J. Dairy Sci. 98:1–19
http://dx.doi.org/10.3168/jds.2014-9269
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Effects of precalving body condition score and prepartum feeding level on production, reproduction, and health parameters in pasture-based transition dairy cows

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ABSTRACT

Precalving feeding level alters postcalving energy balance, dry matter intake, the liver and adipose tissue transcriptome, hepatic lipidosis, and the risk of metabolic diseases in both high-production cows consuming total mixed rations and moderate-production cows grazing pasture. We hypothesized that the reported benefits of a controlled restriction before calving are dependent on precalving body condition score (BCS): low BCS animals would not benefit from reduced feeding levels precalving, but high BCS cows would have metabolic and immunomodulatory profiles indicative of an improved health status. One hundred sixty-one days before calving, 150 cows were allocated randomly to 1 of 6 treatment groups (n = 25) in a 2 × 3 factorial arrangement: 2 precalving BCS categories (4.0 and 5.0; based on a 10-point scale: BCS4 and BCS5, respectively) and 3 levels of energy intake during the 3 wk preceding calving (75, 100, and 125% of estimated requirements). Cows in the BCS4 and BCS5 groups were managed through late lactation to ensure that target calving BCS was achieved at dry off. Cows were then fed to maintain this BCS target until 3 wk before expected calving date, at which point they were managed within their allotted precalving energy intake treatments by offering different allowances of fresh pasture/cow per day. Milk production, body weight, and BCS were measured weekly; blood was sampled weekly before and after calving and on d 0, 1, 2, 3, and 4 relative to calving. Aspirated plasma was assayed for nonesterified fatty acids, β-hydroxybutyrate, total protein, albumin, cholesterol, haptoglobin, IL-1β, IL-6, total antioxidant capacity, and reactive oxygen species. Liver was sampled wk 1, 2, and 4 postcalving for triacylglycerol analysis. Results confirm that precalving BCS and precalving feeding level have both independent and interdependent effects on production and health characteristics of transition dairy cows. Irrespective of precalving BCS, a controlled restriction precalving reduced the net release of nonesterified fatty acids from adipose tissue postpartum and increased plasma calcium concentrations, reducing the risk of milk fever. Fatter cows produced more milk but lost more BCS postcalving and had greater blood β-hydroxybutyrate concentrations and increased hepatic lipidosis. In comparison, after calving, indicators of reduced immune competence were accentuated in BCS4 cows subjected to a feed restriction before calving, probably increasing the risk of infectious diseases. It would appear from these results that optimally conditioned cows will benefit from a short-term (2–3 wk) controlled feed restriction (75–90% of requirements), whereas cows in less than optimal condition should be fed to requirements before calving.

Key words: transition cow, health, welfare, hypocalcemia

INTRODUCTION

The period of transition between late pregnancy and early lactation poses a significant metabolic challenge to the high-yielding dairy cow (Bell, 1995; Drackley, 1999). Roche (2012) estimated that the cost of failing to transition optimally between pregnancy and lactation cost the New Zealand dairy industry in excess of $1.0 billion per annum. Immune competence is compromised during this period (Burton et al., 2001), even in low- to moderate-yielding grazing dairy cows (Crookenden et al., 2014; Heiser et al., 2015); this is likely a major reason for cows failing to transition and

Received December 21, 2014.
Accepted June 2, 2015.
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may be responsible for the estimated 30 to 50% of dairy cows that experience health disorders in the period immediately postcalving (LeBlanc, 2010).

For almost a century, it has been accepted that dairy cows in the weeks preceding calving should be fed ad libitum amounts of high quality feeds. Boutflour (1928) identified "neglect of the preparation of the cow for her next lactation period" as 1 of the 4 factors most limiting milk production. In his article, he recommended "steaming up" the cow during the weeks precalving. Furthermore, epidemiological studies (Dyk et al., 1995; Sheehy et al., 2014) indicated positive associations between prepartum NEFA concentration or BCS loss and the incidence of postpartum metabolic and infectious diseases. Similarly, Bertics et al. (1992) concluded that providing cows with additional feed in the weeks before calving reduced liver triacylglycerol (**TAG**) concentration on the day of calving. Based on these results, it was concluded that BCS loss and NEFA release prepartum should be avoided.

Subsequent experiments designed to generate a controlled release of NEFA prepartum, however, did not identify the metabolic disturbances reported in the epidemiological studies (Agenäs et al., 2003; Holtenius et al., 2003; Roche et al., 2005; Douglas et al., 2006; Loor et al., 2006). In fact, energy balance (**EBAL**) and metabolic and molecular indicators of health were improved in the cows with higher NEFA prepartum in many studies (Roche et al., 2005; Douglas et al., 2006; Loor et al., 2006; Roche, 2007). These results, along with animal behavior data noting less time spent feeding and lower DMI before calving in animals that presented with infectious (Huzzey et al., 2007) and metabolic (Goldhawk et al., 2009) diseases after calving indicate that, although an increase in blood NEFA before calving was associated with postpartum disease, it was not causative. Subsequent studies (Janovick and Drackley, 2010; Janovick et al., 2011) have since confirmed that feeding a low-energy diet or restricting the volume of feed a cow consumes in the weeks before calving improves indicators of metabolic health.

Although there are an increasing number of studies aimed at understanding metabolic and molecular changes associated with dietary energy intake before calving (Schmitt et al., 2011; Akbar et al., 2013; Graugnard et al., 2013; Ji et al., 2014), the contributory factors remain poorly understood. One animal factor that could interact with precalving level of feeding is cow BCS. Fatter cows mobilize more BCS in early lactation and have reduced DMI and greater liver TAG (Bobe et al., 2004; Roche et al., 2009; Akbar et al., 2015). Consistent with the hypothesis that the effect of precalving level of feeding is dependent on precalving BCS, Roche et al. (2013) reported significant effects of calving BCS on cow metabolic profiles. Therefore, it is plausible that the reported effects of feeding less energy precalving are dependent on the BCS of the cow precalving, with fatter cows more likely to benefit from controlled NEFA release prepartum. The objective of the presented experiment was to determine the relationship between precalving BCS and level of feeding on production and reproduction variables and on indicators of metabolic health.

MATERIALS AND METHODS

The Ruakura Animal Ethics Committee (Hamilton, New Zealand) approved all animal manipulations in accordance with the New Zealand Animal Welfare Act (1999). The experiment was undertaken at Scott Farm, Hamilton, New Zealand. (37°46′S 175°18′E) between January and October 2013.

A group of 170 mid-lactation dairy cows of mixed age and breed (Holstein-Friesian, Jersey, Holstein-Friesian × Jersey) were considered as candidates for the experiment. From these, 150 cows that passed a veterinary clinical examination, which included a full pathology health panel, were enrolled in the experiment on January 21, 2013. Cows were allocated randomly to 1 of 6 treatment groups (25 cows per group) in a 2 × 3 factorial arrangement: 2 precalving BCS categories (4.0 and 5.0; based on a 10-point scale, where 1 is emaciated and 10 obese; Roche et al., 2004: **BCS4** and **BCS5**, respectively) and 3 levels of energy intake during the 3 wk preceding calving (75, 100, and 125% of estimated requirements; Roche et al., 2005: **Feed75**, **Feed100**, and **Feed125**, respectively). Although cow allocation to treatment was random, groups were assessed to ensure they were balanced for age, breed, BCS at the time of enrolment, and expected calving date. Age at enrollment was 4.0 ± 1.4 yr (mean ± SD). Mean calving date was July 11 ± 10.2 d.

Approach to Establish Treatment Groups

From February 1 (205 DIM), feeding levels were manipulated with the intention of generating the 2 BCS treatment groups (n = 75) before the end of lactation. Three groups of cows were managed separately to achieve the treatment target by being assigned to gain, maintain, or lose BCS groups. Cows in all treatment groups grazed an allowance of fresh pasture and were supplemented with pasture silage, corn silage, and palm kernel expeller. Estimated total DMI was 5.7 ± 0.83, 8.7 ± 1.60, and 13.4 ± 2.90 kg/d for lose, maintain, and gain BCS groups, respectively. Blood was sampled

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