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Effect of supplemental protein feeding frequency on ruminal characteristics and microbial N production in sheep fed treated rice straw

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Abstract

Four rumen cannulated Suffolk ewes, fed a basal diet of rice straw treated with ammonia or urea-calcium hydroxide were used in a feeding trial to study the effects of supplemental protein, offered in either one meal per day at 08:00 h or two meals per day at 17:00 and 01:00 h, on feed intake, digestibility, N retention and microbial N yield. The study was a 4 × 4 Latin square design with 2 × 2 factorial arrangements. Intake of DM was not influenced by feeding frequency of protein supplement. However, digestibility of OM, NDF, and cellulose was higher ($P < 0.05$) for sheep offered supplemental protein twice than once. Urinary N excretion was lower ($P < 0.05$) and N retention was higher ($P < 0.01$) in sheep offered supplemental protein twice a day. Average rumen ammonia N and VFA were higher ($P < 0.05$) when sheep received the supplemental protein twice. Purine derivatives and estimated microbial N yield tended to be higher ($P < 0.05$) when supplemented protein was offered twice rather than once per day. This study indicated that the digestibility, rumen fermentation end products and microbial N yield of ammoniated straw would be improved by offering supplemental protein twice a day than once a day.

Keywords: Sheep; Ammoniated straw; Supplemental protein; Feeding frequency

1. Introduction

Since ruminants in tropical and sub-tropical countries are likely to depend almost entirely on pasture, crop residues and agricultural by-product of relatively poor nutritional status, improvement in ruminant productivity will require increased effort to investigate the different possible ways and means for upgrading poor roughages through increasing their digestibility and voluntary intake.

The ammoniation method, using ammonia gas, ammonium hydroxide or urea to improve the digestibility of fibrous roughages is an accepted technique (Sundstol

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et al., 1978; Pradhan et al., 1997; Orden et al., 2000). In developing countries, urea treatment is perfectly adapted to small farmer conditions, at both the individual and the cooperative level (Chenost, 1995). However, economic constraints may be main limiting factors because many developing countries have promoted market economy and farmer is no longer getting subsidized urea (Zhang et al., 1995). Fadel Elseed et al. (2003) suggested that, when amount of urea was reduced from 4 to 2% and combined with calcium hydroxide (0.5%) the improvement in rumen degradability was somewhat smaller than ammonia treatment, but the economical feasibility may give additional value to the urea-calcium hydroxide treatment.

Ammoniation alone is insufficient to support ruminants beyond the maintenance level, thus there is a need for concentrate supplementation in treated rice straw-based diets (Orden et al., 2000). Supplementing low-quality straw-based diets with N sources elevates ruminal ammonia N concentration to provide rumen bacteria with their requirements to achieve maximum rates of fermentation (Fike et al., 1995). To achieve maximal rumen microbial growth synchronizing the release of carbohydrate and N has been suggested as an important factor (Russell and Hespell, 1981; Sinclair et al., 1993, 1995). In contrast, synchronizing carbohydrate and N does not increase microbial yield (Hererra-Saldana et al., 1990; Henning et al., 1993).

The availability of cotton-seed meal (CSM) and groundnut meal in some tropical countries makes it a valuable source for N supplementation to poor-quality forages. Since it is very important to select a supplemental protein that provides adequate amount of rumen degradable protein to meet, but not exceed, microbe requirements to maximize the microbial fermentation of poor forages, there is a need to manipulate the feeding of the above protein meals because of their relatively high degradability.

In an in situ study, Fadel Elseed et al., (2003) showed that for ammoniated straw, most of N is degraded almost instantaneously whereas the fiber may take up to 8 h to start degradation. The question is, when feeding a N supplement with a relatively more even N supply to animals on ammoniated straw, can this lead to an improvement in utilization of ammoniated straw?

It was the objective of this experiment to investigate the effect of feeding frequency of CSM as a N supplement on the performance of sheep offered treated rice straw-based diets. To achieve this aim, voluntary feed intake, digestibility, N retention and microbial yield were measured.

2. Materials and method

2.1. Preparation of basal diets

One ton of rice straw, chopped to about 3 cm, was treated with either 3% ammonia solution (25% NH_3) (AS) or 2% urea plus 0.5% calcium hydroxide dissolved in water (US). For the US, the straw was sprayed with urea-calcium hydroxide solution (1 l/kg DM straw), thoroughly mixed and the air was removed using a vacuum cleaner from each sack (10 kg treated straw/sack). For the AS the air was removed before the injection of ammonia solution. The sacks were tightly sealed and stored for 7 weeks. After the curing period the treated straw was spread on polyethylene sheets for one day to allow the evaporation of excess ammonia before offering it to animals.

2.2. Experimental design and procedure

Four rumen cannulated Suffolk ewes with an average BW of 64 ± 5 kg, housed individually in metabolism crates equipped with a feeder and fecal and urine collecting equipment, were used in this study. Water and salt licks were freely available.

The experimental design was a 4 × 4 Latin square with 2 × 2 factorial arrangement of treatments. The four treatments were: (1) AS plus 150 g cotton-seed meal offered once a day at 08:00 h (1×); (2) AS plus 150 g CSM divided into two equal portions offered at 17:00 and 01:00 h (2×); (3) US plus 150 g CSM offered once a day at 08:00 h (1×); (4) US plus 150 g CSM divided into two equal portion offered at 17:00 and 01:00 h (2×).

Time to offer the CSM supplement was determined according to the conventional feeding regimens (1×), while for 2× the time was decided according to the balance between carbohydrate and N availability in the rumen assessed by the in situ technique from the results of hourly feed intake of the treated rice straw, AS and US, and CSM for about 6 weeks before the onset of the experiment. CSM was offered at 01:00 h by a semiautomatic feeder.