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Dry matter intake and digestibility of temperate pastures supplemented with sorghum grain in wethers and heifers

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Abstract

The aim of this study was to evaluate the effect of sorghum grain supplementation on total and forage dry matter (DM) intake and digestibility of wethers and heifers consuming temperate pasture. Twenty four Corriedale x Milchschaf wethers and 24 crossbred heifers fed temperate pasture were non-supplemented or supplemented with sorghum grain at 5, 10 or 15 g/kg body weight (BW). Offered and refused feed were measured for 11 days and faeces voided were recorded daily during five days. Samples of feeds and faeces were collected daily and analyzed for DM. Supplement inclusion led to an inverse response in both species. Total dry matter intake (TDMI) of supplemented wethers was 20% lower than non-supplemented ones. Forage dry matter intake (FDMI) averaged 40% less in supplemented groups than in non-supplemented ones. Heifers receiving the supplement had 23% more TDMI but 10% less FDMI than non-supplemented, and lower FDMI was observed as supplementation increased. Dry matter digestibility (DMD) was 0.69 for wethers and 0.65 for heifers, with no differences between treatments. When the results from all animals were analyzed together, no differences on TDMI, lower FDMI and higher DMD were observed for the supplemented groups. In conclusion, sorghum grain supplementation affected TDMI differently in the two species, reducing TDMI in wethers and increasing TDMI in heifers. Supplementation reduced FDMI, the reduction being higher in wethers than in heifers. Dry matter digestibility of supplemented diets was higher, probably due to grain digestibility.

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Introduction

Temperate pastures are a good source of nutrients for ruminants. Dry matter (DM) and nitrogen fractions of these kinds of pastures are extensively degraded in the rumen (Hoffman *et al.*, 1993; Repetto *et al.*, 2005). However, low to medium energy concentration of this feed, in addition to high moisture and NDF levels affect DM intake (NRC, 2001), which may result in lower energy consumption.

One possible objective of grain supplementation on pasture based diets for ruminants is to improve DM and energy intake. When cereal grains are included on pasture based diets, interactions between feeds may occur. Generally, when the amount of supplement is increased, pasture DM intake is reduced and total DM intake increases (Walker *et al.*, 2001; Tozer *et al*., 2004; Molle *et al*., 2008).

Grains are almost always more digestible than pasture, and their inclusion on mixed diets may improve whole diet digestibility (Dixon & Stockdale, 1999; Kaur *et al.*, 2008). Animals consuming temperate pastures and supplemented with grains that contain readily ruminal fermentable carbohydrates, show an increase in nitrogen utilization efficiency (García *et al*., 2000), microbial incorporation of $N\text{-}NH_3$ (Owens *et al*., 1997; Bargo *et al.*, 2003) and efficiency of microbial protein synthesis (Van Vuuren *et al.*, 1993; Horadagoa *et al.*, 2008). However, grain supplementation can decrease ruminal pH (Cajarville *et al.*, 2006; Horadagoa *et al*., 2008), which could lead to a lower cellulolytic activity and fibre rumen digestibility (Van Soest, 1994). Therefore, reduction of forage fibre digestion caused by grain supplementation may determine a lower increment on whole diet digestibility than expected (Dixon & Stockdale, 1999).

The aim of this study was to evaluate the effect of sorghum grain supplementation on total and forage DM intake and digestibility of wethers and heifers consuming a fresh temperate pasture (*Lotus corniculatus*).

Materials and Methods

The experiment was conducted on the Experimental farm of the Veterinary Faculty of Uruguay, located in San José Department, Uruguay (34º South and 55º West). Twenty four Corriedale x Milchschaf wethers (45.6 ± 6.2 kg body weight (BW)) and 24 crossbred heifers (210.0 ± 42.5 kg BW) were blocked in four groups according to their BW, and within each group were randomly assigned to one of four treatments: non-supplemented (0 g/kg) or supplemented with sorghum grain at 5, 10 or 15 g/kg BW.

Animals were housed in metabolism cages and fed fresh temperate pasture (*Lotus corniculatus)* (317 DM g/kg, 930 g organic matter/kg DM, 126 g crude protein/kg DM, 416 g neutral detergent fibre (NDF)/kg DM) *ad libitum*, allowing 200 g/kg of orts, while ground sorghum grain was provided, individually and in two equal meals (08:00 and 20:00). After 21 days of adaptation, offered and refused feeds were measured for 11 days and faeces voided were recorded daily during the last five days. Samples of feeds and faeces were collected daily and stored at -18 ºC. At the end of the experimental period samples from each animal were dried at 60 °C. Dry matter was determined according to AOAC (1984).

Daily total DM intake (TDMI) and forage DM intake (FDMI) were determined by difference between DM feed supplied and refused. Dry matter digestibility (DMD) was determined for each animal as DM intake (g/day) minus faecal DM output (g/day) divided DM intake (g/day).

Total DM intake, FDMI and DMD were analyzed for heifers and wethers separately and for both together by GLM procedure, considering the block and species effect. Means were separated by orthogonal contrasts to compare different levels of supplementation (SAS, 2000). Significance was always declared at $P < 0.05$.

Results and Discussion

The concentrate represented a similar proportion of the diet for both species, without significant differences ($P = 0.54$). For non-supplemented wethers and those supplemented with 5, 10 and 15 g/kg BW, the concentrate represented 0, 137, 318 and 495 g/kg of diet DM, respectively. For heifers, concentrate represented 0, 120, 299 and 449 g/kg of diet DM, respectively.

The TDMI and FDMI of the wethers and heifers are presented in Table 1. The inclusion of the supplement led to an inverse response in the two species: wethers had a reduction in TDMI, while the TDMI of the heifers increased with the inclusion of the supplement in the diet. Therefore, when analyzing all animals together, the effect of supplementation vanished. This could indicate that, with similar diets, wethers and heifers presented different intake regulatory mechanisms.

The TDMI of supplemented wethers was 20% lower than that of non-supplemented ones ($P < 0.05$). This could be explained by an important reduction in FDMI in the supplemented groups, which averaged 40% less than non-supplemented ones. Increasing level of sorghum in supplemented groups reduced FDMI from 81.7 to 49.0 g/kg of $BW^{0.75}$ ($P < 0.01$), but did not affect TDMI ($P \geq 0.24$). The depressive effect observed after the inclusion of supplement in this study was not expected, and was different from those reported by other authors. Kaur *et al.* (2008) worked with different levels of concentrate in a mixed fresh ryegrass, lucerne hay and maize silage based diet, and found an increase on TDMI when higher amounts of supplement were included in the diet. In their review, Dixon & Stockdale (1999) reported an increase on TDMI and metabolizable energy intake when forage was supplemented with grain-based concentrates. The same authors reported a reduction of 23% on forage intake when 368 g/kg of concentrate was included in a hay-based diet of sheep, which was lower than the reduction obtained in the 10 g/kg supplemented group with a lower amount of concentrate. Molle *et al.* (2008) reported a higher substitution rate than Dixon & Stockedale (1999) when high quality pastures were supplemented with concentrate in sheep. In conclusion, differences in the FDMI reduction in wethers could be explained by the high quality forage used in our study.

In contrast to the results of the wethers, supplementation of heifers led to 23% more TDMI than non-supplemented ones ($P < 0.01$). Supplementation of heifers led to 10% less FDMI than no supplementation ($P < 0.05$), while lower FDMI was observed when sorghum supplementation increased ($P < 0.05$). As in wethers, no differences on TDMI were found by increasing sorghum supplementation ($P \geq 0.17$). These results may be explained by the increased substitution rate when sorghum grain supplementation increased. Our results were expected and are in agreement with other authors (Reis & Combs, 2000; Walker *et al.*,

Table 1 Total dry matter intake (TDMI) and forage dry matter intake (FDMI), g/kg of metabolic body weight ($BW^{0.75}$) of wethers (W) and heifers (H) fed temperate pasture (*Lotus corniculatus) ad libitum* and non-supplemented (0) or supplemented with ground sorghum grain at 5, 10 or 15 g/kg of their BW (5, 10 and 15)

	TDMI			FDMI		
Supplement	W	H	A[1]	W	H	A[1]
0	106.9	106.0	106.4	106.9	106.0	106.4
5	93.3	127.6	110.5	81.7	109.3	95.5
10	84.0	130.9	107.5	59.3	94.2	76.8
15	84.6	136.9	110.8	49.0	82.6	65.8
s.e.	6.0	3.6	4.0	6.3	3.6	4.1
0 *vs.* 5, 10 and 15	<0.05	<0.01	ns	<0.01	<0.05	<0.01
5 *vs.* 10 and 15	ns	ns	ns	<0.01	<0.01	<0.01
10 *vs.* 15	ns	ns	ns	ns	<0.05	0.08

1- Wethers and heifers all measurements analyzed together

2001; Bargo *et al.*, 2003), who reported a high substitution rate when grazing cows were supplemented with different levels of concentrates.

Dry matter digestibility (DMD) in wethers and heifers is presented in Table 2. Dry matter digestibility was 0.69 (s.e. = 0.03) for wethers and 0.65 (s.e. = 0.03) for heifers, with no differences between treatments (P ≥0.10). Kaur *et al.* (2008) reported lower DMD in sheep when supplementation level increased from 150 g/kg to 450 g/kg of the whole diet, which was explained by a reduction in NDF and ADF digestibility. Bargo *et al.* (2003) reported that supplementation with energy concentrates led to similar organic matter digestibility with a reduction in NDF digestibility. In our study DMD was not affected by grain supplementation. However, increased grain supplementation reduced ruminal pH from 6.45 to 5.43 for wethers (Aguerre *et al.*, 2008a) and from 6.80 to 6.17 for heifers (Aguerre *et al.*, 2008b). The lower pH could affect fibre digestibility, but this reduction was probably compensated by higher grain digestibility.

Table 2 Dry matter digestibility of wethers (W) and heifers (H) fed temperate pasture (*Lotus corniculatus) ad libitum* and non-supplemented (0) or supplemented with ground sorghum grain at 5, 10 or 15 g/kg of their BW (5, 10 and 15)

Supplement	W	H	A[1]
0	0.67	0.61	0.64
5	0.66	0.65	0.66
10	0.68	0.68	0.68
15	0.74	0.66	0.70
s.e.	0.03	0.03	0.02
0 *vs* 5, 10 and 15	ns	0.1	<0.05
5 *vs* 10 and 15	ns	ns	0.06
10 *vs* 15	ns	ns	ns

1- Wethers and heifers all measurements analyzed together

When all animals were analyzed together, no differences on TDMI, less FDMI (P <0.01) and high DMD (P <0.05) were found on supplemented groups.

Conclusion

In conclusion, the inclusion of supplement led to an inverse response in TDMI in the two species. It reduced TDMI by 20% for wethers and increased TDMI by 23% for heifers. This could indicate different intake regulatory mechanisms. Forage DM intake was reduced in both species, but the reduction in wethers was higher than in heifers (40% *vs.* 10%). Dry matter digestibility of supplemented diets (all animals analyzed together) was higher probably due to grain digestibility.

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