J. Dairy Sci. 100:536–547
https://doi.org/10.3168/jds.2016-11206

A comparison of serum metabolic and production profiles of dairy cows that maintained or lost body condition 15 days before calving

M. R. Sheehy,*† A. G. Fahey,‡[1] S. P. M. Aungier,* F. Carter,* M. A. Crowe,* and F. J. Mulligan*
*School of Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland
†Devenish Nutrition Ltd., Belfast BT1 3BG, United Kingdom
‡School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4, Ireland

ABSTRACT

Body condition score (BCS) change is an indirect measure of energy balance. Energy balance before calving may affect production and health in the following lactation. It is likely that cows may experience BCS loss before calving due to negative energy balance. The objective of this study was to determine if loss of BCS 15 d before calving affected milk production, BCS profile, and metabolic status during the transition period and early lactation. On d −15 to d 0 relative to calving, BCS was assessed (1 = emaciated, 5 = obese) for 98 Holstein-Friesian cows. The cows were divided into 2 groups: those that did not lose BCS between d −15 and d 0 (maintained, BCS-M, n = 55) and those that lost BCS from d −15 to d 0 (lost, BCS-L, n = 43, average loss of 0.29 ± 0.11 BCS). The fixed effects of BCS group, parity, week (day when analyzing milk production records), their interactions, and a random effect of cow were analyzed using PROC MIXED of SAS (SAS Institute Inc., Cary, NC). Before calving, BCS-L cows tended to have higher concentrations of nonesterified fatty acids than BCS-M cows (0.88 vs. 0.78 mmol/L). After calving, BCS-L cows had higher nonesterified fatty acid concentrations in wk 1 (0.93 vs. 0.71 mmol/L), wk 2 (0.84 vs. 0.69 mmol/L), and wk 4 (0.81 vs. 0.63 mmol/L) than BCS-M cows. The BCS-L cows had higher concentrations of β-hydroxybutyrate (BHB) in wk 1 (0.72 vs. 0.57 mmol/L), wk 2 (0.97 vs. 0.70 mmol/L), and wk 4 (0.94 vs. 0.67 mmol/L) compared with BCS-M cows. We detected significant reductions in insulin concentrations in BCS-L cows from wk −1 (2.23 vs. 1.37 μIU/mL) to wk 2 (1.68 vs. 0.89 μIU/mL) and wk 4 (2.21 vs 1.59 μIU/mL) compared with BCS-M cows. Prevalence of subclinical ketosis increased in BCS-L cows in wk 3 and 4 when BHB was ≥1.4 mmol/L and in wk 1, 3, and 4 when BHB was ≥1.2 mmol/L. In wk 1, BCS-L cows tended to have lower levels of calcium than BCS-M cows (2.33 vs. 2.27 mmol/L). We found no differences between the groups of cows for milk yield and energy-corrected milk. The BCS-L cows had lower BCS up to 75 d in lactation. Overall, BCS-L cows had higher somatic cell scores with an elevated somatic cell score on d 45, d 60, and d 75. There was an overall tendency for BCS-L cows to have higher fat yield and an overall significant increase in fat percentage. Overall, BCS-L cows had lower lactose percentage, with a reduction on d 60. This work shows that BCS loss before calving may have significant consequences for metabolic status, milk composition, somatic cell score, and BCS profile in dairy cows.
Key words: transition period, body condition score, milk production, dry cow nutrition, metabolic status

INTRODUCTION

The transition period for dairy cows has been defined as the period from 3 wk prepartum to 3 wk postpartum (Grummer, 1995; Drackley, 1999). This period is considered the most critical period in the lactation cycle (Grummer, 1995; Huzzey et al., 2005) because 50% of transition cows may be affected by disease (LeBlanc, 2010). These diseases can be of a metabolic, nutritional, or infectious nature (Mulligan and Doherty, 2008). During the prepartum close-up period, which is 3 wk before the expected calving date (Dann et al., 2006), cows may experience reduced feed intake, resulting in negative energy balance. It is generally accepted that a detrimentally altered metabolic status is a consequence of negative energy balance in the prepartum or postpartum period. An adverse metabolic status in this period is generally associated with poor health and reduced reproductive outcomes. Studies have shown that if prepartum nonesterified fatty acids (**NEFA**) concentrations increase above 0.5 mmol/L, there is an increased risk of retained placenta, increased time to pregnancy, reduced milk production, metritis (Ospina et al., 2010a,b; Chapinal et al., 2011, 2012a), and increased risk of displaced abomasum (LeBlanc et al.,

Received March 22, 2016.
Accepted September 14, 2016.
[1]Corresponding author: alan.fahey@ucd.ie

2005). Prepartum BHB concentrations ≥0.8 mmol/L were associated with reduced milk production and increased risk of displaced abomasum (Chapinal et al., 2012b). Negative energy status in the close-up period also appears to be associated with exacerbated immune system suppression due to impaired neutrophil function in the periparturient period (Hammon et al., 2006).

High concentrations of NEFA and BHB indicating negative energy balance are associated with hypocalcemia in early lactation (Martinez et al., 2012; Ribeiro et al., 2013). It is imperative that nutritional strategies used for transition cows do not result in negatively altered calcium status. Several studies have highlighted that calcium concentrations are important for cow health. Concentrations lower than 2.0 mmol/L are associated with metritis, displaced abomasum, reduced milk production and reduced pregnancy rates to first service (Chapinal et al., 2011, 2012b; Martinez et al., 2012). Furthermore, negatively altered calcium status in dairy cattle has been shown to have a detrimental effect on neutrophil function (Martinez et al., 2014).

Several nutritional strategies have been advocated internationally with the aim of optimizing transition cow nutritional status, health, and productivity. One such nutritional strategy involves controlled or restricted energy feeding during the dry period (Dann et al., 2005; Cardoso et al., 2013; Roche et al., 2013). Some of the research with this controlled energy nutritional strategy for late gestation cows indicates favorable changes in some but not all metabolic and production parameters in the periparturient period (Keogh et al., 2009; Cardoso et al., 2013). However, it remains to be seen whether this restricted-energy dry-cow feeding strategy is suited to all cow types, production systems, prior nutritional conditioning strategies, dry-cow BCS, and dry-period lengths, and whether any prepartum BCS loss caused by such a strategy has a positive or negative influence on metabolic status. The application of the controlled energy feeding strategy, whether by accident or design, in the close-up dry period only may not be advantageous (Cardoso et al., 2013). In addition to cases where restricted energy allowance precalving is planned, there are many cases of negatively altered metabolic status and negative energy balance prepartum that arise because of inadequate nutrition and management at farm level. These cases may have a greater effect on the health and productivity of cows as the degree of restriction may be more severe. However, severe under-feeding prepartum is not often documented as a result of controlled research but is generally identified through herd health investigations.

The consequences of BCS loss and negatively altered metabolic status prepartum for the metabolic status and BCS profile of postpartum cows are not commonly reported in the literature. Therefore, the objective of this study was to evaluate the effect of BCS loss 15 d before calving on serum metabolic compounds, mineral compounds, and milk production and composition. These cows consumed a diet that that met their prepartum energy requirements (AFRC, 1993).

MATERIALS AND METHODS

This study involved a retrospective analysis of BCS and lactation records. The study was approved by the Animal Research Ethics Committee of University College Dublin (Ireland) and was licensed by the Department of Health and Children, Ireland, in accordance with the Cruelty to Animals Act (Ireland 1876) and European Union Directive 86/609/EC.

Experimental Dairy Cows

This study was conducted using a commercial dairy farm supplying milk for liquid consumption in Ireland. There were a total of 220 Holstein-Friesian dairy cows on the farm, and cows with lameness and health issues were removed to reduce confounding. After removing these cows, 98 Holstein-Friesian spring-calving animals were monitored in this study. The calving period occurred from January to May with a mean calving date of March 4 (Table 1). The average 305-d milk yield of the previous lactations for the 67 multiparous cows was 8,800 ± 154 kg.

Cows were divided into 2 groups based on BCS change between d −15 (±2 d) and d 0 relative to calving. Cows that maintained their BCS were allocated to the **BCS-M** group, and cows that lost BCS in the same period

Table 1. Frequency of calving of cows that maintained (BCS-M) and cows that lost (BCS-L) body condition in the 15 d before calving for each month within parity

	Parity 1			Parity 2			Parity 3+			
Group	January	February	March	January	February	March	January	February	March	Total
BCS-M	13	2	8	3	2	7	2	7	11	55
BCS-L	2	2	4	2	4	9	4	4	12	43
Total	15	4	12	5	6	16	6	11	23	98