

Herbage intake by Churra ewes grazing at two different sward heights

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ABSTRACT

Herbage intake and some characteristics of diet selected by grazing Churra ewes were studied on two plots of a *Lolium-Festuca-Trifolium* pasture maintained at two different sward heights (sward heights (SH): 4 cm (SSH) and 8 cm (HSH) in two periods (PE): summer and autumn. Herbage intake was estimated from measurements of faecal output and of digestibility of extrusa samples. With the exception of crude protein content, no significant ($P \geq 0.05$) effects of PE nor SH were detected in the chemical composition and digestibility of herbage on offer. Daily herbage intake (g OM/kg live weight) was greater ($P \leq 0.10$) on HSH than on SSH and was also greater ($P \leq 0.05$) in autumn than in summer. Significant effects of PE ($P \leq 0.01$) and SH ($P \leq 0.05$) were obtained in the selection ratios (calculated as the content of each considerable component in extrusa samples divided by its content in the herbage on offer) for all chemical fractions and for digestibility. Except for cellulose, interaction between main factors had a significant ($P \leq 0.001$) effect on the selection ratios.

KEY WORDS: sheep, pastures, grazing, intake

INTRODUCTION

Grazing behaviour of ruminants is complex. Forage intake and selectivity grazing are functions of numerous pasture and animal characteristics (Arnold, 1964; Cordova et al., 1978; Milne, 1991). Intake has been correlated with forage availability, sward height and nutritional quality (Hodgson, 1968; Allison, 1985; Minson, 1987). Such complexity has made prediction of forage intake and

animal performance of grazing ruminants very difficult. However, a knowledge of the intake of nutrients obtained by the animal from pasture is essential to establish whether nutritional requirements can be met and to assess the likely animal performance and levels of output.

Sheep production based on grazing systems could be an alternative to agricultural production on irrigated areas in Spain, in which agriculture has led to surplus production. The study of factors influencing grazing intake by the most important sheep breeds should be carried out to obtain the basic information necessary for developing grazing systems in Spanish irrigated areas. The Churra breed is the more important nucleus of milk-producing sheep in Spain. Nevertheless, at present, there are few data on intake of herbage by Churra sheep as affected by herbage availability. The aim of the current work was to study the effect of height of sward on herbage intake by grazing Churra ewes taking into account diet selection on an irrigated pasture.

MATERIAL AND METHODS

Pasture and treatments

The experiment was conducted on the Estación Agrícola Experimental (CSIC) in León (NW Spain) during 1989. The measurements were carried out on two paddocks, each of 0.1 ha, of a sward that had been sown with a mixture of *Lolium perenne*, *Festuca arundinacea* and *Trifolium repens* in 1985. The experimental paddocks had been grazed since 1986 from April to November.

The work was carried out according to two periods (PE) x two sward heights (SH) experimental design. The target sward heights were: 4 cm (short sward height – SSH) and 8 cm (high sward height – HSH) on each experimental plot.

Animals and management

Churra ewes among 3 and 5 years old were used in this work. Two balanced groups, of five animals each, were identified and designated "experiment sheep". Each experimental group was allocated to one of the two SH treatment plots. These animals remained grazing on their plot until the end of the experiment.

Throughout the experimental period, the requisite sward height was maintained by increasing or decreasing the number of animals on any plot whilst retaining the basic nucleus of experiment sheep within each plot.

Animal measurements

Animals were weighed a week before starting each herbage intake measurement period and the day after its end.

Herbage intake was estimated over 5-day periods in summer (3-7 July) and autumn (18-22 September) from measurements of faecal output and of digestibility of organic matter of herbage selected by grazing sheep. Faecal output of experimental sheep was determined by total collection using harnesses. Faecal bags were changed once daily at 9.30 h. The digestibility of herbage selected was estimated from samples collected on the first four days of each faeces collection period using six oesophageal fistulated sheep. One sample per day was obtained from each animal, with three animals sampled in the morning (9.30) and three in the evening (18.30), and alternating the time of collection in each paddock. Extrusa samples obtained from the same animal on each period were bulked for analytical determinations.

Sward measurements

Sward surface height was measured twice weekly using the Hill Farming Research Organisation sward stick (Barthram, 1986). Herbage height was recorded at 50 random locations per plot on each occasion. The herbage mass on offer was estimated twice during each herbage intake measurement period, by cutting four quadrates (30 x 30 cm) per paddock to ground level. Mean herbage mass in each treatment was calculated as the average of the two measurements, by scaling up to one ha.

Analytical determinations

Faeces, herbage and extrusa samples were dried in a forced air oven at 60°C to a constant weight. After drying, all samples were ground to pass a 1-mm screen. Ash content was determined using A.O.A.C. (1980) method. All data were expressed on an ash free (organic matter - OM) basis.

In vitro organic matter digestibility (IVD) was determined in herbage and extrusa samples by the technique of Tilley and Terry (1963). Herbage and extrusa samples were also analysed for nitrogen, neutral detergent fibre (NDF), cellulose (CEL) and permanganate lignin (LIG) contents. Nitrogen was determined by the Kjeldahl procedure (A.O.A.C., 1980). Samples were analysed for NDF, CEL and LIG according to Goering and Van Soest (1970).

Estimation of selection of diet

Selection exerted by the grazing animals was estimated using selection ratios, calculated according to Hodgson (1979) as the content of each considerable component in the diet (extrusa samples) divided by its content in the herbage on offer. Selection ratios were calculated for IVD, CP, NDF, CEL and LIG.

Statistical analysis

Data were subjected to variance analysis using Statgraphics (Statistical Graphics Corporation, 1986) with PE and SH in the statistical model. PE x SH interaction was also included in the model for herbage intake, diet characteristics and selection rate data.

RESULTS

Mean sward heights (cm) and herbage masses (kg OM/ha) are shown in Table 1. Small differences between actual and target sward heights were obtained in both periods, being the mean obtained in summer greater ($P \leq 0.001$) than the obtained in autumn. Herbage mass paralleled sward height values, although was not affected by PE.

Within each period (Table 1) difference ($P \leq 0.05$) in all the chemical fractions and IVD of herbage has been observed between both plots. On the other hand, in

TABLE 1
Sward height (cm), herbage mass (kg OM/ha and chemical composition (g/kg OM) in vitro organic matter digestibility (%) of herbage on offer as affected by period (PE) and sward height (SH)

	Summer		Autumn		SEM	PE	SH
	SSH	HSH	SSH	HSH			
Sward Height	3.8 ^a	8.8 ^b	3.4 ^a	7.4 ^b	0.16	*	***
Herbage mass	600 ^a	1247 ^c	657 ^a	1113 ^b	49.1	NS	**
Chemical composition							
Crude protein	174 ^{ab}	162 ^a	254 ^c	187 ^b	6.8	*	*
Neutral detergent fibre	699 ^c	585 ^b	500 ^a	602 ^b	24.6	NS	NS
Cellulose	280 ^c	259 ^b	208 ^a	259 ^b	8.5	NS	NS
Lignin	68 ^c	45 ^b	33 ^a	45 ^b	4.1	NS	NS
<i>In vitro organic matter digestibility</i>	65.6 ^a	76.7 ^c	76.8 ^c	70.6 ^b	2.01	NS	NS

SSH, HSH: Short sward height, high sward height. SEM: Pooled standard error of the mean. Values in the same row with different superscripts are significantly different ($P \leq 0.05$)

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TABLE 2
Organic matter intake (g/kg W/day) and chemical composition (g/kg OM) and *in vitro* organic matter digestibility (%) of the diet selected by sheep (extrusa) as affected by period (PE) and sward height (SH)

	Summer		Autumn		SEM	PE	SH	PE \times SH
	SSH	HSH	SSH	HSH				
Organic matter intake	13 ^a	22 ^b	21 ^b	31 ^c	1.69	*	NS	NS
Crude protein	203 ^a	201 ^a	297 ^b	283 ^b	2.55	***	NS	NS
Neutral detergent fibre	612 ^c	528 ^{ab}	506 ^a	539 ^b	3.78	**	***	***
Cellulose	263 ^d	230 ^c	183 ^a	207 ^b	1.92	***	*	***
Lignin	54 ^b	59 ^b	36 ^a	33 ^a	1.73	***	NS	NS
<i>In vitro</i> organic matter digestibility	70 ^a	77 ^c	80 ^c	84 ^d	0.33	***	***	NS

SSH, HSH: short sward height, high sward height. SEM: pooled standard error of the mean in the same row, values with different superscripts are significantly different ($P \leq 0.05$)

TABLE 3
Selection ratios for crude protein, neutral detergent fibre, cellulose, lignin and *in vitro* organic matter digestibility as affected by period (PE) and sward height (SH)

	Summer		Autumn		SEM	PE	SH	PE \times SH
	SSH	HSH	SSH	HSH				
Crude protein	1.21 ^a	1.24 ^a	1.17 ^a	1.52 ^b	0.015	***	***	***
Neutral detergent fibre	0.88 ^a	0.90 ^a	1.01 ^b	0.89 ^a	0.006	**	*	***
Cellulose	0.94 ^c	0.87 ^b	0.88 ^b	0.80 ^a	0.005	***	***	NS
Lignin	0.79 ^{ab}	1.32 ^c	1.08 ^{cb}	0.74 ^a	0.038	**	*	***
<i>In vitro</i> organic matter digestibility	1.07 ^b	1.00 ^a	1.04 ^b	1.19 ^c	0.046	***	*	***

SSH, HSH: short sward height, high sward height. SEM: pooled standard error of the mean in the same row, values with different superscripts are significantly different ($P \leq 0.05$)

the SSH herbage both all the chemical contents and IVD changed between summer and autumn, whereas in the herbage of the HSH plot no differences were detected in NDF, CEL and LIG contents. Only CP content of herbage was significantly affected ($P \leq 0.05$) by the main factors (PE and SH).

Daily herbage intakes relative to live weight (g OM/kg LW/day) are presented in Table 2. Herbage OM intake was greater ($P \leq 0.05$) in autumn than in summer and tended ($P \leq 0.10$) to be less in SHS than in HSH. The chemical composition (g/kg OM) of sheep diets (extrusa samples) is also displayed in Table 2. Both SH and PE as well as main factors interaction – with the exception of CEL – had a significant ($P \leq 0.001$) effect on selection ratios (Table 3).

DISCUSSION

Although only crude protein content of herbage on offer was affected by the sward height, other differences on chemical composition between SSH and HSH were also found within periods. In summer, differences in chemical composition and IVD herbage suggest that the nutritive quality of herbage was worse in SSH than in HSH, whereas in autumn herbage was poorer in HSH than in SSH. In SSH differences between summer and autumn could reflect better nutritive quality of herbage in autumn and could point out expected differences between mature herbage (summer) and leafy regrowth (autumn). However, the differences observed within HSH did not seem to be related to this type of change. The maintenance of sward heights during a period of declining herbage growth led to a reduction of grazing pressure in autumn. In accordance with Gibb and Baker (1989), relaxation of grazing pressure allowed the accumulation of more dead material on taller swards than on the shorter ones. Then, in HSH, the differences between summer and autumn in chemical composition and digestibility could reflect this fact.

The nutritive value of the diet varied with season. IVD and CP content were markedly greater in autumn than in summer. In the same way, both cell wall NDF and its fractions contents were less in autumn than in summer. Differences between seasons in these parameters were not so clear in the herbage on offer as in the diets. Then, as it could be expected (Jung et al., 1989; Newman et al., 1992), the nutritive value of the diet does not exactly parallel the nutritive value of the herbage on offer, because size of the differences between herbage and diet composition changed with period. In our work, the nutritive quality of diet selected seemed to be better than that of herbage on offer, but a greater increase was noted in autumn than in summer. This could suggest that, in this study, selection intensity was not as great in summer as it was in autumn. Likewise, selection ratios were nearer to 1 in summer than in autumn (see Table 3). Similar effects of season on selection ratios for IVD, CP, NDF and LIG have been obtained by Jung et al. (1989), who pointed to the degree of selectivity increasing during the grazing season.

Although SH had a significant effect in all the selectivity index, there were remarkable differences between summer and autumn. Whereas in autumn the selection ratios suggest a greater selection for a more nutritive diet in HSH than in SSH, the selection ratios obtained in the HSH in summer could point to a selection against NDF and CEL, a selection for CP and LIG, and no selection for IVD (see Table 3).

Generally, it has been observed that animals selected diets that are more digestible than the herbage as a whole (Fontenot and Blaser, 1965; Jung and Koong, 1985), however, our results agree with those obtained by Jung et al.

(1989), who also observed selectivity index greater than 1 for lignin and no selection for IVD in some of their experimental periods.

As expected, herbage organic matter intake was greater in HSH than in SSH. Several studies have shown that herbage intake by sheep grazing in temperate pastures is severely depressed when sward height falls under 4 cm (Allden and Whittaker, 1970; Penning, 1986; Orr et al., 1990). One of the main arguments that could be used to explain reduced intake where there is a low sward height is that the amount that can be taken with each bite is low (Stobbs, 1973; Penning, 1986; Orr et al., 1990). In a mechanistic explanation of reduced intake on short swards, the lower weight of each bite can partly be offset by the animal increasing the number of harvesting bites. However, there is an upper limit to the total number of bites that animals will take each day, and as a result, increasing the number of harvesting bites will not compensate for the reduced of each bite (Minson, 1987). On the other hand, as it was pointed out, selection ratios (see Table 3) seem to reflect a some degree of herbage selection. Such selection would lead to reduce the size of prehended bites and, as a consequence, herbage intake would be limited (Illius, 1986). Than, the very low herbage intake in SSH in summer could be explained by a situation of that kind.

Herbage organic matter intake was also affected by period (see Table 2), the mean values being greater in autumn than in summer. Differences between seasons in the quantity of herbage intake by grazing animals were also noted by several authors (Baker et al., 1980; Jung and Sahlu, 1989; Penning et al., 1991). Herbage intake increased as digestibility of herbage intake increased and this agrees with the results obtained by several workers (Hodgson, 1968; Hodgson et al, 1991). However, it should be noted that perhaps some changes in sward canopy structure between summer and autumn resulted in a more heterogeneous structure in autumn. Than, a greater selection in autumn could be a consequence of a selection for patches more easy harvested: a horizontal selection (Milne, 1991). In this case, selection could not be a limit to the size of bites as it could be in summer.

CONCLUSION

Although height of herbage affects both quantity and quality of herbage intake by Churra sheep, the complexity of factors affecting selective grazing made difficult to predict herbage intake from height and chemical composition of the herbage on offer.

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STRESZCZENIE

Pobranie zielonki przez owce Churra z pastwisk o dwóch różnych wysokościach porostu

Pobranie zielonki i charakterystykę wybranej przez owce Churra paszy badano na dwóch kwadrach pastwiska (*Lolium-Festuca-Trifolium*), przy dwóch różnych wysokościach porostu: niski (SSH) – 4 cm i wysoki (HSH) – 8 cm, oraz w dwóch sezonach (PE): letnim i jesiennym. Pobranie zielonki oznaczono na podstawie ilości wydalonego kału i strawności prób pobranych z przetokowanego przelyku owiec. Skład chemiczny i strawność pobieranych pasz nie różniły się istotnie ($P \geq 0.05$) w zależności od sezonu i wysokości porostu, z wyjątkiem zawartości białka ogólnego. Dzielne pobranie (g substancji organicznej na 1 kg masy ciała, w grupie HSH było nieco większe niż w grupie SSH ($P \leq 0.10$), a istotnie większe ($P \leq 0.05$) jesienią niż latem. Stwierdzono istotny wpływ sezonu ($P \leq 0.01$) i wysokości porostu ($P \leq 0.05$) w pobranej przez owce zielonce (obliczony jako zawartość każdej z roślin w próbach pobranych z przelyku, podzielona przez ich zawartość w oferowanym poroście) na skład chemiczny składników pokarmowych i ich strawność. Interakcja wysokości porostu x sezon była wysoce istotna dla wszystkich składników pokarmowych, z wyjątkiem celulozy.