Rumen bacteria in sheep fed supplemented teff hay

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Low-protein teff hay was supplemented with 3% urea and 6% starch to promote growth of the amylolytic bacteria, which liberate branched chain amino acids in the rumen upon lysis. These serve as a source of branched chain volatile fatty acids for the fibrolytic bacteria and thus result in improved fibre digestion. When compared to the diet supplemented with 3% urea only, there was no increase in the numbers of the amylolytic or fibrolytic bacteria, nor any noteworthy change in the food consumption, digestibility or rate of passage. The intended effect was probably not achieved due to the fact that the starch and urea supplement was sprayed onto the hay, resulting in an even distribution throughout. The starch was therefore released slowly, depending on intake and steady-state conditions would have prevailed in which cell lysis would have been minimal.

Laeproteïen tefhooi is aangevul met 3% ureum en 6% stysel om die groei van die amilolitiese bakterieë aan te moedig, wat vertakte ketting aminosure in die rumen vrystel wanneer lise plaasvind. Dié sal as 'n bron van vertakte ketting vetsure vir die veselverterende bakterieë dien en so verbeterde veselvertering tot gevolg hê. In vergelyking met die rantsoen wat net met 3% ureum aangevul is, was daar geen toename in die aantal amilolitiese of veselverterende bakterieë nie en ook geen noemenswaardige verandering in voerinname, verteerbaarheid of vloeitempo nie. Die beplande effek is waarskynlik nie verkry nie omdat die stysel en ureum aanvulling op die hooi gesproei is, wat tot 'n eweredige verspreiding gelei het. Die stysel is dus stadig vrygestel, na gelang van inname, vloei-ewewig is behou en gevolglik was sellise minimaal.

Keywords: Rumen bacteria, direct count, indirect count, functional groups, supplemented teff hay.

Introduction

In South Africa the forages fed to farm animals usually contain adequate amounts of crude fibre for energy, but are lacking in nitrogen during the dry season which lasts from 5 to 7 months of each year. Because of the lack of nitrogen in these forages, the level of the bacteria in the rumen of sheep and cattle is too low to permit the digestion of adequate amounts of these forages to nourish the animals, which consequently lose a great deal of mass. Van Gylswyk (1970) showed that the addition of 3% urea to low-protein teff hay increased the level of the fibre-digesting bacteria so that consumption of forage increased by 50% and the mass-loss of the animals was very much reduced. When 1% branched chain fatty acids (BCVFA) were added in addition to the urea supplement, the animals consumed even more forage, which was digested to a greater extent, so that they almost maintained their body mass. From these results it seemed that the lack of BCVFA was the limiting factor which resulted in poor performance of the animals on these low-protein hay diets. Since there was no commercial source of BCVFA available, it was decided to supplement the teff hay with 6% starch in addition to the 3% urea. The amylolytic bacteria which in general can synthesize all their amino acids from NH_3 and straight chain volatile fatty acids (VFA), would proliferate, lyse and liberate branched chain amino acids in the rumen. These could then in turn serve as a source of BCVFA for the fibrolytic bacteria and thus result in improved fibre digestion.

Methods

Four Merino wethers fitted with rumen cannulae were used. Sheep K18 and P50 were adapted to teff hay supplemented with 3% urea, and sheep K19 and K26 to teff hay supplemented with 3% urea and 6% starch in the first part of the experiment and *vice versa*. The diets were analyzed for cellulose and hemicellulose. Rate of passage was determined using ^{144}Ce-labelled hay and liquid flow rate using ^{51}Cr-EDTA.

Samples of ruminal ingesta for bacterial counts were taken 2,5 h after feeding using a sampling tube. The sample was processed for 30 sec using an Ultra-Turrax Homogenizer to remove bacteria attached to solid particles of ingesta. The samples were serially diluted in an anaerobic diluent. The techniques and culture media have been described by Kistner (1960) and Van Gylswyk (1970). Indirect counts were obtained by isolating colonies from the non-specific medium used for counting the total culturable bacteria. These isolates were then purified and tested for their ability to ferment glucose, starch, xylan, cellulose and lactate.

Results and Discussion

Data for food intake, liquid and dry matter turnover and digestibility in the rumen of sheep fed the two different supplemented teff hay diets, are summarized in Table 1. There was no difference in the performance of the sheep on the two diets and the supplementation of 6% starch in addition to the 3% urea had no effect on hay consumption, digestibility or flow rates.

Table 1 Food intake, liquid and dry matter turnover and digestibility in the rumen of sheep fed supplemented teff hay diets (unpublished results of R. Ford and L.A. van Dugteren)

	Teff hay supplemented with	
Measurement	3% urea	3% urea 6% starch
Food intake	1 268	1 211
Fluid volumes (*l*)	9,30	9,02
Liquid turnover (vol/day)	1,17	1,29
Turnover of dry matter (per day)	0,43	0,41
Digestibility (%) — dry matter	61,7	63,8
— holocellulose	62,9	63,2
— α-cellulose	65,0	64,6
— hemicellulose	61,3	61,6

The reason for the lack of response was also reflected in the bacterial counts (Table 2). The addition of starch to the hay did not result in an increase in the numbers of the amylolytic bacteria or the glucolytics which also take part in the fermentation of starch. The indirect counts confirmed these results, although the counts for each functional group were higher for the xylanolytic, glucolytic, and cellulolytic bacteria (Table 2). The increase in the indirect counts of the glucolytic and amylolytic bacteria above the direct counts, can be ascribed to the fact that these two groups of bacteria were incubated for only 16 to 20 h before the direct counts were made, whereas the indirect counts were incubated for 7 days. A later in-

Table 2 Comparison between direct* and indirect counts ($\times 10^7$/g ingesta) of bacteria in the rumen of sheep fed supplemented teff hay diets

Counts		Teff hay supplemented with 3% urea	Teff hay supplemented with 3% urea + 6% starch
Total culturable count		93,3	107,0
Glucolytics	Direct	6,25	5,53
	Indirect	82,3	97,3
Amylolytics	Direct	2,08	2,30
	Indirect	59,5	60,0
Xylanolytics	Direct	3,05	3,40
	Indirect	54,5	67,5
Cellulolytics	Direct	2,65	2,48
	Indirect	6,0	6,0

*Unpublished results of R. Ford and L.A. van Dugteren.

vestigation into optimal incubation times for the different functional groups of rumen bacteria (Mackie, Heath and Therion, unpublished results), showed that counts of the amylolytic and glucolytic bacteria doubled between two and five days of incubation. The direct counts of these two groups were thus underestimated at least two-fold throughout the present investigation. In ecological studies it would perhaps be better to sacrifice a degree of specificity and to use longer incubation periods to obtain more realistic counts.

The percentage composition of the bacteria digesting the diet, calculated from the indirect counts for sheep adapted to teff hay supplemented with 3% urea was: cellulolytic 6, xylanolytic 59, amylolytic 64 and glucolytic 89. When the diet consisted of teff hay supplemented with 3% urea and 6% starch it was: cellulolytic 6, xylanolytic 63, amylolytic 56 and glucolytic 90. Thus the composition of the microbial population was very similar for both diets.

Supplementation of the low-protein teff hay (3,7% CP) with 3% urea and 6% starch had no effect on the number of starch-fermenting bacteria and presumably did not increase the concentration of BCVFA's. Unfortunately the level of BCVFA in the rumen was not monitored during the experiment, due to practical problems. The induction of an endogenous source of BCVFA's as a result of the lysis of starch-fermenting bacteria, probably failed because there was no increase in the number of amylolytic bacteria and hence no increase in the number of fibrolytic bacteria whose growth would have been promoted by the availability of BCVFA's. The intended effect was probably not achieved due to the fact that the starch and urea supplement was sprayed onto the teff hay, resulting in an even distribution throughout. The starch was therefore evenly released, according to intake, thus at no time were there high ruminal starch concentrations for rapid multiplication of the amylolytic bacteria, followed by low concentrations when lysis would occur due to starvation (Leedle, Bryant & Hespell, 1982), and steady-state conditions prevailed. In order to obtain rapid multiplication of starch-fermenting bacteria it would be necessary to administer the supplement as a dose per ruminal cannula. However, when this was done the animals died of NH_3-poisoning and acidosis.

The overall result of the failure to promote the growth of the cellulolytic bacteria was that no noteworthy change in food consumption, digestibility or rate of passage occurred, as was observed by Van Gylswyk (1970), when teff hay was supplemented with BCVFA and urea.

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