THE RESPONSE OF SUCROSE SUPPLEMENTS TO MICROBIAL PROTEIN PRODUCTION IN THE RUMEN OF CATTLE GIVEN GRASS SILAGE BASED DIET

H. Khalili and P. Huhtanen
University of Helsinki, Department of
Animal Husbandry SF-00710 Helsinki, Finland

and

M. Tala
College of Veterinary Medicine, SF-00550 Helsinki, Finland

Introduction

The efficiency of microbial N synthesis in animals given grass silage based diets is often lower than the mean value for all diets (Thomas and Thomas, 1985). Low efficiencies may be related to low ATP yields from silage fermentation products, poor synchronization of the energy and N releases from silage, and high proportion of non protein N in silage N. The objective of the present study was to investigate which is a factor of greater importance in stimulating microbial protein synthesis, balancing the energy and N releases in the rumen by feeding sucrose twice daily or increasing the energy supply *per se* by continuous intraruminal infusion of sucrose. A further objective was to investigate whether the adverse effects of feeding sucrose twice daily on rumen fermentation can be avoided by inclusion of sodium bicarbonate ($NaHCO_3$) in the diet.

Materials and Methods

The effects of sucrose supplements on N digestion were examined in a 4 x 4 Latin square experiment in cattle (LW 344 kg) fitted with a rumen and duodenal cannula. The control diet (diet C) offered at the level of 5.2 kg DM/d consisted (g/kg; DM basis) of grass silage (700), barley (240) and rapeseed meal (60). The other three diets were supplemented with 1.0 kg of sucrose per day given either in two meals (diet S), in two meals with 0.25 kg of $NaHCO_3$ (diet B) or as continuous intraruminal infusion (diet I). The animals were fed twice daily at 12 h intervals. Cr-mordanted straw, incorporated into the diet, and LiCoEDTA, infused continuously into the rumen, were used as digesta flow markers. Duodenal samples were taken every 3 h during the 12 h daytime feeding cycle for 3 consequtive days, starting at 0, 1 and 2 h after feeding. Purine bases of nucleic acids were used as a microbial marker. Rumen samples were analysed for pH, ammonia N, VFA and lactic acid. Rumen liquid dilution rate was determined using LiCoEDTA.

Results and Discussion

Sucrose supplements reduced ($P < 0.001$) rumen ammonia N concentration (figure 1). Although feeding sucrose twice daily should result in a more favourable time-course carbohydrate fermentation within 2-3 h after feeding when the peak in ammonia production was attained, conti-

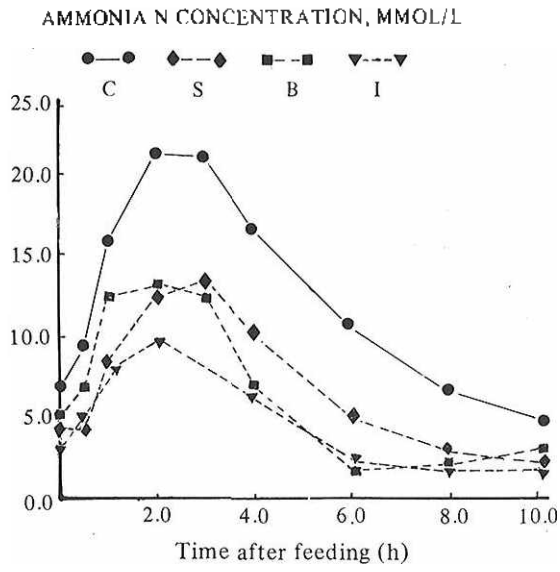

Figure 1. The effect of sucrose supplements on rumen ammonia N concentration.

TABLE 1. THE DIGESTION OF NITROGEN (g/24 h) BY THE CATTLE GIVEN THE 4 DIETS

	Diets				SEM	Significance	
	C	S	B	I		C.V. other	Between sugars
In feed	156.3	154.4	156.7	156.7	0.7		
At proximal duodenum							
Non-ammonia N	135.3	162.2	155.5	162.6	4.6	*	NS
Microbial N	71.8	89.8	93.8	104.5	5.0	*	NS
Microbial N/kg OMADR[1]	25.5	27.6	26.4	30.8	2.1	NS	NS
In faeces							
Total N	33.8	45.0	42.0	47.2	0.7	***	**
Purine N[2] 9.9	9.9	15.8	12.4	16.7	0.7	***	**

[1]OMADR = organic matter apparently digested in the rumen
[2]Ribonucleic acid N equivalents

nuous infusion of sucrose appeared to be more efficient in reducing rumen ammonia concentration. The present results do not support the concept that for maximal microbial ammonia fixation the breakdown of dietary N should be closely synchronized with the release of energy from fermentation of carbohydrates.

Reduction in rumen ammonia concentration by sucrose supplementation reflected increased microbial N synthesis in the rumen (table 1). Consistently with the slightly lower rumen ammonia concentration, continuous infusion of sucrose resulted in a more marked stimulation of microbial protein synthesis than did diets S and B. Three points may be considered for the increased microbial protein synthesis obtained with diet I as compared with that obtained with diet S. First, a smaller variation in rumen microbial pool size may have resulted in a smaller maintenance requirement. Second, the fermentation pathway was more favourable with diet I (less lactic acid during the first 3 h after feeding; 4.0 vs. 12.5 mmol/l), which will result in a higher ATP yield per hexose equivalent. Third, the lower pH during the first few hours after feeding with diet S may have diverged energy from growth to nongrowth purposes (Strobel and Russel, 1986). On the other hand, higher average rumen pH with diet B than with diet S (6.24 vs. 6.03) did not increase microbial protein synthesis, which is in disagreement with the findings of Newbold et al. (1987). All the sucrose supplements increased significantly ($P < 0.01$) rumen liquid dilution rate (0.100 vs. 0.132).

Faecal N excretion was increased ($P < 0.001$) by the sucrose supplements. Greater ($P < 0.001$) faecal excretion of purine N with sucrose diets may be attributed to increased hindgut fermentation. Inclusion of $NaHCO_3$ in the diet reduced faecal output of purine N compared with other sucrose diets, indicating a more efficient fibre digestion in the rumen.

(Key Words: Silage, Sucrose, Microbial Synthesis).

Literature Cited

Newbold, C.J., P.C. Thomas and D.G. Chamberlain. 1987. Effect of sodium bicarbonate on nitrogen metabolism in the rumen of sheep fed on a silage based diet. Proc. Nutr. Soc. 46:49A.

Strobel, H. and J.B. Russell. 1986. Effect of pH and energy spilling on bacterial protein synthesis by carbohydrate-limiting cultures of mixed rumen bacteria. J. Dairy Sci. 69:2941-2947.

Thomas, C. and P.C. Thomas. 1985. Factors affecting the nutritive values of grass silages. In Recent Advances in Animal Nutrition. pp.223-256. Ed. Haresign, W. and D.J.A. Cole. Butterworths, London.