FEEDING CALCIUM CHLORIDE PREPARTUM REDUCES UDDER EDEMA AND INCREASES INTAKE POSTPARTUM IN DAIRY HEIFERS

M. Lema[1], W.B. Tucker[2], M. Aslam[1], I.S. Shin[3], P. Le Ruyet[4] and G.D. Adams[5]

Story in Brief

Twenty Holstein heifers in a completely randomized design were used to evaluate the effects of prepartum dietary $CaCl_2$ on development and regression of edema and on subsequent lactational performance. Heifers were assigned to diets containing either 2.17% limestone or 1.5% $CaCl_2$ (DM basis) at 3 wk before expected calving date. Test diets were fed only prepartum; at calving, all heifers were offered a lactation diet for 3 wk. Severity of edema was evaluated on a daily basis throughout the experiment. Calcium chloride reduced the severity of edema, although this response was most evident during the first week of feeding this salt. The beneficial effects of $CaCl_2$ on edema prepartum disappeared postpartum, when $CaCl_2$ was removed from the diet. Indeed, edema was higher for $CaCl_2$ heifers than for the limestone heifers at 2 wk postpartum. Calcium chloride reduced DMI prepartum but, following parturition, a compensatory increase in feed intake was detected. Postpartum daily DMI averaged 1.3-kg higher for heifers fed $CaCl_2$ than for those fed the limestone diet prepartum. Milk yield and composition were somewhat lower for $CaCl_2$ heifers, although this response was most evident at 1 wk postpartum. Feeding $CaCl_2$ prepartum to prevent milk fever may also reduce the severity of udder edema prepartum and increase feed intake during early lactation.

(Key Words: Calcium Chloride, Udder Edema, Cation-Anion Balance.)

---

[1]Graduate Student [2]Assistant Professor [3]Postdoctoral Research Associate
[4]Visiting Scholar [5]Instructor

Introduction

When an udder is affected by edema, it is more susceptible to mastitis and physical injury. In general, edema is more severe in heifers than in cows. Although prepartum grain consumption has been suspected as a causative factor, several reports have shown that edema is associated more with dietary salt included in a grain mix than with the grain itself (Conway et al., 1977; Hutjens, 1980; Nestor et al., 1988).

Typically, dairy farmers utilize a therapeutic approach to combat udder edema; diuretics are administered to cows with severe edema postpartum. These compounds generally eliminate udder swelling. However, a prophylactic regimen to prevent edema or to cause rapid regression of edema postpartum would reduce stress on the cow and the udder. The objective of this study was to evaluate the influence of prepartum dietary $CaCl_2$ on the temporal development and regression of udder edema and on subsequent lactational performance of dairy heifers.

Materials and Methods

Twenty Holstein heifers averaging 567 $\pm$ 43 kg BW were arranged in a completely randomized design. Heifers were assigned to diets (Table 1) containing either 2.17% limestone (control) or 1.5% $CaCl_2$ (DM basis) at 3 wk before expected calving date. Diets consisted of sorghum silage and grain and were identical except for the Ca source. Test diets were fed until parturition; at calving, all heifers were fed the same postpartum diet (Table 1) for 3 wk.

Severity of edema was evaluated independently by five people daily throughout the experiment. A 10-point rating system (0 = no edema, 10 = severe edema) described elsewhere (Tucker et al., 1992) was utilized to evaluate the presence of edema. Two, 2-h training sessions were utilized before the study to familiarize evaluators with the rating system.

Intake was recorded daily and averaged by week throughout the study. Milk yield was recorded daily. Milk samples were collected weekly during consecutive p.m. and a.m. milkings.

Results and Discussion

Edema Ratings

Edema scores at different stages during the study for the control and $CaCl_2$ heifers are presented in Table 2. Although the difference was

Table 1. Ingredient and nutrient composition of diets[a].

Ingredient	Prepartum Control	Prepartum $CaCl_2$	Postpartum Fresh
Sorghum silage	60.59	61.00	17.60
Shelled corn, ground	27.52	27.71	36.69
Soybean meal, 44%CP	9.27	9.34	12.05
Trace mineralized salt[b]	.19	.19	.24
Dicalcium phosphate	.08	.08	.62
Dynamate[c]	.16	.16	.16
Vitamin A premix[d]	.01	.01	.01
Vitamin E premix[e]	.01	.01	.01
Limestone	2.17	....	.64
$CaCl_2$, 78%	....	1.50	....
Alfalfa hay	....	....	13.14
Whole cottonseed	....	....	7.88
Corn distillers grain, with solubles	....	....	8.33
Blood and feather meal[f]	....	....	.54
Alkaten[g]	....	....	1.00
Megalac[h]	....	....	1.01
Magnesium oxide	....	....	.08
Analyzed nutrient composition[i]			
DM	33.3	33.5	60.8
CP	11.9	11.9	21.2
NE_L, Mcal / kg	1.57	1.59	1.79
ADF	24.6	24.8	18.8
NDF	33.4	33.6	26.9
Ca	1.09	.96	.90
P	.26	.27	.41
Mg	.38	.38	.34
Na	.10	.09	.41
K	1.06	1.10	1.32
S	.18	.20	.23
Cl	.20	.89	.26
meq(Na + K) - (Cl + S)/ 100 g diet DM	14.59	-5.53	29.91

[a]Dry matter basis.
[b]Contained 92% NaCl, .250% Mn, .200% Fe, .033% Cu, .007% I, .005% Zn, and .0025% Co.

Table 1. (Continued)

[c]Double sulfate of potassium and magnesium, Pitman-Moore, Inc., Mundelein, IL.

[d]Supplies 30,000,000 IU Vitamin A per kg of premix.

[e]Supplies 500,000 IU Vitamin E per kg of premix.

[f]Bipro 82, Mid-South Milling Co., Memphis, TN.

[g]Naturally occurring sodium sesquicarbonate, Church & Dwight Co., Inc., Princeton, NJ.

[h]Calcium salt of fatty acids, Church & Dwight Co., Inc., Princeton, NJ.

[i]Analyzed nutrient content, except for ADF, NDF and NEL, which were calculated from individual dietary ingredients.

Table 2. Weekly average edema ratings of heifers consuming limestone (Control) or $CaCl_2$ prepartum.

Days relative to calving	Diet: Control	Diet: $CaCl_2$	SE	*P*
-21 to -15	1.82	1.09	.23	.040
-14 to -8	3.82	3.14	.53	.372
-7 to -1	5.73	5.07	.51	.372
0	5.33	5.30	.80	.980
1 to 7	6.05	5.39	.48	.340
8 to 14	2.42	4.06	.39	.012
15 to 21	.71	.44	.15	.207
Prepartum edema	3.79	2.99	.38	.156
Postpartum edema	3.03	2.94	.47	.897

significant only from 21 to 15 d prepartum, heifers fed the $CaCl_2$ diet tended to develop less edema than those fed the control diet throughout the prepartum interval ($P = .156$). Onset and development of edema were more gradual for $CaCl_2$ heifers than for controls prepartum. Mechanisms controlling the development and regression of udder edema are poorly understood; however, in our study the influence of $CaCl_2$ on edema disappeared upon removal of $CaCl_2$ from the diet. Residual beneficial effects were not noted. Indeed, during wk 2 postpartum edema score was greater ($P = .012$) for heifers fed $CaCl_2$ than for those fed the control diet, potentially the result of a rebound response by mechanisms controlling extracellular fluid volume in reaction to the removal of $CaCl_2$ from the diet.

Dry Matter Intake

Table 3 presents daily DMI by week relative to calving. At 3 wk prepartum, heifers fed the control diet had higher DMI than those fed the $CaCl_2$ diet (P = .003); this difference had disappeared by wk 2 prepartum. Mean prepartum DMI was higher (P = .057) for control than for $CaCl_2$ heifers; however, intake appeared to be more consistent throughout the prepartum interval for the $CaCl_2$ heifers. Acidogenic diets depress intake: Tucker et al. (1991) reported that heifers fed 1.5% $CaCl_2$ had higher blood hydrogen ion concentration than those fed no $CaCl_2$. This might explain why DMI decreased for heifers fed $CaCl_2$ in our study. Poor palatability of this mineral compound also may have been a factor. Dry matter intake fell sharply immediately prior to calving, but increased following calving for both treatment groups. Dry matter intake was not significantly different for control and $CaCl_2$ heifers at wk 1 postpartum, but tended to be higher (P = .089) for heifers fed the $CaCl_2$ diet at wk 2. Heifers fed $CaCl_2$ also tended to have higher (P = .101) mean DMI for the 3-wk postpartum interval. The increase in DMI postpartum when $CaCl_2$ was removed from the diet may be related to improved diet palatability or perhaps to more

Table 3. Mean daily DMI of heifers fed limestone (Control) or $CaCl_2$ prepartum.

Week relative to calving	Diet: Control	Diet: $CaCl_2$	SE	P
-3	9.99	8.38	.33	.003
-2	9.30	8.64	.39	.249
-1	8.16	7.83	.34	.500
+1	10.16	11.59	.66	.141
+2	13.74	14.84	.43	.089
+3	14.72	15.97	.70	.220
Prepartum DMI, kg/d	9.10	8.27	.29	.057
Postpartum DMI, kg/d	12.87	14.13	.52	.101

vigorous ruminal muscle contraction as a result of the improved Ca status that diets with a low DCAB afford.

Milk Yield and Composition

Milk yield and composition by weeks postpartum are presented in Table 4. Milk, 4% FCM, fat and protein yields were slightly higher for the heifers fed the control diet than for those fed $CaCl_2$ each of the 3 wk postpartum, but the differences were larger in wk 1 than in wk 2 and 3; this might be attributed to residual effects of lower energy intake.

Table 4. Milk yield and composition during 3 wk postpartum of heifers fed diets containing limestone (Control) or $CaCl_2$ prepartum.

	Week	Diet: Control	Diet: $CaCl_2$	SE	*P*
Milk yield, kg	1	20.54	17.05	1.42	.100
	2	24.48	22.88	1.65	.501
	3	24.64	22.47	1.72	.383
4% FCM, kg	1	19.98	16.66	1.35	.099
	2	22.35	21.37	1.46	.641
	3	23.88	21.53	1.76	.358
Milk fat, %	1	3.95	3.90	.32	.908
	2	3.45	3.62	.21	.575
	3	3.76	3.54	.27	.554
Milk fat, kg	1	.78	.66	.06	.166
	2	.84	.81	.06	.798
	3	.93	.81	.08	.319
Milk protein, %	1	3.65	3.56	.19	.730
	2	3.07	3.31	.06	.009
	3	3.18	3.30	.08	.326
Milk protein, kg	1	.75	.61	.06	.137
	2	.75	.76	.05	.866
	3	.79	.77	.05	.843

Addition of $CaCl_2$ to a diet lowers dietary cation-anion balance (DCAB). Wang et al. (1991) reported that feeding low DCAB prepartum increased subsequent 305-d milk yield. In our study, the higher postpartum DMI of $CaCl_2$ heifers did not increase milk yield or milk component yield during the first 3 wk after calving. Milk from the $CaCl_2$ heifers had higher protein ($P = .009$) content during wk 2; otherwise, milk composition was similar for the two groups of heifers.

Feeding $CaCl_2$ prepartum reduced the severity of edema; however, this benefit disappeared postpartum, when $CaCl_2$ was removed from the diet. Feeding $CaCl_2$ prepartum reduced DMI; however, withdrawal of $CaCl_2$ from the diet at calving caused DMI postpartum to increase. Indeed, daily DMI was 1.3 kg higher for $CaCl_2$ heifers than for the control heifers during the 3-wk postpartum interval. This increase in intake may help ease the transition to lactation diets, although the increased DMI was not accompanied by increased yield of milk or milk components in our study.

Literature Cited

Conway, J. F. et al. 1977. Effects of sodium chloride supplementation on the incidence and severity of mammary edema and on serum sodium levels in pre-parturient cows and heifers. J. Dairy Sci. 60:110.

Hutjens, M. F. 1980. Can we feed to prevent udder edema? Hoard's Dairyman 125:1178.

Nestor, K. E., Jr. et al. 1988. Influence of sodium chloride and potassium bicarbonate on udder edema and selected blood parameters. J. Dairy Sci. 71:366.

Tucker, W. B. et al. 1991. Influence of calcium chloride on systemic acid-base status and calcium metabolism in dairy heifers. J. Dairy Sci. 74:1401.

Tucker, W. B. et al. 1992. Evaluation of a system for rating edema in dairy cattle. J. Dairy Sci. (in press, JDS1269-JBH)

Wang, C. et al. 1991. Effects of dietary negative cation-anion difference and high calcium content prepartum on calcium metabolism, health, lactational and reproductive performance of Holstein cows. J. Dairy Sci. 74(Suppl. 1):275. (Abstr.)