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Timing of supplementation alters grazing behavior and milk production response in dairy cows

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ABSTRACT

Offering feed supplements to grazing dairy cows results in substitution of pasture; however, previous data indicate that the time at which concentrate supplements are offered might affect the level of substitution. These data indicated that cows grazed more intensely presunset, regardless of the amount of supplement offered. It was, therefore, hypothesized that substitution rate would be less, and response to supplement greater if cows received their supplement at the p.m. rather than the a.m. milking. Forty-eight multiparous, nonpregnant, Holstein-Friesian cows, approximately 60 d in milk, were randomly allocated to 1 of 3 treatments in an incomplete crossover arrangement. Treatments were pasture only, pasture + 3 kg of concentrate supplement dry matter (DM) offered during the a.m. milking (AM-SUP), and pasture + 3 kg of concentrate supplement DM offered during the p.m. milking (PM-SUP). Time spent grazing and calculated pasture DM intake did not differ between the AM-SUP and PM-SUP cows. However, a tendency (0.18 kg of milk/kg of concentrate DM) was observed for an increased marginal milk response (kg of milk/kg of DM supplement) for the AM-SUP cows when compared with PM-SUP cows. Irrespective of when supplements were offered, supplementation reduced total grazing time by a similar amount, and the reduction in time spent grazing was evident throughout the day. Cows in the PM-SUP group ruminated for longer and cows in the AM-SUP group spent more time idle compared with the pasture only groups. Cows in the AM-SUP group grazed for less time during the major a.m. grazing bout following a.m. milking compared with PM-SUP cows; in comparison, the major p.m. grazing bout following p.m. milking was unaffected by supplementation. The results indicated possible improvements in marginal milk response to supplements from altering the timing of delivery.
Key words: timing of supplementation, grazing behavior, dairy cow

INTRODUCTION

Low DMI is a major limitation to milk production in pasture-based dairy systems resulting in nutrient intakes that are insufficient to match the milk production potential of the grazing dairy cow (Kolver and Muller, 1998). In an attempt to increase total DM and ME intakes, supplements may be offered to grazing cows. However, the marginal milk response (**MR**) to supplements varies markedly, primarily because of a reduction in pasture DMI (Stockdale, 2000; Bargo et al., 2003). The decrease in pasture DMI with increasing supplement DMI is termed substitution (Bargo et al., 2003).

Substitution is reflected by changes in the dairy cows grazing behavior, with a reported 12 min decrease in grazing time for every 1 kg of DM supplement consumed (Bargo et al., 2003; Sheahan et al., 2011) and an increase in rumination time (Sheahan et al., 2011). Sheahan et al. (2011) reported that when cows were supplemented at a.m. and p.m. milking, the effect on grazing time was not consistent throughout the day, with supplementation reducing grazing time during the day but not immediately preceding sunset, which is the most intensive grazing bout of the day (Gibb et al., 1998; Scaglia et al., 2009). Sheahan et al. (2011) hypothesized that the cessation of grazing following a.m. supplementation was due to neuroendocrine factors resulting from the digestion of feed, rather than physical factors, and that sunset signaled the end of grazing following p.m. milking, irrespective of supplementation in the p.m. Based on the lack of effect of concentrate supplementation on time spent grazing before sunset for cows supplemented in the a.m. and p.m., it was hypothesized that substitution would be less, and therefore, the milk production response to concentrate greater, when cows received the same amount of concentrate supplement in the p.m. rather than in the a.m.

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MATERIALS AND METHODS

This experiment was conducted at Lye Farm (DairyNZ, Hamilton, New Zealand) from September to October 2011, and was approved by the Ruakura Animal Ethics Committee, Hamilton, New Zealand.

Experimental Design

The experimental design was an incomplete crossover arrangement, with 48 multiparous, nonpregnant, Holstein-Friesian cows, approximately 60 DIM, randomly assigned to 1 of 3 treatments (n = 16 cows/treatment): pasture only (**PAST**), pasture + 3 kg of concentrate supplement DM offered during the a.m. milking (**AM-SUP**), and pasture + 3 kg of concentrate supplement DM offered during the p.m. milking (**PM-SUP**). The initial concentrate supplement allocation was 1 kg of DM/d, and then increased by 1 kg of DM/d until full allocation was obtained. Cows then underwent a 10-d adaptation period before a 7-d measurement period. At the end of the 7-d measurement period, cows were reassigned to a new treatment in the following manner: of cows previously in the AM-SUP treatment group, 8 were assigned to PM-SUP and 8 to PAST treatment; of cows previously in the PM-SUP treatment group, 8 were assigned to AM-SUP treatment, and 8 to PAST treatment; of cows previously in the PAST treatment group, 8 were assigned to AM-SUP treatment and 8 to PM-SUP treatment. A 10-d adaptation period followed by a 7-d measurement period was repeated.

Pasture and Concentrate Supplement

Cows were grazed as 1 herd for 24 h/d for the duration of the experiment and were only removed for a.m. and p.m. milkings. Pasture allowance was sufficient to ensure DMI up to approximately 20 kg of DM/d for the unsupplemented cows. Cows had access to a fresh allocation of pasture after each milking. Each allocation was 50% of the daily allowance. Pasture was of high quality (Table 1) throughout the experiment and each pasture allocation was sampled by hand plucking a representative pasture sample to simulate grazing, just before cows entering the paddock, for quality analysis (Dairy One Cooperative Inc., Ithaca, NY). The concentrate supplement was offered (3 kg of DM) during milking at either the a.m. or p.m. milking, in accordance with allocated treatment. The supplement was a pelleted concentrate composed of distillers grain (35% DM), palm kernel expeller (25% DM), maize grain (15% DM), wheat middlings (15% DM), and minerals (10% DM). Refusals were recorded daily, with an average of 2.90 kg of DM and 2.96 kg of DM consumed ($P < 0.05$) for the AM-SUP and PM-SUP cows, respectively.

Pasture DMI

Pasture DMI was calculated from mean daily milk energy output plus cow maintenance requirements for BW change. Cows were weighed once per week after a.m. milking. Bodyweight gain/loss was calculated for each individual cow by calculating the difference in BW over the 4-wk period. The efficiency with which energy was used for milk production was assumed to be 65%, and the maintenance requirements for lactating grazing dairy cows was 0.6 MJ/kg of $BW^{0.75}$ (Holmes et al., 2003). The energy required for 1 kg of BW gain or supplied from 1 kg of BW loss was assumed to be 32 and 25 MJ/cow per day, respectively (Holmes et al., 2003). Energy intake was divided by the mean pasture ME

Table 1. Chemical composition of bulked a.m. and p.m. pasture samples and concentrate supplement offered

Item	a.m. Pasture[1]	p.m. Pasture[1]	Supplement
DM %	90.6	90.6	93.5
Chemical composition (% of DM)			
CP	27.0	26.5	21.8
ADF	23.9	23.8	22.3
NDF	44.0	43.1	35.7
Lignin	2.4	2.4	5.2
NFC	22.8	24.3	34.5
Starch	0.6	0.6	14.3
Fat	4.3	4.2	5.65
NSC	14.8	18.4	26.4
Ash	9.9	9.8	10.5
IVTD,[4] 24 h (% of DM)	90.8	90.8	75.5
NDF, 24 h (% of NDF)	79.5	78.5	31.5
ME[5] (MJ/kg of DM)	13.9	13.9	10.3

[1]Pasture samples were collected immediately before cows grazed fresh pasture allocation.

[4]IVTD = in vitro true digestibility.

[5]Metabolizable energy was calculated from IVTD.