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Diurnal patterns of rumen fill in grazing sheep

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ABSTRACT

The diurnal pattern of grazing and of rumen fill was studied to assess whether the initiation and cessation of eating were associated with any particular level of rumen fill.

Four wethers fitted with large rumen cannulae grazed Huia white clover or Matua prairie grass for 14 to 21 days. Animals grazed longer on the prairie grass than on the white clover (8.9 v 5.8 h). Major grazing periods were evident in the morning and afternoon, although the animals generally spent more of each hour in grazing during the afternoon.

Rumen fill (volume, wet weight and dry weight) showed diurnal patterns of change similar to the grazing pattern. The maximum level of rumen fill (9.5 and 7.0 g DM/kg live weight (W) on grass and clover respectively) was observed at the end of the afternoon grazing period and the minimum at 0900 h on the grass (5.2 g DM/kg W) and at 1300 h on the clover (3.9 g DM/kg W).

The implication of these results is that the intake of these roughages is less than that which is physically possible if the animal ate consistently to its maximum fill.

Keywords Sheep; white clover; prairie grass; wet weight; dry weight; rumen; volume.

INTRODUCTION

The major factor limiting animal production is the level of intake achieved. With roughage diets intake is thought to be controlled by the amount of digesta that can be accommodated in the rumen and the rate of its removal (Balch and Campling, 1962). Thus with animals within any physiological state rumen fill is relatively constant across a range of roughage diets and hence intake is proportional to the rate of digesta removal from the rumen (Ulyatt *et al.*, 1967; Thornton and Minson, 1973; Poppi *et al.*, 1981). However, animals on a legume diet have lower levels of rumen fill than those on a grass diet (Thornton and Minson, 1973).

This concept of a physical regulation of intake implies that animals experience satiety at a particular level of fill. However, Forbes (1980) has proposed that there is an interaction of physical and metabolic control mechanisms whereby the intake at a single meal need not necessarily cease at a particular level of rumen distension. This may partly explain why rumen fill increases in lactating animals (Hutton *et al.*, 1964).

In a study on intake regulation of grazing animals it is necessary to know the extent to which the level of rumen fill influences the initiation and cessation of grazing. Such data are also required in intake models incorporating both physical and metabolic control systems. In this study the relationship between grazing pattern and rumen fill was examined in wethers grazing white clover or prairie grass pastures.

MATERIALS AND METHODS

Four wethers (65 ± 1.8 kg) fitted with large rumen cannulae (85 mm) were set stocked on Matua prairie grass (*Bromus catharticus*, Grasslands Matua) or Huia white clover (*Trifolium repens*) swards for 14 to 21 days during March and April with sunrise and sunset approximately 0600 and 1900 h. The prairie grass sward had an average height of 9.4 cm with a range of 1.5 to 18 cm and a herbage mass of 2100 kg DM/ha. The white clover sward had an average height of 12.3 cm with a range of 4 to 18 cm and a herbage mass of 2400 kg DM/ha. Allowance was liberal at 10 and 11.5 kg DM/head/d for prairie grass and white clover swards respectively. Grazing pattern was established by using grazing clocks designed to measure the time the animal's head was in the down position. The sampling times were organised to coincide with the beginning and end of each major grazing period — 0100 h, 0500 h (start morning), 0900 h (end morning), 1300 h (start afternoon), 2100 h (end afternoon) and 1700 h on the grass sward only. In the case of the clover studies, sampling was carried out over one 24 h period. With the prairie grass studies each sampling time was replicated and only 2 rumen emptyings were carried out each day. Rumen emptying thus was extended over a 6 d period.

At each sampling the rumen was emptied via the rumen cannula and digesta stored in a water bath at 37 to 39°C. The wet weight and volume of digesta were recorded and 2 samples (approximately 50 g) were taken for dry matter determination. The

removal, sampling and return of digesta to the animal took approximately 10 min.

Each sheep was infused continuously with approximately 0.9 g ytterbium/d as YbCl₃. Grab samples of faeces were taken regularly, ytterbium analysed and faecal organic matter output calculated. Three oesophageal fistulated animals were used to obtain representative samples of the diet selected and *in-vitro* organic matter digestibility of the extrusa was determined. From the faecal output and *in-vitro* digestibility, organic matter intake was calculated.

RESULTS AND DISCUSSION

As these trials were done consecutively, it is not statistically valid to compare results from grass and legume swards. The average organic matter intake (OMI) achieved by the animals was 16.1 (± 0.81) and 14.6 (± 0.71) g/kg live weight (W) for grass and legume respectively, with organic matter digestibilities of 0.67 and 0.74. Thus DOMI was similar on grass and legume pastures (10.8 g/kg W) and supplied approximately 11 MJ metabolizable energy (Beever *et al.*, 1985). Calculated maintenance was 10.5 MJ metabolizable energy (MAFF 1975) and these animals subsequently reached live weights of approximately 80 kg. Thus intake appeared to be regulated metabolically to achieve a constant DOMI slightly in excess of calculated maintenance.

The grazing times of animals on these pastures were 8.9 (± 0.8) and 5.8 (± 0.8) h/d for grass and legume respectively which agrees with previous published reports (Lancashire and Keogh, 1966). The higher rate of intake of legume could be due in part to the easy accessibility of its green leaf for grazing (Hodgson, 1982). Of interest are the actual grazing times achieved as these are less than the potential grazing time available for animals which is assumed to be the maximum grazing time observed in sheep i.e. 12 to 13 h/d (Arnold and Dudzinski, 1981). If it is assumed that animals grazing both swards had a potential requirement in excess of that achieved then there appears to be no physical reason in terms of grazing time available why this could not have been achieved. However, the fact that a similar DOMI was achieved on both pastures suggests that the animals were regulating intake metabolically and in that case grazing time differences reflect differences in rate of intake.

There was a diurnal pattern of grazing (Fig. 1, 2) which differed slightly between animals on the grass and legume swards. Animals started grazing at approximately sunrise and stopped close to sunset with another grazing period around midnight or the early hours of the morning. Such a pattern has been observed previously but the daylight grazing has often been divided into a morning grazing and an afternoon grazing with a distinct break around

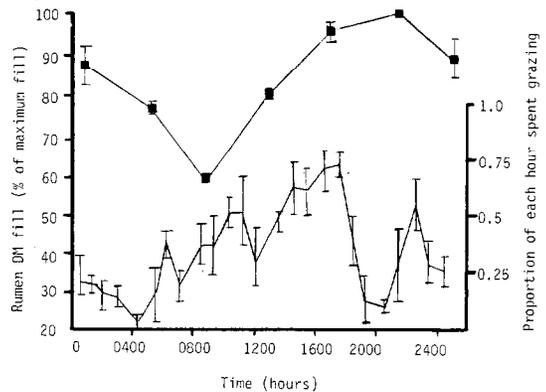


FIG. 1 The relationship between the proportion of each hour spent grazing (●) and the percentage of the maximum rumen dry matter fill (■) of wethers grazing prairie grass (SEM indicated by bars).

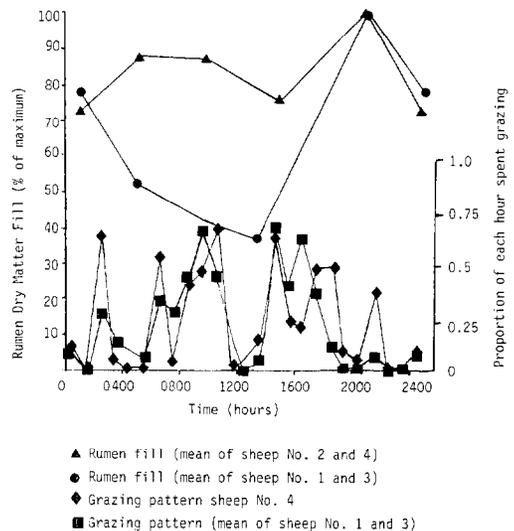


FIG. 2 The relationship between the percentage of the maximum dry matter fill in the rumen and the grazing pattern of wethers grazing white clover.

midday (Pearson *et al.*, 1951; Scott and Sutherland, 1981). Such a pattern occurred on the legume sward (Fig. 2) but not on the grass sward (Fig. 1). Most grazing was done during daylight hours (0.74 and 0.80 of total grazing time on grass and clover, respectively) and these proportions are similar to other reports (Hughes and Reid, 1951).

The intensity of grazing, defined as the proportion of each hour spent in grazing, does not appear to have been previously reported. Animals on the legume swards had a similar intensity of grazing over the morning and afternoon (0.3 to 0.6) but those on the grass sward had an increasing intensity of

grazing as the day progressed from 0500 h to the end of grazing at approximately 1800 h (Fig. 1, 2). The morning grazing on grass was characterised by an hourly proportion of time spent grazing being generally less than 0.5 while in the afternoon it was greater than 0.5. Eating patterns indoors were similar to that observed on grass (Forbes, 1980).

Changes in intensity of grazing must inevitably lead to changes in rate of intake over a grazing period. Rumen fill (dry matter content, wet digesta content and digesta volume) would be expected to alter accordingly and a diurnal pattern of rumen fill was observed (Table 1). The actual pattern (an increase during the day) was unexpected, given the concept of a morning and afternoon grazing but was closely associated with the pattern of intensity of grazing. Thus animals only reached a maximum rumen load at the cessation of the afternoon grazing and the rate of intake over the morning grazing was insufficient to markedly increase rumen fill. The changes in rumen fill were particularly consistent on grass but animals on the legume showed more variation. However, as the results for the legume sward were obtained during a single 24 h period they need further rigorous confirmation. The results are generally in agreement with values obtained from animals slaughtered at different times of the day (Ulyatt, 1971).

TABLE 1 Volume (ml/kg W), wet and dry weight of rumen digesta (g/kg W) in animals grazing prairie grass or white clover.

Time	0100	0500	0900	1300	1700	2100
Prairie grass						
Volume	97.62	90.22	74.15	88.99	108.97	102.13
SE	7.38	5.56	6.69	8.11	7.04	7.8
Wet weight	82.73	77.15	62.39	78.8	96.78	92.5
SE	5.75	5.19	5.78	6.52	5.94	6.34
Dry weight	8.36	7.43	5.14	7.47	9.02	9.48
SE	0.7	0.69	0.57	0.83	0.77	1.01
White clover						
Volume	79.41	75.77	87.23	71.13	-	96.36
SE	4.2	6.54	7.18	9.85	-	5.53
Wet weight	53.91	49.58	44.27	77.02	-	66.69
SE	7.92	6.3	7.36	7.31	-	6.44
Dry weight	5.34	4.70	4.21	3.88	-	6.99
SE	1.01	0.68	0.84	0.75	-	1.02

Animals grazing legume swards generally had lower rumen dry matter, wet weight and volume throughout the day when compared to those on grass which agrees with results from indoor trials (Thornton and Minson, 1973). The maximum dry matter content of 9.5 g/kg live weight on grass and 7.0 g/kg live weight on clover swards is much lower than that observed in sheep under indoor, steady-

state feeding conditions (21 g/kg W; Poppi *et al.*, 1981).

Grazing animals do not appear to regulate grazing pattern by reference to the level of rumen fill. The rumen appears to reach its maximum level of fill only at the end of the afternoon grazing. Examination of the proportion of grazing done in each hour indicates that there is considerable scope for increasing this over the morning grazing or in the midnight grazing period. The implications of such a pattern of rumen fill and grazing intensity is that physical limitation is unlikely to be the primary obstacle to increasing the intake of these forages. There may have been an apparent physical limitation against continuing the afternoon grazing on the grass as the rumen was very distended. These results suggest that simple models based on either physical or metabolic regulators of intake are not applicable to the grazing animal. Models such as that proposed by Forbes (1980) are required which incorporate physical and metabolic regulators, the relative importance of which may vary throughout the day.

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