Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 2 *Dairy Research (1984-2014)*

Article 180

2013

Effects of chromium propionate and supplemental amino acids on dairy cattle performance near peak lactation

Francisco J. Vargas

Kai Yuan

Evan C. Titgemeyer

See next page for additional authors

Effects of Chromium Propionate and Supplemental Amino Acids on Dairy Cattle Performance Near Peak Lactation

F. Vargas, K. Yuan, E. Titgemeyer, L. Mamedova, and B. J. Bradford

Summary
Feeding chromium in early lactation can increase milk production, but responses during peak lactation have not been studied. The objective of this study was to evaluate responses to chromium propionate during this period as well as interactions with rumen-protected lysine and methionine. Chromium propionate increased feed intake and tended to increase energy-corrected milk yield, and primiparous cows showed greater responses in feed intake and milk protein yield than multiparous cows. In this study, feeding chromium propionate near peak lactation increased feed intake and tended to increase productivity, but no benefits of supplementing rumen-protected lysine and methionine were observed.

Key words: chromium, amino acids, lactation

Introduction
After parturition, cows must adapt to milk secretion, but their daily dry matter intake rarely matches the nutrient demands for that activity. Because of these extremely high nutrient requirements, cows near peak lactation are the most likely to experience amino acid deficiencies, which can limit peak milk and, in turn, decrease whole-lactation productivity.

It is known that dietary chromium (**Cr**) can enhance carbohydrate metabolism and affect protein synthesis, which can contribute to improved metabolic function after calving. In fact, previous studies have reported increases in milk production when supplemental Cr was utilized in diets during the first 3 weeks of lactation. Some producers have now begun feeding supplemental Cr later in lactation, but no controlled studies have evaluated whether Cr is beneficial at this stage of lactation. Furthermore, no information is available about interactions between amino acid nutrition and Cr supplementation in dairy cattle. Therefore, further investigation is necessary into responses to Cr near peak lactation, both in the presence and absence of supplemental AA.

Experimental Procedures
Forty-eight lactating Holstein cows (21 primiparous and 27 multiparous, 38 ± 15 DIM) were used in a randomized complete block design with 4 treatments. The cows were stratified by calving date into 12 blocks and assigned randomly to treatments within block. All cows were housed in tie-stalls and individually fed a common diet (Table 1). Analysis by the Cornell Net Carbohydrate and Protein System version 6.1 (NDS version 3, Ruminant Management & Nutrition, Reggio Emilia, Italy) estimated metabolizable methionine supply at 47 g/day (2.03% of metabolizable protein) and metabolizable lysine supply at 148 g/day (6.38% of metabolizable protein) at a DMI of 22 kg/day. Treatments were premixed with ground corn and offered as a top-dress at a rate of 200 g/cow daily for 35 days. Treatments were control, Cr propionate (**CrPr**; 8 mg/day Cr in the form of 20 g/day KemTRACE Chromium Propionate 0.04%, Kemin Industries, Des Moines, IA), rumen-protected lysine and methionine (**RPLM**;

10 g/day lysine and 5 g/day methionine, intestinally available), or both (**CrPr+RPLM**). The RPLM supplement was composed of 48.8 g/day of LysiPEARL and 15.3 g/day of MetiPEARL (Kemin Industries). Cows were milked 3 times daily (3:00 a.m., 11:00 a.m., and 7:00 p.m.) and fed once daily (4:00 p.m.) for ad libitum intake, targeting 10% daily refusals.

Feed offered and feed refused were measured for each cow daily to determine DMI. Milk yield was recorded for each cow daily. Body weights and BCS were measured on days 1 and 35. Milk samples were collected 3 days per week and were analyzed for concentration of fat, true protein, lactose, MUN, and somatic cells. Samples of feed ingredients were collected weekly and frozen for analysis.

One cow on CrPr+RPLM developed severe mastitis on day 20 of treatment and was subsequently removed from the study. No data were collected or analyzed for this cow. Milk and DMI data were averaged by week prior to analysis. Data were analyzed using the MIXED procedure of SAS to assess the fixed effects of parity (primiparous vs. multiparous); time; CrPr; RPLM; 2-, 3-, and 4-way interactions; and the random effect of block. Significance was declared at $P \leq 0.05$ and tendencies at $0.05 < P < 0.10$.

Results and Discussion

Dry matter intake was significantly increased by CrPr ($P < 0.05$) but was not significantly affected by RPLM when fed for 5 weeks near peak lactation (Table 2). Although neither RPLM nor CrPr significantly altered yields of milk or milk components, CrPr tended to increase ECM ($P = 0.09$) by 6% (Table 2). In addition, there was evidence of parity × CrPr interactions for both DMI ($P = 0.06$) and milk protein yield ($P = 0.04$), in both cases indicating positive responses to CrPr in primiparous cows but not in multiparous cows (Figure 1). Feed efficiency was unaffected, because the increases in milk yield and DMI in response to Cr supplementation paralleled each other.

The interaction of RPLM and CrPr affected milk protein content ($P = 0.04$, Table 2). Somewhat counterintuitively, in the absence of CrPr, RPLM decreased milk protein content ($P < 0.01$), but no effect of RPLM was detected in the presence of CrPr ($P = 0.77$). Rumen-protected lysine and methionine also decreased the efficiency of N utilization for milk protein ($P = 0.05$). There was a CrPr × week interaction ($P = 0.04$) for lactose content, reflecting significantly greater lactose content (4.99 vs. 4.86 ± 0.036%) in response to CrPr during week 1. What caused this response or why it was transient is unclear. No treatment effects were detected for BW change or BCS change (Table 2). The negative values for BW and BCS changes suggested that cows were in a catabolic state.

Plasma amino acid profiles are presented in Table 3. The proportion of lysine significantly increased ($P = 0.05$) and that of methionine tended to increase ($P = 0.07$) in response to RPLM, as was expected when these amino acids were supplemented. On the other hand, the proportion of threonine was significantly decreased by RPLM ($P < 0.01$). A tendency for a CrPr × RPLM interaction ($P = 0.06$) was observed for tryptophan, reflecting a decreased proportion of tryptophan by CrPr in the presence of RPLM ($P = 0.03$), but not in the absence of RPLM ($P = 0.64$). The plasma lysine and methionine responses to RPLM were less than might have been expected, given the lack of increased milk protein yield. We observed approximately a 10% increase in lysine and 6% increase in methionine as a proportion of AA in response to estimated supplementation of 10 and 5 g/day, respectively, in contrast to previous findings demonstrating 30% increases or greater with similar supplementation rates.

Conclusions

The supplementation of CrPr increased DMI and tended to increase ECM yield of peak-lactation cows when fed for a 5-wk period, and DMI as well as milk protein yield was particularly enhanced in primiparous cows. The inclusion of RPLM increased lysine and tended to increase methionine as a proportion of plasma AA but decreased the efficiency of N utilization for milk protein. These findings indicate that responses to dietary Cr in the dairy cow are not limited to early lactation, but fail to demonstrate any increased responsiveness to supplemental essential amino acids when CrPr is fed.

Table 1. Ingredient and nutritional composition of the basal diet

Ingredient	% of DM
Corn silage	31.5
Alfalfa hay	23.4
Wet corn gluten feed[1]	6.8
Ground corn	23.1
Whole cottonseed	4.6
Expeller soybean meal	2.1
Solvent extracted soybean meal	5.1
Calcium salts of fatty acids[2]	0.8
Micronutrient premix	2.6
Nutrient	
DM, % as-fed	57.9
OM	91.3
CP	16.7
NDF	31.7
ADF	20.1
Forage NDF	22.1
NFC	39.8
Ether extract	3.1
Model-predicted ME[3] Mcal/kg	2.50

[1]Sweet Bran, Cargill Corn Milling, Blair, NE.
[2]Megalac R, Arm & Hammer Animal Nutrition, Princeton, NJ.
[3]Metabolizable energy predicted by CNCPS 6.1 (NDS version 3, Ruminant Management & Nutrition, Reggio Emilia, Italy).

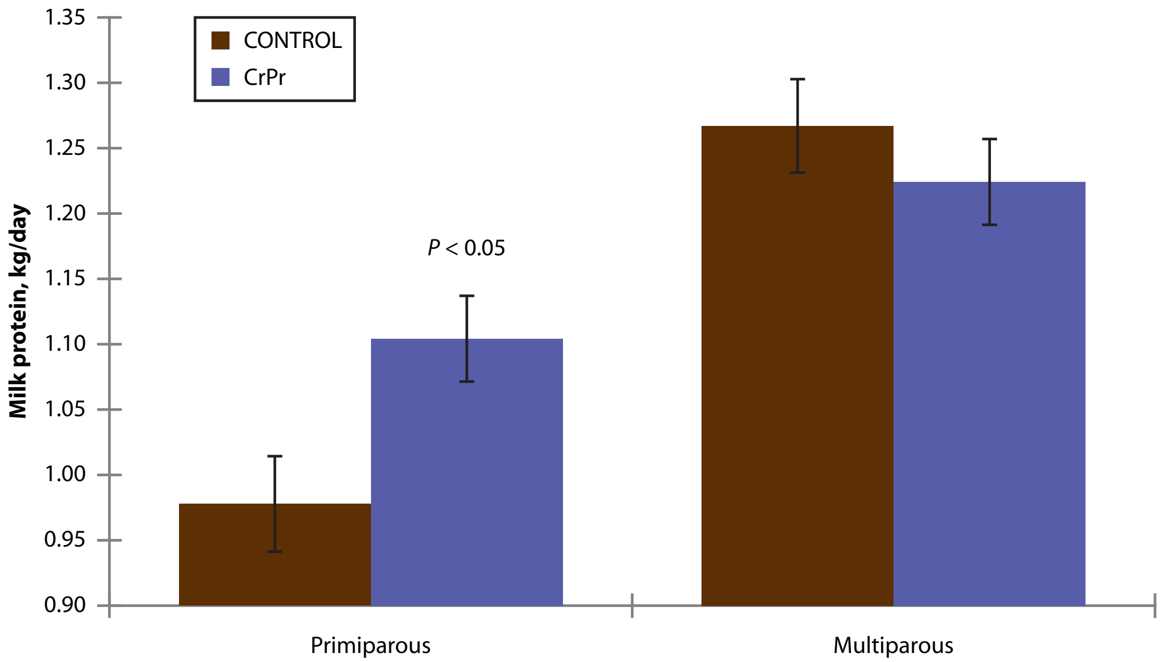
Table 2. Chromium propionate (CrPr) and rumen-protected lysine and methionine (RPLM) effects on intake, productivity, and milk composition of lactating dairy cows

	Control		RPLM			*P*-value		
Item	Control	CrPr	Control	CrPr	SEM	CrPr	RPLM	Interaction
DMI[1], kg/d	19.89	22.20	21.73	22.28	1.10	< 0.05	0.18	0.23
Milk yield, kg/d	40.53	43.72	42.42	43.25	1.44	0.14	0.61	0.39
Milk fat, %	4.20	4.13	3.95	3.97	0.15	0.88	0.19	0.74
Milk protein, %	2.75	2.67	2.62	2.68	0.04	0.66	0.09	0.04
Milk lactose, %	4.90	4.99	4.89	4.90	0.04	0.26	0.24	0.37
MUN[2], mg/dL	13.21	14.01	13.78	13.10	0.56	0.89	0.70	0.09
SCC[3] linear score	1.59	1.10	1.58	1.65	0.50	0.66	0.56	0.56
Fat yield, kg/d	1.68	1.81	1.66	1.70	0.07	0.27	0.37	0.58
Protein yield, kg/d	1.12	1.16	1.12	1.17	0.03	0.22	0.93	0.86
Lactose yield, kg/d	2.01	2.17	2.09	2.15	0.07	0.15	0.74	0.54
Body weight change, kg/29 d	-14.6	-9.9	-13.7	-7.6	4.15	0.21	0.74	0.89
BCS[4] change	-0.31	-0.32	-0.33	-0.27	0.09	0.06	0.86	0.32
ECM[5], kg/d	43.14	46.30	43.09	44.91	1.47	0.09	0.62	0.65
ECM/DMI	2.18	2.08	2.02	2.02	0.08	0.53	0.16	0.56

[1]Dry matter intake.
[2]Milk urea nitrogen.
[3]Somatic cell count.
[4]Body condition score.
[5]Energy-corrected milk = (0.327 × milk yield) + (12.95 × fat yield) + (7.65 × protein yield); (Dairy Record Management Systems, 2013).

Table 3. Chromium propionate (CrPr) and rumen-protected lysine and methionine (RPLM) effects on plasma amino acids on lactating dairy cows

Amino acid	Control		RPLM			*P*-value		
(molar % of total AA)	Control	CrPr	Control	CrPr	SEM	CrPr	RPLM	Interaction
Glycine	15.57	15.07	14.98	13.92	1.10	0.48	0.42	0.80
Valine	12.19	12.19	11.90	11.07	0.65	0.47	0.28	0.53
Alanine	10.88	11.84	11.72	11.53	0.43	0.37	0.52	0.18
Glutamine	8.70	7.97	8.95	9.44	0.58	0.81	0.09	0.22
Leucine	8.20	8.08	8.11	7.89	0.45	0.66	0.71	0.91
Isoleucine	6.82	6.63	6.77	6.71	0.40	0.72	0.96	0.86
Threonine	4.52	4.72	4.17	3.97	0.24	0.99	0.02	0.25
Citruline	4.40	4.65	4.08	4.18	0.34	0.32	0.23	0.81
Serine	3.95	3.96	3.99	3.81	0.17	0.58	0.73	0.55
Arginine	3.61	4.07	4.01	3.94	0.21	0.30	0.45	0.16
Lysine	3.34	3.37	3.80	3.59	0.17	0.55	0.05	0.47
Glutamate	3.02	2.91	2.78	2.85	0.28	0.91	0.47	0.67
Tyrosine	2.14	2.15	2.30	2.23	0.10	0.75	0.22	0.65
Histidine	2.10	2.09	1.89	2.05	0.07	0.28	0.09	0.25
Asparagine	2.06	1.85	2.20	2.22	0.24	0.63	0.18	0.55
Phenylalanine	1.97	1.96	2.13	2.03	0.08	0.43	0.11	0.52
Taurine	1.75	1.90	1.58	1.80	0.17	0.27	0.41	0.83
Ornithine	1.73	1.68	1.77	1.73	0.10	0.56	0.64	0.97
Tryptophan	1.63	1.68	1.73	1.53	0.07	0.18	0.69	0.06
Methionine	0.95	0.99	1.06	1.01	0.04	0.93	0.07	0.12
Aspartate	0.32	0.38	0.33	0.34	0.02	0.13	0.51	0.28
Total amino acids, m*M*	2.47	2.39	2.14	2.39	0.10	0.39	0.11	0.11



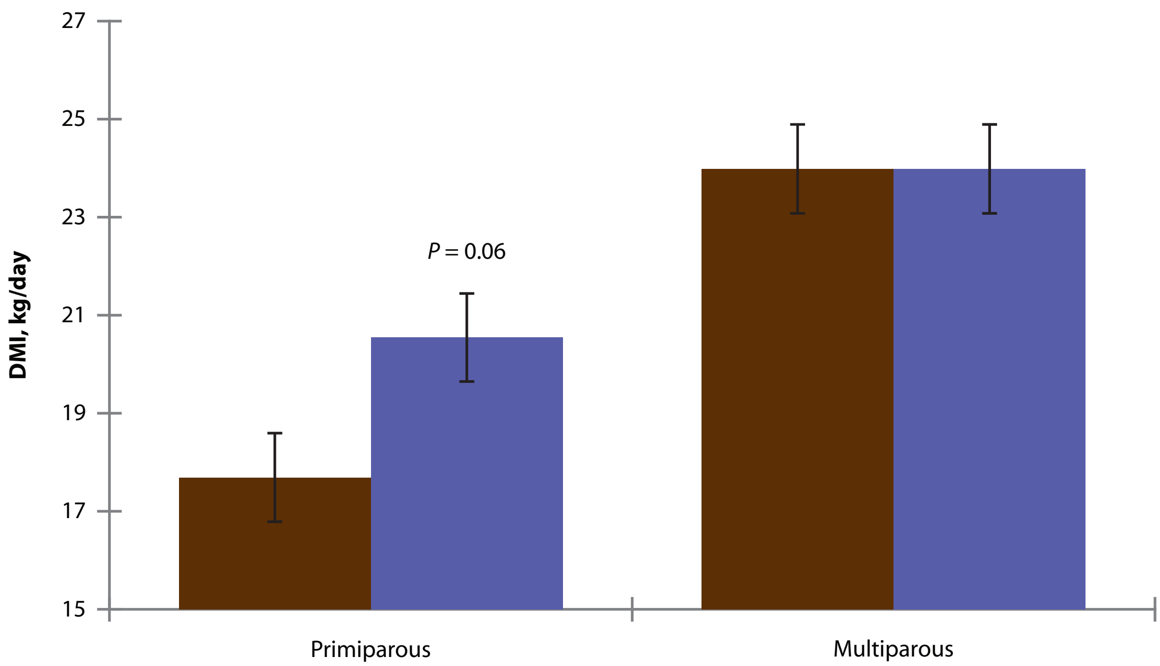


Figure 1. Interactions of chromium propionate (CrPr) and parity for milk protein yield (A) and dry matter intake (DMI; B). Supplements were fed for 35 days near peak lactation, and DMI and milk production responses were analyzed by week throughout the study. Values are LSM ± SEM, n = 10 to 13.