



Evaluation of Chromium Propionate on Milk Production of Holstein Cows under Heat Stress Conditions

Abstract

A field trial was conducted on a commercial 800-cow Holstein dairy in southeastern Pennsylvania to evaluate the effect of chromium (Cr) propionate (Cr-Pro) on milk yield by 2nd lactation and greater cows under heat stress conditions. The trial was conducted from June through October 2012 and the dairy had been supplementing Cr-Pro to all lactating cows for six months prior to the initiation of the trial. The trial design was a split plot with parallel treatments where the high group (2nd and greater lactation, 14-150 days in milk (DIM) cows were randomly assigned to either the Control (No Cr-Pro) or Cr-Pro supplemented to provide 8 mg Cr/h/d. Milk yield, lbs/cow/d, was significantly greater (107.5 vs. 101.8, $P < 0.0001$) for Cr-Pro supplemented cows compared to control cows.

When cows that calved prior to the trial were analyzed separately, the effect of Cr-Pro supplementation on maintaining milk production during heat stress resulted in 3.6 lbs/cow/d more milk ($P < 0.05$). Cows that calved in July received less than 4 weeks of Cr-Pro supplementation prior to entering the treatment groups, and as a result, there was no difference ($P > 0.05$) in milk yield between treatment groups. Cows that calved in August received 5 weeks of Cr-Pro supplementation prior to entering the treatment groups, and when receiving Cr-Pro in the high group produced 10.6 lbs/cow/d more milk ($P < 0.0001$) from weeks 3 through 11 postpartum. These results may suggest Cr-Pro supplemented from -21 d pre-fresh through peak production to receive full benefit on milk yield, and supplementation of Cr-Pro through 150 DIM will help maintain milk yield during periods of heat stress. At a cost of \$0.05/cow/day, the ROI for each scenario would be roughly 26:1 and 14:1, respectively.

Introduction

Feeding chromium (Cr) to dairy cows in prepartum and postpartum diets has consistently increased milk yield of cows during early lactation^{5,7,9,11}. The influence of Cr on milk production has been attributed to its effects on energy metabolism reflected through decreased mobilization of NEFA from adipose tissue and increased insulin sensitivity^{7,10}. Rockwell and Allen⁷ further theorized additional energy in Cr-supplemented diets may be associated with generation of more glucose from propionate by the liver due to increased glucagon concentrations.

Increased glucose availability and utilization may have significant benefits to milk production during extended periods of high ambient air temperature (i.e. heat stress). Studies in Iran⁴, Saudi Arabia^{1,9}, and China² designed to test the effect of Cr on milk yield under heat stress all showed increased milk yield with Cr supplementation. Field research in Mexico³ with both 1st lactation and mature Holstein dairy cows under heat stress showed that Cr-Pro supplementation improved milk production. The 1st lactation animals reached peak milk yield 30 days sooner while mature cows supplemented with Cr-Pro produced 11.7 lbs more milk at peak. However, there is a lack of field data from U.S. dairy herds fed chromium under heat stress conditions. Therefore, our hypothesis was supplementation of Cr to mature, early-lactation cows experiencing heat stress would improve milk yield in a commercial Holstein dairy herd in the U.S. The objective of the trial was to

evaluate the effect of supplementing chromium propionate on milk production of a high-producing Holstein dairy herd in a southeast Pennsylvania from July through October.

Materials and Methods

This trial was conducted at an 800-cow commercial Holstein dairy in southeast Pennsylvania from July 2012 through October 2012. The herd consisted of approximately 700 lactating and 100 dry cows. Prior to the trial, the herd was consistently between 170-175 days in milk (DIM) and shipping between 85 – 90 lbs of milk per cow per day. Veterinary services, including reproductive programs and nutritional services, were provided by the University of Pennsylvania Veterinary School Field Service.

The trial design was a split plot with two parallel treatments where high group (2nd and greater lactation, 14 – 150 days in milk (DIM)) cows were randomly assigned to one of two treatments, 1) Control – No Cr-Pro and 2) Cr-Pro supplemented to provide 8 mg Cr/h/d. One week prior to treatment initiation, all high group cows were mixed and randomly assigned to a treatment pen, and after initiation of the treatment period, cows leaving the post-fresh group were assigned to treatment on an alternating basis. All lactating cows in the trial herd had been supplemented with Cr-Pro at a rate providing 8 mg Cr/h/d for six months leading up to the trial. At the initiation of the trial in addition to the treatment groups, all cows in the pre-fresh group (-21 d to calving) and post-fresh group (1 to 14 DIM) received Cr-Pro supplementation. Chromium propionate was mixed at a rate of 1.3 lbs/ton into the pre-fresh grain mix and 1.7 lbs/ton into a lactating cow grain mix, which were then incorporated into finished diets. All diets were formulated to meet NRC⁶ nutrient requirements using CPM formulation software. Data for milk yield, milk components, and days in milk (DIM) were analyzed using PROC MIXED within SAS⁸. The model included the fixed effects of pen, date, treatment, days in milk, and the interactions of pen by date, and pen by treatment along with the random effect of cow within pen. Significance was determined at $P < 0.05$ and tendency at $0.05 < P < 0.10$.

Results and Discussion

The random assignment of high group cows to treatment groups resulted in a significantly less DIM (136 vs. 150, $P < 0.0001$) and greater milk yield (115.4 vs. 107.8 lbs/cow/d, $P < 0.0001$) for the Cr-Pro treatment group versus controls, respectively, in the first week of the trial (7/7/2012; Figure 1). To better describe the differences in milk yield, cows within each treatment group were classified by their month of calving as pre-trial, July, August, or September 2012, and the data reanalyzed with month of calving and the interaction of month of calving by treatment added to the model (Table 1). For cows that calved pre-trial, cows supplemented with Cr-Pro produced significantly greater (110.0 vs. 106.3 lbs., $P < 0.05$) milk yield compared to control cows over the entire four month trial (Table 1). Cows that calved in August and September and received Cr-Pro in the high group had significantly greater ($P < 0.05$) milk yield compared to control cows (Table 1).

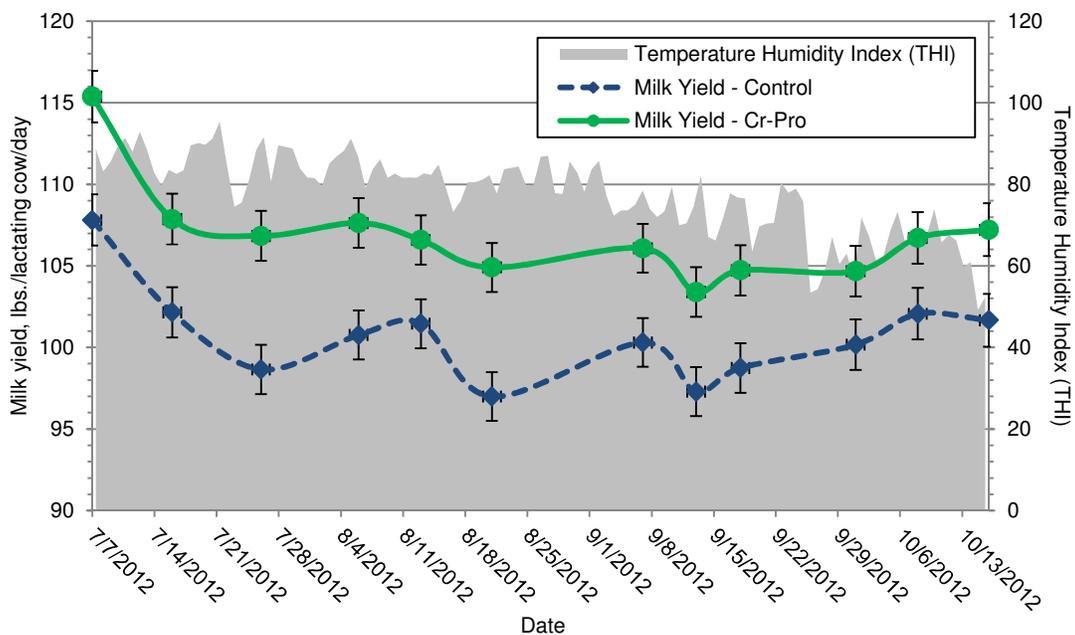


Figure 1. Effect of chromium propionate on milk yield over time

Table 1. Effect of month of calving, treatment and days in milk on milk yield

Month of calving	Days in Milk				Milk yield			
	Control	SD	Cr-Pro	SD	Control	SEM	Cr-Pro	SEM
All months	140	78.4	127	66.7	101.8 ^b	1.5	107.5 ^a	1.5
Pre-trial	131	49.4	131	47.6	106.3 ^b	1.3	110.0 ^a	1.2
July 2012	63	19.3	63	20.0	107.6	2.5	108.6	2.6
August 2012	48	12.4	47	12.7	97.9 ^b	2.8	108.7 ^a	2.7
September 2012	32	6.9	31	6.7	95.2 ^b	3.6	102.5 ^a	3.6

^{a,b} Means within a row with different superscripts are significantly different, $P < 0.05$.

Stress from environmental temperatures above the thermo-neutral zone of the dairy cow result in reduced dry matter intake (DMI), and consequently, reduced milk production⁹. In the current study, milk production in early lactation cows decreased with prolonged exposure to high ambient air temperatures (Figure 1). However, cows supplemented with Cr-Pro maintained milk production more consistently throughout the trial period (Figure 1). Research trials in Iran⁴, Saudi Arabia^{1,9}, and China² targeting heat stress responses have all reported significant increases in milk yield with Cr supplementation. Field research³, conducted in Mexico under high desert conditions, reported a significant 11.7 lbs. increase in peak milk for mature cows supplemented with Cr-Pro.

The response to Cr-Pro supplementation was partially dependent on the month of calving (Table 1), which under the design conditions of the current trial affected the length of Cr supplementation. The trial herd had been supplementing Cr-Pro to all lactating cows for six months prior to initiation of the study. Therefore, cows already in the high groups prior to the start of the trial had been exposed to Cr for a minimum of four weeks

and on average for three months. The difference in milk yield between Cr-Pro and control groups continued until daily high ambient air temperatures consistently remained below 80°F. The milk yield difference from maintaining production with Cr supplementation was 3.7 lbs/cow/d for the current study. In other heat stress studies^{1,2,4,9}, the average milk response to Cr supplementation ranged from 2.5 to 8.1 lbs/cow/d. Based on an average uniform milk price of \$18.97/CWT for the Northeast Federal Milk Market over the entire trial, the supplementation of Cr-Pro resulted in \$0.70/cow/d more revenue against a cost of \$0.05/cow/day for an ROI of 14:1.

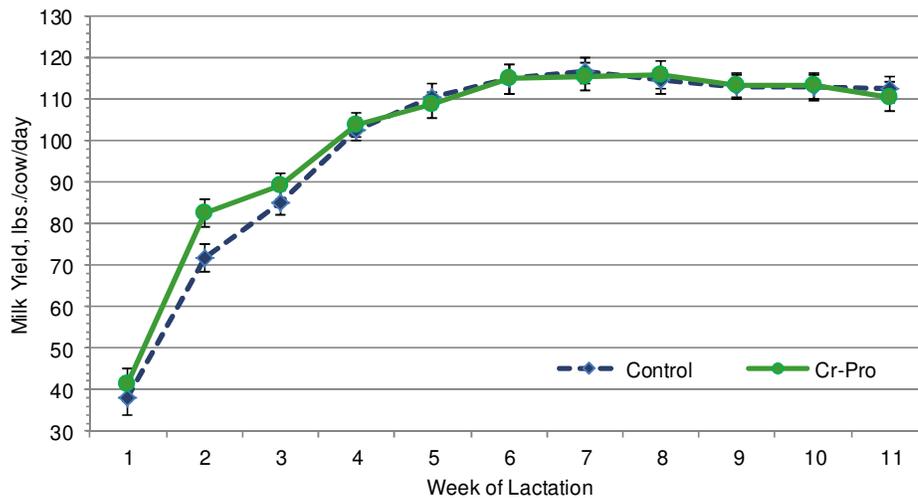


Figure 2. Milk yield by week of lactation for cows calving in July 2012

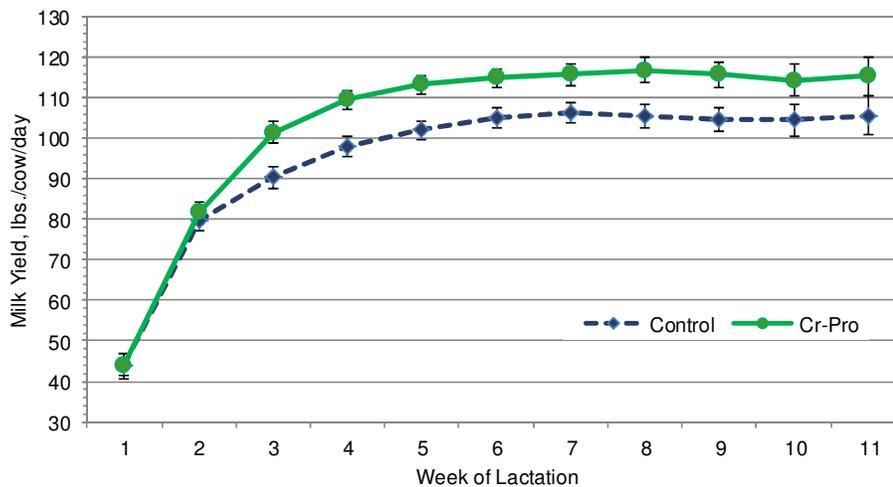


Figure 3. Milk yield by week of lactation for cows calving in August 2012

There was no difference in milk yield between treatment groups for cows calving in July (Table 1). These cows received Cr-Pro supplementation for less than four weeks prior to entering the treatment groups because Cr-Pro was only added to the pre-fresh diet at the initiation of the trial. In comparison, cows calving in August and September in the Cr-Pro supplemented group produced 10.8 and 7.3 lbs. of milk more than the control group, respectively (Table 1). These cows would have received Cr a minimum of 5 weeks prior to entering the treatment groups. These results would suggest that in order to obtain the full benefit to milk production from Cr supplementation, cows should receive Cr-Pro from -21 d pre-fresh through peak production. To provide further support, the milk yield responses for cows calving in July and August were determined by week of lactation and are provided in Figures 2 and 3, respectively. There was no difference ($P > 0.05$) in milk yield by week of lactation for cows calving in July between treatment groups (Figure 2). However, cows calving in August and receiving Cr-Pro from -21 d pre-fresh through peak production produced significantly greater (10.6 lbs./cow/d from weeks 3 through 11, $P < 0.0001$) milk yield than cows calving in the same that received Cr-Pro from -21 d pre-fresh to 14 DIM (Figure 3).

With an average uniform milk price of \$18.97/CWT, the supplementation of Cr-Pro from -21 d pre-fresh through 11 weeks postpartum generated \$126.68 in additional revenue against a cost of \$4.90 for a ROI of 26:1. From a production standpoint, a customer who invests in supplementing chromium propionate to pre-fresh and lactating cows should feel confident in the return on their investment, especially during periods of heat stress.

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