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Effects of potential dietary antiprotozoal supplements on rumen fermentation and digestibility in heifers

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Abstract

Antiprotozoal activity of dietary supplements of tannin, saponin, and linoleic acid were tested with four ruminally and duodenally cannulated heifers in a 4 × 4 Latin square experiment. The four dietary treatments were control (basal diet), quebracho (source of tannin), quillaja (source of saponin), and safflower oil (source of linoleic acid). The basal diet was based on rolled barley grain and barley silage. Three additional experimental diets were prepared by incorporating in the basal diet (g/kg of dry matter) quillaja extract (8); quebracho (6); or high linoleic acid safflower oil (27); replacing equal amounts of barley grain. The diets were fed as total mixed rations in four experimental periods of 47 days. Safflower oil caused a log reduction in numbers of protozoa as compared to the control, whereas the protozoa populations in the rumen of heifers fed quabracho, quillaja were only slightly lower than that of the control. On all diets, the proportion of *Entodinia* in the total protozoa population was more than 0.85. Cellulolytic, amylolytic and deaminative enzyme activities as well as concentrations of ammonia and volatile fatty acids in ruminal fluid were not affected by treatment. There was no indication that dietary supplements altered digestibility or the flow of non-ammonia nitrogen or

Abbreviations: ADF, acid detergent fibre; aNDF, neutral detergent fibre including ash; CMCase, carboxymethylcellulase; DM, dry matter; MFS, methyl-green formalin solution; N, nitrogen; NAN, non-ammonia nitrogen; OM, organic matter; S.D., standard deviation; TMR, total mixed ration; VFA, volatile fatty acid

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bacterial nitrogen to the duodenum. It was concluded that although the supplements tended to lower the number of protozoa in ruminal fluid, this decline was not sufficient to significantly decrease predation of bacteria. Consequently, neither reduction in rumen ammonia nor an increase in duodenal flow of bacterial nitrogen to the duodenum was observed. Administering these additives in concentrations that are high enough to reduce protozoal numbers, without having adverse affects on feed intake or digestibility, may be difficult.

Keywords: Linoleic acid; Quebracho; Quillaja; Rumen protozoa; Safflower oil; Saponin; Tannin

1. Introduction

Ciliate protozoa play a diverse role in the ruminal metabolism of nutrients (Williams and Coleman, 1992). Protozoa are predators of bacteria, and their consumption and digestion of bacteria is an energetically wasteful process that contributes to the undesirable recycling of nitrogen in the rumen (Jouany, 1996). Bacterial protein flow to the duodenum in fauna-free sheep was found to be 35% higher than the microbial (bacteria plus protozoa) protein flow in faunated sheep (Ivan et al., 1992). To improve the efficiency of feed protein utilization, considerable effort has been made to find a means of total elimination of protozoa from the rumen (defaunation), but a practical defaunation technique has not been established (Hegarty, 1999). A massive reduction in the rumen protozoa population (reduced fauna) by chemical drenching of experimental animals has been found to improve milk production (Moate, 1989). However, such a method to produce reduced fauna is not practical for use in ruminant production. Hristov et al. (2003, 2004) tested a large number of substances *in vitro* and of those examined, tannins, saponin-based plant extracts and linoleic acid were particularly effective at reducing protozoal numbers. These bioactive compounds lowered numbers of protozoa without specifically inhibiting the activity of bacterial populations. The objective of the present experiment was to investigate the ability of feed additives with high tannin content (*i.e.*, quebracho), high saponin content (*i.e.*, quillaja) and high linoleic acid content (*i.e.*, safflower oil) to suppress the ruminal protozoa population in beef heifers. Dietary concentrations of the additives employed were derived from *in vitro* data and with consideration for their possible impacts on feed intake and digestibility. This investigation included examination of the effects of these additives on rumen fermentation, microbiological activity, digestibility, and duodenal flow of non-ammonia nitrogen (NAN).

2. Materials and methods

2.1. Animals and feeding

Four Jersey heifers (601 ± 43.5 kg, mean body weight $\pm$ S.D.) equipped with ruminal and duodenal cannulae were used in a 4×4 Latin square experiment consisting of four dietary treatments and four periods. The animals were gradually adapted to a barley-based diet over a period of 4 weeks before the start of the experiment. The basal diet (control)