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Short communication

Rumination behavior of grazing dairy cows in response to restricted time at pasture

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ABSTRACT

The short-term adaptations of cattle behavior to time restrictions at pasture are poorly understood. This study explored the diurnal rumination pattern of dairy cows in response to restrictions to time at pasture. Six groups of eight Holstein–Friesian cows (470 ± 47 kg, 35 ± 9 days in milk) were strip-grazed on a perennial ryegrass (*Lolium perenne* L.) pasture over 21 days (2 groups per treatment) for either 4 h after each milking (2 × 4), one period of 8 h between milkings (1 × 8), or 24 h excluding milking times (control, CTL). All cows were equipped with HR Tag™ rumination collars which recorded chewing activity and regurgitation of digesta boluses during rumination. Cows in 1 × 8 reduced daily rumination time by 36% compared with cows in 2 × 4 and CTL (304, 402 and 423 SED 26.3 min, respectively). There were no differences in the average intervals between regurgitation of digesta boluses (48.9 ± 0.96 s) and average interval between chewing actions was also similar (0.7 ± 0.02 s) between treatments. Treatment affected the diurnal rumination pattern. There was little rumination during the time at pasture for the restricted cows (1 × 8 and 2 × 4), whereas the CTL cows ruminated for almost a third of the time between the am and pm milking. In all treatments, cows ruminated the longest during the night. These results suggest grazing dairy cows modulate their time for rumination to compensate for a reduction in available grazing time. This behavioral study contributes to the understanding of changes in rumination behavior and associated effects in grazing dairy cattle in response to hunger.

1. Introduction

Rumination is a key component of rumen digestion, and the physical breakdown of plant material in the rumen is thought to be one of the main functions controlling digestion rate and outflow of digesta from the rumen, and in turn dry matter intake (DMI). Rumination also has a key role in salivation, rumen buffering and health, rumen fermentation patterns and thereby chemical composition of the milk (Mertens, 1997). Rumination has a circadian but flexible pattern, which is modulated by feeding frequency and physical and chemical characteristics of the diet (Pearce, 1965), feeding time (Welch and Smith, 1969) and photoperiod (Gordon and McAllister, 1970). Several studies have evaluated the impact of feed restriction on feeding behavior and performance of cattle but few have focused on the effect of restricting time at pasture on grazing and rumination behavior of cattle (Chilibroste et al., 2007; Gregorini et al., 2008a; Kennedy et al., 2009; Perez-Ramirez et al., 2009). Only Kennedy et al. (2009) provide details of rumination behavior. However, the Kennedy et al. (2009) observations do not describe the effect on the diurnal pattern of rumination. Moreover, Kennedy et al. (2009) supplemented cows with concentrates. This demonstrates the paucity of information on how this type of restriction affects rumination and its pattern of grazing dairy cows under a 100% pasture

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diet. The objective of this study was to explore and improve the understanding of rumination behavior and its diurnal pattern in grazing dairy cows as affected by restricting time at pasture.

2. Materials and methods

2.1. Research site and experimental procedures

This study was approved by the Ruakura Animal Ethics Committee (Hamilton, New Zealand) and conducted at Scott Farm, DairyNZ, Hamilton (New Zealand) during September and October 2008. Forty-eight Holstein–Friesian cows (470 ± 47 kg BW; 35 ± 9 DIM) were randomly assigned to 6 groups (8 cows per group) and grazed a *Lolium perenne* L. sward according to the following treatments (2 groups per treatment), either 4 h after each milking (2×4), 8 h between milkings (1×8), or 24 hours excluding milking times (CTL). Cows were balanced between groups for calving date, milk yield, and live weight prior to the study. Daily pasture strips were allocated at 08:00 h (after morning milking). Cows were milked at 07:00 and 16:00 h. Details of cow and sward management are described in Gregorini et al. (2009) and Clark et al. (2010). Cows were adapted to treatments for a period of 16 d, after which measurements were made for a further 21 days.

2.2. Measurements and calculations

All cows were equipped with HR Tag™ rumination collars (SCR Engineering Ltd., Netanya, Israel). The collars measure rumination activity through the sound of chewing, and regurgitation of boluses during rumination (Bar and Solomon, 2010). The collars were recently validated (Schirmann et al., 2009) and showed good agreement between the automated data and visual observations providing confidence in their use. The collar has a microphone incorporated in a plastic case, which is located adjacent to the dorsal aspect of the neck on the left side. The sounds are analyzed through an algorithm inside the tag. The device stores rumination data in two h intervals, average interval (s) between boluses and average interval (s) between chewing actions for periods of 24 h. This information is automatically downloaded every time the cow enters the milking parlor.

2.3. Statistical analysis

A power calculation was performed prior to the experiment to ensure a 90% power of detecting a 10% difference. Furthermore, the degree of animal variation was reduced by having six cows per group as opposed to having few cows and more groups. Group was the experimental unit as suggested by Lean and Lean (2010). Data from the cows within each group were averaged to obtain one mean value for each measurement per day. The daily means were analyzed for treatment effects using ANOVA with group as the blocking factor and treatment as the fixed effect. The repeated measurements through time were modeled using spline models within the linear mixed model framework as described by Verbyla et al. (1999). Treatments, linear trend of time and their interaction were included as fixed effects and group, linear trend of time within group, spline and the interaction of treatment with spline were included as random effects. Residual maximum likelihood (REML) in GenStat 12.1 was used to fit these models.

3. Results and discussion

Results are shown in Table 1 and Fig. 1. Treatment affected daily rumination time ($P = 0.03$) and its diurnal pattern ($P < 0.01$). The average interval between boluses and average interval between chewing actions while ruminating were not affected ($P > 0.05$) by treatment. Milk production (20.8, 22.1 and 24 kg/cow/d for 1×8, 2×4 and CTL, respectively), herbage DMI (12.5, 13.9 and 13.7 kg DM/cow/d for 1×8, 2×4 and CTL, respectively) and grazing behavior were also evaluated in the experiment and published elsewhere (Clark et al., 2010; Gregorini et al., 2009).

The rumination times observed in the present experiment are representative of values reported in the literature (i.e. dairy cows grazing cool season grasses) and similar to the daily rumination times reported by Kennedy et al. (2009). However, cows with the longest period away from pasture before the new pasture allocation (1×8) reduced daily rumination time by 36%, while cows with similar treatment in the study of Kennedy et al. (2009) only reduced daily rumination time by 20%. The greater treatment effect observed in the present study, compared with Kennedy et al. (2009), may be associated with the absence of concentrate supplementation.

All cows exhibited the circadian pattern of rumination with the longest period of rumination activity recorded during the night (Fig. 1), which shows that even under contrasting restriction of time at pasture, the night is still the preferred time to ruminate. However, cows in the 1×8 treatment showed an important reduction in rumination time during the night relative to the other treatments. It is also clear that allocation of time to ruminate during the day was affected by treatments (Fig. 1) and changes in diurnal rumination pattern (according to treatment) may have been an attempt to make more efficient use of available grazing time. The patterns in the 1×8 and 2×4 treatments, as well as the overall reduction in rumination time by cows assigned to the 1×8 treatment reinforces the concept that rumination is a flexible and subordinate behavior to grazing, enabling cattle to compensate for less time at pasture. Gregorini et al. (2009) reported that cows in 1×8 spent 83% of the time grazing during the first 4 h after the allocation of the new pasture break (08:00 h), compared to 73 and 65% for cows in 2×4 and CTL treatments, respectively. Gregorini et al. (2009) also reported that cows in 1×8 consumed 90% of their daily DMI during those 4 h, compared to 66 for cows in 2×4 and CTL treatments.

Table 1
Daily rumination time, average interval between boluses and average interval between chewing actions over a 24 h period for cows offered pasture for 8 h between milkings (1×8), 4 h after each milking (2×4), or for 24 h (control, CTL).

Variable	Treatment			SED	*P*-value
	1×8	2×4	CTL		
Daily rumination time (min/day)	304	402	423	26.3	0.038
Interval between boluses (s)	50.06	48.41	48.37	1.628	0.117
Interval between ruminative chewings (s)	0.68	0.72	0.71	0.012	0.559