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Behavioral and physiological effects of a short-term feed restriction in lactating dairy cattle with different body condition scores at calving

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ABSTRACT

Body condition score (BCS) around calving, and the typical BCS loss for up to 100 d after parturition, is associated with both production and reproductive performance of dairy cattle. In addition, there is public concern that thin cows may have impaired welfare, particularly in early lactation where feed demand exceeds pasture growth, and a lag exists between peak milk energy requirements and intake. The aim of this experiment was to determine how BCS at calving influences behavioral and physiological responses to a short-term feed restriction at 47 DIM. Body condition score (on a 10-point scale) at calving was manipulated by modifying the diets in the previous lactation of healthy dairy cattle to generate 3 treatment groups: low BCS (3.4; n = 17), medium BCS (4.6; n = 18), or high BCS (5.4; n = 20). Cows were tested in 4 groups for 8 consecutive days; testing consisted of different levels of feed allocation (d 1 and 2: 100%; d 3 and 4: 75%; d 5: 50%; d 6 to 8: 125%), where 100% was 15 kg of DM/cow per day. All BCS groups had similar and marked behavioral and physiological responses to feed restriction. For example, they increased vocalization, time spent eating silage and grazing, aggressive behavior, and fat metabolism (as measured by concentrations of β–hydroxybutyrate and nonesterified fatty acids), and reduced milk production. Body condition affected some of these responses. Fewer cows with low BCS engaged in aggressive interactions in a feed competition test (trough filled with silage that could be consumed in 15 min) on the first day of feed restriction (low: 32%; medium: 74%; high: 64%; standard error of difference = 15.4%). High BCS cows had greater concentrations of β–hydroxybutyrate and nonesterified fatty acids throughout the experimental period, which suggests more fat mobilization; however, plasma leptin and fecal glucocorticosteroid metabolite concentrations were unaffected by BCS. Whereas cows demonstrated marked responses to feed restriction, the results suggest that a BCS of 3.4, 4.6, or 5.4 in healthy cows at calving does not overwhelmingly influence this response at 47 DIM.

Key words: feed restriction, animal welfare, pasture

INTRODUCTION

Body condition score at calving and the subsequent BCS loss for 50 to 100 d DIM are associated with production and reproductive performance (reviewed by Roche et al., 2009). When cows are over-conditioned at calving, subsequent health issues and reduced production have been reported. For example, high-producing cows with a high BCS at calving consume less DM in early lactation, produce less milk, and are at increased risk of metabolic disorders, such as ketosis, fatty liver, and milk fever (Heuer et al., 1999; Ingvartsen, 2006; Roche and Berry, 2006; Roche et al., 2009), and are more likely to develop lameness in late lactation (Gearhart et al., 1990). In contrast, cows with a low BCS are at an increased risk of reproductive failure (Heuer et al., 1999; Roche et al., 2007b, 2009) and have low peak milk yield (Frood and Croxton, 1978; Roche et al., 2007a, 2009). In addition, there is public concern that thin cows may have impaired welfare, although the scientific evidence for this is limited.

A cow's BCS may influence how it responds to environmental challenges, such as exposure to inclement weather conditions. Energy reserves are used to mitigate the negative effects of winter weather; therefore, thin cows may be more sensitive to cold weather. When exposed to artificial rain and wind, low BCS cows spent more time eating silage and less time lying down compared with high BCS cows (BCS 4 vs. 9 on a 10-point scale; Tucker et al., 2007). Low BCS cows also had a lower minimum body temperature and NEFA concentrations compared with high BCS cows (Tucker et al.,

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2007). Collectively, these results suggest a protective effect of BCS, at least at very high levels of condition, against inclement winter weather.

Feed availability in pasture-based dairy systems varies throughout the year and may sometimes be limited, especially in winter and early spring. This is of particular concern in seasonal calving systems, where feed demand exceeds pasture growth, and a lag between peak milk energy requirements and DMI exists. In general, cattle respond to limited feed availability with a range of behavioral and physiological mechanisms. Behavioral responses to food shortage include increased grazing times (Phillips and Hecheimi, 1989; Gibb et al., 1999; Rook, 2005) and aggression between animals as competition for feed increases (limited feeding space; DeVries et al., 2004). Physiological responses to feed shortage include elevated cortisol (Ward et al., 1992) and NEFA concentrations (Agenäs et al., 2003; Chelikani et al., 2004; Roche, 2007; Laeger et al., 2012), reduced immune function (Moyes et al., 2010), as well as reduced milk production (Agenäs et al., 2003; Roche, 2007). When feed is readily available, low BCS cows consume more feed (Broster and Broster, 1998; Hayirli et al., 2002; Matthews et al., 2012) and spend more time eating compared with high BCS cows (Tucker et al., 2007; Matthews et al., 2012); however, little is known about how BCS at calving interacts with a period of feed restriction after parturition to affect cow behavior and metabolism. It is possible that if low BCS cows cannot meet their nutritional requirements, their welfare is more likely to be impaired due to the continued depletion of body reserves.

The aim of this experiment was to determine how BCS at calving influences behavioral and physiological responses to a short-term feed restriction in lactating cows. Experimental groups of cows with a calving BCS of 3.4, 4.6, or 5.4 (on a 10-point scale; Roche et al., 2004) were created by modifying their diet during the previous lactation, and the response to a short-term feed restriction was investigated at 47 DIM, when nutrient requirements are high and pasture availability may be low in seasonal calving pasture-based systems. It was predicted that all cows would demonstrate behavioral and physiological responses to the feed restriction after parturition, but that cows with low calving BCS would demonstrate a more marked response.

MATERIALS AND METHODS

Animals and Treatments

All procedures involving animals in this study were approved by the Ruakura Animal Ethics Committee under the New Zealand Animal Welfare Act 1999. The current study was a part of a larger investigation aiming to explore the welfare of dairy cattle calving at BCS 3.5, 4.5, or 5.5. The study was undertaken at the DairyNZ Lye Farm, Hamilton, New Zealand (37°76′S 175°37′E). A group of 60 healthy (as determined by a veterinary clinical examination) cows without previous history of disease, including mastitis, and confirmed pregnancy status, were enrolled in the experiment on 1 February 2011.

Cows were allocated randomly to treatment groups (20 cows per group), ensuring treatments 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 expected calving date was 9 July ± 9 d. Fourteen cows in each group were Holstein-Friesian, with the balance being 75% Holstein-Friesian and 25% Jersey-cross.

From 1 February, feeding levels were manipulated with the intention of generating 3 BCS groups before the end of lactation; target BCS at drying off was 5.0, 4.0, and 3.0 for the high, medium, and low groups, respectively (based on a 10-point scale, where 1 is emaciated and 10 obese; Roche et al., 2004). Following drying off (all cows had a minimum dry period of 60 d), cows were offered pasture and supplements to allow for fetal growth and a gain of 0.5 BCS units before calving, with the intention that mean calving BCS would be 5.5, 4.5, and 3.5, for the high, medium, and low groups, respectively. This would be equivalent to 3.3, 2.9, and 2.6, respectively, in systems based on a 5-point scale (Roche et al., 2004).

During late lactation, daily feed allowances took into account the average BCS state of the group and the proposed trajectory of BCS change. Cows in the high, medium, and low treatments had an estimated daily DMI of fresh pasture of 12.3 (± 3.38), 11.2 (± 2.26), and 6.8 (± 1.69) kg of DM, respectively. Maize and pasture silage, and rolled maize grain were provided to supplement DMI when pasture availability did not meet cow requirements. Allocated feed supplements were weighed, and estimations of wastage are included in the final calculation of DMI from these sources (Table 1). When an individual cow's BCS was not tracking toward the treatment target, she was moved to a group with a feeding regimen that facilitated the desired change. Groups grazed the same paddock with electric fences separating them. Mean pasture DMI was calculated as the product of the difference between the pre- and postgrazing pasture mass and area grazed on 3 d/wk, as outlined by Roche et al. (2005). Pasture and supplementary feed samples representative of what the cows were offered were collected and processed for quality analysis. Feed samples were oven-dried at 60°C, ground to pass through a 0.5-mm sieve (Christy Laboratory