J. Dairy Sci. 101:1–13
https://doi.org/10.3168/jds.2017-12917

Effect of prophylactic oral calcium supplementation on postpartum mineral status and markers of energy balance of multiparous Jersey cows

A. Valldecabres,* J. A. A. Pires,† and N. Silva-del-Río*‡[1]
*Veterinary Medicine Teaching and Research Center, 18830 Road 112, Tulare, CA 93274
†INRA, Université Clermont Auvergne, VetAgro Sup, UMR Herbivores, F-63122 Saint-Genès-Champanelle, France
‡Department of Population Health and Reproduction, School of Veterinary Medicine, University of California, Davis 95616

ABSTRACT

The effects of prophylactic oral Ca supplementation on blood mineral status and markers of energy balance were evaluated on 205 multiparous Jersey cows at a commercial dairy. Postpartum, cows were systematically assigned to control (n = 105) or oral Ca supplementation (CaOS; 50 to 60 g of Ca as boluses; n = 100) at 0 and 1 d in milk (DIM). Blood samples for analysis of serum minerals (Ca, P, Mg, K, Na, Fe, Zn, and Cu) were collected before and 1 h after treatment at 0 and 1 DIM, and at 2 DIM. Urine pH was measured immediately before and 1 h after treatment administration (n = 96). A subset of 74 cows was evaluated for plasma glucose and fatty acid concentrations at 0, 1, and 2 DIM. Cows were classified according to their initial calcemic status (Ca status) as normocalcemic (NC; serum Ca >2.12 mmol/L) or subclinically hypocalcemic (SCH; serum Ca ≤2.12 mmol/L). Average serum Ca concentration was higher in CaOS than control cows (2.12 vs. 2.06 mmol/L); this treatment effect was higher for SCH [CaOS (2.03 mmol/L); control (1.89 mmol/L)] than NC cows [CaOS (2.22 mmol/L); control (2.22 mmol/L)]. The incidence of subclinical hypocalcemia was lower for CaOS than control cows (53 vs. 65%); however, at 2 DIM the prevalence of subclinical hypocalcemia tended to be higher for CaOS cows, mostly because it was higher for CaOS-NC than control-NC cows (70 vs. 25%). Urine pH was lower for CaOS than control cows (6.10 vs. 7.04). Lower serum Mg concentration was detected for CaOS-SCH (1.06 mmol/L) than for control-SCH (1.10 mmol/L) cows. Cows in the CaOS group had higher serum K (4.68 vs. 4.53 mmol/L), lower plasma glucose (2.97 vs. 3.10 mmol/L), and at 2 DIM higher plasma fatty acid concentrations (0.43 vs. 0.35 mmol/L) than control cows. Our results showed that postpartum serum Ca concentration increases with oral Ca supplementation, but calcemic status influenced treatment response. Future studies should evaluate the long-term implications on production and reproduction of oral Ca supplementation in Jersey cows.
Key words: oral calcium supplementation, subclinical hypocalcemia, dairy cow

INTRODUCTION

The abrupt increase in Ca requirements of periparturient dairy cows challenges their homeorhetic mechanisms to maintain optimal blood Ca concentration to support biological functions. For instance, Ca concentration in colostrum averages 4.7 g/kg (Kehoe et al., 2007); the amount of Ca secreted in 5 kg of colostrum is 8 times the Ca present in the plasma pool of a 600-kg cow (Goff, 2004). Subclinical hypocalcemia is associated with impaired neutrophil function, increased risk of disease (subclinical ketosis, displaced abomasum, metritis, and subclinical endometritis), reduced DMI and milk yield, and decreased odds of pregnancy at first AI (Chapinal et al., 2011, 2012; Martinez et al., 2012, 2014; Ribeiro et al., 2013). Evidence indicates that subclinical hypocalcemia can affect the metabolic status of cows, decrease insulin concentration, and increase fatty acid mobilization, lipid accumulation in liver, and blood glucose concentration (Reinhardt et al., 2011; Chamberlin et al., 2013; Martinez et al., 2014).

Nowadays, clinical hypocalcemia is relatively rare, but 41 to 54% of multiparous cows experience subclinical hypocalcemia (**SCH**; serum Ca <2.00 mmol/L; Reinhardt et al., 2011). Recent studies reported that serum Ca concentration below 2.10 to 2.20 mmol/L was negatively associated with production, reproduction, and health outcomes. These studies suggest that the threshold for SCH should be higher than the traditional 2.00 mmol/L (Chapinal et al., 2011, 2012; Martinez et al., 2012, 2014). The identification of cows with SCH remains a challenge. The absence of clinical signs and the lack of cow-side diagnostic tools leave prophylactic strategies as the only treatment alternative. Feeding anionic salts to close-up cows is a common strategy

Received March 22, 2017.
Accepted January 9, 2018.
[1]Corresponding author: nsilvadelrio@ucdavis.edu

used in over 50% of large (>500 cows) US dairy herds (USDA NAMHS, 2014) and has successfully reduced the incidence of clinical hypocalcemia (Moore et al., 2000; Charbonneau et al., 2006). However, SCH still remains a problem in dairies feeding anionic salts to close-up cows. In a recent study, the prevalence of SCH within 24 h postpartum (serum Ca <2.12 mmol/L) in 11 commercial dairies feeding close-up negative dietary cation-anion difference rations was 59% for multiparous cows (Brady, 2013).

Additional management strategies to prevent detrimental effects of SCH are peripartum intravenous, subcutaneous, or oral Ca supplementation. After supplementation, Ca hemodynamics vary with route of administration. Blanc et al. (2014) showed that prophylactic treatment of SCH with 10.7 g of intravenous Ca at parturition resulted in a transient hypercalcemia, followed by a hypocalcemic stage that lasted at least 24 h. In a recent study, the subcutaneous injection of 15.2 g of Ca was able to increase and maintain postpartum serum Ca concentration above 2.12 mmol/L, and when administered in 2 doses (7.6 g of Ca at 0 and 1 DIM), decrease the risk of metritis and clinical and subclinical endometritis (Amanlou et al., 2016). Oral administration of 86 (0 and 1 DIM) and 43 (2, 3, and 4 DIM) g of Ca as boluses had a positive effect on peripartum serum and blood ionized Ca concentration (Martinez et al., 2016). Nevertheless, Oetzel and Miller (2012) found that oral Ca supplementation (43 g of Ca as bolus) had no effect on blood ionized Ca concentration. The susceptibility to hypocalcemia varies by breed, with Jerseys having higher risk than Holsteins (Goff et al., 1995; Lean et al., 2006; Roche and Berry, 2006). However, most studies evaluating prophylactic strategies have been conducted on Holsteins. We hypothesized that oral supplementation with highly soluble forms of Ca would help not only to sustain serum Ca concentration in postpartum Jersey cows while homeorhetic mechanisms cope with the onset of lactation but also to improve postpartum mineral status and energy balance. Our objective was to evaluate the effect of prophylactic oral Ca supplementation (50 to 60 g of Ca as boluses) at 0 and 1 DIM on postpartum serum concentrations of Ca and other minerals as well as blood concentrations of markers of energy balance of multiparous Jersey cows fed a close-up ration with negative dietary cation-anion difference.

MATERIALS AND METHODS

All procedures were approved by the University of California Davis Institutional Animal Care and Use Committee (#18846).

Table 1. Ingredients and nutrient composition of close-up and fresh cow rations

Item	Close-up	Fresh
Ingredient (% of DM)		
Almond hulls	—	5.1
Aminoplus	—	2.3
Canola	17.4	12.0
Close-up mineral	3.1	—
Corn silage	38.0	11.0
Distillers dried grains	—	4.8
Lactating cow mineral	—	0.1
Limestone	3.1	—
Mineral mix	—	4.2
Rolled corn	13.6	15.0
Rumen-protected fat	—	0.2
Sorghum	—	2.4
Soy hulls	14.9	3.4
Straw	9.3	—
Winter forage	—	40.0
Zeolite	0.6	—
Nutrient composition[1] (DM basis)		
CP (%)	16.25	17.25
Crude fat (%)	2.48	3.98
ADF (%)	26.30	20.10
NDF (%)	37.75	30.45
Lignin (%)	4.17	4.66
Starch (%)	18.85	22.05
Ash (%)	14.87	8.88
Ca (%)	2.86	1.19
P (%)	0.40	0.48
Mg (%)	0.43	0.36
K (%)	1.27	1.37
S (%)	0.47	0.34
Na (%)	0.13	0.29
Cl (%)	0.92	0.43
DCAD[2] (mEq/100 g)	−17.61	14.55

[1]Wet chemistry analysis (Cumberland Valley Analytical Services; Hagerstown, MD).

[2]Dietary cation-anion difference calculations were performed according to the following equation: DCAD (mEq/100 g) = [(Na + K) − (Cl + S)].

Study Herd Management

The study was conducted on a commercial dry-lot Jersey herd in California from January to April 2016. The herd milked 2,789 cows twice a day, producing on average 23.8 kg/d during the study period. During the last 3 wk of gestation, dry cows were moved to a close-up pen and offered a corn silage-based TMR with anionic salts once a day (Table 1).

Close-up cows showing secondary signs of calving were moved to a prepartum pen. Once primary signs of calving were observed, cows were accommodated into individual calving pens bedded with straw. Calves were separated from dams immediately after parturition. Twice a day, fresh cows were moved from the maternity pen to a colostrum pen, where they stayed for 4 d. From 4 to 14 DIM, cows were housed in a fresh cow pen, and later were moved to lactation pens. Cows housed in the colostrum and fresh cow pens were evaluated daily by