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Severity of Ruminal Acidosis in Primiparous Holstein Cows During the Periparturient Period

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ABSTRACT

The objectives of this study were: 1) to determine the effect of providing additional prepartum concentrate on the occurrence and severity of ruminal acidosis (RA) and lactational performance during the periparturient period in primiparous cows; and 2) to characterize the occurrence and severity of RA during the periparturient period. We hypothesized that providing additional concentrate prepartum would reduce postpartum RA. Fourteen ruminally cannulated Holstein heifers were paired by expected calving date and body condition score. The heifers were assigned to 1 of 2 prepartum feeding regimens: 1) a control treatment consisting of a far-off diet (forage:concentrate, F:C = 80:20) fed from d –60 to d –25 and a close-up diet (F:C = 54:46) fed from d –24 until parturition; or 2) a high-concentrate (HC) feeding program consisting of 4 prepartum diets, HC-1 (F:C = 68:32) fed from d –60 to d –43, HC-2 (F:C = 60:40) fed from d –42 to d –25, HC-3 (F:C = 52:48) fed from d –24 to d –13, and HC-4 (F:C = 46:54) fed from d –12 until parturition. All cows received the same lactation diet postpartum. Ruminal pH was measured continuously from d –5 to d +5, and for 3 consecutive days starting on d +17 ± 1.2, d +37 ± 1.4, and d +58 ± 1.5 relative to parturition using an indwelling ruminal pH system. Ruminal acidosis was considered to occur when ruminal pH was <5.8 (total RA). Ruminal acidosis was further partitioned into: 1) mild RA (5.8 > ruminal pH > 5.5), 2) moderate RA (5.5 > ruminal pH > 5.2), and 3) acute RA (ruminal pH < 5.2). Feeding additional concentrate prepartum did not reduce postpartum RA. In fact, cows fed the HC treatment had more daily episodes of acute RA than cows fed the control treatment. Day relative to parturition affected the occurrence and severity of RA; RA increased following parturition and was sustained thereafter. The DM intake during the last 5 d of gestation was lower for cows fed the HC treatment compared with cows fed the control treatment, but lactational performance was not affected. We conclude that, under the conditions imposed, feeding additional concentrate prepartum does not reduce postpartum RA. Furthermore, the incidence and severity of RA increases immediately postpartum, emphasizing the need to develop and implement feeding strategies that reduce this risk.

Key words: ruminal acidosis, dairy cow, transition period

INTRODUCTION

Transition cows undergo drastic metabolic and hormonal changes in response to increased nutrient demands of the growing fetus, parturition, and the onset of lactation (Grummer, 1995; Dann et al., 1999; Drackley, 1999). The majority of these changes increase the cow's susceptibility to metabolic disorders immediately before and after parturition (Drackley, 1999). In first-lactation heifers, body growth also competes for nutrients (NRC, 2001). As parturition approaches, DMI decreases (Hayirli et al., 2003) but nutrient requirements increase (NRC, 2001). To account for the reduction in DMI as parturition approaches, various nutritional strategies have been developed. One particular strategy is to increase the dietary energy density by including higher proportions of concentrate (McNamara et al., 2003; Rabelo et al., 2003). However, feeding a diet with low NDF content often results in a greater magnitude of DMI depression near parturition (Hayirli et al., 2003; Rabelo et al., 2003). Positive benefits of supplying more concentrate prepartum include improved growth of ruminal papillae (Dirksen et al., 1985) and changes in ruminal microflora (Tajima et al., 2000) such that the rumen is better adapted to the energy-dense diet fed postpartum (NRC, 2001). Postpartum diets often contain high levels of fermentable carbohydrate and low levels of fiber to maximize energy intake. Large changes in dietary composition, which occur at parturition, increase the risk of ruminal acidosis (**RA**; Nocek, 1997). This problem may be exacerbated in primiparous cows when compared with multiparous cows because primiparous cows have not had previous long-term exposure to a highly fermentable lactation diet.

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Krause and Oetzel (2006) investigated the incidence of RA postpartum using clinical observation data and reported that primiparous cows had a higher risk of RA than multiparous cows.

Gröhn and Bruss (1990) conducted a large epidemiological study (>60,000 cows) and found that the greatest number of cases of RA were diagnosed during the first few months after calving. Although Gröhn and Bruss (1990) have characterized the occurrence of RA throughout the production cycle, only one spot sample of ruminal fluid was collected for ruminal pH measurement, and pH paper was used as an indicator of low ruminal pH. As a result, only qualitative assessments were made based on irregular sampling; thus, many cases of subacute RA would have gone undetected. Furthermore, Gröhn and Bruss (1990) did not report any dietary information. In contrast, Krause and Oetzel (2006) conducted a review of subacute RA and reported that the risk for RA increases with increasing DIM, corresponding to increasing DMI.

To understand ruminal pH dynamics during the periparturient period, it is important to comprehensively measure ruminal pH daily and relate the results to dietary treatment. Previously, the lack of equipment available for continuous ruminal pH measurement in unrestrained cows limited measurements in transition cows. However, Penner et al. (2006) developed a new system capable of continuous ruminal pH measurement in unrestrained cattle. This system can characterize ruminal pH in applications in which continuous measurement was previously not feasible. The first objective of this study was to determine the effect of additional prepartum concentrate allocation on postpartum RA and lactational performance. The second objective was to characterize the occurrence and severity of RA in primiparous Holstein cows during the periparturient period. We hypothesized that the occurrence and severity of RA would increase postpartum, but feeding additional concentrate prepartum would ameliorate postpartum RA.

MATERIALS AND METHODS

Experimental Design and Animals

Eighteen Holstein heifers were used in a completely randomized design with 2 dietary treatments. Heifers, rather than multiparous cows, were used in this study because few published studies have examined feeding strategies to transition heifers from a pregnant nonlactating state to a nonpregnant lactating state. Furthermore, the inclusion of parity as an additional factor in the experiment would have reduced the statistical power had an interaction between diet and parity occurred. The experiment began in March 2005 and ended in November 2005. Individual cows were monitored from 60 d before the expected calving date until 60 d after calving. Heifers were fitted with a ruminal cannula (Bar Diamond, Parma, ID) between 70 and 100 d in gestation and were housed at the Lethbridge Research Center Dairy and Metabolism Facility (Lethbridge, Alberta, Canada). Cows were weighed on 2 consecutive days and BCS was determined (Wildman et al., 1982) prior to the start of the study, before each diet change, and on d +17 ± 1.2, d +37 ± 1.4, and d +58 ± 1.5 postcalving. After parturition, cows were milked twice daily at 0630 and 1630 h and milk yield was recorded. Mean and standard deviation values for BW, BCS (5-point scale), and DMI at the start of the study (d –58 ± 4.7 relative to parturition) were 633 ± 52.0 kg, 3.5 ± 0.23, and 12.0 ± 1.44 kg/d, respectively. All procedures were approved by the Lethbridge Research Center Animal Care Committee and were in accordance with the guidelines of the Canadian Council of Animal Care (Ottawa, Ontario, Canada).

Experimental Treatments

Heifers were paired by expected calving date and BCS and assigned to: 1) control treatment consisting of a far-off diet (forage:concentrate, **F:C** = 81:19) fed from d –60 to d –25 and a close-up diet (F:C = 54:46) fed from d –24 until parturition; or 2) a high-concentrate (**HC**) feeding program consisting of 4 prepartum diets, HC-1 (F:C = 68:32) fed from d –60 to d –43, HC-2 (F:C = 59:41) fed from d –42 to d –25, HC-3 (F:C = 52:48) fed from d –24 to d –13, and HC-4 (F:C = 47:53) fed from d –12 until parturition. All cows received the same lactation diet postpartum. The control treatment was designed to reflect the NRC (2001) recommendations for transitioning a heifer from a nonlactating pregnant state to a nonpregnant lactating state. In contrast, the HC treatment was designed to provide additional energy prepartum by increasing the proportion of concentrate. The pelleted concentrate used for the HC treatment included ground barley grain and nonforage fiber sources such as wheat middlings, dried beet pulp, and dry corn distillers grains (Table 1). Diets HC-1 and HC-2 were formulated to have CP contents similar to the far-off control diet, whereas diets HC-3 and HC-4 were formulated to have CP contents similar to the close-up control diet. The F:C ratio of the HC diets was altered by decreasing the proportion of barley silage and grass hay (the ratio of barley silage to grass hay was maintained) and increasing the proportion of nonforage fiber sources (wheat middlings, dried beet pulp, and dried distillers grains) and barley grain. Diets were formulated using the Cornell-Penn-Miner System (cpm Dairy, Version 3.0.4a; University of Pennsylvania, Ken-