

FACTORS AFFECTING DIGESTION OF GRAIN-SUPPLEMENTED STRAW

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It has been suggested that the decline in the intake and digestion of roughage when supplemented with concentrates containing readily fermentable carbohydrates is due to the lowering of the pH of the ruminal contents which results in a decrease in the number and/or activity of the fibre-digesting bacteria (Raymond, 1969).

This hypothesis has been examined in sheep fed maize straw supplemented with various amounts of maize grain in a diet where nitrogen was not limiting.

Material and Methods

18 mature castrated male Merinos fitted with rumen cannulae were used. In the *preliminary period* all sheep were fed maize straw (4.3% crude protein) *ad libitum* once daily, plus a protein-mineral supplement (65.6% crude protein) at the rate of 135 g supplement per kg straw eaten. The crude protein content of the diet as a whole was 11.6%.

In the *experimental period* the sheep were divided into six groups balanced with respect to their intake of straw in the preliminary period. They were fed straw and protein-mineral supplement as before. Pellets containing maize grits, (crushed maize endos-

perm) protein and minerals (75.3 % starch ; 13.7% crude protein) were fed twice daily to the different groups in amounts to provide 0, 7.8, 15.6, 23.5, 31.3 or 39.3% by weight of the total daily intake.

The following were determined on all sheep: intake of straw; digestion of cellulose and hemicellulose; rate of passage of ¹⁴⁴Ce-¹⁴⁴Pr-labelled straw; pH, and NH₃ and volatile fatty acid content of rumen fluid.

The number and predominant morphological types of bacteria digesting cellulose and hemicellulose were determined in one sheep in each group.

Results and Discussion

Both the intake of straw and the percentage digestion of cellulose and hemicellulose fell linearly as the proportion of grain in the diet increased (fig. 1). The mean retention time of ¹⁴⁴Ce-¹⁴⁴Pr-labelled straw was, however, not influenced by the diet.

The concentration of ammonia in the rumen was similar on all diets. The minimal values over 24 hours were 7-15mM. The fibrolytic bacteria were therefore unlikely to have been nitrogen-limited. The concentration of branched-chain volatile fatty acids in the rumen was high (isobutyrate 0.5-3.8mM; isovalerate + 2-methylbutyrate 0.5-5.3 mM) and varied little with diet. They were there-

fore also unlikely to have limited the growth of those fibrolytic bacteria for which they are essential nutrients.

The pH of the rumen of the sheep fed pellets differed materially from the controls only in the groups receiving more than 23.5% pellets. It has been suggested that the optimum pH for many of the important fibrolytic rumen bacteria is above pH 6, and it has been shown the cellulolytic activity of ruminal contents *in vitro* is very low at this pH, (Stewart, 1977). Particular attention was therefore paid to the time and the extent to which the pH of the rumen contents of sheep in the various groups fell below this value. This was calculated as « pH-hours below 6.0 » from the area of the pH-time curve lying below pH 6. The results (table 1) show that this was not a critical factor in the decline in fibre digestion in the sheep fed up to and including 23.5% pellets. With diets containing more pellets it may have been a contributing factor, but cannot have been the major one because there was no break in the intake and digestibility curves at this point.

Bacteria digesting hemicellulose were counted either as colonies growing on medium containing 0.3% xylan, or as organisms producing clearings in medium containing 3% xylan. (Henning, 1979). The latter are probably most active in the rumen (Morris and Henning, unpublished results). Neither group decreased in number as the proportion of pellets increased (fig. 2 a). There may, however, have been a change in the predominant species. While the number of isolates examined was too small to draw definite conclusions, it appeared that the proportion of cocci similar to ruminococci in morphology decreased as the amount of grain fed increased, while oval rods resembling *Bacteroides* spp. became prominent only when the diet contained more than 7.8% pellets. By contrast the number of cellulolytic bacteria showed a downward trend as more grain was fed (fig. 2 b) but there was no change in the proportions of the predominant genera which in all cases were presumptively identified as *Ruminococcus*, *Bacteroides* and *Eubacterium*. There was no relationship between the number or types of hemicellulolytic and cellulolytic bacteria in the rumen of the individual sheep and the pH-hours below 6 (fig. 2 a and b).

Table 1.— Effect of diet on time and extent pH of rumen falls below 6.0

% Pellets in diet	pH-hours below 6
0	0.77(0.06—2.04)
7.8	2.66(0 — 5.58)
15.6	1.19(0 — 2.24)
23.5	2.02(0.73—3.27)
31.3	6.89(2.06—12.77)
39.3	4.42(3.45 — 5.64)

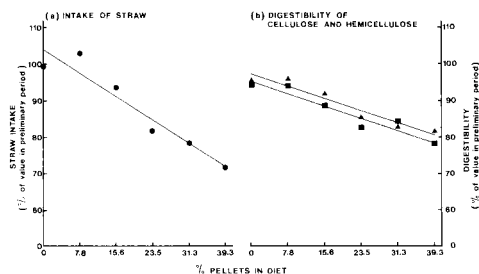


Fig. 1.— Effect of percent pellets in diet on: a) intake of straw; b) digestibility of hemicellulose (■—■) and cellulose (▲—▲). Group means calculated from results of each sheep expressed as percent of its value when no pellets were fed in the preliminary period.

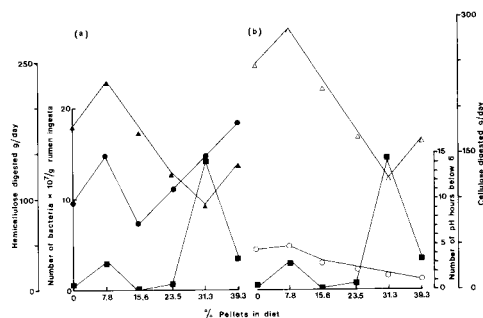


Fig. 2.— Effect of different amounts of pelleted maize fed with maize straw for 10 weeks to 1 sheep in each group on:

a) ●—● number of hemicellulolytic bacteria producing clearings in agar growth medium containing 3% xylan; ▲—▲ amount of hemicellulose digested per day; ■—■ number of pH-hours below 6 in the rumen;
b) ○—○ number of cellulolytic bacteria; △—△ amount of cellulose digested per day; ■—■ number of pH-hours below 6 in the rumen.

Conclusion

Some factor other than N limitation and pH influences the number and activity of

fibre-digesting bacteria when starch is fed. The possibility that starch or its break-down products may inhibit the synthesis or activity of cellulose or hemicellulose should be investigated.

Table 2. — Predominant morphological types of bacteria producing clearings in medium containing 3% xylan*

% pellets in diet	N ^o of colonies examined	Percent of total isolates		
		Cocci	Curved Rods	Oval rods
0	12	50	50	0
7.8	11	36	64	0
15.6	6	33	17	50
23.5	12	17	50	33
31.3	9	0	67	33
39.3	9	0	67	33

* Colonies isolated from counts made after 6 and 10 weeks on diet.

References

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