The aim of manipulation is to increase the content of health-promoting unsaturated fatty acids, particularly conjugated linoleic acids (CLA), in ruminant products by controlling biohydrogenation of unsaturated fatty acids in the rumen.

High doses of plant extracts and secondary plant metabolites resulted in detrimental effects on rumen microbial fermentation (decrease in total VFA concentration), except in cade oil, capsicum oil, dill oil, ginger oil, and extracts rich in saponins (fenugreek and yucca).

Anethol, anise oil, carvone, and tea tree oil decreased the proportion of acetate and propionate, and increased the proportion of butyrate.

Garlic oil and benzyl salicylate reduced the acetate and increased the propionate and butyrate proportions, which suggests an antimethanogenic effect.

Cade oil (Juniperus oxycedrus), capsicum oil, and ginger oil resulted in small effects on rumen microbial fermentation probably related to their low content in oxygenated hydrocarbons.

High doses of fenugreek (Trigonella foenum-graecum) resulted in reductions in ammonia concentrations of 19.2 and 39.1%, respectively.

Careful selection and combination of these additives may allow the manipulation of rumen microbial fermentation.

However, their efficacy requires determination of potential ruminal adaptation in long-term in vivo feeding conditions.

CONCLUSIONS

The plant kingdom contains an almost unlimited number of plants and chemical compounds that could be used to manipulate undesirable aspects of ruminal fermentation and to promote the more desirable activities.

Well known classes of chemicals, such as saponins, essential oils and tannins, have already been investigated in some detail, but others which are less well known or not identified to date may be useful.

The major goal is the truly innovative uses for plants or their extracts in ruminant feeding.