

Effects of Chromium Propionate Supplementation on Immunity and Subclinical Endometritis in Dairy Cows during the Periparturient Period

Abstract

A study was conducted with sixty one (61) multiparous Holstein cows to determine the effects of chromium propionate (Cr-Pro) supplementation during the periparturient period and early lactation on immunity and subclinical endometritis. After a one week preliminary period, cows were assigned randomly to one of two treatments from 21 d before expected calving through 63 d post-calving. Treatments were control and chromium propionate (Cr-Pro; 8 mg Cr/cow/d). Characterization of subclinical endometritis by low volume uterine lavage and cytology were determined on all cows at 7 days (1st lavage) and on one day between 40 and 60 days (2nd lavage) post-calving. Cows fed Cr-Pro had lower incidence of subclinical endometritis for 2nd lavage with cut-off point of 10% neutrophils (30 vs. 57% of cows; $P < 0.05$). In conclusion, supplementation with Cr-Pro resulted in a 47% reduction in the incidence of subclinical endometritis, suggesting the potential for subsequent benefits on reproductive performance.

KEYWORDS: Dairy, Cattle, Chromium, Transition, Subclinical endometritis

Introduction

Supplementing chromium to dairy cows during the periparturient period has consistently increased milk yield of cows during early lactation^{5,6}. In addition to its effects on energy metabolism, several studies suggest that chromium (Cr) may also have an effect on the immune system in cattle⁸. Recent work has defined the potential linkages between energy metabolism during the periparturient period and reproductive performance. The effect of energy status on reproduction may be attributable to changes in subclinical (cytological-diagnosed) endometritis incidence in cows with poorer energy status. In 2011, Cheong et al.³ found that the odds of having subclinical endometritis were 3.9 times greater in cows with ketosis compared to non-ketotic cows. Gilbert et al.⁴ demonstrated that the incidence of cytological-diagnosed endometritis (CDE) was high (~53% of cows between 40 and 60 days in milk) across five commercial dairy farms and that CDE had profoundly negative effects on first service conception rate (11 vs. 36%) and median days to pregnancy (118 vs. 206).

Therefore, the hypothesis of this study was that Cr supplementation may affect incidence of CDE either through direct effects on energy metabolism or through indirect effects on immune function. The objectives of the study were to evaluate the effects of chromium propionate supplementation to dairy cows during the periparturient period and early lactation on performance, metabolism, aspects of immune function, and the incidence of CDE.

Materials and Methods

Sixty one (61) multiparous Holstein cows from the Cornell University Teaching and Research Center Dairy were recruited based on previous 305d mature equivalent milk yield, and randomly assigned to either one of two treatments in a completely randomized block (CRB) designed experiment.

Treatments

1. No supplemental Cr (Control)
2. Supplemental Cr propionate (Cr-Pro), supplied at a dosage rate of 8 mg/h/d of supplemental Cr.

Cows were enrolled into the experiment at 28 d before expected calving and assigned to dietary treatments from 21 d before expected calving through 63 d post-calving. The Cr-Pro treatment was administered by top dress once daily following fresh feed delivery. In the prepartum period, all cows received a basal diet formulated to meet the nutrient requirements for a mature close-up Holstein dry cow⁷, and after calving, all cows were switched to a basal diet formulated for a mature Holstein fresh cow⁷.

Low volume uterine lavage⁶ and cytology were determined on all cows at 7 d post-calving (1st lavage) and on one day between 40 and 60 d post-calving (2nd lavage). The percentage of neutrophils at the first lavage was determined as a continuous variable for statistical comparison. For 2nd lavage, the incidence of subclinical endometritis was assessed using a cut point of 10% neutrophils³. Kaplan-Meier analysis of time to pregnancy was used as the primary index of reproductive performance⁵.

Data for reproductive performance was analyzed by Kaplan-Meier (K-M) survival method³. Dichotomous data analysis was used to evaluate the effects of treatment on neutrophil activity and incidence of CDE. Significance was declared at $P < 0.05$, and trends were declared at $0.05 \leq P \leq 0.15$.

Results and Discussion

Incidence of health disorders for cows remaining in the final dataset are presented in Table 1. The reproductive performance of the cows in the study is illustrated in Figures 1 – 3. The proportion of non-ovulating cows was not affected ($P > 0.15$) by treatment, and approximately 25% of the cows in each treatment group were anovulatory through 56 DIM (Figure 1). Supplementation of Cr-Pro had no significant effect ($P = 0.57$) on proportion of non-pregnant cows within each treatment group at 150 DIM even though the proportions were 0.62 and 0.46 for the control and Cr-Pro treatment groups, respectively (Figure 2). There was no significant effect of CDE on proportions of non-pregnant cows as the P -value for the survival curve analysis was only slightly beyond the declared trend range at $P = 0.18$. Proportions of non-pregnant cows were 0.48 and 0.58 for the normal and CDE groups, respectively, at 150 DIM (Figure 3).

Table 1. Health events for cows within the final dataset

Disorder	Control (n = 29)		Cr-Pro (n = 28)	
	No. of cows	No. of episodes	No. of cows	No. of episodes
Twins	2	2	0	0
Retained Placenta	0	0	4	4
Metritis	0	0	0	0
Ketosis	0	0	3	3
Displaced Abomasum	0	0	1	1
Mastitis	3	3	2	2
Hypocalcaemia	5	5	1	1
Lame	1	1	1	1
Digestive Upset	2	2	5	5
Fever	0	0	0	0
Dystocia	0	0	0	0

Figure 1. Effect of treatment on proportion non-ovulating cows through 56 days in milk

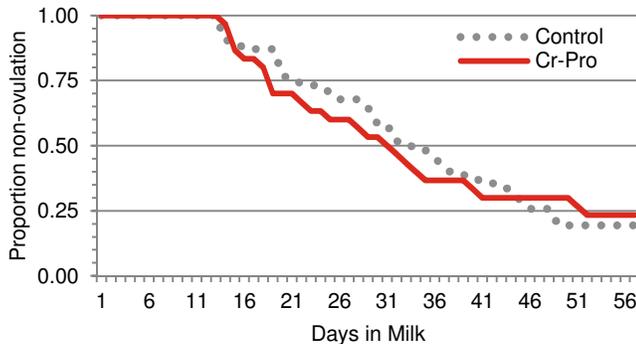


Figure 2. Effect of treatment on proportion non-pregnant cows through 150 days in milk

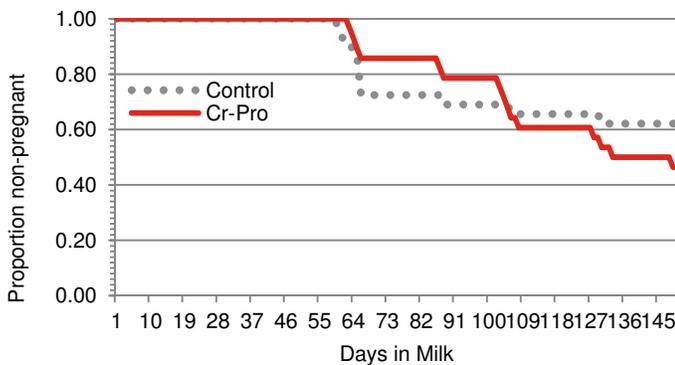
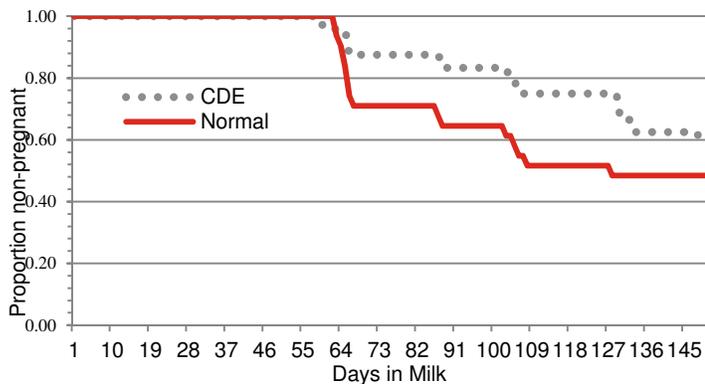


Figure 3. Effect of cytological-diagnosed endometritis (CDE) versus normal on proportion non-pregnant cows through 150 days in milk



The results of endometrial cytology for each treatment are shown in Table 2. For the 1st lavage at 7 d postpartum, there was a tendency ($P = 0.15$) for a greater percentage of neutrophils among cells recovered in lavage fluids for cows supplemented with Cr-Pro compared to control cows. At 40 to 60 d postpartum (i.e. 2nd lavage), cows supplemented with Cr-Pro had significantly less ($P < 0.05$) incidence of subclinical endometritis, defined as $> 10\%$ of differentiated cells as neutrophils within recovered lavage fluids.

Table 2. Effect of treatment on endometrial cytology

Item	Treatment		SEM	P-value
	Control	Cr-Pro		
	----- Mean -----			
7 d postpartum				
% of Neutrophils	32.8	41.1	4.1	0.15
40 to 60 d postpartum				
Subclinical Endometritis ¹	16	8	---	0.02
Normal	11	20		

¹Neutrophils > 10%

Early lactation cows experience immune stress associated with impaired neutrophil and lymphocyte function². Supplementation of Cr to early lactation cows has increased antibody and blastogenic responses of peripheral mononuclear cells¹, but has not been shown to alter neutrophil function in the form of phagocytosis². In the current study, there was a trend ($P = 0.15$) for Cr-Pro supplemented cows to have a greater % of neutrophils in uterine lavage fluids at 7 d postpartum compared to control cows. However, by 40 to 60 d postpartum, Cr-Pro supplemented cows had significantly less ($P = 0.02$) subclinical endometritis. These findings may suggest that Cr-Pro supplementation enhanced immune response in early lactation to bacterial infections in the uterus by increasing neutrophil proliferation, which cleared infections more effectively, and resulted in fewer cows with subclinical endometritis later in lactation. The negative impact of subclinical endometritis on reproductive performance is fairly clear⁶, and in the current study, as shown in Figure 3, there was an indication that subclinical endometritis may have reduced the proportion of non-pregnant cows at 150 days in lactation.

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