J. Dairy Sci. 101:1–4
https://doi.org/10.3168/jds.2018-14829

Short communication: Blood mineral and gas concentrations of calves born to cows fed prepartum diets differing in dietary cation-anion difference and calcium concentration

A. L. Diehl,* J. K. Bernard,*[1] S. Tao,* T. N. Smith,* T. Marins,* D. J. Kirk,† D. J. McLean,† and J. D. Chapman†
*Department of Animal and Dairy Science, University of Georgia, Tifton 31793
†Phibro Animal Health Corp., Teaneck, NJ 07666

ABSTRACT

Eighty-two multiparous Holstein cows were fed diets differing in dietary cation-anion difference (DCAD) and Ca concentrations in a randomized block design experiment beginning 4 wk before anticipated calving to determine the effects on colostrum yield and quality and acid-base balance and mineral status of newborn calves. Treatments were arranged as a 2 × 2 factorial to provide 2 DCAD [−22 mEq/100 g of dry matter (NEG) or −3 mEq/100 g of dry matter (NEU)] and 2 supplemental Ca concentrations (1.3 or 1.8% of dry matter). After calving, cows were milked within 2 to 8 h and colostrum yield was recorded. Calves were fed 200 g of IgG of a commercial colostrum replacer within 4 h of birth. No differences were observed in birth weight or dystocia score among treatments, which averaged 42.7 kg and 1.12, respectively. Colostrum yield was not different among treatments and averaged 8.75 kg. Colostrum quality, as measured using a Brix refractometer, was not affected by DCAD but was higher for 1.3% compared with 1.8% Ca: 21.58% and 19.87%, respectively. Colostrum IgG concentrations were higher for NEG compared with NEU and for 1.3% compared with 1.8% Ca. No differences were observed in concentrations of serum IgG, Ca, P, K, Cl, anion gap, or whole blood pH, partial pressure of O_2, or SO_2 of calves among treatments. Serum Mg and lactate concentrations were higher and CO_2 tended to be lower for calves born to cows fed 1.3% compared with 1.8% Ca. Interactions of DCAD and Ca were observed for serum Na and Cl, which were higher for NEU-1.3% Ca and NEG-1.8% Ca compared with NEU-1.8% Ca and NEG-1.3% Ca. Whole blood partial pressure of CO_2, and HCO_3 exhibited an interaction of DCAD and Ca and tended to be lower for NEU-1.3% Ca and NEG-1.8% Ca compared with NEU-1.8% Ca and NEG-1.3% Ca. Results of this trial indicate that feeding prepartum diets with 1.8% compared with 1.3% supplemental Ca reduced colostrum quality and serum concentrations of Mg and lactate in calves immediately after birth. Feeding NEG supported higher colostrum IgG concentrations. Blood mineral concentrations and blood gas balance tended to differ, but the effects were not consistent across DCAD and Ca.

Key words: dietary cation-anion difference, calcium, colostrum, blood mineral

Short Communication

Feeding a negative DCAD prepartum diet has been adopted by many dairy producers in the United States as a means of reducing the incidence of hypocalcemia or milk fever (NAHMS, 2014). Clinical hypocalcemia in the United States has been reported to affect approximately 5 to 7% of multiparous cows, whereas approximately 50% of multiparous cows are reported to have subclinical blood Ca concentrations (Reinhardt et al., 2011). Feeding a negative DCAD diet creates a compensated metabolic acidosis, which positively alters Ca homeostasic mechanisms. Previous research has reported decreased blood pH and blood gas concentrations of cows fed acidogenic diets (Oetzel, 1988), but the effects on the newborn calf have not been extensively studied. Metabolic and respiratory acidosis, typically the result of dystocia, are strongly correlated with increased incidence of calf mortality (Szenci, 1985; Lombard et al., 2007). Tucker et al. (1992) did not observe any effect of feeding dams a negative versus positive DCAD diet prepartum on serum mineral concentrations of calves. However, others have reported negative effects on IgG absorption in calves whose dam were fed negative DCAD diets (Joyce and Sanchez, 1994; Guy et al., 1996; Quigley and Drewry, 1998). More recently, Collazos et al. (2017) reported a transient metabolic acidosis in calves born to dams fed acidogenic diets prepartum. The objectives of this trial were to determine the effects of prepartum DCAD and dietary Ca

Received March 26, 2018.
Accepted June 13, 2018.
[1] Corresponding author: jbernard@uga.edu

concentration on colostrum quality, newborn calf blood minerals, and gas concentration.

Eighty-two Holstein calves born to multiparous cows (1.9 ± 1.0 lactations) fed diets differing in DCAD [−3 (**NEU**) or −21 (**NEG**) mEq/100 g of DM] and Ca (1.3% or 1.8% of DM) were used in the trial (Diehl, 2017). Prepartum urine pH was reduced ($P < 0.0001$) for cows fed NEG compared with NEU and averaged 7.45, 6.66, 6.05, and 6.01 for 1.3% Ca + NEU, 1.8% Ca + NEU, 1.3% Ca + NEG, and 1.8% Ca + NEG (SE = 0.21), respectively. Serum Ca concentrations of the dams were not different among treatments immediately after calving and averaged 7.60, 7.94, 7.81, and 7.94 mg/dL for 1.3% Ca + NEU, 1.8% Ca + NEU, 1.3% Ca + NEG, and 1.8% Ca + NEG (SE = 0.20), respectively. Cows calved in a dry lot or were brought into a dry calving pen when parturition was near. Time of birth, sex, and dystocia score were recorded at calving. Calves were separated within 4 to 6 h after birth and fed a colostrum replacer to provide 200 g of IgG (Bovine IgG, Land O'Lakes Animal Milk Products Co., Shoreview, MN) via bottle or tube if necessary. Calves were individually housed in a calf barn or in individual calf hutches on sand.

Colostrum was harvested and sampled within 2 to 8 h of calving. Brix analysis was conducted immediately after colostrum harvest (MISCO DD-1 Refractometer, MISCO, Solon, OH) and an aliquot was frozen for IgG analysis using radial immunodiffusion (Bovine IgG Test Kit, Triple J Farms, Bellingham, WA). Blood samples were collected immediately after birth before colostrum feeding and again at 24 h after birth. Samples were placed on ice and immediately transported to the laboratory (University of Georgia Veterinarian Diagnostic Laboratory, Tifton) for analysis of lactate; pH; blood gases including partial pressure (**p**) of O_2, pCO_2, pSO_2, and $pHCO_3$; and minerals including Ca, Mg, Na, K, and Cl using an Advia 1800 Chemistry System (Siemens Medical Solutions USA Inc., Malvern, PA). Body weight was recorded before the calf entering individual calf pens on the day of birth.

The PROC MIXED procedures of SAS (SAS Institute Inc., Cary, NC) were used to analyze the data. The model included block (age and expected calving date), DCAD treatment, Ca treatment, interaction of DCAD and Ca, day, and the interactions of day and treatments. Significance was declared when $P \leq 0.05$ and trends were declared when $P > 0.05$ and ≤ 0.10. When an interaction was detected, the PDIFF option was used for mean separation.

Gestation length was not affected by prepartum DCAD (278.7 and 277.2 d, SE = 0.9 d for NEG and NEU, respectively), but tended to be lower (P = 0.0626) for cows fed 1.8% Ca compared 1.3% Ca (279.2 and 276.1 d, SE = 0.9 d, respectively). Birth weight and dystocia score were not different among treatments ($P > 0.10$) and averaged 42.7 kg and 1.12, respectively. No differences ($P > 0.10$) were observed in colostrum yield among treatments and averaged 8.75 kg (Table 1). Colostrum quality, as assessed by Brix refractometry, was not different among DCAD treatments, but was higher ($P = 0.0442$) for 1.3% Ca compared with 1.8% Ca: 21.58% and 19.87%, respectively. Concentrations of IgG measured via radial immunodiffusion were higher for NEG compared with NEU ($P = 0.0034$) and averaged 9,982.1 and 5,395.0 mg/dL, respectively. Colostrum from cows fed 1.3% had higher ($P = 0.0120$) IgG concentrations compared with 1.8% Ca: 9,558.5 and 5,818.4 mg/dL, respectively.

Blood metabolites of calves are shown in Table 2. Concentrations of serum Ca ($P < 0.0001$), P (P = 0.0023), Mg ($P = 0.0327$), K ($P = 0.0195$), anion gap ($P = 0.0005$), whole blood pCO_2 ($P < 0.0001$), and lactate ($P < 0.0001$) were higher but serum CO_2 ($P < 0.0001$) and whole blood SO_2 ($P = 0.0004$) were lower on d 0 compared with d 1. No differences ($P >$ 0.10) were observed among treatments in serum concentrations of Ca, P, K, anion gap, or whole blood pH, pO_2, pCO_2, or pSO_2. Calves born to cows fed 1.3% Ca had higher concentrations of serum Mg ($P = 0.0391$) and lactate ($P = 0.0591$) compared with calves born to cows fed 1.8% Ca. A DCAD × Ca interaction was observed for serum Na ($P = 0.0232$), serum Cl (P = 0.0619), and whole blood HCO_3 ($P = 0.0515$), which were higher for calves whose dams were fed NEG and 1.3% Ca compared with NEG and 1.8% Ca. A DCAD × day interaction was observed for serum CO_2 (P = 0.0062) and whole blood HCO_3 ($P = 0.0237$). Serum

Table 1. Colostrum yield and characteristics of cows fed diets differing in prepartum DCAD and Ca concentrations[1]

Item	NEU		NEG		SE	*P*-value		
	1.3% Ca	1.8% Ca	1.3% Ca	1.8% Ca		DCAD	Ca	DCAD × Ca
Yield, kg/d	10.1	7.9	8.4	8.6	1.2	0.6092	0.4567	0.3085
Brix, %	21.42	19.16	21.74	20.58	0.81	0.2792	0.0442	0.4914
IgG, mg/L	6,135.9	4,654.0	12,981.1	6,982.8	1,171.0	0.0034	0.0120	0.1153

[1]NEU = neutral DCAD; NEG = negative DCAD.