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# Some rumen characteristics and performance data of cows differing in bloat susceptibility

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## ABSTRACT

Sixteen high (HS) and 16 low (LS) bloat susceptible dairy cows were offered hay or pasture when not lactating and pasture or 75% pasture 25% hay when lactating. There were no significant differences between susceptibility groups in voluntary intake or apparent digestibility of DM, OM, nitrogen or energy on either occasion. There was a trend for HS cows to produce less milk of higher fat, protein and lactose content than LS cows.

Rumen digesta studies on 5 HS and 5 LS rumen-fistulated, dry, pregnant cows at a maintenance level of feeding indicated that the proportion of digesta lost from the rumen after feeding was higher for LS cows than HS cows on pasture, but not on hay. There was no significant difference between susceptibilities in post-feeding fluid dilution rate. HS cows tended to have higher rumen fluid osmolality and Na concentration during the post-feeding period on pasture, but not on hay.

**Keywords** Bloat susceptibility; rumen volume; cows; milk yield; intake; digestibility.

## INTRODUCTION

Cockrem *et al.* (1983) reviewed a selection experiment at Ruakura that has resulted in dairy cows differing in susceptibility to bloat. It has been suggested that high susceptibility may be associated with greater rumen digesta volume (Cockrem *et al.*, 1983) and differences in salivary protein composition (McIntosh and Cockrem, 1977). This paper is a preliminary report on a study investigating rumen physiology and function of these cows that differ in bloat susceptibility. Data on intake, milk yield and composition, digestibility and some rumen characteristics are reported.

## EXPERIMENTAL

### Experiments 1 and 2.

Voluntary food intakes of 16 high (HS) and 16 low (LS) susceptible 3- and 4-year old cows were established when they were dry and when lactating. Cows were in their 6th to 7th month of pregnancy in Experiment 1, and their 4th to 5th month of lactation in Experiment 2. Twenty seven cows were common to both experiments. Diets offered in Experiment 1 were pasture and hay; in Experiment 2 pasture and 75% pasture plus 25% hay. Each experiment consisted of 2 three-week periods, with 8 HS and 8 LS cows on each diet in the first period, diets being changed over in the second period. Cows were confined to individual pens ($10 \times 2$ m) allowing continuous access to feed and water which were offered *ad libitum*.

During the final 2 weeks of each period 12 cows (3 HS and 3 LS per diet) were confined to metabolism stalls that allowed the separate collection of urine and faeces and measurement of water intake.

Live weights (LW) were recorded, after 24 h fasting, at the end of each 3-week period. In Experiment 2 milk yields were determined at each milking, and milk composition weekly on a sample representing 4 consecutive milkings.

### Experiment 3

Five HS and 5 LS rumen-fistulated, dry, pregnant cows were individually offered thawed pasture or chaffed hay, at a maintenance level of feeding, for 2 h each day. Water was offered, to appetite, for 10 minutes either at the end of the 2 h feeding period (pasture) or after both 1 and 2 h feeding (hay). Each feed was offered for 5 weeks, with all cows on hay followed by pasture. Reticulo-rumen (hereafter referred to as rumen) measurements were made on each diet on 3 days separated by weekly intervals. On these days, the contents of each cow were removed, weighed, sampled and replaced immediately after the end of the 2 h feeding period (0 h) and 8 and 21 h later. Fluid dilution rates were estimated on these days by addition of 1 ℓ CrEDTA (2.7 g Cr/ℓ; Binnerts *et al.*, 1968) at 0 h followed by sampling at 1 to 2 h intervals for 8 h. These samples were analysed for osmolality, Na and K in addition to Cr.

At the midpoint and end of the experiment each cow's rumen capacity was estimated on 3 consecutive days by inserting a meteorological balloon into the emptied rumen and filling with water.

Live weights were recorded on 3 consecutive days at the start and end of each 5-week feed period.

## RESULTS

### Experiments 1 and 2 (Tables 1 and 2)

Differences between susceptibility groups in voluntary intake (g DM/kg $LW^{0.75}$) or apparent digestibility of dry matter (DM), organic matter (OM), nitrogen (N) or energy (E) were small and not significant for both dry and lactating cows on all diets. Digestibility values (averaged for both susceptibility groups) in Experiment 1 for pasture and hay respectively were DM 73.8 and 54.3%, OM 76.7 and 56.3%, N 71.5 and 50.8%. In Experiment 2 the values for pasture and 75% pasture 25% hay respectively were DM 71.2 and 68.2%, OM 73.8 and 70.3%, N 64.5 and 65.8%. LS cows consumed more water than HS cows, the difference being significant ($P<0.05$) on the mixed diet.

Except for protein content of milk where that of HS cows was higher than LS cows ($P<0.10$), milk yield and composition did not differ between susceptibility groups. There was a tendency however for LS cows to produce more milk of a lower fat, protein, and lactose content. LS cows were heavier than HS cows in both Experiments, significantly so ($P<0.05$) during lactation.

**TABLE 1** Intake, energy digestibility and live weight for non lactating pregnant HS and LS cows. (Experiment 1)

| Feed | Pasture | | Hay | | |
|---|---|---|---|---|---|
| Susceptibility | HS | LS | HS | LS | SED |
| Fasted LW (kg) | 360 | 379 | 371 | 394 | 15 |
| DMI (kg/cow/d) | 9.1 | 9.7 | 8.5 | 9.0 | 0.6 |
| (g/kg $LW^{0.75}$/d) | 110 | 113 | 100 | 102 | 5 |
| Water intake (kg/cow/d) | 3.2 | 3.7 | 34.7 | 35.8 | 3.6 |
| Energy digestibility (%) | 73.5 | 72.3 | 52.1 | 53.6 | 1.1 |

### Experiment 3

For both diets, intakes of DM and water (amount drunk and in feed) by HS and LS cows were similar except LS cows consumed 6.9 kg more water ($P<0.10$) on pasture than HS cows (Table 3).

Loss of digesta was compared for HS and LS groups by examining the relationship between weight of digesta in the rumen immediately post feeding and that 21 h later (Fig. 1). On pasture, the slopes of the regression lines did not differ between susceptibility groups so the average within group slope has been presented (Table 4). The relationship indicates that not only was digesta loss proportional to the amount present after feeding but also for a given amount present after feeding LS cows lost a significantly greater proportion than HS cows (31% and 48% for HS and LS respectively), resulting in lower digesta levels in LS cows 21 h after feeding. The difference between susceptibility groups in digesta loss was accounted for by differences in both fluid and DM (Table 4). Of the additional 9.5 kg digesta lost by LS cows compared to HS cows, 93% was fluid and 7% DM. This DM content is within the range of those found in the rumen over measurement periods (5.9 to 10.4% DM).

On hay, neither the slope nor intercepts differed significantly between susceptibility groups for digesta, fluid or DM. The overall equation for digesta is shown in Table 4.

Fluid dilution rate, net fluid inflow into the rumen

**TABLE 2** Intake, energy digestibility, live weight and milk production data for lactating HS and LS cows (Experiment 2)

| Feed | Pasture | | 75 Pasture 25 Hay | | |
|---|---|---|---|---|---|
| Susceptibility | HS | LS | HS | LS | SED |
| Fasted LW(kg) | 327 | 364 | 329 | 365 | 14* |
| DMI (kg/cow/d) | 13.7 | 14.8 | 13.0 | 13.9 | 0.6 |
| (g/kg $LW^{0.75}$/d) | 178 | 178 | 168 | 167 | 6 |
| Water intake kg/cow/d | 11.8 | 15.7 | 17.8 | 25.5 | 2.9* |
| Energy digestibility (%) | 69.2 | 69.3 | 66.7 | 66.4 | 0.7 |
| Milk yield (kg/cow/d) | 13.3 | 15.4 | 12.3 | 14.3 | 1.0** |
| Fat (%) | 5.21 | 4.97 | 5.05 | 4.88 | 0.20 |
| Protein (%) | 3.75 | 3.57 | 3.66 | 3.48 | 0.10** |
| Lactose (%) | 4.99 | 4.85 | 4.99 | 4.88 | 0.08 |

**TABLE 3** Intake and live weight for rumen fistulated, pregnant, non lactating HS and LS cows

| Feed | Pasture | | | Hay | | |
|---|---|---|---|---|---|---|
| Susceptibility | HS | LS | SED | HS | LS | SED |
| LW (kg) | 382 | 428 | 34 | 390 | 449 | 32 |
| Intake DM | 3.24 | 3.19 | 0.35 | 4.76 | 5.11 | 0.44 |
| (kg/cow/d) Water | 20.9 | 27.8 | 2.71† | 20.8 | 21.0 | 3.54 |

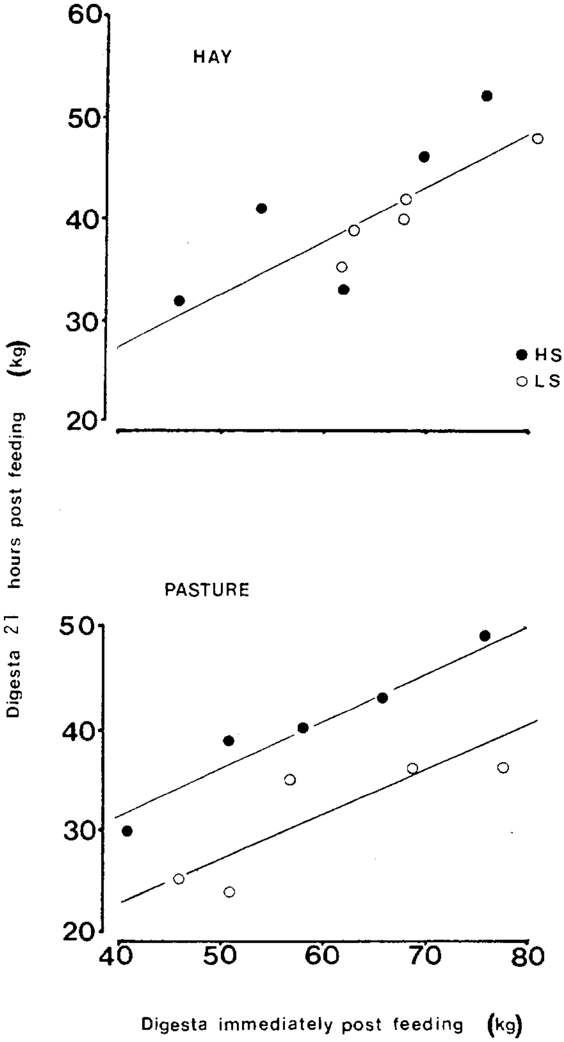


**FIG. 1** Relationship between digesta replaced immediately post feeding and that remaining 21 h later

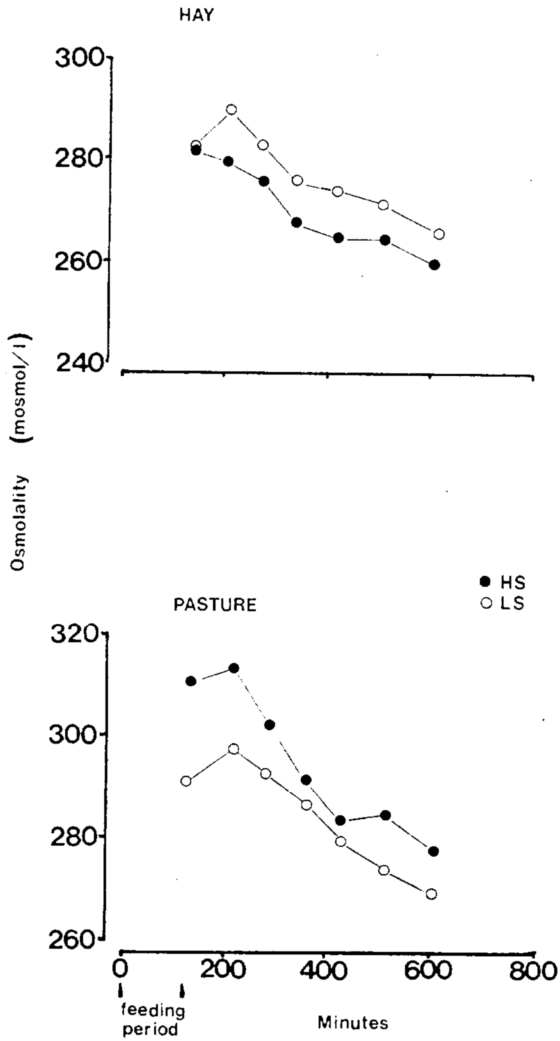


**FIG. 2** Changes in rumen fluid osmolality for 8 h following a 2 h feeding period

**TABLE 4** Summary of regressions of digesta present in the rumen 21 h post feeding (kg) on digesta present immediately post feeding (kg) for HS and LS cows

| | Regression Coefficient | SE | Intercepts HS | Intercepts LS | SE | $R^2$ |
|---|---|---|---|---|---|---|
| Pasture | | | | | | |
| Total digesta | 0.46 | 0.07 | 13.28 | 3.76 | 1.76*** | 0.87 |
| Fluid | 0.46 | 0.08 | 12.80 | 4.00 | 1.64** | 0.86 |
| DM | 0.47 | 0.06 | 0.50 | −0.20 | 0.16** | 0.89 |
| Hay | | | | | | |
| Total digesta | 0.52 | 0.14 | 6.83 | | 8.97 | 0.60 |

**TABLE 5** Rumen fluid dilution rates, and fluid net inflow to and outflow from the rumen during the 8 h post-feeding period for HS and LS cows

| Feed | Pasture | | | Hay | | |
|---|---|---|---|---|---|---|
| Susceptibility | HS | LS | SED | HS | LS | SED |
| Dilution rate/h | 0.0498 | 0.0521 | 0.0043 | 0.0706 | 0.0760 | 0.0043 |
| Net inflow (ℓ/h) | 2.46 | 2.35 | 0.32 | 3.51 | 4.01 | 0.52 |
| Outflow (ℓ/h) | 3.42 | 3.78 | 0.58 | 4.66 | 5.64 | 0.46† |

and outflow to the omasum (calculated after Reid, 1965) were not significantly different between susceptibility groups, except outflow was higher for LS cows than HS cows on hay ($P<0.10$) during the 8 h period (Table 5).

On hay, LS cows had higher rumen fluid osmolalities but the difference was not significant (Fig. 2). On pasture, LS cows had lower osmolalities than HS cows, significant ($P<0.05$) immediately and 7 to 8 hours after feeding.

Total Na + K concentrations also indicated an interaction between diet and susceptibility with values for LS cows being higher on hay but lower on pasture compared to the HS cows. Average Na + K concentrations over the sample period on hay were 144.1 and 145.4 mmol/ℓ (NS) and on pasture were 136.8 and 130.1 mmol/ℓ ($P<0.05$), for HS and LS cows respectively. Na appeared to have a greater influence than K, though susceptibility differences were not significant for either ion taken separately. Average Na concentrations on hay were 96.2 and 100.3 mmol/ℓ and on pasture 82.8 and 75.4 mmol/ℓ, for HS and LS cows respectively. The corresponding K concentrations were 47.9 and 45.1 mmol/ℓ and 54.0 and 54.7 mmol/ℓ.

The average water-filled rumen capacities of HS and LS cows were 84.1 and 93.6 kg respectively (SED 5.96, NS) or 22% of live weight for both groups.

## DISCUSSION

Differences between susceptibility groups in milk yield and composition were small. The differences may have been due to breed effects. The breeding programme's use of Friesian and Jersey bulls of each susceptibility to obtain crossbred progeny has resulted in a greater Friesian proportion in the LS cows and Jersey in the HS cows. The Jersey contribution by founder bulls (2HS, 2LS per breed) to cows used in Experiment 1 and 2 were 50% and 34% for HS and LS groups respectively. Breed differences may also have accounted for the LW differences.

Clear evidence was obtained that susceptibility groups differed in digestion characteristics. This was shown by the data obtained on digesta loss, osmolality and the diet-susceptibility interaction. The explanation of differences is less certain and likely to be complex. For example, on pasture the differences between susceptibility groups in the amount of fluid present in the rumen after 21 h was not due to differences in net fluid input during the first 8 h, since dilution rates and net inflow as measured by Cr were similar. This implies differences in losses via the omasum. Obviously further work on this is required.

The lower digesta weights in the LS cows 21 h after feeding on pasture, and possibly, larger rumen capacity in LS cows lends support to the observation of lower digesta levels in LS cows made by Cockrem *et al.* (1983).

The data on rumen characteristics were obtained with dry cows at a low level of intake, approximating steady-state conditions. The differences between susceptibility groups may be enhanced during lactation by the change in physiological state and higher levels of nutrition. This possibility is presently being investigated. The differences obtained with dry cows, and possible differences with lactating cows, do not appear to be reflected in animal performance as indicated by yield of milk constituents, intake and apparent digestibility of feed. Irrespective of the physiological mechanisms involved, the selection programme appears to have resulted in animals that differ in bloat susceptibility but not performance.

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