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Response of cows differing in bloat susceptibility to intraruminal water and electrolyte loading

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ABSTRACT

Changes in rumen digesta and electrolyte composition were investigated in 4 high (HS) and 4 low (LS) bloat susceptible cows for 7.5 h following intraruminal loading with 10 ℓ water containing 0 (L), 1.76 (C), 3.52 (H) or 7.04 (HH) moles Na. Pre-treatment Na concentrations averaged 130 mmol/ℓ for both susceptibility groups, with increases averaging -20, 10, 42 and 95 mmol/ℓ after addition of L, C, H and HH respectively. Susceptibility groups did not differ in rate of return of Na concentration towards pre-treatment values. Increasing Na loading decreased fluid loss from the rumen but LS cows consistently lost more fluid than HS cows, with no treatment-susceptibility interaction.

Keywords Bloat; susceptibility; Na; K; inflow; outflow; mechanisms; dairy cows; digesta amount.

INTRODUCTION

Cockrem *et al.* (1983) suggested that high susceptibility to bloat in dairy cows may be associated with greater rumen digesta volume. Carruthers (1984) verified that cows of low bloat susceptibility (LS) had a lower quantity of rumen digesta 21 h after feeding on pasture than did cows of high susceptibility (HS). This arose because post-feeding digesta loss was higher for LS than HS cows. The data also indicated that these differences between HS and LS cows may be associated with differences in rumen fluid osmolality and Na concentration. An investigation of this possibility is reported here. Changes in quantity and composition of rumen digesta of HS and LS cows were monitored following intraruminal loading with water and electrolyte solutions.

EXPERIMENTAL

Four HS and 4 LS non-pregnant, non-lactating cows fitted with rumen fistulae were individually offered for 27 days chaffed ryegrass — white clover hay at a maintenance feeding level for 3 h each day. Water was offered to appetite after 1.5 and 3 h of feeding. The cows were managed in 2 groups (2HS, 2LS) staggered in feeding and measurements by 45 minutes. Feed periods began at 1430 and 1515 h.

On 4 days during the last 14 days digesta from the reticulum and rumen, (hereafter referred to as rumen), were removed, weighed, sampled and replaced 15 h after the feeding period (0 h) and again 1.5 and 7.5 h later. At 0 h the electrolyte solutions (Table 1), warmed to 39°C, were mixed with the digesta. Each 10 ℓ solution also contained 2.65 g Cr, as CrEDTA. The solutions were administered to each

cow according to a 4 x 4 Latin Square arrangement with at least 3 days between successive additions. Osmolality, Na, K and Cr contents of rumen fluid were determined at 1.0, 0.5 and 0 h before, and 0, 0.75, 1.5 h and thereafter at hourly intervals until 7.5 h after addition of solutions.

TABLE 1 Composition of solutions added to digesta (g/10 ℓ water)

Solution	NaCl	Na ₂ HPO ₄ ·2H ₂ O	NaHCO ₃	KCl
L	0	0	0	0
C ¹	98.3	46.2	4.7	5.7
H	196.5	92.4	9.4	11.4
HH	393.0	184.8	18.8	22.8

¹Similar to artificial saliva (McDougall 1948)

RESULTS

Osmolality (mosmol/kg), and Na and K concentrations (mmol/ℓ) prior to addition of solutions did not differ between susceptibility groups and averaged 276, 130 and 14 respectively. The corresponding values immediately after additions were 240, 110 and 11; 284, 140 and 13; 329, 172 and 15 and 416, 225 and 17, for L, C, H and HH respectively.

There was no difference between susceptibility groups in rate of return of Na concentration towards pre-addition values (Figure 1). Trends in osmolality were similar to those of Na. K concentrations invariably decreased on all treatments, with average decreases over 7.5 h of 1.8, 3.1, 4.5 and 5.7 mmol/ℓ for L, C, H and HH respectively. There were no

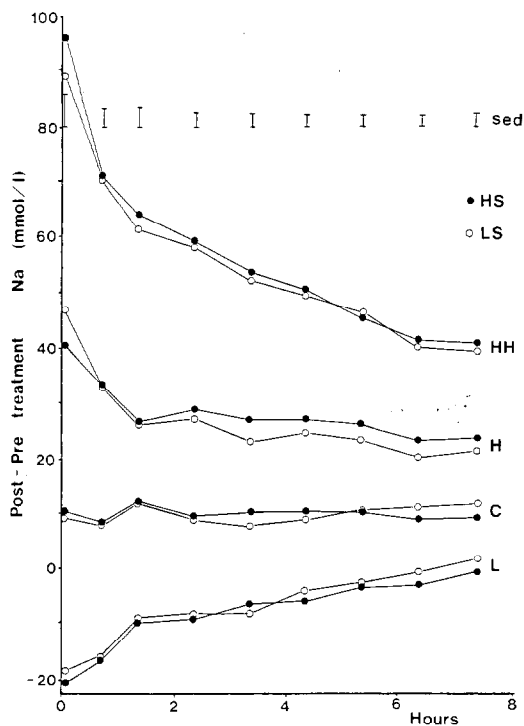


FIG. 1 Change (post-treatment minus pre-treatment) in rumen Na concentration (mmol/l) over 7.5 h following addition of electrolyte solutions to the rumens of cows of high (HS) and low (LS) susceptibility to bloat.

differences between susceptibility groups in K concentration or osmolality.

Loss of fluid and total digesta from the rumen decreased with increasing osmolality, and the difference between treatments was apparent after 1.5 h (Table 2). Large reductions in Na concentration during 0 to 7.5 h were accompanied by only small losses in fluid. Although the same slope ($-0.07 (\pm 0.011) \text{ kg}/(\text{mmol}/\ell)$) described the relationship between change in fluid quantity (ΔF , kg) and change in Na concentration (ΔNa , mmol/l) for each susceptibility group, LS cows lost more fluid than HS ($P < 0.01$) for any given shift in Na concentration as indicated by:

$$\Delta F = -0.07 \Delta \text{Na} - 5.87 \quad (\text{HS cows})$$

$$\Delta F = -0.07 \Delta \text{Na} - 8.83 \quad (\text{LS cows})$$

Net inflows to the rumen and outflows to the omasum (Table 3, calculated from dilution of Cr in the rumen after Reid (1965)) suggested lower fluid loss with HH was due to lower outflow, not increased net inflow. Therefore rumen Na concentration declined because of absorption, not dilution. The greater change in digesta of LS cows (Table 2) appeared to result from increased outflow rather than from reduced net inflow (Table 3).

TABLE 2 Effect of intraruminal addition of water (L) and electrolyte solutions (C, H, HH) on change in weight (kg) of fluid and solid digesta.

	Treatment					Susceptibility effect		
	L	C	H	HH	SED	HS	LS	SED
Fluid								
0-1.5 h	-1.7	-1.8	-0.7	0.5	0.5**	-0.6	-1.2	0.6
1.5-7.5 h	-6.8	-6.3	-5.5	-3.5	0.7***	-4.3	-6.8	0.9*
0-7.5 h	-8.5	-8.1	-6.3	-3.0	0.8***	-4.9	-7.9	1.1*
Solid								
0-1.5 h	-1.1	-0.7	-0.5	-0.4	0.4	-0.5	-0.9	0.2†
1.5-7.5 h	-0.8	-0.7	-0.8	-1.0	0.3	-0.9	-0.8	0.2
0-7.5 h	-1.9	-1.4	-1.3	-1.4	0.3	-1.3	-1.7	0.2

† $P < 0.10$

TABLE 3 Calculated net inflows to the rumen and outflows to the omasum (ℓ/h)

	Treatment					Susceptibility effect		
	L	C	H	HH	SED	HS	LS	SED
Inflow	4.50	5.09	4.76	4.31	0.29†	4.47	4.86	0.38
Outflow	5.63	6.17	5.60	4.71	0.29**	5.13	5.92	0.47

† $P < 0.10$

DISCUSSION

In the previous study with these cows (Carruthers 1984), differences between HS and LS cows in quantity of rumen digesta after fasting were obtained on pasture but not on hay. Also associated with the change in diet were relative changes between HS and LS cows in rumen osmolality and Na concentration, suggesting that these may be involved in the mechanisms responsible for the differing digesta losses. In the present work, LS cows consistently lost more fluid digesta than HS cows over a wide range in Na concentration. This was not due to differences in quantity of digesta in the rumen (Carruthers, 1984), which averaged 63.3 and 65.9 kg (SED 3.1) for HS and LS respectively, after solution addition. That this occurred without susceptibility group differences in net fluid inflow or rate of change of Na concentration, suggests the higher LS losses were not associated with the mechanisms which restore rumen conditions after hypo- and hyper-osmolar loading. The mechanisms responsible have yet to be identified.

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