HOW DO CATTLE AND SHEEP ALTER INGESTIVE BEHAVIOUR IN RESPONSE TO CHANGES IN SWARD STATE?

P. D. Penning, R. J. Orr, A .J. Parsons and A. Harvey
Institute of Grassland and Environmental Research, North Wyke, Okehampton, Devon EX20 2SB. UK.

ABSTRACT

Ingestive behaviour of yearling Friesian heifers continuously stocked on monocultures of *Lolium perenne* (G) or *Trifolium repens* (C) maintained at sward heights of 7-8 cm, was recorded. Bite masses, prehension biting and mastication rates were similar between treatments (211 vs. 230 mg DM prehension bite^{-1}, 61 vs. 55 prehension bites and 11 vs. 13 mastications, min^{-1} for G and C, respectively). DM intake rates were 12.9 g min^{-1} for both treatments. Animals grazed longer (536 vs.436 min) and ruminated longer (526 vs. 267 min^{-1}) on G compared with C. Daily intakes were 6.9 vs.5.6 kg DM for G and C. Growth rates for G and C were similar (0.97 vs 0.99 kg live weight d^{-1}). Grass had a lower digestibility than clover (DOMD 60 vs. 77%). It is suggested that cattle have higher intake rates than do sheep because a lower proportion of their total jaw movements are used to masticate herbage.

KEYWORDS

Sheep, cattle, grazing, ryegrass, white clover, behaviour, bite mass

INTRODUCTION

Comparing intake rates achieved by lactating dairy cows (Gibb *et al.*, 1997) with those of lactating sheep grazing similar swards (Penning *et al.*,1995), shows that cows have herbage intake rates more than 5 times those of sheep. In a theoretical analysis of the ingestive behaviour of grazing ruminants, Parsons *et al.* (1994) postulated that this higher intake rate could not be due solely to the greater dental arcade size and hence bite mass by cattle. They hypothesised that the main factor influencing intake rate was handling time i.e. the time required to take a bite of herbage of a given mass *(prehension)* and then to manipulate and chew that herbage *(mastication)* before swallowing it. They suggested that cattle achieved these relatively high intake rates because they required fewer mastications per prehension bite of a given herbage mass than did sheep. Penning *et al.* (1995) demonstrated that sheep were able to eat clover faster than grass because fewer mastications per unit bite mass were required. If cattle do require relatively few mastications during ingestion of herbage, it is suggested that they may be unable to reduce the number of mastications in the same way as sheep, and thus may be unable to increase their intake rate, when grazing clover as compared with grass. This paper describes the behavioural strategies adopted by cattle when grazing monocultures of grass and white clover and compares their ingestive behaviour with that of sheep.

MATERIALS AND METHODS

Four groups, each of three yearling Friesian heifers (average live weight 310 ± 7.3 kg), grazed monocultures of perennial ryegrass (G; *Lolium perenne* cv.Parcour) or white clover (C; *Trifolium repens* cv. Kent Wild White) from May until October. There were two replicates of each herbage species. Target sward surface heights (SSH; Bircham, 1981) of 7 to 8 cm were maintained by continuous variable stocking using additional heifers. Grazing behaviour was recorded automatically over 24 h on two occasions for all animals, using sensors to detect jaw movements (Champion *et al.*, 1994). Herbage intake rates were measured over 1 h, by weighing animals before and after grazing on four occasions, using the technique of Penning and Hooper (1985) modified so that estimates of insensible weight loss were made after grazing. Hand-plucked samples of herbage were taken which were representative of the material grazed by the animals. These were analysed subsequently for dry matter content (DM) and chemical composition.

RESULTS AND DISCUSSION

N content and digestibility of the herbage DM were lower for G than C treatments (N, 3.0 v 5.3%; P<0.001 and DOMD, 60 v 77%; P<0.01) and NDF values were higher (23.9 v 15.8%; P<0.01). Herbage DM content was higher on G than C (27.4 v 17.0%; P<0.001). Mean bite mass of fresh herbage on treatment G was 55% of that for C (Table 1) but mean bite mass on treatment G, expressed as DM, was 92% of that for treatment C and was not significantly different. This reflects the differences in DM content between the two herbage species. Prehension biting rate tended to be higher on G than C and this resulted in similar intake rates (Bite Mass x Prehension Biting Rate) of DM for the two treatments. Cattle grazed 100 min 24 h^{-1} longer on treatment G than C; this gave daily intakes (Intake Rate x Grazing Time) that tended to be higher for treatment G (6.92 v 5.61 kg; P=0.29). Animal live-weight gains were similar on both treatments (0.97 v 0.99 ± s.e.d. 0.107 kg d^{-1} for treatments G and C, respectively). These results suggest that, to overcome the lower digestibility of the grass, cattle increased their intake of grass by increasing grazing time. They also suggest that neither fatigue nor gut fill were major factors limiting intake, but that chemical or metabolic controls, were the main influencing factors. Cattle on treatment G spent almost twice as long ruminating as those on C (Table 1). Cattle on G spent 74% of each 24 h either eating or ruminating compared with treatment C where animals spent only 59% of their time in these activities. This suggests that energy expenditure may also have been greater on G than C treatments and this would also have contributed to the apparent advantages of clover compared with grass. Comparisons with published data for sheep grazing similar swards to those in this experiment are shown in Table 2. Cattle had an incisor width approximately 1.8 times that of the sheep but bite masses were 2.5 times greater for the cattle than sheep. However, if cattle are able to open their mouths wider than sheep and also increase bite area still further by extending their tongues, then this could account for differences in bite mass. Total rate of jaw movements for cattle was about 50% of that of sheep. Cattle had only 0.2 mastication jaw movement for each prehension jaw movement compared with sheep, which had 1.7 or 1.3 mastications per prehension jaw movement for G and C, respectively. Thus cattle only required 3.9 s and 3.8s to ingest 1 g of grass or clover DM, whereas sheep required 4.6 s g^{-1} of grass and 4.1 s g^{-1} of clover DM. Cattle and sheep spent longer ruminating g^{-1} of grass ingested than g^{-1} of clover and sheep ruminated longer g^{-1} of herbage ingested than cattle. The results confirm the suggestion by Parsons *et al.* (1995), that a major factor contributing to the higher intake rate of herbage by cattle compared with that of sheep, was the lower proportion of total jaw movements allocated to masticating herbage during grazing, by cattle than by sheep, giving rise to lower handling costs per unit of herbage ingested. In addition, cattle ruminated less than sheep and both animal species ruminated longer on grass than clover, per unit of DM intake. Rumination may also be considered as handling cost. These additional costs will not directly affect intake rate but could affect total daily intake by reducing time available for grazing.

These results offer an explanation of how cattle achieve higher intake rates than sheep and why, herbage intake rate by cattle grazing clover, is similar to that for cattle grazing grass.

ACKNOWLEDGEMENTS

We acknowledge financial support from MAFF and BBSRC during the execution of these studies.

REFERENCES

Bircham, J.S. 1981. Herbage growth and utilisation under continuous stocking management. Ph. D. Thesis, University of Edinburgh. pp. 213.

Champion R.A., S.M. Rutter and P.D. Penning. 1994. A solid state grazing behaviour recording system. Proc. 4th Brit. Grassld. Soc. Research Conf., September 1994. Reading. pp 155-156.

Gibb, M.J., C.H. Huckle, R. Nuthall and A.J. Rook. 1977. Effect of sward surface height on intake and grazing behaviour by lactating Holstein-Friesian cows. Anim. Sci. (In press).

Parsons, A.J., J.H.M. Thornley, J. Newman and P.D.Penning. 1994. A mechanistic model of some physical determinants of intake rate and diet selection in a two-species temperate grassland sward. Func. Ecol., **8**: 187-204.

Penning, P.D., A.J. Parsons, R.J. Orr, A. Harvey and R.A. Champion. 1995. Intake and behaviour responses by sheep, in different physiological states, when grazing monocultures of grass or white clover. App. Anim. Behav. Sci., **45**: 63-78.

Penning, P.D. and G.E. Hooper. 1985. An evaluation of the use of short-term weight changes in grazing sheep for estimating herbage intake. Grass Forage Sci., **40**: 79-84.

Table 1

The effects of herbage species on the ingestive behaviour of cattle.

	Grass	Clover	F Probability
Bite mass (mg prehension bite^{-1}):			
Fresh matter	770	1388	0.08
Dry matter	211	230	0.45
Jaw movement rates (min^{-1}) during eating:			
Prehension bites	61.3	55.3	0.23
Mastication chews	11.3	12.7	0.53
Total jaw movements	72.6	68.0	0.16
Intake rate (g min^{-1} grazing):			
Fresh matter	46.6	77.4	0.07
Dry matter	12.9	12.9	0.98
Time spent (min 24 h^{-1}):			
Eating	536	436	0.05
Ruminating	526	267	<0.01
Idling	378	737	<0.01

Table 2

Comparison of ingestive behaviour by sheep‡ and cattle grazing grass or white clover swards at a surface height of 7 cm

	Sheep		Cattle	
	Grass	Clover	Grass	Clover
Live weight (kg)	85		310	
Incisor width (cm)	3.85		7.08	
Bite mass (mg DM prehension bite^{-1})	83	93	211	230
Total jaw movements (min^{-1})	159	156	73	68
Number of mastication/prehension jaw movement	1.7	1.3	0.2	0.2
Time to open and close jaws during grazing(s)	0.38	0.38	0.82	0.88
Eating time (s g^{-1} DM ingested)	4.6	4.1	3.9	3.8
Ruminating time (s g^{-1} DM ingested)	7.9	5.4	4.6	2.8

‡ Lactating ewes (Penning *et al.*, 1995)