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Effects of selection for shear strength on the voluntary intake and digestion of perennial ryegrass fed to sheep

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ABSTRACT

The effects of selecting for reduced leaf shear strength in perennial ryegrass on voluntary intake, digestibility and rumen outflow in sheep were studied.

Two perennial ryegrass cultivars, selected on the basis of leaf shear strength (LS and HS) were fed to Romney wethers in May and October 1988 indoors for 2 weeks to measure voluntary intakes. Higher daily intakes of LS than HS (102 gDM/kg^{0.75} v 86 gDM/kg^{0.75}) were recorded in October, but no significant differences were observed in May, apparently as a result of high amounts of dead matter in the herbage.

Eight rumen fistulated wethers were fed either LS or HS cultivars in May. Cr-EDTA-Ru-phenanthroline marker solution was infused for 6 days to measure rumen outflow and total faecal collection was made for digestibility determination in May. Total faecal collection was also made in October following the measurement of voluntary intake. In both experimental periods eating behaviour was also recorded.

Low digestibilities were observed in May with no significant differences between LS and HS (65% v 67%), but in October higher digestibility of HS than LS was observed (76% v 73%), and also longer rumination times for sheep fed HS than LS were recorded in October (542 min/kgDM/day v 426 min/kgDM/day). The rate of DM disappearance of herbage containing low amount of dead matter (8%) when suspended in the rumen of cows, was significantly greater for LS than HS. Further investigations with good quality pasture with low dead matter are suggested.

Keywords Shear strength; intake; digestibility; retention time; ryegrass; sheep;

INTRODUCTION

Prolonged retention of digesta in the rumen of forage-fed animals can reduce voluntary intake and feeding value (Thornton and Minson, 1973). Black *et al.* (1982) using computer simulations suggested that slow degradation and rumen outflow rates were principal factors causing long rumen retention times and reduced voluntary intakes in sheep fed perennial ryegrass. Rumen retention times are likely to be influenced by the rates of particle size reduction through chewing and rumination (Ulyatt *et al.*, 1986).

The hypothesis to be tested in the present investigation was whether perennial ryegrass selected for reduced leaf shear strength would be rapidly degraded by chewing and rumination, so that rumen retention times would be reduced, thereby increasing voluntary feed intake and animal growth rates.

To examine this, trials were conducted to

measure the voluntary intakes and parameters of rumen digestion of sheep fed perennial ryegrass selected for either low (LS) or high (HS) leaf shear strength (Mackinnon *et al.*, 1988).

MATERIALS AND METHODS

Perennial Ryegrass Selections

LS and HS perennial ryegrass cultivars were selected from a population of "Grasslands Nui" using leaf shear strength as a criterion by the Grassland Division, DSIR (Easton, 1989). Each cultivar was sown into a separate half of a 0.25 ha paddock located at DSIR, Palmerston North.

Voluntary Intake

Two trials were conducted to measure the voluntary intake of lambs housed in metabolism

crates and offered freshly-cut LS or HS ryegrass to appetite.

In May 1988, 10 Romney wethers (mean body weight 36.0 ± 2.1 kg) were randomly allocated to either the LS or HS treatment. Following a 7-day adjustment period, voluntary intakes were measured for a 7-day period after which the lambs were crossed over to the other treatment for a further 4-day adjustment and 7-day measurement period. On the last 5 days of each measurement period, 4 lambs were selected and eating behaviour was recorded over a 24-hour period using jaw harnesses.

In October 1988, during a 12-day preliminary feeding period, 16 Romney wethers were offered freshly-cut mixed ryegrass/white clover herbage to appetite and voluntary intakes were measured. The selected 12 lambs were allocated to either the LS or HS treatment according to body weight (mean body weight 35.1 ± 2.9 kg) and voluntary intakes measured over a 14-day period. The monitoring of eating behaviour was also made for 4 lambs in the same manner described above.

Digestibility

In May 1988, 8 rumen fistulated Romney wethers (mean body weight 71.0 ± 5.1 kg) were randomly allocated to either the LS or HS treatment and fed freshly-cut herbage at a daily rate of 50 gDM/kg^{0.75} using continuous hourly feeders. This level approximated to 90% of their *ad libitum* intake measured during a 6-day preliminary period. Total faecal collections were made in the last 6 days of a 10-day feeding period using faecal bags. The animals were then crossed over to the other treatment and the procedure repeated.

In October 1988, following the measurement of voluntary intake, the lambs were fitted with faecal bags and a total collection made over 9 days.

Rumen Retention Times

On May 1988 during the last 6 days of the feeding periods, the fistulated wethers were infused into the rumen with a Cr-EDTA-ruthenium-phenanthroline dual marker solution at a mean daily rate of 537 mg and

13 mg/kgDM intake for Cr and Ru respectively (Binnerts *et al.*, 1968; Tan *et al.*, 1971). At the end of each period, rumen contents were totally removed, weighed, samples taken for DM and marker analyses, and contents returned. Rumen mean retention times (MRT) of chromium and ruthenium were calculated by the continuous infusion and total emptying procedure (Faichney, 1975).

Dry Matter Disappearance Rates

After the May 1988 trials, 4 rumen fistulated wethers were allocated to either LS or HS treatment. One kg of freshly-cut regrowth herbage containing approximately 8% dead matter was offered to each wether after rumen emptying. The animals were allowed to eat for approximately 40 minutes when virtually all the herbage had been consumed. Ingesta were then recovered from the rumen before being regurgitated and placed in polyester bags which were suspended in the rumens of 3 cows fed freshly-cut mixed pasture (8 kgDM/day in hourly aliquots). The bags were removed from the rumen after 3,6,12,19,24 and 36 hours.

Analyses

Leaf shear strength measurements were made at a point midway along the length of live leaves with groups of 10 leaves obtained from herbage offered using the Instron Food Testing Instrument Model 1140 (Instron Ltd) attached with Warner Bratzler Meat Shear Compression Type (2830-013) (Instron Ltd., 1973).

Proportions of dead matter in the herbage offered were determined by dissection.

Dry matter concentrations were determined on samples of herbage offered, refused and placed in the polyester bags, faeces and rumen digesta.

Chromium and ruthenium concentrations in rumen digesta were determined by XRF spectrometry (Evans *et al.*, 1977).

RESULTS AND DISCUSSION

Table 1 shows the mean leaf shear strengths and

TABLE 1 Shear strengths and proportions of dead matter in LS and HS perennial ryegrass cultivars.

	LS	May HS	SEM	LS	October HS	SEM
Shear strength (newton/leaf)	7	11***	± 0.6	9	13***	± 0.4
Dead matter (% DM)	24.9	20.0	-	Trace	Trace	

proportions of dead matter contained in the herbage offered during the voluntary intake and digestibility trials of May and October.

The leaf shear strengths were significantly lower for LS herbage in both periods. In May, both herbages contained a substantial proportion of dead matter (20-25%) whereas in October, only trace amounts existed.

Table 2 shows the mean voluntary intakes, digestibilities and eating and ruminating times for LS and HS herbage fed to sheep.

In May, DM intakes were relatively low and no significant differences existed between the LS and HS treatments. However, in October, the DM intakes were higher than in May and significantly greater for lambs fed LS compared with HS.

DM digestibilities were lower in May than in October. In May, no significant differences were observed between treatments but in October, the digestibility of HS was significantly higher than that of LS. This may be related to the greater intakes of DM recorded for the LS and also to the longer rumination times for HS, although no significant differences in times for eating between LS and HS were observed. There were no significant differences in eating behaviour in May. Mean rumen retention times were calculated for

the particulate and liquid phases using the concentration of Ru and Cr markers respectively. These measurements were only made in May and no significant differences occurred between treatments (particulate phase 16.8 h and 16.3 h (SEM ± 0.8); liquid phase 9.2 h and 8.7 h (SEM ± 0.3) for LS and HS, respectively). MacKinnon *et al.* (1988) have suggested that selection of LS plants may increase the rate of breakdown during chewing and therefore reduce rumen retention times and increase voluntary intakes. The fact that this was not observed in the May trials may be related to the low digestibilities and high proportion of dead matter in the herbage. It would, therefore, be desirable to repeat these measurements with herbage of higher nutritive value.

Figure 1 shows the cumulative disappearance of DM during microbial digestion of forage which had been chewed during eating only.

The rate of DM digestion was greater for LS than HS at 6, 12, 19 and 24 hours. After 36 hours of digestion, the difference between treatments was no longer apparent. This would lend support to the hypothesis that with herbages containing relatively low proportions of dead matter (8%), a reduction in leaf shear strength will increase rates

TABLE 2 Voluntary dry matter intakes, dry matter digestibilities and eating behaviours of sheep fed LS and HS perennial ryegrass cultivars.

	LS	May HS	SEM	LS	October HS	SEM
DM intake (g/kg0.75/d)	65	67	± 2.5	102	86***	± 3.0
DM digestibility (%)	65.9	66.9	± 0.5	73.0	76.4*	± 0.5
Eating behaviour						
Eating (min/kgDM/d)	330	351	± 27.8	259	225	± 11.1
Ruminating (min/kgDM/d)	471	468	± 61.9	426	542**	± 14.8

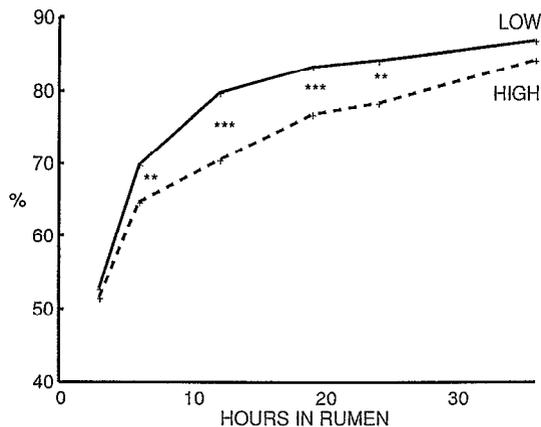


FIG. 1 Cumulative dry matter disappearance (%) of LS and HS perennial ryegrass suspended in polyester bags in the rumen of pasture-fed cows.

of breakdown in the rumen, which may lead to reduced retention times.

John *et al.* (1989) found that shear strength of HS forage residue was about 60% greater than LS during microbial digestion. The faster rate of DM digestion and lower shear strength of LS selection would enhance clearance of rumen digesta and thus contribute to higher feed intakes.

CONCLUSIONS

These results indicate that perennial ryegrass selected for low leaf shear strength was consumed in greater quantities and was digested more rapidly in the rumen than perennial ryegrass selected for high leaf shear strength. However, these differences were only observed when the herbage contained low proportions of dead matter. Preliminary studies also indicate increased liveweight gains are possible for lambs grazing LS compared with HS ryegrasses.

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