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RUMEN MOTILITY IN SHEEP AND CATTLE AS AFFECTED BY FEEDS AND FEEDING

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SUMMARY

Rumen "A" and "B" sequence contractions were recorded over several 24 h periods from three sheep fed pelleted lucerne, chaffed lucerne hay and Ruanui ryegrass and from four cattle fed only the latter two diets. Rumen motility was related to jaw activity: eating ruminating and resting. The effects of diet and differences between sheep and cattle are demonstrated. The sheep were used to determine the pattern and rate of digesta movement within the rumen using radiographic techniques. A similar pattern was evident for all diets but rates of movement varied between diets.

INTRODUCTION

Contractions of the muscular walls and pillars of the reticulo-rumen (rumen) mix and circulate the digesta within the rumen. Two types of contraction have been identified for both sheep (Phillipson, 1939; Reid, 1963) and cattle (Schalk and Amadon, 1928; Reid and Cornwall, 1959). Rumen "A" sequences (primary, or mixing cycles) are characterized by a caudally moving wave of contractions commencing with a biphasic or triphasic contraction of the reticulum. "A" sequences appear to coincide with exit of digesta (liquid and particulate fractions) from the rumen to the lower alimentary tract (Freer *et al.*, 1962; Bost, 1970). Rumen "B' sequences (secondary, or eructation cycle) are cranially moving contractions which do *not* involve contraction of the reticulum. "B" sequences are most commonly associated with eructation of gaseous fermentation products.

This paper reports the effects of different diets on the frequency of A and B sequence contractions in sheep and cattle. Some preliminary observations on the patterns of digesta movement in the sheep rumen are also presented.

EXPERIMENTAL

Three Romney ewes and four dry cows of mixed breeding, all with rumen fistulae, were used in the experiments. The sheep were held indoors in metabolism crates for the duration of the experiment and transported to Massey University where radiological observations were carried out. Cattle were tethered indoors and able to lie down at will.

Sheep were fed three diets: Lucerne pellets, chaffed lucerne hay, fresh Ruanui ryegrass. Cattle were fed chaffed lucerne hay and fresh Ruanui ryegrass. Sheep DM intakes were restricted to 2.5% of their body weight at the commencement of the experiment; cow DM intakes of chaffed lucerne hay were similar to individual intakes of Ruanui ryegrass offered *ad libitum*.

Rumen A and B sequences in cattle were identified by monitoring pressure changes at three locations in the reticulo-rumen (Reid and Cornwall, 1959). In sheep, pressure records were made from two sites in the rumen, but reticulum contractions were detected by electrodes implanted subcutaneously (Reid, Waghorn and Williams, unpublished). Both sheep and catle were fitted with jaw harnesses to detect feeding and rumination during recording of rumen activity. Recording was carried out for two 24 h periods with sheep and for four 24 h periods with cattle.

Digesta movement in the sheep rumen was determined radiologically. Fifty millilitres of barium-based radio-opaque marker (Micropaque, Nicholas Laboratories Ltd) was deposited in the rumen and its dispersal monitored by taking a series of radiographs (usually at 5-minute intervals) for periods up to 90 minutes, by which time the marker had usually become quite diffuse. The marker was placed in the caudodorsal blind sac of the rumen (Fig. 2) using a short tube inserted through the fistula; or given orally as a drench. For each site of marker release two series of radiographs were taken in the lateral plane and one series was taken dorso-ventrally. These observations were repeated with each of the three sheep for the three diets. The radiographs were analysed by measuring the changed location of the barium front in successive plates of a series. Rumen A sequences were monitored, whilst radiological observations were being made, to obtain some indication of the rumen activity associated with digesta movement.

RESULTS

Diurnal patterns of rumen motility (Fig. 1) for both sheep and cattle showed a similar pattern. Eating stimulated increased motility. The degree of response appeared related to animal species, frequency of feeding, and diet. Response during eating was greater in sheep than cattle, and also when animals were fed once rather than twice daily. Greatest response occurred when pelleted lucerne was fed to sheep. Cattle showed less diurnal variation in rümen motility than did sheep fed similar diets. Pelleted and chaffed lucerne diets fed to sheep resulted in the most rapid motility during eating and the least rapid motility later in the day (Fig. 1). As a result the mean frequency of sequences (A and B) was quite similar for all feeds in both sheep and cattle.

Figure 2 shows patterns of digesta movement in the sheep rumen revealed by radiographic studies. Patterns of movement were similar in all sheep and showed little variation between the three feeds. As might be expected, digesta with fluid consistency (pelleted diets) resulted in a more diffiuse spread of marker in the rumen but the basic flow pattern remained evi-

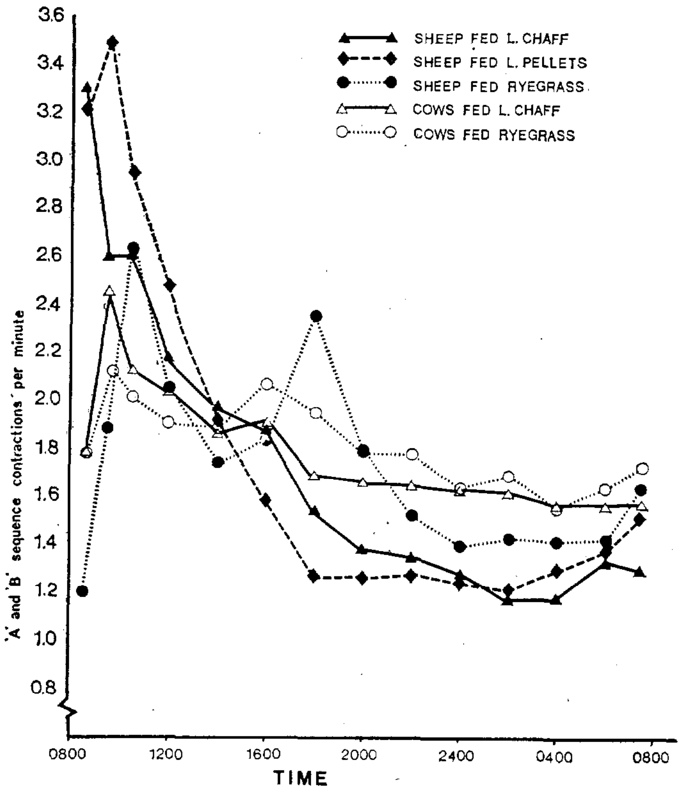

FIG. 1: *Diurnal patterns of rumen motility for sheep and cattle. Feeding was at 0900 h for lucerne chaff and pellet diets and twice daily (0900 and 1600 h) with ryegrass feeding.*

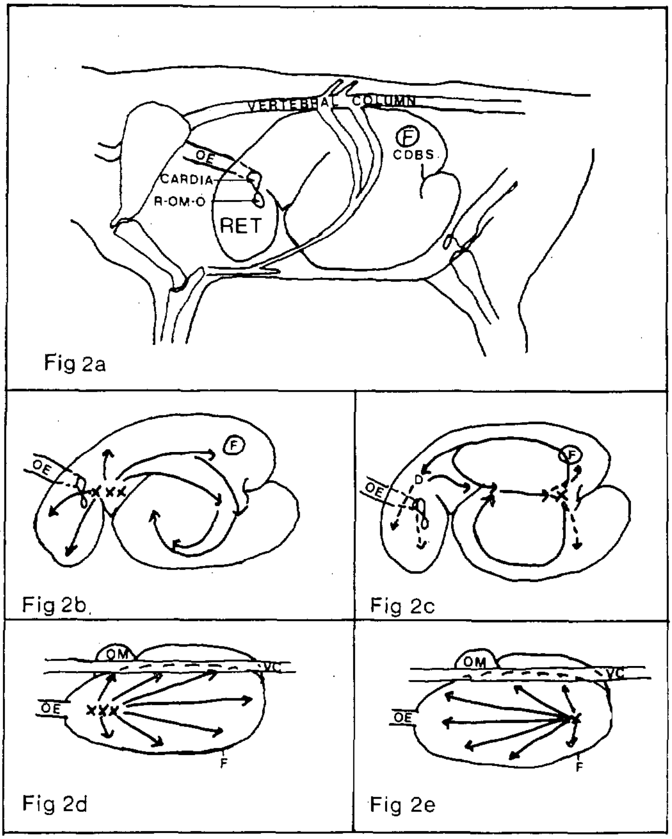

FIG. 2: *Movement of radio-opaque marker in the rumen following drenching (b and d) or introduction through the fistula (c and e); both horizontal (b and c) and dorso ventral (d and e) views are shown.*
CDBS — caudodorsal blind sac of rumen; F — fistula; OE — oesophagus; OM — omasum; RET — reticulum; ROMO — reticulo-omasal orifice; VC — vertebral column; x — region of radio-opaque marker release.

dent. The principal effect of diet observed in this study was to alter the rate of digesta movement. This was best demonstrated by measuring rates of movement across the dorsal rumen (viewed in the lateral plane) after marker had been released in the caudodorsal blind sac. Times taken to move from the fistula to the reticulum, a distance of approximately 26 cm (Fig. 2c), were 52, 20 and 24 minutes for chaff, pellets and ryegrass diets, respectively. Rumen motility was similar for the three diets.

The spiralling of digesta about the mid-rumen as seen in the lateral plane (Figs. 2b, c) had no counterpart when viewed dorso-ventrally (Figs. 2d, e). The marker indicated a simple flow pattern approximately parallel to the vertebral column, without bias towards any particular region of the rumen. Marker given orally could be seen in the omasum within 5 to 10 minutes of administration.

DISCUSSION

Rumen motility is influenced by many variables, including level of feeding and the nature of the feed. These factors are reflected in times spent eating, ruminating and resting (Table 1).

In the present experiments the large differences in level of feeding between sheep and cattle (expressed in terms of BW) seem to approximate typical intakes of the two species. Ryegrass was in effect offered *ad libitum* to both sheep and cattle, neither consuming all that was offered.

Rumen A and B sequence contraction rates and the ratio of B sequences to A sequences were similar for both sheep and cattle for all feeds, although sheep fed lucerne pellets showed a slightly higher B:A sequence ratio. The very short eating and rumination periods observed with sheep fed lucerne pellets probably reflect the lack of long fibre and the high palatability of this diet.

The effect of eating on rumen motility showed considerable variation between sheep and cattle as well as between feeds with sheep. Apart from a higher degree of motility whilst resting in

TABLE 1: RUMEN MOTILITY (A AND B SEQUENCES COMBINED) IN SHEEP AND CATTLE FED DIFFERING DIETS

	Sheep			*Cattle*	
	Chaffed Lucerne	*Pelletted Lucerne*	*Ruanui Ryegrass*	*Chaffed Lucerne*	*Ruanui Ryegrass*
Intake % BW	2.12	2.12	1.89	1.13	1.14
Eating time (min/day)	207	87	259	231	310
Ruminating time (min/day)	516	254	432	350	424
Resting time (min/day)	717	1099	749	859	706
Contractions/min:					
Eating	2.63	3.53	2.65	2.30	2.25
Ruminating	1.57	1.61	1.88	1.54	1.67
Resting	1.30	1.53	1.36	1.68	1.70
Mean	1.59	1.66	1.75	1.75	1.81
Ratio B/A	0.57	0.67	0.55	0.53	0.54

cattle as compared with sheep, other differences between feeds and between sheep and cattle were small.

Lateral views of feed circulation in the sheep rumen (Figs. 2b, c) following either oral or caudodorsal blind sac administration of marker are readily related to a single basic pattern. The apparently opposing circulations in the dorso-ventral projections (Figs. 2d, e) arise because digesta in the dorsal and ventral regions of the rumen moves cranially, whilst digesta in the middle region of the rumen moves caudally. The only clear difference attributable to feed type was the more rapid movement of grass and pellet digesta compared with the chaff digesta. A possible factor contributing to this difference was the nature of the digesta in the rumen: digesta in chaff-fed sheep at the time of observation appeared more structured and less fluid than digesta when the other diets were fed.

Attempts to model rumen function (Ulyatt *et al.*, 1976) have demonstrated a limited understanding of rumen motility and its effect on particle breakdown and passage out of the rumen. An improved knowledge of relationships between rumen motility and eating, rumination and resting, combined with influences of diet, is necessary to better understand digestion in the rumen.

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