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Effect of feeding a negative dietary cation-anion difference diet for an extended time prepartum on postpartum serum and urine metabolites and performance

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ABSTRACT

Forty-five multiparous Holstein cows and 15 springing Holstein heifers were used in a randomized block design trial to determine the effect of length of feeding a negative dietary anion-cation difference (DCAD) diet prepartum on serum and urine metabolites, dry matter (DM) intake, and milk yield and composition. After training to eat through Calan doors (American Calan Inc., Northwood, NH), cows within parity were assigned randomly to 1 of 3 treatments and fed a negative-DCAD diet for 3 (3W), 4 (4W), or 6 wk (6W) before predicted calving. Actual days cows were fed negative-DCAD diets was 19.2 ± 4.1, 27.9 ± 3.1, and 41.5 ± 4.1d for 3W, 4W, and 6W, respectively. Before the trial, all cows were fed a high-forage, low-energy diet. During the trial, cows were fed a diet formulated for late gestation (14.6% CP, 42.3% NDF, 20.5% starch, 7.1% ash, and 0.97% Ca) supplemented with Animate (Prince Agri Products Inc., Quincy, IL), with a resulting DCAD (Na + K − Cl − S) of −21.02 mEq/100 g of DM. After calving, cows were fed a diet formulated for early lactation (18.0% CP, 36.4% NDF, 24.2% starch, 8.1% ash, and 0.94% Ca) for the following 6 wk with a DCAD of 20.55 mEq/100 g of DM. Urine pH was not different among treatments before calving and averaged 6.36. No differences were observed in prepartum DM intake, which averaged 11.4, 11.5, and 11.7 kg/d for 3W, 4W, and 6W, respectively. Prepartum serum total protein, albumin, and Ca concentrations, and anion gap were within normal limits but decreased linearly with increasing time cows were fed a negative-DCAD diet. No differences were observed in serum metabolite concentrations on the day of calving. Postpartum, serum total protein and globulin concentrations increased linearly with increasing length of time the negative-DCAD diet was fed. No differences were observed in postpartum DM intake, milk yield, or concentration of fat or protein among treatments: 19.1 kg/d, 40.6 kg/d, 4.30%, and 2.80%; 19.6 kg/d, 41.5 kg/d, 4.50%, and 2.90%; and 18.6 kg/d, 41.0 kg/d, 4.30%, and 2.73% for 3W, 4W, and 6W, respectively. Results of this trial indicate that no differences existed in health or milk production or components in cows fed a negative-DCAD diet for up to 6 wk prepartum compared with those fed a negative-DCAD diet for 3 or 4 wk prepartum.
Key words: dietary cation-anion difference, milk yield, milk composition

INTRODUCTION

The transition from late gestation to lactation requires enormous physiological adaptations by the dairy cow, which can significantly affect the following lactation and subsequent reproduction. Nutrition management during the transition period is challenged by reduced DMI during the late-gestation period coupled with a drastic increase in nutrient requirements following calving. One of the most significant challenges involves Ca homeostasis and can result in clinical or subclinical hypocalcaemia. Block (1984) reported that cows experiencing clinical hypocalcaemia during the immediate periparturient period produced 14% less milk than cows with normal serum Ca concentrations. In addition to decreased milk yield, cows that experienced clinical or subclinical hypocalcaemia are at greater risk for developing other metabolic disorders (Curtis et al., 1985). Feeding negative DCAD diets prepartum stimulated Ca absorption and mobilization, thus preventing hypocalcaemia, and maintained DMI and improved milk yield postpartum (Block, 1984; DeGroot et al., 2010).

Animate (Prince Agri Products Inc., Quincy, IL) is an anionic mineral supplement containing (% of DM), 13.9% Cl, 5.4% S, 4.8% Mg, and 39.0% CP that is designed for use in close-up dry cow diets to acidify the diet, reducing the incidence of clinical and subclinical hypocalcaemia, resulting in greater DMI and milk yield postpartum (Puntenney, 2006). Feeding a

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negative-DCAD diet starting 21 d prepartum was shown to be effective in preventing hypocalcaemia (Chan et al., 2006; DeGroot et al., 2010). Degaris et al. (2008) reported increased ECM and milk protein yield postpartum when cows were fed prepartum transition diets with a DCAD of −15 mEq/100 g for 25 and 22 d prepartum, respectively. Most studies have focused on the effect of feeding variable levels of DCAD, whereas limited research has been conducted on the length of feeding a DCAD diet to transition cows. The objective of this study was to evaluate the effects of length of time feeding a negative-DCAD diet prepartum on serum metabolites and performance postpartum.

MATERIALS AND METHODS

Forty-five dairy cows and 15 primiparous Holstein heifers were used in a randomized block design trial starting 21 ± 3, 28 ± 3, or 42 ± 3 d prepartum. Cows were assigned to treatment based on expected calving date and parity. Because some cows calved earlier or later than expected, treatment assignments were based on days fed the negative-DCAD diet according to actual calving date and was defined as less than 24 d (**3W**), 25 to 34 d (**4W**), or longer than 36 d (**6W**) providing 23, 18, and 18 animals for each treatment, respectively. One primiparous cow was removed from the trial because of a breech birth. All protocols were approved by the University of Georgia Institutional Animal Care and Use Committee (Tifton).

Prior to beginning the trial, cows were fed a high-fiber, low-energy diet based on bermudagrass baleage, corn silage, and supplemental concentration to meet NRC (2001) requirements for protein, minerals, and vitamins. Before beginning the trial, cows were trained to eat through Calan doors (American Calan Inc., Northwood, NH). Cows were housed in a freestall barn equipped with fans and misters and were allowed unlimited access to an exercise lot. Cows were moved to either the grassed lot or a box stall at calving and returned to the freestall area after calving.

Experimental diets were formulated to meet NRC (2001) requirements for late gestation and early lactation (Table 1). Animate (anionic mineral supplement; Prince Agri Products Inc., Quincy, IL) was included in the late-gestation diet as an acidifying agent. The amount fed was adjusted after measuring urinary pH to maintain a pH within the range of 6.0 to 6.5 during the first days of the trial. Once the amount required to achieve the desired pH was determined, the amount fed was maintained throughout the trial as outlined in Table 1. Experimental diets were mixed and fed once daily using a DataRanger mixer (American Calan Inc.). Cows had free access to water throughout the day. The amount of feed provided was adjusted to maintain a minimum of 5% refusal. The amount of feed offered and refused was recorded daily.

Table 1. Ingredient composition of experimental diets (% of DM)

	Diet	
Ingredient	Prepartum	Postpartum
Corn silage	42.86	35.59
Alfalfa hay	5.95	
Ryegrass baleage		9.79
Bermudagrass baleage	7.94	
Whole cottonseed		8.90
Ground corn	8.93	16.55
Brewers grains, wet	7.94	12.46
Citrus pulp	3.97	4.45
Soybean hulls (pelleted)	7.94	
Animate[1]	4.56	
Soybean meal (48% CP)	5.95	3.56
AminoPlus[2]		1.78
Prolak[3]	0.79	3.20
Sodium bicarbonate		0.89
Magnesium oxide	0.16	0.36
Calcium carbonate	1.19	1.07
Salt		0.18
Potassium carbonate		0.27
Yeast culture	0.50	0.22
Trace mineral	0.14	0.14
Vitamin E	0.14	0.02
Rumensin (3 g/lb)[4]	0.48	0.34
Zinpro Availa-4[5]	0.08	0.04
OmniGen-AF[6]	0.50	0.22

[1]Anionic mineral supplement, Prince Agri Products Inc. (Quincy, IL).
[2]Ruminally protected soybean meal (Ag Processing Inc. Omaha, NE).
[3]Marine and animal rumen-undegradable protein supplement (H. J. Baker & Bro. Inc. Westport, CT).
[4]Elanco Animal Health (Indianapolis, IN).
[5]Organic zinc, manganese, copper, and cobalt (Zinpro Corp., Eden Prairie, MN).
[6]Immune modulator (Prince Agri Products Inc.).

Samples of dietary ingredients, TMR, and orts were collected 3 d each week and analyzed for DM content by drying samples at 50°C for 48 h in a forced-air oven. Individual samples were ground to pass through a 6-mm screen using a Wiley mill (Thomas Scientific, Swedesboro, NJ), and composited by week. A subsample was ground to pass through a 1-mm screen before analysis of ash (AOAC International, 2000), N (Leco FP-528 Nitrogen Analyzer; Leco Corp., St. Joseph, MO), NDF (Van Soest et al., 1991), ADF (AOAC International, 2000), starch (Hall, 2009), sugar (DuBois et al., 1956), and ether extract and minerals (AOAC International, 2000).

After calving, cows were milked 3 times daily beginning at 0000, 0800, and 1600 h. Milk weights were recorded electronically at each milking (Alpro; DeLaval Inc., Kansas City, MO), totaled each day, and a weekly average calculated. Milk samples were collected from 3 consecutive milkings each week for analysis of fat, protein, lactose, SNF, and MUN concentrations by