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Brown Algae as a Feed Additive: Impacts on Ruminant production

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Abstract

Seaweeds have been utilized for food and feed as well as ingredients in medicinal and cosmetic products for as long as humans have been associated with the sea. In mid of 20th century, there are numerous reports evaluating the nutritive value of seaweeds as efforts to expand its use in livestock production intensified. Brown algae have been a component for ruminant diets in coastal areas and its effects on both animal and environmental health.

Introduction

Seaweeds (also known as macro-algae) refer to macroscopic plants that occur in the intertidal and sub-tidal regions and also in estuaries and mangroves of the ocean. According to their pigmentation, seaweeds or macro-algae can be classified into three main categories: green (*Chlorophyceae*), red (*Rhodophyceae*) and brown (*Phaeophyceae*). Among the three groups, brown algae have the most attention for their use in livestock production due to the bioactive nature of the plant secondary compounds that they contain. In the past year, brown algae were noted for their high mineral and vitamin content (Chapman and Chapman, 1980) and they were often added to the diet for this purpose.

Nutritional Value of Brown Algae

Brown algae contains large quantities of vitamins and minerals like macro and trace minerals (8–40%) and are rich in carotenes (20-170 ppm), vitamin C (500-3000 ppm) and other vitamins including B_{12}. Brown algae contain protein (3-5% of dry matter basis) and lacks significant quantities of lysine or methionine. A unique characteristic of brown algae is the high content of iodine, ranging from 1500-8000 ppm in *Laminaria* spp and 500-1000 ppm in *Fucus* spp. Brown algae are abundant in soluble fibers such as alginates, carrageenan and agar; they are indigestible by mammalian endogenous enzymes. Brown algae contain unique polyphenolic compounds (phlorotannins) and sulphur-containing carbohydrates (fucoidans) that possess varying biological activities.

Biological Activities in Animal Production

Biological activities of phlorotannin's and their antimicrobial activity is likely the most significant in terms of their use in livestock production. Phlorotannin's exhibit bactericidal activity against both Gram positive and Gram-negative bacteria, a characteristic that differs from terrestrial tannins which inhibit primarily Gram-positive bacteria. Wang *et al*. (2010b) have examined effects of phlorotannin's isolated from *Ascophyllum nodosum* on the three cellulolytic and four non-cellulolytic bacteria and found that pure cultures of these bacteria were very sensitive to phlorotannin's. In mixed ruminal culture, the effect of phlorotannin's on ruminal bacteria was species dependent. phlorotannin's reduced the population of cellulolytic bacteria, but increased the populations of non-cellulolytic and total bacteria. Different effects on rumen bacteria in pure culture *vs.* mixed culture may reflect the influence of rumen environment on the biological activity of phlorotannin's.

Uses Of Brown Algae in Ruminant Feed

Feeding brown algae to animals as main feed component were depended on the type of animal, diet and species of brown algae as well as their concentrations in the diet. There are many other bioactive compounds in brown algae including fatty acids, terpenes, carbonyls, and bromophenols that possess antimicrobial activity.

Impact On Immune Function, Health and Production Performance of Ruminants

Hansen *et al*. (2003) compares the feeding value of a *Laminaria digitata* and *Laminaria hyberborea mixture* as sole feed source to North Ronaldsay sheep that were pre-exposed or non-exposed to the same seaweeds. They found that both pre-exposed and non-exposed sheep has been similar feed intake as compared to a mixed hay diet. Although they also observed that these seaweeds have a high *in situ* DM and organic matter (OM) digestibility (83%), after 96-h of *in situ* incubation, this property was mainly attributed to the high solubility of the material as both endogenous and microbial enzymes were unable to degrade some of these soluble polysaccharides. Black (1955) also shows that the digestibility of *A. nodosum* meal is 29.7% and 26.2%, whereas it has 66.2% and 71.0% with *Laminaria* meal for sheep and swine, respectively. Mayer *et al*. (2009) have reported the potential biological active compounds in seaweed. Therefore, when whole brown algae are fed to livestock, its effect on intestinal microbial populations is likely a reflection of the net impact of these compounds on microbial activity. Archer *et al*. (2007) also observed that feeding *A. nodosum* meal at a rate of 20 g/kg of DM to lambs for 2 weeks prior to transport lowered body temperature during transport, but it also lowered antibody production and appeared to lower adrenal function. Plasma protein, albumin, calcium, phosphorus, glucose, blood urea nitrogen, aspartate amino transferase, magnesium, sodium, potassium and chloride concentrations post- transport has been also linearly decreased as the dietary level of *A. nodosum* meal

increased from 0.5 to 2%.

Conclusion

Brown seaweed has been shown to contain a number of unique biologically active compounds that may reduce the shedding of pathogens and improve the immune status and health of ruminants.

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