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BRIEF COMMUNICATION: The effect of concentrate supplementation on milk production during an extended lactation in grazing dairy cows

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INTRODUCTION

Extended lactation systems where cows are milked for longer than 300 days, provide an opportunity for farmers to use the lactation potential of genetically superior cows, reduce calving and mating costs, even-out labour requirements, and/or build herd size by retaining non-pregnant cows. However, depending upon cow genetic strain and nutrition, milk production can be reduced in an extended lactation system relative to a 'normal' lactation of 260 to 300 days (Kolver *et al*., 2007; Grainger *et al*., 2009).

Winter-feeding levels are potentially important in contributing to the success of extended lactations in a pasture-based system. Cows fed pasture-based diets have a second lactational peak during the second spring of extended lactation, coinciding with an increase in the availability and quality of pasture (Kolver *et al*., 2007; Grainger *et al*., 2009). Increased nutrition stimulates secretory activity and proliferation of mammary epithelial cells during early lactation (Norgaard *et al*., 2005), and strategic use of supplementation during winter pasture deficits may improve milk production responses to extended lactations through a similar mechanism.

The objective of this experiment was to investigate the effect of concentrate supplementation during winter on milk production during an extended lactation in grazing dairy cows.

MATERIALS AND METHODS

Sixty non-pregnant Holstein-Friesian and Friesian x Jersey cows (268 ± 22.1 days in milk (DIM) and 13.6 ± 2.46 kg milk/cow/d) were assembled at DairyNZ Lye Farm in May 2007 to be milked for an extended lactation. Cows were randomly allocated to one of two winter feeding treatments; pasture only (PAST) or pasture plus 4.7 kg dry matter (DM) concentrate/cow/d (CONC) for 123 days between May and September 2007 (n = 30 cows/treatment). All cows returned to a pasture-only diet from September until the end of extended lactation (carry-over period).

During the winter treatment period, cows in the CONC group were individually offered 4.7 kg DM/d (5.5 kg fresh matter/d) of maize-barley concentrate pellets, fed in equal portions at the morning and evening milkings. Individual residues were measured at each milking to determine concentrate intake. A common pasture allowance (45 kg DM/cow/d) was offered to all cows, and post-grazing residuals were used to determine pasture allocation; 1,600 to 1,800 kg DM/ha was targeted during autumn, winter, and spring, and 2,200 to 2,400 kg DM/ha during summer. Pasture silage was offered to maintain pasture residual targets when pasture availability was limiting. A total of 652 kg DM pasture silage/cow was offered for 100 days between May and September 2007 (mean 3.4 kg DM/cow/d), 5 days in December 2007 (0.8 kg DM/cow/d), and 61 days in January to April 2008 (mean 4.4 kg DM/cow/d).

Cows were re-bred to spontaneous oestrus starting on 2 October 2007 (412 DIM) using artificial insemination for 6 weeks followed by natural mating for 4 weeks. Each cow was dried-off when milk yield declined below 5 kg/d for two consecutive weeks, with a final 'dry-off' date of 28 March 2008 due to summer drought.

Individual milk yield and composition were determined daily and weekly, respectively. Live weight (LWT) and body condition score (BCS, 1-10 scale; Roche *et al*., 2006) were recorded fortnightly. Cumulative milk production data, and changes in LWT and BCS, were calculated for each cow across the winter treatment (~268 to 391 DIM), carry-over (~392 and 569 DIM), and total extended lactation (~268 to 569 DIM) periods. Data were analysed using linear models (ANOVA) in GenStat (Payne *et al*., 2008). Data from the two-week period immediately before the start of winter treatments were used as a co-variate. Within-treatment correlations were determined between production parameters measured during the co-variate period, and cumulative milk and milksolids (fat + protein) yields during the total extended lactation period.

RESULTS AND DISCUSSION

During the winter treatment period, cows in the CONC group consumed a total of 544 kg DM concentrate/cow (mean 4.4 kg DM/cow/d), and produced greater yields of milk (20%), fat (16%), and protein (24%) compared with cows in the PAST group (Table 1). Average immediate responses to

TABLE 1: Mean milk production, live weight and body condition score (BCS; 1 = Emaciated to 10 = Obese) of cows fed a pasture-only diet (PAST) or pasture plus 4.7 kg DM concentrate/cow/d (CONC) during the winter (~268 to 391 days in milk; DIM) of an extended lactation followed by an all-pasture diet until 'dry-off' (~569 DIM). SED = Standard error of difference.

	PAST	CONC	SED	P value
Winter treatment period[1]				
Cumulative milk yield (kg/cow)	1668	2003	69	<0.0001
Cumulative fat yield (kg/cow)	80.8	93.4	3.6	<0.001
Cumulative protein yield (kg/cow)	67.1	83.4	2.7	<0.0001
Live weight change (kg/cow)[2]	47	69	5	<0.001
BCS change (units/cow)[2]	0.97	1.34	0.18	<0.05
Carry-over period[3]				
Cumulative milk yield (kg/cow)	2261	2456	212	>0.15
Cumulative fat yield (kg/cow)	114.3	127.0	12.3	>0.15
Cumulative protein yield (kg/cow)	94.3	104.0	9.9	>0.15
Total extended lactation period[4]				
Cumulative milk yield (kg/cow)	3930	4460	274	0.06
Cumulative fat yield (kg/cow)	195.2	220.4	15.5	0.11
Cumulative protein yield (kg/cow)	161.4	187.4	12.4	<0.05
Live weight change (kg/cow)[2]	115	126	8	>0.15
BCS change (units/cow)[2]	1.97	1.90	0.24	>0.15
Live weight at dry-off (kg/cow)	603	614	8	>0.15
BCS at dry-off (units/cow)	6.24	6.16	0.24	>0.15

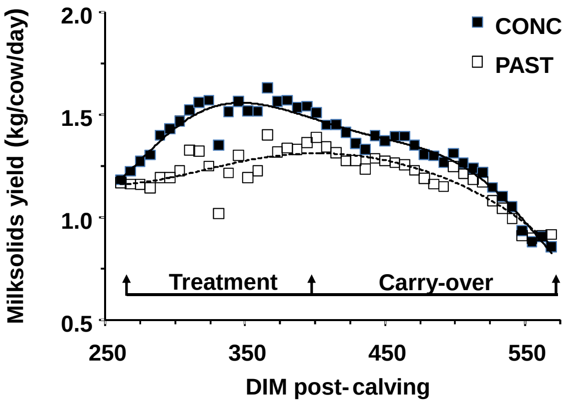
[1]Production data during the winter treatment period (May to September; ~268 to 391 DIM).
[2]Increase in live weight or BCS between the start and finish of the period.
[3]Production data during the carry-over period (September to 'dry-off'; ~392 to 569 DIM) when all cows received a pasture-only diet.
[4]Production data during the total extended lactation period (May to April; ~268 to 569 DIM).

feed supplementation were 0.62 kg milk, 23 g fat, 30 g protein, and 53 g milksolids/kg DM concentrate fed. These results are comparable to those of a recent Irish study, where increased nutrition during the winter indoor feeding period of an extended lactation resulted in a 12% increase in milk production at 0.74 kg milk/kg DM concentrate fed (Butler *et al*., 2006). Immediate responses in the present study were also slightly smaller than those reported by Grainger *et al*. (2008) of 0.72 kg milk and 70 g milksolids/kg DM concentrate fed during the second spring (~420 DIM) of extended lactation, and 0.84 kg milk and 84 g milksolids/kg DM concentrate fed during the second autumn (~600 DIM). Greater responses to concentrate supplementation would be likely under more restricted pasture and pasture silage allowances (Bargo *et al*., 2003), in higher-producing cows of greater genetic merit (Bargo *et al*., 2003), and in Holstein-Friesians containing a large proportion of North American genetic ancestry (Kolver *et al*., 2007; Grainger *et al*., 2009) due to reduced substitution of concentrate for pasture and better partitioning of nutrients into milk production.

Although there was a numerical carry-over response in the CONC group of approximately 10% more milk, fat, protein, and milksolids, these differences were not statistically significant (Table 1 and Figure 1). A positive carry-over effect on milk production was consistent with the results of Butler *et al*. (2006), and would be expected if higher levels of nutrition during the winter of an extended lactation increased the number of mammary epithelial cells. Increased energy intake during early lactation was previously reported to lead to greater milk yields, which were associated with increased mammary epithelial cell activity and a short-term rise in proliferation (Norgaard *et al*., 2005). Mammary cell turnover was not examined in the current study; however, increased proliferation of epithelial cells during winter concentrate supplementation could explain, at least in part, the subsequent carry-over effect on milk production.

During the total extended lactation period from May 2007 to April 2008, the CONC group produced 13% more milk and fat, and 16% more protein than the PAST group (Table 1). Total responses to winter supplementation were 0.97 kg milk, 46 g fat, and 48 g protein/kg DM concentrate fed. Average milksolids yields were 356.5 and 407.8 kg/cow for PAST and CONC groups ($P = 0.07$), respectively, but there was no significant difference in lactation length between treatments (564 and 573 DIM, respectively). Lactation length, and consequently,

FIGURE 1: Mean milksolids production (kg/cow/d) of cows fed a pasture-only diet (PAST) or pasture plus 4.7 kg DM concentrate/cow/d (CONC) during the winter (~268 to 391 days in milk (DIM); treatment period) of an extended lactation followed by an all-pasture diet until 'dry-off' (~392 to 569 DIM; carry-over period).



total production were less than expected as cows were dried-off 30 to 45 days early due to summer drought severely limiting pasture quantity and quality from January (~525 DIM) onwards (Figure 1). The greater daily milk and milksolids yields of cows in the CONC group during the carry-over period (Figure 1) may have translated into more days in milk and further increases in total milk and milksolids yields compared with the PAST group had animals been able to reach their potential.

Marked variation also existed between cows with the greatest total milk and milksolids yields recorded in those cows that had the highest daily yields immediately before extending the lactation ($r = 0.72$, $P < 0.001$, and $r = 0.57$, $P < 0.001$, respectively). In addition, BCS at the start of the extended lactation was inversely associated with total extended lactation milk and milksolids yields ($r = -0.48$, $P < 0.001$, and $r = -0.52$, $P < 0.001$, respectively). These results support the findings of Kay *et al*. (2007), indicating that high-producing cows that partition energy towards milk production rather than BCS gain are better suited to extended lactations.

Cows less suitable for an extended lactation have large increases in BCS and poor milk production responses to concentrate supplementation beyond 300 DIM (Kolver *et al*., 2007). However, strategic use of supplementary feeds during winter pasture deficits may help to minimise excessive BCS gain during extended lactations. While cows in the CONC group gained more ($P < 0.05$) LWT and BCS during the winter treatment period, there were no significant differences in LWT and BCS by the end of lactation (Table 1).

In conclusion, increasing the level of winter feeding increased milk production during an extended lactation, however, performance varied between cows. Results indicate that appropriate nutrition and cow selection are required for productive extended lactations, and that further research is required to determine the profitability of these farm systems.

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