INFLUENCE OF THE LEVEL OF CONCENTRATE IN SHEEP DIET ON COMPOSITION AND DISTRIBUTION OF BACTERIA IN RUMINAL AND DUODENAL CONTENTS AND DUODENAL BACTERIAL FLOW ESTIMATION

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Introduction

Rumen bacteria are mainly solid adherent bacteria (SAB) which differ in their chemical composition from liquid adherent bacteria (LAB) (Legay-Carmier and Bauchart, 1989; Merry and McAllan, 1983). The effect of the nature of the feeds on these characteristics and the consequences on the dynamics of the bacterial population out of the rumen are unknown (Poncet et al., 1989). The aim of this work was to precise these aspects on sheep given three diets differing in their proportion of concentrate.

Materials and Methods

Four adult sheep (65 kg live weight) fitted with rumen and T-shaped duodenal cannulae were given successively same amounts (1211 ± 20 g DM in 8 egal meals per day) of 3 diets composed of good quality grass hay and dehydrated beet pulp-based concentrate in 3 proportions (100/0, 70/30, 40/60). Yb acetate, CrEDTA and ^{15}N solution were infused as flow and microbial markers respectively.

On each diet and animal, rumen contents were emptyed. Representative samples were squeezed dry through a calibrated gauze (250 μm pore size), and washed three-time in saline (NaCl 9 g/l at 39 °C). The filtrates were centrifuged at 800 g for 30 mn and the supernatants at 27,000 g for 30 mn to isolate LAB. Particles including small particles of the liquid phase have been wet-sieved (sieve size: 2, 1, 0.1 mm). The bacterial colonization of particles of each size (g bacterial DM/100 g particulate DM) was calculated from their ^{15}N enrichment of a bacterial sample separated according to Legay-Carmier and Bauchart (1988). Particulate and liquid phases of the duodenal content were separated from each of the nine spot-samples taken over 3 d on each animal, by centrifugation (800 g – 30 mn) and washing the pellets. The bacterial colonization of particles and bacterial distribution among the digesta were calculated as for rumen contents. Theoretical nitrogen content and ^{15}N enrichment of the bacterial population flowing out of the rumen have been calculated from the corresponding values for each bacterial pool in the rumen and the bacterial distribution in duodenal contents, assuming that this distribution is close to that in the rumen outflow. The error in the estimation of bacterial N flow at the duodenum arising from the use of a non representative sample of this bacterial population (LAB only) has been evaluated from the ratio: ^{15}N enrichment in the theoretically representative sample/^{15}N enrichment of LAB.

Results and Discussion

Bacterial colonization of digesta particles was not affected by diet and sampling level (rumen or duodenum), but was much larger on particles passing the 0.1 mm sieve than on those retained on that sieve (table 1). In rumen contents, LAB account for only one fifth of total bacteria whereas SAB on particles passing the 0.1 mm sieve (SAB < 0.1) represent more than two third of total SAB. The diet had a significant effect on the distribution of SAB among particles of different sizes. The duodenal distribution of bacteria differed significantly from that in the rumen because of differential rates of passage of liquids and particles and a different distribution of particles according to their size (no particles > 2 mm). There were no significant effects of the diet as in rumen contents.

Nitrogen (N) contents of SAB and LAB in the

TABLE 1. INFLUENCE OF THE LEVEL OF DEHYDRATED BEET PULP IN THE DIET ON THE BACTERIAL COLONIZATION OF FEED PARTICLES, THE DISTRIBUTION AND N CONTENT OF BACTERIA IN RUMEN AND DUODENAL CONTENTS OF FOUR SHEEP.

Hay/concentrate in the diet		100/0		70/30		40/60	
Sampling site		Rumen	Duodenum	Rumen	Duodenum	Rumen	Duodenum
Bacterial colonization	>2 (1)	12.1	ND (3)	12.2	ND	11.1	ND
(g bact. DM/100 g	>1	13.4	16.2	11.9	19.1	9.7	8.8
particulate DM)	>0.1	11.7	12.6	10.1	10.1	13.7	13.4
	<0.1	52.7	35.4	45.9	49.5	49.6	46.1
Distribution of	LAB (2)	17.8	39.4	23.6	32.4	18.6	28.5
bacter	B	19.4	0	15.4	0	14.8	0
	SAB >1	2.0	2.6	1.4	0.9	1.1	0.6
	SAB >0.1	9.4	12.2	8.3	6.4	6.5	9.1
	SAB <0.1	51.3	45.7	50.6	60.3	59.2	61.7
N content of bacteria	LAB	8.17	7.17	5.98	6.54	5.58	6.48
(% DM)	SAB >2 (1)	5.26	ND	4.88	ND	5.57	ND
	SAB >0.1	5.26	ND	5.52	5.28	5.79	ND
	SAB <0.1	5.68	6.36	7.73	6.86	7.44	7.10

(1) Sieve size (mm) (2) see text (3) ND=not determined because of too small amounts of particles.

rumen were low (mean = 6.24 % DM) and unaffected by diet and sampling site. However large and unexplainable differences were noted within and between the LAB and SAB < 0.1 pools. Values agree with those obtained previously on similar diets (Poncet et al., 1989). Large variation were also obtained for ^{15}N enrichment (not reported here) between LAB and SAB, but not between diet. Average ^{15}N enrichment decreased: 0.1224 ± 0.0011; 0.0972 ± 0.0117; 0.0893 ± 0.009; 0.0518 ± 0.0011 for ruminal LAB, SAB < 0.01; SAB > 0.1 and SAB > 2 respectively.

On the basis of these results, bacterial flow out of the rumen was underestimated by 15 to 20% when the ^{15}N enrichment of rumen LAB was used rather than that of a theoretically representative rumen bacterial sample. These discrepancies are explained 1) by differences in the chemical composition of bacteria in each pool and 2) by differences in partition of bacteria pools between ruminal and duodenal contents.

(Key Words: Bacterial Compartiments, Rumen, Duodenum)

Literature Cited

Legay-Carmier, F. and D. Bauchart. 1988. Distribution of bacteria in the rumen contents of dairy cows given a diet supplemented with soya been oil. Br. J. Nutr. (in press).

Merry, R.J. and A.B. McAllan. 1983. A comparison of the chemical composition of mixed bacteria harvested from the liquid and solid fractions of rumen digesta. Br. J. Nutr. 50: 701-709.

Poncet, C., J.P. Lalles, W.Z. Yang, L. Bernard, O. Marvalin and E. Delval. 1988. Differences de teneurs en azote et ARN entre les bacteries libres et les bacteries fixees aux particules alimentaires du contenu de rumen, dans le cas de differentes rations: consequences sur l'estimation de la synthese d'azote bacterien. Repr. Nutr. Develop. (in press).