Herbage intake, ingestive behaviour and diet selection in sheep grazing *Holcus lanatus* and perennial ryegrass swards

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ABSTRACT

Grazing behaviour, diet selection, and herbage intake of ewes in mid-pregnancy were studied on perennial ryegrass/white clover and *Holcus lanatus*/white clover swards rotationally grazed at medium and high allowances (6% and 12% of liveweight as herbage dry matter respectively) during late autumn. Estimates of herbage mass and sward height before grazing were similar for the two pasture types.

Animals on both pasture types concentrated grass rather than clover in the diet, and extrusa samples from both showed evidence of limited concentrations of condensed tannins. Herbage intake was 28% higher from ryegrass than from Yorkshire fog swards (1410 vs 1100 ±29 g DM/day) and 19% greater at high allowance (1370 vs 1150 ± 50 g OM/day). Bite weight was 61% greater for Yorkshire fog than for ryegrass (139 vs 86 ± 7.0 g OM/bite) and 30% lower for medium allowance than for high allowance (90 vs 130 ± 7.0 mg OM/bite). Grazing time was higher on ryegrass swards and for medium allowance (610 vs 500 ± 34 mins and 620 vs 495 ±27 mins) whereas differences in rate of biting were small. There was a small advantage in the organic matter digestibility of the herbage selected in favour of ryegrass swards (85.7 vs 82.2 ±0.3%), while no differences were found between herbage allowances.

It is concluded that herbage intake was influenced more by nutritional than by behavioural constraints, but that these effects need to be investigated in animals of higher production potential and nutrient demand.

Keywords: Yorkshire fog; ryegrass; white clover; grazing allowance; sheep; ingestive behaviour; diet selection and herbage intake.

INTRODUCTION

Yorkshire fog (*Holcus lanatus* L.) is an alternative species to perennial ryegrass (*Lolium perenne* L.) for low to moderate soil fertility conditions (Watkin and Robinson, 1974; Harvey *et al.*, 1984; Morton *et al.*, 1992), and there is active interest in the potential value of its condensed tannins in enhancing the efficiency of dietary protein utilisation (Terrill *et al.*, 1992a). However, there is a lack of information on herbage intake, diet selection, and ingestive behaviour of sheep grazing Yorkshire fog. The specific aim of this study was to investigate differences between Yorkshire fog and perennial ryegrass in these variables.

MATERIALS AND METHODS

The trial was conducted on 0.2 ha paddocks of established Yorkshire fog (cv. Massey Basyn) or perennial ryegrass (cv. Grasslands Nui), each grown with white clover (cv. Grasslands Tahora), which had been continuously stocked with sheep for two years. There were four paddocks of each mixture, distributed at random, and each paddock was divided into two parts by electric fences in the ratio 2:1 to give daily herbage allowances of 6% (medium) and 12% (high) of LW on a DM basis. The four replicate paddocks of each species were grazed for periods of 7 days, in sequence, from May to June 1992. The average instantaneous stocking rates were 90 and 45 ewes ha^{-1} for medium and high allowances respectively.

A total of 48 adult Romney ewes in mid-pregnancy (mean weight 64 ± 7.2 SD kg) were used, 24 in the first two periods and 24 in the second two periods of the experiment. The ewes were randomised amongst treatments in groups of six according to fasted liveweight, and grazed spare plots one week before measurements commenced.

Herbage mass was estimated by cutting six 0.1 m^2 quadrats to ground level with an electric shearing handpiece in each plot before grazing. Fresh sub-samples were bulked within each replicate and dissected into categories for morphology (leaves, stem, live and dead tissue) and species, then dried and weighed. Sward surface height (SSH) was measured using a sward stick (Barthram, 1986), with 40 random measurements per plot. The vertical distribution of plant tissue within the sward canopy was measured using an inclined point quadrat (Warren Wilson, 1963) set at 32.5° to the horizontal; 100 contacts were recorded in each plot, and identified for species, morphology (leaf, stem, petiole) and state (live and dead).

Initial and final liveweights were recorded for each set of ewes. Faecal output was estimated for all animals using intraruminal controlled release capsules of chromium sesquioxide (CRC; Captec (NZ) Limited, Auckland), according to procedures described by Parker *et al.* (1989). There were two consecutive 5-day periods of faecal sampling in each half of the experiment. The chromic oxide release rates were determined from capsules recovered from 12 ewes (3 per treatment) slaughtered at the end of the trial.

Two pairs of castrated male sheep fistulated at the oesophagus were rotated between sward type and allowance plots on a daily basis to provide one extrusa sample from each animal from each plot. The extrusa samples were stored at

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-20°C before division into two portions. On one portion, the proportions of grass and white clover in the total diet were assessed by suspending a sample in water in a gridded tray and identifying plant material at grid intersections. The other portion was freeze-dried and ground (1 mm diameter sieve) and then analysed for *in vitro* digestibility on individual samples (Roughan & Holland, 1970), and condensed tannins (CT) on samples bulked within periods (Terrill *et al.*, 1992b).

Herbage organic matter intake was estimated as specified by Parker *et al.* (1992) using the above estimates of faecal output and diet digestibility.

One 24 hour grazing behaviour study was carried out in each of the last two grazing periods. Grazing, ruminating or resting activity was manually recorded for each ewe at intervals of 15 minutes. Rate of biting (bites/minute) was obtained using a 20-bites technique (Jamieson & Hodgson, 1979) recorded by stop-watch during grazing periods at dawn, mid-morning, early afternoon and dusk. The weight of herbage in individual bites was determined by counting the number of bites taken by OF sheep during the collection of extrusa samples (Stobbs, 1973).

The pasture and animal data were analysed using the statistical package SAS (SAS Institute Inc., 1985), based on a split-plot design with 4 blocks, taking pasture type as the main plot and grazing allowance as the split-plot factor. Liveweight gains were adjusted by covariance for initial weight.

RESULTS

Interactions between sward type and grazing allowance were not significant for any sward or animal variable, so results are presented as main effects only.

Sward measurements

There were no significant differences in herbage mass or height between sward types before grazing (Table 1).

Proportions of dead material, and of sown grass and clover in the live component, were similar for the two swards (Table 1). In each case the sward was grass-dominant, and the clover was distributed towards the base (Hu, 1993).

TABLE 1: Herbage mass (kg DM/ha), sward height (cm) and species composition (% of DM) of perennial ryegrass and Yorkshire fog swards.

	Sward	
	Perennial ryegrass	Yorkshire fog
Herbage mass (kg DM/ha)	2250 ± 119	2880 ± 119
Sward height (cm)	13.4 ± 0.42	13.0 ± 0.42
Proportion (% total contacts) of:		
Live material	91 ± 1.8	88 ± 1.1
Proportion (% live contacts) of:		
Sown grass	81 ± 3.5	76 ± 2.2
Other grasses	5 ± 0.9	12 ± 1.2
White clover	14 ± 2.5	12 ± 1.4

Animal measurements

Grasses were the main constituents of the diet selected on all treatments, and there were no significant differences in the relative proportions of grasses to white clover selected between swards and allowances (Table 2). Proportions of dead tissue in the extrusa were negligible.

TABLE 2: Botanical and chemical composition of the diet selected from perennial ryegrass and Yorkshire fog swards.

	Sward type			Herbage allowance		
	Perennial ryegrass	Yorkshire fog	SEM	6%	12%	SEM
Proportion (% contacts) of:						
Grass	98.7	98.3	0.32	98.7	98.2	0.33
Clover	1.3	1.7	0.32	1.3	1.8	0.33
OM digestibility (%)	85.7	82.2	0.3*	83.6	84.3	0.1
Concentration (% DM) of:						
Free tannin	.068	.072	.003			
Protein-bound tannin	.135	.148	.001*			
Fibre-bound tannin	.004	.028	.005			
Total condensed tannin	.208	.248	.009			

The concentration of protein-bound CT was consistently higher in extrusa from the Yorkshire fog sward, whereas concentrations of fibre-bound CT and free CT in samples from both swards were variable. All concentrations were relatively low, and close to the lower limits of estimation (Terrill *et al.*, 1992).

There was no significant difference in the release rate of chromic oxide (Cr_2O_3) amongst treatments, therefore a common Cr_2O_3 release rate of 122 mg Cr_2O_3 day^{-1} was used. Organic matter digestibility (OMD) of the diet selected was 4 units higher for ryegrass swards than for Yorkshire fog swards (Table 2), but there was no significant difference between allowances. OM intakes were 28% greater for ryegrass swards than for Yorkshire fog swards and 19% greater for high allowance than for medium allowance (Table 3).

The mean bite weight on Yorkshire fog swards was significantly higher (61%) than on the ryegrass swards (Table 3). On average, the recovery rate of oesophageal boluses for

TABLE 3: Herbage intake, ingestive behaviour and live weight gain of sheep grazing perennial ryegrass and Yorkshire fog swards at medium (6% LW) and high (12% LW) herbage allowance.

	Sward type			Herbage allowance		
	Perennial ryegrass	Yorkshire fog	SEM	6%	12%	SEM
Bite weight (mg OM)	86	139	7.0*	90	130	7.0*
Bite rate (bites/min)	53	48	2.2	52	48	2.5
Grazing time (mins)	612	501	34	618	496	27
Daily herbage intake (g OM/ewe)	1410	1100	29**	1150	1370	50.1*
Live weight gain (g/day)	168	111	18.8	120	159	23.5

both swards was 89%. Rates of biting did not differ between swards. Grazing time was 22% greater on ryegrass swards than on Yorkshire fog swards, but the difference was not significant. Reduction in herbage allowance from 12% to 6% depressed mean bite weight by 30%, but did not affect rate of biting. Grazing time tended to be higher at medium than at high grazing allowance.

Liveweight gain was 34% ($P < 0.08$) greater on ryegrass swards than on Yorkshire fog swards, and 25% higher (NS) at high allowance than at medium allowance.

DISCUSSION

Comparative studies of herbage intake and sheep performance between perennial ryegrass and Yorkshire fog swards appear to be limited to the earlier experiments of Watkin *et al.* (1974) and to the recent trial published by Morton *et al.* (1992). There is no information comparing these swards in terms of sward structure, diet selection, and ingestive behaviour.

The sheep concentrated grass in the diet to a similar extent on both swards (Tables 1 and 2), reflecting the distribution of clover foliage towards the base of the canopy in both cases (Hu, 1993). The concentration of white clover in the diet selected was only marginally higher at high allowance, despite greater opportunity for selection.

The vertical distribution of the sward components in both canopies was similar to the results reported by Bootsma *et al.* (1990) and L'Huillier *et al.* (1986) in autumn swards, where the greater grazing intensity was confined to the surface horizons mainly consisting of green leaf. Leaf and pseudostem components could not be distinguished in extrusa samples, but visual appraisal suggested that green leaf was the main component of the diet selected.

The *in vitro* digestibility of the diet was not affected by grazing allowance and only to a limited extent by sward species. The significantly lower OMD of extrusa samples taken from Yorkshire fog swards compared to ryegrass swards is in accord with the results of Morton *et al.* (1992), but in contrast to the published evidence of Watt (1987) and Harvey *et al.* (1984) who found no differences in OMD between Yorkshire fog and perennial ryegrass. However, in these experiments pasture samples were taken by sward cutting techniques.

Terrill *et al.* (1992a,b) found that both Yorkshire fog and perennial ryegrass contain trace amounts of CT, the CT values being slightly higher for Yorkshire fog, especially for the CT fraction bound to protein. The results of this experiment confirm these findings. It is unlikely that CT had any influence on animal performance in the conditions of the present experiment because of the low CT concentration in the diet (Table 2), as well as the low bypass-protein requirements of the experimental ewes which were in mid-gestation. There was no indication that the small differences in tannin content influenced discrimination between the grass and legume components of the two swards.

The herbage intake (kg OM ewe^{-1} day-1) and liveweight gain (g ewe^{-1} day^{-1}) achieved were similar to those suggested by Geenty and Rattray (1987) for grazing ewes in mid-pregnancy under New Zealand pasture conditions.

Bite weight was greater from *Holcus* than from ryegrass swards (Table 3). This effect may reflect the greater bulk density of herbage in *Holcus* swards (Hu, 1993) and, taken with the information on diet composition, indicates no particular behavioural constraints on the intake of *Holcus*. In contrast, daily herbage intake was greater from ryegrass than from *Holcus* swards at both allowances (Table 3). To our knowledge, this is the first reported case of an inverse relationship between the two variables. Evidence from the behaviour studies clearly indicates that the advantage to *Holcus* in terms of bite weight was offset by lower bite rate and grazing time. These factors do not explain the inverse relationship between bite weight and daily intake in strict quantitative terms, and there is clearly a need for more detailed work on the components of ingestive behaviour. However, the above contrasts are supported by evidence from a later trial at this laboratory (Montossi, unpublished data).

Reducing the daily herbage allowance from 12 to 6% of LW depressed daily herbage intake by 16%. This decline appears to be related principally to reductions in bite weight. Grazing time increased with declining herbage allowance, though the effect was not completely compensatory, while rate of biting was similar in both allowances. Similar effects of variations in herbage allowance on ingestive behaviour variables have been reported (Hodgson, 1985; Poppi *et al.*, 1987), though intake responses have not usually been observed to such high levels of allowance. Differences between treatments in herbage intake were reflected in differences in weight gain. However, levels of variation were high relative to the low weight increments of the ewes.

CONCLUSIONS

Evidence from this trial confirms the limited concentrations of condensed tannins in Yorkshire fog, and provides further evidence that low concentrations exist in perennial ryegrass. There was no evidence of differences in the degree of discrimination between the grass and legume components in the two swards.

Levels of herbage intake per sheep were substantially lower for Yorkshire fog than for perennial ryegrass swards. Though not conclusive, the evidence suggests that the most important limits were nutritional rather than behavioural in origin, and reflected differences in diet digestibility rather than in bite weight. This evidence requires substantiation for animals with higher growth potential and nutrient demand, and over an expanded range of growing seasons.

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