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Evaluation of Chromium Propionate on Reproductive Performance of Holstein Cows

Abstract

A field trial was conducted on a commercial 800-cow Holstein dairy in southeastern Pennsylvania to evaluate the effect of chromium propionate (Cr-Pro) on reproductive performance. The trial was conducted from January through October 2012 and was an all-off/all-on design where all lactating cows received 8 mg Cr/head/d delivered through a base corn mix included in all lactating diets. Pregnancy rate (PR), defined as the heat detection rate multiplied by conception rate, plateaued at 27% from January 2010 through December 2011. Chromium (Cr) supplementation commenced in January 2012, and by March, PR had begun increasing and continued to increase to 31.5% by July. The 1st service conception rate (CR) remained at 45% throughout this period, but 2nd, 3rd, and 4th service CR all increased to their greatest levels on record for the herd. Body condition scores (BCS) for post-fresh cows were similar ($P = 0.22$) from January to May, but BCS in high group cows significantly increased ($P = 0.023$) over the same period. These changes would suggest that cows moving from the post-fresh group to the high group lost less body condition during the period from January to May than cows prior to that time period. Based on the improvement in BCS and the increases in CR for repeated services, the results would suggest that Cr-Pro supplementation reduced negative energy balance in cows that failed to conceive at 1st service, thereby allowing for improved CR in repeated services.

In conclusion, Cr-Pro supplementation during lactation improved reproductive performance of high-producing Holstein cows managed under commercial conditions. At a cost of $0.05/cow/day, the reproductive return on investment would be roughly 4.7:1.

KEYWORDS: Chromium, reproduction, dairy, cattle

Introduction

Feeding chromium to dairy cows in prepartum and postpartum diets has consistently increased milk yield of cows during early lactation[4,6]. 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[6,8]. Rockwell and Allen[6] further theorized that additional energy in Cr-supplemented diets may be associated with generation of more glucose from propionate by the liver due to increased glucagon concentrations. These improvements in glucose production and utilization may reduce the time that cows experience negative energy balance (NEB) in early lactation. The degree of NEB has been associated with reduced reproductive performance regardless of parity and milk yield[1]. Field research in Mexico[3] with both 1st lactation and mature Holstein dairy cows showed that Cr-Pro supplementation improved both milk production and reproductive performance. The 1st lactation animals reached peak milk yield 30 days sooner and had 0.8 fewer services per conception with Cr-Pro supplementation. Mature cows supplemented with Cr-Pro produced 5.3 kg more milk at peak and reached 1st insemination 9 days sooner than non-supplemented cows.

However, there is a lack of field reproductive data from U.S. dairy herds fed chromium. Therefore, the hypothesis was that supplementation of chromium to all lactating cows might improve reproductive performance 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 and reproductive performance of a high-producing Holstein dairy herd in southeastern Pennsylvania.

Materials and Methods

This trial was conducted at an 800-cow commercial Holstein dairy in southeastern Pennsylvania consisting 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 ran from January 2012 through October 2012, and the dairy had never been fed supplemental Cr prior to the initiation of the trial. The trial was an all-off/all-on design with a minimum 6 month all-on period to generate sufficient insemination data to evaluate the effectiveness of the treatment. All lactating cows received 8 mg Cr/head/d delivered through a base corn mix included in all lactating diets. Diets were formulated to meet NRC 2001 nutrient requirements using CPM formulation software[5]. Reproductive performance records had been collected on the herd since October 2006, which served as baseline data against which to compare the reproductive performance of the herd during the all-on period.

Daily milk weights from the parlor and reproductive data were monitored by the herdsperson and incorporated into Dairy Herd Improvement Association (DHIA) records. Body condition scores were determined in January 2012 prior to Cr-Pro supplementation and again in May 2012 after 5 months of Cr-Pro supplementation by two independent scorers. Where appropriate, milk yield, milk components, reproductive performance, and BCS data were statistically analyzed using MIXED procedures of SAS[7]. Significance was determined at $P < 0.05$ and tendency at $0.05 < P < 0.10$.

Results and Discussion

Supplementation of Cr-Pro began after the January 17, 2012 test date, but there was no change in peak milk until after the 4th month of supplementation (Table 1). The delay in the effect was partially due to method by which DHIA determines peak. The DHIA definition for peak is: "A cow's highest daily milk production within a lactation for a test day prior to 150 days in milk. Peak is determined after a cow reaches 100 days in milk and is updated until the cow reaches 150 days in milk"[2]. Therefore, the impact of Cr-Pro supplementation on peak milk yield records would be lessened until the test date a minimum of 100 days after initiation of supplementation when all cows would be eligible. A one lb increase in peak milk equates to approximately 225 – 250 extra lbs. of milk for the lactation.

Table 1. Test day average milk, standardized 150-day milk, and peak milk by lactation group by test date

				Peak Milk[2]	
Test date	Milk	150-Day Milk[1]	1st Lactation	2nd Lactation	3rd+ Lactation
	------- lbs. per cow -------				
1/17/2012	87.2	92.3	90	118	124
2/21/2012	91.2	95.7	91	118	123
3/20/2012	92.6	96.9	91	117	122
4/17/2012	91.6	96.7	91	118	123
5/17/2012	92.0	98.9	91	118	124
6/14/2012	88.7	96.6	92	119	125
7/19/2012	83.4	91.7	94	120	127
8/21/2012	80.8	89.3	93	122	128
9/18/2012	82.7	90.8	92	122	129
10/22/2012	87.1	94.3	90	122	129

[1]Expected production per day at 150 days in milk

[2]A cow's highest daily milk production within a lactation for a test day prior to 150 days in milk. Peak is determined after a cow reaches 100 days in milk and is updated until the cow reaches 150 days in milk

The baseline reproductive status, as defined by pregnancy rate (PR), plateaued at 27% from January 2010 through December 2011 (Figure 1). Chromium supplementation commenced in January 2012, and by March, PR had begun increasing and continued to increase to 31.5% by July (Figure 1). During the same period, Cr-Pro supplementation increased the overall CR from roughly 36% to 42%, where it remained for the duration of the study (Figure 1).

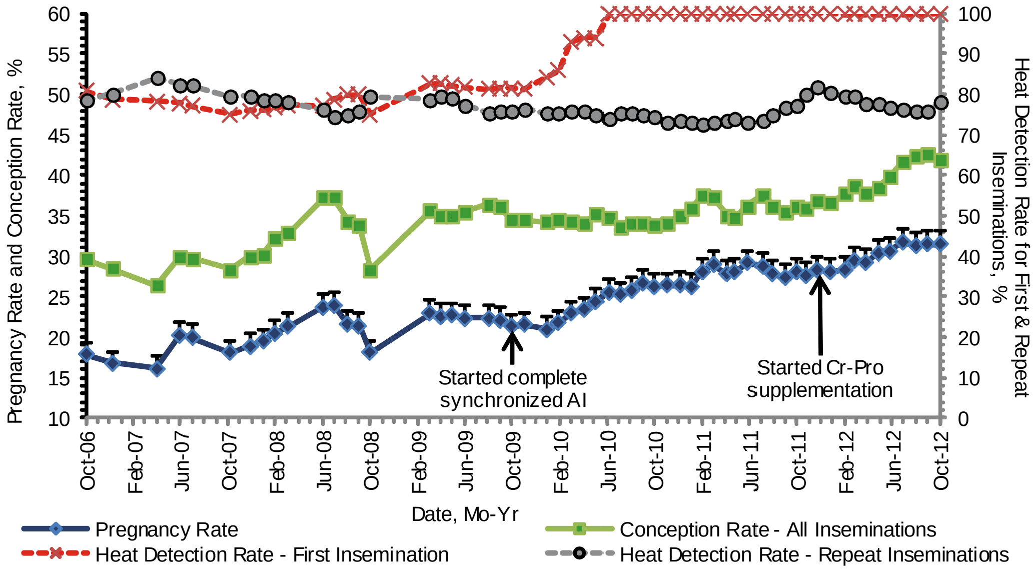

Figure 1. Pregnancy and conception rates with heat detection rates from October 2006 through October 2012

Conception rates for the 1st insemination CR increased from approximately 40% in the fall of 2009 to a plateau of 45% in November 2011. Conception rates for 2nd, 3rd, and 4th inseminations varied widely over the same period. After initiation of Cr-Pro supplementation, the 1st service CR remained at 45% throughout this period, but the 2nd, 3rd, and 4th insemination CR all increased to their greatest levels on record for the study herd.

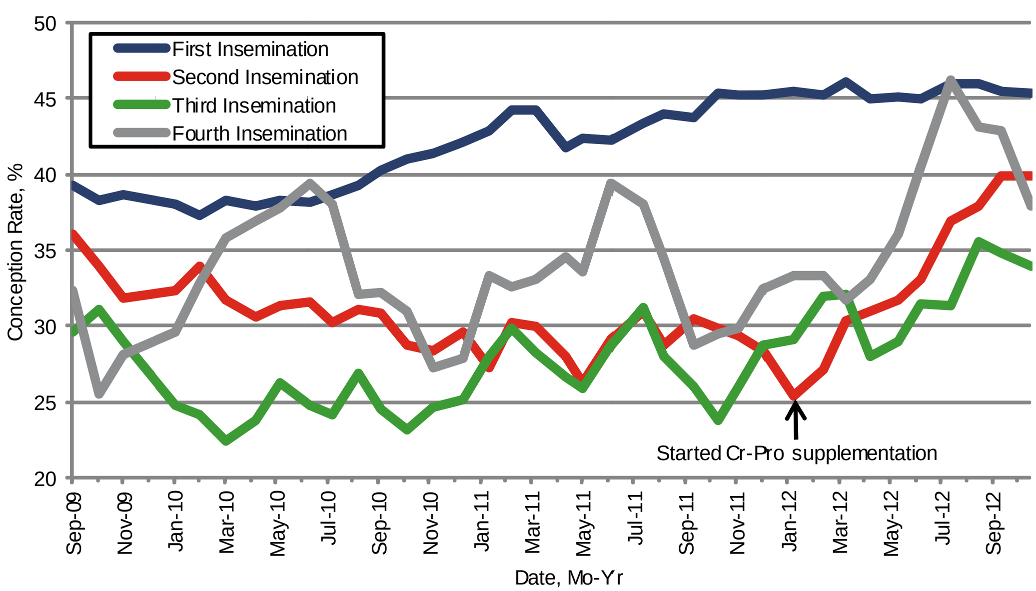

Figure 2. Conception rates for 1st, 2nd, 3rd and 4th inseminations from September 2009 through October 2012

The distribution of BCS for transition cows did not change (P = 0.22) over five months of Cr-Pro supplementation. Transition cows in the study herd were defined as 1st calf heifers and mature cows from -21 d prepartum to 14 d postpartum. The High group contained only mature cows from 14 to 150 days in milk (DIM). The distribution of BCS for High group cows did significantly change (P = 0.023) over the same five month period of Cr-Pro supplementation. The mean BCS for the High group increased from 2.5 to 2.8, suggesting that cows moving from the post-fresh group to the high group lost less body condition during the period from January to May than cows prior to that time period.

Table 2. Body condition score of transition and high group cows prior to and after five months of Cr-Pro supplementation

	Transition Cows[1], #			High Group Cows[2], #		
Body condition score	January	May	Total	January	May	Total
2				6	4	10
2.25				1	0	1
2.5				13	7	20
2.75	1	0.5[3]	1.5	9	16	25
3.0	1	0.5	1.5	3	17	20
3.25	10	1	11	1	6	7
3.5	21	21	42	0	1	1
3.75	9	6	15			
4.0	0.5	1	1.5			
Total	42.5	30	72.5	33	51	84
Chi-Square	X^2= 6.5	*P* = 0.22		X^2= 14.71	*P* = 0.023	
Mean BCS ±SD	3.5 ±0.2	3.5 ±0.2	3.5 ±0.2	2.5 ±0.3	2.8 ±0.3	2.7 ±0.4

[1]Cows in close-up and post-fresh pens. Close-up pen houses mature cows and 1st calf heifers from 3 wks prior to anticipated calving date to calving. Post-fresh pen houses mature cows and 1st calf heifers from calving to approximately 14 days in milk (DIM).
[2]Cows in high group pens. High group pens house mature cows from approximately 14 to 150 DIM.
[3]Empty cells were populated with 0.5 cows to ensure data continuity for statistical analysis.

In the current trial, peak milk for all lactation groups increased over the duration of the study with the greatest increase occurring for the 3rd and greater lactation cows (+ 7 lbs.). A one lb increase in peak milk equates to 225 – 250 more lbs. of milk for the lactation. The change for the 3rd and greater lactation cows during this trial represents roughly 1,575 – 1,750 lbs. more milk per lactation. Research in Mexico[3] reported a significant 10.6 lbs. increase in peak milk for mature cows supplemented with Cr-Pro.

The increase in PR associated with Cr-Pro in the trial herd was driven directly by increased CR. The effect came from increased CR in the 2nd, 3rd, and 4th inseminations. At the same time that the repeat insemination CR increased, the BCS of the high group cows significantly increased while the BCS of the transition cows remained unchanged. This change would suggest that the cows in early lactation regained body condition sooner when supplemented with Cr-Pro, which would suggest that these cows came out of NEB sooner. Low CR is often associated with issues of NEB[1]. Therefore, if Cr-Pro supplementation improves energy utilization, the cows in the trial herd were less severely impacted by NEB in early lactation and were more fertile under the timed AI program. With milk prices at $18.00 to $20.00 per CWT, replacement heifer value at $1,400, and cull cow value at $500, the increase in PR from 28 to 31.5% with the supplementation of Cr-Pro could result in $85/cow/year or $68,000 for a herd of 800 cows. At a cost of $0.05/head/day, the reproductive return on investment based on the current trial would be roughly 4.7:1. From a performance standpoint, a customer who invests in supplementing chromium propionate to their lactating herd may feel confident in the decision.

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