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Extended negative dietary cation-anion difference feeding does not negatively affect postpartum performance of multiparous dairy cows

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ABSTRACT

Low postpartum blood calcium remains one of the largest constraints to postpartum feed intake, milk yield, and energy balance in transitioning dairy cows. Supplemental dietary anions decrease the dietary cation-anion difference (DCAD) and reduce the risk for postpartum hypocalcemia. Prepartum management strategies aiming to minimize social stress and diet changes have resulted in a need to explore the effects of extended exposure to a negative DCAD (>21 d) diet. Holstein and Holstein-cross dairy cows (n = 60) were assigned to 1 of 3 treatments 42 d before expected calving to evaluate effects of supplying anions for 21 or 42 d during the dry period on energy status, postpartum production, and Ca homeostasis. Treatments included (1) a control diet (CON; DCAD = 12 mEq/100 g ofDM), (2) a 21-d negative DCAD diet (21-ND; DCAD = 12 and −16 mEq/100 g of DM), and (3) a 42-d negative DCAD diet (42-ND; DCAD = −16 mEq/100 g of DM). Cows fed CON were fed positive DCAD prepartum for 42 d. Cows fed 21-ND received the positive DCAD (12 mEq/100 g of DM) diet for the first 21 d of the dry period and the anionic diet (−16 mEq/100 g of DM) from d 22 until calving. Cows fed 42-ND received the anionic diet for the entire dry period. Control and anionic diets were formulated by using 2 isonitrogenous protein mixes: (1) 97.5% soybean meal and (2) 52.8% BioChlor (Church & Dwight Co. Inc.), 45.8% soybean meal. Supplementing anions induced a mild metabolic acidosis, reducing urine pH for 21-ND and 42-ND compared with CON. Prepartum DMI was not different among treatments. Postpartum DMI was higher for 21-ND compared with CON (20.8 vs. 18.1 ± 1.1 kg/d), and 42-ND had similar DMI compared with 21-ND. During the first 56 d of lactation 21-ND had greater average milk production compared with CON (44.8 vs. 39.2 ± 2.1 kg/d). Average milk production by 42-ND was similar to 21-ND. Postpartum total blood Ca concentration was greater for 42-ND. Cows fed anionic diets prepartum tended to have lower lipid accumulation in the liver after calving compared with CON. These data suggest low-DCAD diets fed for 21 or 42 d during the dry period can have positive effects on postpartum DMI, Ca homeostasis, and milk production.

Key words: dietary cation-anion difference, hypocalcemia, transition dairy cow

INTRODUCTION

Low postpartum blood calcium continues to affect upwards of 10% of dairy cows clinically (milk fever) and 50% subclinically (hypocalcemia), depending on cow age and number of lactations (Reinhardt et al., 2011). According to the NAHMS (2007) survey, 26.7% of producers supplement anions to decrease the DCAD of the prepartum diet to aid against hypocalcemia (<8 mg/dL total blood Ca; DeGaris and Lean, 2008). Supplementation of anions in the form of anionic salts has often resulted in reduced DMI during the prepartum period (Gaynor et al., 1989; Leclerc and Block, 1989; Oetzel and Barmore, 1993; Joyce et al., 1997; Vagnoni and Oetzel, 1998; Moore et al., 2000). To avoid using anionic products, or to decrease the extent of anionic supplementation needed to lower DCAD in the prepartum diet, a large percentage of producers (46.9%) are selecting low-potassium forages as an alternative method to prevent hypocalcemia (NAHMS, 2007). Few studies (Moore et al., 2000; Siciliano-Jones et al., 2008; Ramos-Nieves et al., 2009) assess the need for anionic supplementation when feeding a low-cation prepartum diet.

Additionally, producers have expressed interest in grouping cohorts of dry cows with similar calving dates in the same pen to achieve the all-in, all-out strategy. Benefits of this strategy are discussed by Nordlund et al. (2006) and Nordlund (2009), and include decreased social stress due to fewer additions and removals of cows within prefresh pens. This strategy can encourage consistent DMI during the prepartum period by limiting re-establishments of hierarchies, competition for feed, and feed bunk displacements (Hasegawa et al., 1997; von Keyserlingk et al., 2008).

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In an effort to reduce stresses associated with cow movement and to reduce feeding management issues, 1 dry cow diet could be fed to cows grouped by these recommendations; however, limited research is available on extended negative DCAD feeding. Current feeding strategies for supplementing anions during the prepartum period are largely based on results reported by Oetzel et al. (1988), who discovered improvements in postpartum blood Ca and decreased hypocalcemia could be made by the inclusion of dietary anions for 21 d prepartum. However, research (Block, 1984) suggests extended negative DCAD may be more beneficial to transition cows to improve Ca homeostasis through calving and increase postpartum performance.

The objectives of this study were to re-evaluate the benefits of reduced DCAD in prepartum diets inherently low in cations due to selection of low-potassium forages and, second, to explore the effects of extended negative DCAD feeding on Ca homeostasis, DMI, and, thus, energy status and postpartum milk yield. We hypothesized that feeding a negative DCAD 21 d prepartum would result in greater postpartum performance compared with control and, second, negative DCAD for 21 and 42 d would result in similar performance.

MATERIALS AND METHODS

Treatments

Ration-balancing software, CPM Dairy (Version 3.0.8; Cornell University, Ithaca, NY; University of Pennsylvania, Kennett Square, PA; and William H. Miner Agricultural Research Institute, Chazy, NY), was used to formulate diets supplying adequate NE_L and metabolizable protein for 650-kg dry cows 280 d in gestation. Positive and negative DCAD diets were produced by altering the ingredient composition (Table 1) of the prepartum protein mixes. Diet nutrient profiles are described in Table 2. Crude protein concentrations of the dry cow diets were higher than anticipated. Additional amounts of anions were necessary to maintain a urine pH in the optimal range identified for Ca homeostasis (Goff, 2008). Ultimately, this led to an increase in dry cow diet CP amounts, as the DCAD-lowering feed additive was blended with the protein source. Crude protein concentration of the control diet were adjusted accordingly to keep prepartum diets isonitrogenous. Dietary cation-anion difference (DM basis) of the prepartum diets was determined through weekly collection of individual ingredients, which were composited by ingredient by month and analyzed for mineral content (AOAC, 1995) in addition to nutrient analysis. Nutrient and mineral profiles of each ingredient were entered into CPM Dairy to calculate DCAD for each treatment on a monthly basis. Treatments included (1) a 42-d control diet (**CON**; DCAD 12 mEq/100 g of DM), (2) a 21-d BioChlor diet (**21-ND**; Church & Dwight Co. Inc.; DCAD 12 and −16 mEq/100 g of DM), and (3) a 42-d BioChlor diet (**42-ND**; Church & Dwight Co. Inc.; DCAD −16 mEq/100 g of DM). The control group received the positive DCAD from d −42 until parturition, with cows on 21-ND receiving the positive DCAD (CON) from d −42 through −22 and the negative DCAD from d −21 to parturition. The 42-ND treatment group received the negative DCAD for the entire 42-d dry period.

Assignment to Treatments

On d −42 before expected calving date, 60 multiparous Holstein and Holstein-cross dairy cows were placed on 1 of 3 prepartum treatments. Prior to the start of the trial, treatment groups were balanced (Table 3) for previous 305 d mature-equivalent milk yield (11,343.0 ± 1,754.0 kg; mean ± SD), BW at dry-off (643.5 ± 96.7 kg), BCS at dry-off (3.3 ± 0.3 points), and parity (2.0 ± 1.2 lactations). Days dry were similar (P = 0.89) among treatments (44.9 ± 7.9 d). One cow from both CON and 21-ND were removed due to unidentified health complications 1 wk postpartum. Three cows from 21-ND prematurely calved (>3 wk early), resulting in their removal from the analysis. Dystocia associated with twinning resulted in loss of 1 cow from CON. A cow from 21-ND was removed due to development of an abomasal ulcer, and 1 cow from both 21-ND and 42-ND were removed due to developed lameness (Table 3). All prepartum and postpartum data from removed cows were absent from analysis.

Animal Housing and Management

The experimental protocol was reviewed and approved by the University of Minnesota Institutional Animal Care and Use Committee (IACUC# 1008A87152). Cows were housed in a tiestall barn on rubber mattresses bedded daily with sawdust. Cows were fed in individual feed bunks once daily prepartum at 1100 h. After calving all cows received a common lactation diet (Tables 1 and 2) and were fed twice daily at 0600 and 1200 h. Feed was offered at approximately 10 and 90% of the daily allocation for the morning and afternoon feeding, respectively. Cows were milked twice daily at 0200 and 1400 h.

Sample Collection and Preparation

Feed Collection and Analysis. Individual feed ingredients comprising the dry cow diets and lactation diet

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