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Intake and duodenal protein flow in early weaned lambs grazing white clover, lucerne, ryegrass and prairie grass

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ABSTRACT

Protein (NAN) flow to the small intestine was measured in early-weaned ram lambs grazing pure swards of white clover (W), lucerne (L), ryegrass (R) and prairie grass (P) at high allowances.

Lambs were weaned at 6 weeks of age and measurements made at 8 and 12 weeks of age. Live-weight gain (LWG) measured over 6 weeks after weaning was higher for lambs grazing on legumes (308 ± 25, 321 ± 18 for L and W) than on grasses (230 ± 8, 227 ± 9 for P and R).

No differences were observed within species in duodenal NAN flow between measurements made at 8 and 12 weeks of age. Duodenal NAN flow (g NAN/kg LW/d) was significantly higher for legumes (1.24 ± 0.11, 1.20 ± 0.09 for L and W) than for grasses (0.87 ± 0.006, 0.96 ± 0.06 for P and R). Duodenal NAN flow, expressed as g NAN/kg DOMI, showed a similar pattern (44.9 ± 2.1, 45.0 ± 1.3, 42.8 ± 2.2, 39.3 ± 2.2 respectively for L, W, P and R) though differences between species were lower than when expressed /kg LW.

The rumen retention time (h) of a dry matter marker (^{103}Ru-P) was lower for legumes (8.4 ± 0.43, 9.5 ± 0.74 for L and W) than for grasses (11.5 ± 0.73, 15.1 ± 0.98 for P and R).

Intake (g OM/kg LW/d) was 30% higher for legumes than for grasses.

It was concluded that the higher LWG observed in lambs grazing legumes was associated more with a higher organic matter intake than with an increase in the duodenal NAN/DOMI ratio.

Keywords Sheep; early-weaning; grazing intake; duodenal protein flow; pure pasture species.

INTRODUCTION

Growth rates of lambs at pasture tend to fall below those of 350 to 400 g/day recorded indoors (Fraser and Orskov, 1974; Orskov *et al.*, 1976) although legumes have the ability to promote growth rates in excess of 300 g/d (McLean *et al.*, 1965; Ulyatt, 1971).

Lambs do not obtain sufficient nutrients from pasture to realise their genetic potential for growth and protein supply to the small intestine has been implicated as a major factor (MacRae and Ulyatt, 1974; MacRae, 1976; Barry, 1981).

Limited data are available for protein supply to the small intestine in ruminants offered fresh herbage indoors (MacRae and Ulyatt, 1974; Ulyatt and Egan, 1979; Beever *et al.*, 1980) and grazing (Corbett and Pickering, 1979; Corbett *et al.*, 1982; Ulyatt *et al.*, 1980; Losada *et al.*, 1982). No data appear to exist on protein flow to the small intestine in early-weaned lambs, either offered herbage indoors or grazing fresh herbage.

The experiment described here quantifies the intake and non ammonia nitrogen (NAN) flow at the duodenum in early-weaned lambs grazing pure pasture swards of Huia white clover (*Trifolium repens*), Rere lucerne (*Medicago sativa*), Matua prairie grass (*Bromus catharticus*) and Ruanui ryegrass (*Lolium perenne*) at high allowances.

MATERIALS AND METHODS

Pasture

White clover (W), lucerne (L), ryegrass (R) and prairie grass (P) were maintained as pure species pasture. The pastures were strip-grazed on 2 day shifts. The herbage mass (kg DM/ha) at 8 and 12 weeks respectively was 2790 and 3230, L; 2460 and 2020, W; 1900 and 1740, R and 1660 and 1965, P. Actual DM allowances (kg DM/lamb/d) at 8 and 12 weeks respectively were 5.4 and 5.1, L; 4.1 and 4.7, W; 6.8 and 6.1, R; 6.2 and 6.0, P.

Animals

For each pasture species 22 South Suffolk x Coopworth ram lambs were weaned at 6 weeks of age and grazed the pasture for 6 weeks. A duodenal cannula had previously been inserted into 6 of these lambs at 5 to 5½ weeks of age. A further 6 lambs, of similar age, fistulated in the oesophagus, grazed the pastures to obtain samples of herbage selected by the lambs.

Measurements

Intake and digesta flow were measured when lambs were 8 and 12 weeks of age.

Digesta markers (10 μCi ^{103}Ru-P and 50 μCi ^{51}Cr-EDTA in 150 ml water) were continuously infused into the rumen by portable peristaltic pumps (Everest Electronics, Seaford, South Australia) via a temporary rumen catheter.

Samples of duodenal digesta and faeces were collected over the last 4 days of infusion on 8 separate occasions, staggered to represent 3-hourly intervals over a theoretical 24 hour day. After the cessation of infusion at approximately 1000 h, the rumen retention time of ^{103}Ru-P and ^{51}Cr-EDTA was calculated from the rate of decrease of marker concentration in whole duodenal digesta and faeces respectively.

Intake

Faecal output was calculated from the dilution of ^{103}Ru-P in the faeces. The *in vivo* DM digestibility was estimated from the concentrations of indigestible acid detergent fibre in oesophageal extrusa and faeces (Penning and Johnson, 1983). Organic matter intake (OMI) was calculated as:—

OMI = Faecal OM output/(1 – OM digestibility)

Digesta Flow

Whole duodenal digesta and filtrate (strained through pantyhose) were bulked and concentrations of ^{103}Ru-P, ^{51}Cr-EDTA, OM, total N and NH_3 measured. Digesta flow was calculated using the double marker technique of Faichney (1975).

RESULTS AND DISCUSSION

As no differences were observed between 8 and 12 weeks of age in intake (g OMI/kg live weight (LW)) or duodenal NAN flow (g NAN/kg LW or g NAN/kg DOMI), results have been grouped within pasture species.

Live-weight gain was 321 ± 18, 308 ± 25, 230 ± 8 and 227 ± 9 for lambs grazing white clover, lucerne, prairie grass and ryegrass respectively. These values agree with those reported by McLean *et al.* (1965) but are considerably less than the 360 to 409 g/d reported by Fraser and Orskov (1974) for lambs of a similar age consuming a barley-fishmeal diet.

The reasons for the higher growth rate on legumes appear to be related to the higher DOMI (21 to 53%) and NAN flow (g/kg LW) to the small intestine (25 to 43%) (Table 1). Lambs grazing legumes had higher duodenal NAN flow/kg DOMI but this was not statistically significant ($P>0.05$).

Previous studies on digestion of fresh herbage have used much older lambs and adult sheep or cattle and this appears to be the first study in which these digestion characteristics have been determined in early weaned lambs in a grazing situation with realistic animal production data. No data appear to have been published for prairie grass.

In comparison to previously published reports the duodenal flow of NAN (g/kg LW) was higher than those observed in sheep grazing lucerne (Corbett *et al.*, 1982) and in cattle grazing ryegrass and white clover (Losada *et al.*, 1982) (Table 1). This appeared to be largely due to the high OMI (g/kg LW) achieved, as the duodenal flow of NAN (g/kg DOMI) observed was similar in all studies.

The differences in growth rate, therefore, appeared to be associated more with a difference in DOMI than with differences in protein:energy ratio of absorbed nutrients.

The OM digestibility at 8 and 12 weeks respectively was 0.87 and 0.84, L; 0.84 and 0.83, W; 0.82 and 0.83, R; 0.85 and 0.77, P. With the exception of prairie grass at 12 weeks these values are 1 to 9 percentage units higher than previously published data for grazed herbage estimated from *in-vitro in-vivo* relationships (Geenty and Sykes, 1982;

TABLE 1 Intake (g/kg LW/d) of organic matter (OMI), digestible organic matter (DOMI) and nitrogen (NI) and duodenal NAN flow in grazing ruminants.

	OMI	DOMI	NI	Duodenal NAN flow (g/kg LW/d)	Duodenal NAN flow (g/kg DOMI)
This experiment					
Lucerne	36.5 ± 1.7[a]	31.2 ± 1.6[a]	2.15 ± 0.11[a]	1.24 ± 0.11[a]	44.9 ± 2.1[a]
White clover	33.4 ± 1.1[a]	27.9 ± 1.1[a]	1.69 ± 0.15[b]	1.20 ± 0.09[a]	45.0 ± 2.3[a]
Ryegrass	28.8 ± 1.8[b]	23.1 ± 1.3[b]	1.24 ± 0.05[c]	0.96 ± 0.06[b]	39.2 ± 2.2[a]
Prairie grass	25.1 ± 1.6[b]	20.4 ± 1.4[b]	0.90 ± 0.07[d]	0.87 ± 0.07[b]	42.8 ± 1.7[a]
Other experiments					
Ryegrass[1]	—	Approx. 13-18	—	0.47-0.68	27-41
White clover[2]	—	Approx. 18-23	—	0.74-0.81	29-43
Lucerne[2]	22-30	15-22	0.86-1.41	0.59-1.11	32-56

[1]Losada *et al.* (1982) grazing cattle
[2]Corbett and Pickering (1979), Corbett *et al.*, (1982) grazing sheep

Corbett *et al.*, 1982; Hughes *et al.*, 1984) and may reflect the generally high pasture quality and potential for diet selection in the present study. They may also reflect a difference between the *in-vitro* and the indigestible ADF techniques in the estimation of the *in-vivo* digestibility of high quality ingesta.

The higher OMI and duodenal NAN flows were associated with very low values for marker retention time in the rumen (Table 2). These values are much lower than those observed in animals offered dried forage by Egan and Doyle (1982) (13.9 to 17.1 h) and Margan *et al.* (1982) (16.2 to 24.3 h) and highlight the need to examine critically the extension of data from animals offered dried forage indoors to grazing animals.

TABLE 2 Retention time (h) of markers in the rumen of lambs grazing white clover (W), lucerne (L), prairie grass (P) and ryegrass (R).

	W	L	P	R
Ru-P	9.6 ± 0.74^{ab}	8.5 ± 0.43^{a}	11.5 ± 0.73^{b}	15.1 ± 0.98^{c}
Cr-EDTA	7.7 ± 0.53^{a}	8.2 ± 0.75^{ab}	7.3 ± 0.41^{bc}	10.3 ± 0.47^{c}

The values may, however, reflect the age of the animal as they are similar to those of 10.8 to 14.5 h observed for early-weaned lambs offered clover hay (Cruickshank *et al.*, 1984). This also supports the concept of working with animals in the appropriate physiological state.

The practical significance of these results is the higher LWG achieved by animals on legume pasture and the lack of a difference in LWG between lucerne and white clover and between ryegrass and prairie grass. Based on the LWG achieved by animals consuming a barley/fishmeal diet, the animals grazing legume pastures did not appear to reach their genetic potential for growth.

It is concluded that the higher LWG observed on legume pastures was associated more with a higher DOMI than with the higher duodenal NAN/DOMI ratio.

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