Delaying the time of morning grazing improves milk production in winter

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ABSTRACT

Herbage dry matter content and water-soluble carbohydrate influence cow intake and production. Delaying the time of grazing may increase the dry matter and water-soluble carbohydrates content of herbage and increase grass consumption and milk production. This study determines the cow response to early (8:00 h) and late (11:30 h) offer of winter pasture (*Lolium multiflorum*) for primiparous cows 120 days in lactation. Herbage dry matter content, grazing time and daily herbage dry matter intake increased when the time of grazing of the winter pasture was delayed (140 vs 171 g/kg dry matter (DM), 71 vs 110 minutes and 2.7 vs 4.8 kg DM/cow/d respectively; $P < 0.05$) while the increment in the water-soluble carbohydrates content of the herbage was not significantly different between treatments (53 vs 75 g/kg DM; $P = 0.09$). As a consequence of the higher daily herbage dry matter intake of cows grazing winter pasture late in the morning, daily milk and milksolids production was higher than pasture offered early in the morning (29.2 vs 31.0 L/cow and 2.05 vs 2.19 kg/cow respectively; $P < 0.05$).

Keywords: water-soluble carbohydrates; herbage dry matter; grazing time; herbage intake.

INTRODUCTION

Under temperate conditions pasture digestibility is frequently high in late autumn and winter and does not constrain herbage dry matter (DM) intake of grazing ruminants. Sward structure, pasture availability and low herbage DM content are pasture variables mentioned as limiting factors to herbage DM intake (Kenney and Black, 1984). In addition, the water soluble carbohydrates (WSC) content of the grass consumed by grazing animals has been implicated as a key factor in the diet selection by ruminants (Fisher *et al.*, 1999). It is apparent that the greater preference for grass with higher WSC content is related to higher intakes of such material, and could be associated with an improved efficiency of microbial protein synthesis (Dove & Milne, 1994).

Forage heterogeneity varies diurnally with changes in herbage chemical composition and therefore supplied nutrients (Mayland *et al.*, 2003). Herbage DM and WSC concentrations increase during the day predominantly due to the loss of moisture and accumulation of photosynthates (Griggs *et al.*, 2005). If cattle behaviour exploits such differences, then variation in the characteristics of the herbage during the day may play a role in shaping the daily pattern of activity and nutrient intake by dairy cows.

The objective of this study was to investigate changes in herbage DM intake and grazing behaviour of dairy cows in response to a delay in the time of grazing of a winter pasture and its effect on milk production. It is expected that a delay in the time of grazing of the pasture will enhance DM intake and production per cow during late autumn and winter, through higher herbage DM and WSC contents.

MATERIALS AND METHODS

This trial was conducted on a commercial dairy farm located near Cañuelas, Buenos Aires, Argentina (34º 37´S, 58º 50´W) from early June to mid August 2005. Thirty two primiparous Holstein-Friesian cows (500 kg live weight, 120 days in milk) were allocated to two herds of sixteen cows each and balanced by live weight, condition score and days in milk. These herds were managed as separate mobs during the experiment. They grazed different strips of the same paddock during two periods of thirteen days. Period 1 was between 26 June and 8 July; Period 2 was between 30 July and 11 August. Data were collected on the last three days of each period.

Pasture (*Lolium multiflorum*) was offered daily at two different times in the morning, early grazing (EG) and late grazing (LG). Cows in EG were milked first in the morning and started grazing a new strip of the winter pasture at 8:00 h, in contrast with cows in LG that were milked last in the morning and started grazing a new strip of the winter pasture at 11:30 h. After the morning milking, the two treatment herds were fed supplements in troughs, grazed the winter pasture for a period of 4 hours and moved for the afternoon milking. After evening milking was finished, herds were fed again with supplements and moved to separate stand-off areas during the night. Herds spent same time at the milking platform and feeding supplements; in addition, they were offered similar

TABLE 1: Pre- and post-grazing herbage mass, allowance and chemical composition of the herbage in paddocks grazed for four hours beginning at either 08:00 h (Early graze, EG) or 11:30 h (Late graze, LG). SED = Standard error of difference, DM = Dry matter, WSC = Water soluble carbohydrate, CP = Crude protein, ADF = Acid detergent fibre.

Component	Time of grazing		SED	Significance
	EG	LG		
Pre-grazing herbage mass (kg DM/ha)	2,135	2,223	121	NS
Post-grazing herbage mass (kg DM/ha)	1,337	1,056	67	**
Daily herbage allowance (kg DM/cow)	6.7	6.9	0.5	NS
DM (g/kg DM)	140	171	6	*
WSC (g/kg DM)	53	75	12	NS
CP (g/kg DM)	225	233	6	NS
ADF (g/kg DM)	255	249	16	NS

TABLE 2: Herbage dry matter intake, grazing behaviour, milk production and milk composition of cows who received their daily allowance of pasture over four hours beginning at either 08:00 h (Early graze, EG) or 11:30 h (Late graze, LG). SED = Standard error of difference.

Component	Time of grazing		SED	Significance
	EG	LG		
Herbage dry matter intake (kg DM/cow/d)	2.7	4.8	0.6	*
Time spent grazing (min)[1]	71	110	8	**
Time spent ruminating (min)[1]	72	67	8	NS
Time spent resting (min)[1]	83	48	7	*
Milk yield (L/d)	29.2	31.0	0.6	*
Milksolids yield (kg/d)	2.05	2.19	0.05	*
Fat content (%)	37.7	37.6	0.8	NS
Protein content (%)	32.5	33.2	0.7	NS

[1]During the four hour period that the cows were offered pasture.

amount of supplement during and after each milking.

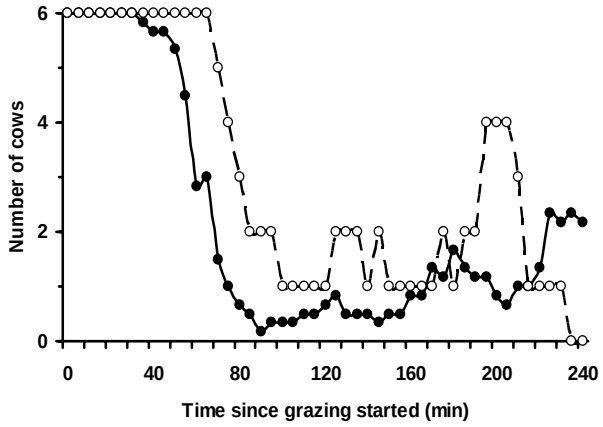
The mean DM requirement per cow was estimated as 20.6 kg/d by considering the LW of the animal, the average milk production and milk composition of cows in the week prior to the start of experiment (National Research Council, 2001). Daily allocation of pasture was at least 7.4 kg DM/cow (herbage intake not limiting). In addition, cows in both treatments were fed with 17.0 kg DM/d of supplements to achieve about 80 % of their DM requirements. The supplement consisted of 3.0 kg DM of wheat bran pellets per cow at each milking; plus 3.3 kg DM maize silage, 0.3 kg DM maize grain, 1.3 kg DM cottonseed and 0.6 kg DM soybean pellets mixed. It was fed in troughs after each milking.

Pre and post-grazing herbage mass was recorded daily in Periods 1 and 2 by cutting the herbage in each of ten quadrats (0.09 m^2) with electric scissors to ground level. Quadrats were randomly distributed within the grazing area and were cut immediately before and after each grazing. The mean intake per cow from the winter pasture was estimated from pre and post-grazing cuts (Le Du & Penning, 1982). Clipped herbage was oven dried at 60ºC for 48 h for DM determination. Additional herbage samples were hand-plucked daily from the pre-grazing sward to post-grazing levels, representing the herbage ingested by the cows. Samples were oven dried at 60ºC for 48 h and analysed for crude protein (semi micro Kjeldhal), acid detergent fibre (Goering & Van Soest, 1970), and soluble carbohydrates (Yemm & Willis, 1954).

The grazing behaviour of six cows randomly chosen from within each group were visually observed daily during each measurement period. The activity of each cow was recorded as grazing, ruminating or resting at five minute intervals. The visual observation started once each group of cows entered the paddock and stopped when the cows were shifted for the afternoon milking.

Milk production was measured twice during the experiment, once in each period, in the same cows,

FIGURE 1: Number of dairy cows in a sub-group of six, grazing in separate paddocks of a winter pasture (*Lolium multiflorum*) who received their daily allowance of pasture over four hours beginning at either 08:00 h (Early graze, ●) or 11:30 h (Late graze, ○).



on two consecutive milkings in the afternoon and following morning. A 30 mL aliquot from a representative subsample of milk was collected from each cow on each date (2.5% of the total daily volume produced) and analysed in the laboratory to determine fat and protein concentrations. The daily yield of milksolids per cow was determined.

All data were analysed as a factorial arrangement of times of grazing and periods by ANOVA using Statistix V3.5 programme. The daily paddocks were the experimental units (n = 6) for pre and post-grazing biomass and herbage chemical composition comparisons between treatments; the selected cows were the experimental units (n = 12) for comparing grazing behaviour and daily milk production between treatments.

RESULTS

There were no interactions between times of grazing and periods; thus, data are presented as average values for the two periods. Late grazing pre-grazing herbage mass and the amount of herbage available per cow were between 4 and 3% higher than EG pasture. However, these differences were not significantly different between EG and LG (Table 1). The herbage DM content was higher in LG than EG (171 vs 140 g/kg); in addition, the WSC content showed an increasing trend for LG (+ 42%, P = 0.09) although values were not significantly different between treatments. Herbage CP and ADF contents were not significantly different between times of grazing.

The post-grazing herbage mass was 27% higher in EG (1,337 kg DM/ha) than LG (1,056 kg DM/ha), indicating that a lower proportion of the herbage offered was removed in EG (Table 1). As a consequence the estimated DM intake per cow was 2.1 kg higher in LG than EG (Table 2). The amount of supplement consumed, either at each milking or in troughs after milking was not measured; however, no supplement remained during measurement periods. Supplement consumption was therefore assumed to be equal to the amount offered and similar in both treatments. Cows spent more time grazing (39 minutes) and less time resting (35 minutes) in LG than EG, but showed similar ruminating time in both treatments (- 7% in LG, Table 2). When grazing activity was compared at a similar time after the time grazing was initiated in each treatment, LG showed a higher proportion of cows grazing (Figure 1).

The mean daily milk and milksolids yield were 1.8 L/cow/d and 0.14 kg/cow/d being 6% and 7% higher respectively in LG cows than EG. Milk fat and protein percent were not significantly different between treatments (Table 2).

DISCUSSION

Cows that grazed the pasture late in the morning at 11:30 h ingested 2.1 kg DM/cow/d more herbage (+ 78%) and produced 1.8 L/cow/d more milk than cows grazing the pasture 3.5 hours earlier in the morning at 8:00 h. In addition, LG cows were able to graze the pasture down to 281 kg DM/ha lower (1,337 – 1,056 kg DM/ha) than the EG cows (Table 1). These findings may have been due to the higher DM content of the pasture, combined with the higher WSC content of the herbage grazed late in the morning of 31 g/kg DM (171 – 140 g/kg DM) and 22 g/kg DM (75 – 53 g/kg DM) respectively (Table 1). This trend is in agreement with previous studies reported by Barrett *et al.* (2001) and Taweel *et al.* (2004).

Changes of herbage DM and WSC content usually occur during the day as a result of moisture loss by evaporation and transpiration, and the photosynthetic activity within the plant (Griggs *et al.*, 2005). The difference in the CP content of the herbage between EG and LG was small (4%), as also observed by Barrett *et al.* (2001). If herbage nitrogen content remained unchanged between times of grazing, the carbon:nitrogen (C:N) ratio in the rumen might be increased for cows grazing the pasture late in the morning. Because of the large impact that a change in the herbage C:N ratio exerts on rumen digestion and metabolism (Dove, 1996), this ratio was suggested as a metabolic signal associated with satiety and intake (Cosgrove & Edwards, 2007), and was probably the reason for the different grazing pattern observed.

As the difference in WSC content was not significantly different between times of grazing

(P = 0.09) , the higher DM intake of LG than EG would be more related to the higher herbage DM content than to the change in WSC content between times of grazing. However, as the WSC are the main energy source in the rumen (Rutter *et* al., 2004) a higher content of these compounds in the DM ingested would improve nitrogen utilization and microbial protein synthesis (Beever *et al.* 1978; Dove and Milne 1994). In contrast, Carruthers and Neil (1997) found no effect of WSC supplementation on microbial protein synthesis for temperate pastures with a relatively low CP content and a WSC:CP ratio of 2.07. This was not the case in the present study in which the WSC of the pasture was low relative to CP with a WSC:CP ratio of 0.24 in EG. Hence, it is possible that any increment in the WSC content (+ 42% from EG to LG), although not significant, would promote nitrogen digestion (Carruthers *et al.* 1997).

The higher DM intake per cow in LG is in line with the increasing time spent grazing (39 minutes higher), in spite of similar time spent ruminating in the EG group. As grazing behaviour was only recorded during the period cows grazed the winter pasture, the expected higher time required to ruminate the greater DM intake may have occurred at other times of the day during which their activities were not recorded. The changes observed in grazing activity may have contributed to the lower post-grazing residual and higher intake achieved in LG and may be a consequence of an improved rumen DM digestion and passage.

It was suggested that the WSC content of the herbage influences short-term diet selection due to its effect on the C:N ratio (Ciavarella *et al.* 2000); nevertheless, Barrett *et al.* (2001) reported similar intake rates for cows grazing perennial ryegrass at different times of the day, despite differences in DM and WSC herbage contents. In the present trial herbage DM intake rate may be estimated through the relationship between the mean daily herbage intake per cow and the mean grazing time registered over the four hours period they grazed the winter pasture daily (Table 2), expressed as kg DM per hour of effective grazing. Intake rates were 2.28 and 2.62 kg DM/h in EG and LG respectively, which showed that delaying the time of the morning grazing from 8:00 h to 11:30 h increased the rate of herbage dry matter intake by 0.34 kg DM/h in LG cows (+ 15 % compared with EG). However, considering the different herbage DM contents registered in the treatments, the estimation of the fresh herbage intake rates was 16.30 and 15.31 kg/h in EG and LG respectively, which showed that fresh herbage consumption was actually reduced by 1 kg/h in LG compared with EG (data estimated from Tables 1 and 2).

Therefore, the higher DM intake rate attributed to LG cows might be a consequence of the intake of herbage of higher DM content; however, the lower fresh herbage intake rate might also indicate that LG cows were more selective than EG cows. As it was suggested by Cosgrove and Edwards (2007) cows may be able to sense in advance the systematic fluctuations of forage C:N ratios occurring during the day. This capacity may allow them to modify their daily intake pattern, particularly the diurnal changes in meal duration, in order to maximize their nutrient intake.

For instance, the initial high motivation of the cows to graze in both treatments declined sooner in EG than LG (Figure 1) despite the LG cows having consumed herbage with a higher DM content. It is possible that both the internal water content of the herbage associated with rumen distension, and a metabolic signal from the rumen associated with the change in C:N ratio in the herbage during the morning, may have determined different thresholds of satiation for the cows in the two treatments and hence grazing activity.

Cows in EG were more active by the end of the grazing, probably in an attempt to compensate the lower DM intake achieved at that time. Grazing was however interrupted by a management decision as cows were removed from the paddock for the afternoon milking leaving behind a higher post-grazing herbage mass. The longer time spent grazing recorded in the LG group might be related to the positive nutritional changes observed in the winter pasture during the morning, which allowed LG cows to consume more herbage.

CONCLUSIONS

Delaying the time of the morning grazing of a winter pasture improved daily herbage DM intake and milk production per cow. The higher DM intake obtained was mainly due to the increased DM content of the pasture. Cows seemed to adjust their grazing activity to diurnal chemical changes occurring in the pasture. The effect of these changes on rumen function, herbage DM intake and grazing behaviour should be further investigated.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support received from Inés Marre and all the Staff at La Luminaria dairy farm. This work was funded by the University of Buenos Aires (Contract G001 UBACyT). We also thank Dr. Mike Wade for making useful suggestions on the manuscript.

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