THE IMPACT OF CHROMIUM SUPPLEMENTATION ON DAIRY CATTLE PERFORMANCE

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Over the last two decades, more than a dozen studies have been published that have evaluated effects of chromium (Cr) supplementation on dairy cattle performance. While nearly all studies reported positive effects of Cr supplementation on yields of milk or milk components, mean milk yield responses for individual treatments across studies have been highly variable ranging from -1.7 to 5.4 kg/d. Several studies have initiated treatment in established lactation, but the majority supplemented Cr during the transition period from pregnancy to lactation. Chromium has been reported to increase insulin sensitivity of tissues in various species including cattle (Subiyatno el al., 1996; Hayirli et al., 2001; Sumner et al., 2007). Strategies to increase insulin sensitivity might decrease lipolysis during the transition period, benefiting feed intake and milk yield (Hayirli et al., 2001; McNamara and Valdez, 2005). Although Cr supplementation increased milk yield in those and other experiments (Yang et al., 1996; Smith et al., 2005; Terramoccia et al., 2005; Sadri et al., 2009; An-Qiang et al., 2009; Nikkhah et al., 2010; Soltan, 2010), Cr supplementation did not affect milk yield (Bryan et al., 2004; Yasui et al., 2014) or feed intake (Sadri et al., 2009; Yasui et al., 2014) in other experiments. Inconsistent effects of Cr on productive performance of dairy cattle might be due to several factors including type of Cr compound, Cr dose, diet, and start time relative to parturition, among others.

While Cr propionate (CrPr) is currently the only Cr compound currently approved for use in dairy cattle in the US, others including Cr methionine (CrMet), and Cr picolinate have been evaluated in studies with lactating cows. Differences in dissociation characteristics of the compounds in the gastrointestinal tract likely affect absorption, but no study has directly compared effects of different Cr compounds on dairy cattle performance.

Experiments have evaluated effects of Cr dose on dairy cattle performance in the peripartum period including Hayirli et al., 2001 and Smith et al., 2005. Both studies used CrMet and Cr was supplemented from 3-4 weeks prepartum to 4 weeks postpartum (PP). Chromium increased DMI and FCM linearly with doses of 0, 3.8, and 7.5 mg Cr/d in the study reported by Smith et al. (2005) but quadratically with doses of 0, 4.2, 8.4, and 16.9 mg Cr/d in the study reported by Hayirli et al. (2001). It is important to note that some research studies have exceeded the maximum allowed by FDA and that supplemental chromium cannot exceed 500 ppb in the final diet of dairy cattle in the US. The optimum dose for DMI and FCM was ~8 mg Cr/d for both studies with increases of 2.4 kg/d DMI and 5.2 kg/d FCM (Hayilri et al., 2001) and 1.5 kg/d DMI and 2.4 kg/d FCM (Smith et al., 2005). The highest dose of 16.9 mg Cr/d reported by Hayirli et al., (2001) decreased yields of milk and FCM compared with control. Terramoccia et al. (2005) also reported dose-response effects of amino acid chelated Cr supplementation to cows in the

peripartum period but the focus of the study was immune response and a set amount of feed was allotted so DMI was limited and the production results, although positive for milk yield, aren't as meaningful.

The interaction between ration starch fermentability and Cr supplementation in the peripartum period was evaluated in two studies. Sadri et al. (2009) supplemented CrMet (~10 mg Cr/d) to cows offered either a barley-based ration or a corn-based ration from 3 weeks before to 4 weeks after parturition. They reported that Cr supplementation increased PP DMI 1.5 kg/d and yields of protein 90 g/d and total solids in milk 450 g/d when supplemented in the barley-based diets only but decreased loss of body weight following parturition when supplemented in both rations. We also reported interactions between diet starch fermentability and Cr supplementation (Rockwell and Allen, 2016). In our study CrPr was supplemented (8 mg Cr/d) to cows from 4 weeks before parturition to 4 weeks after parturition and cows were offered rations containing dry corn (DC) or high moisture corn (HMC) at parturition for 4 weeks and a common ration without Cr for the next 8 weeks to evaluate carryover effects of treatment. The CrPr and corn treatments interacted over time to affect yield of 3.5% fat-corrected milk (FCM) during both the treatment and carryover periods. The CrPr/HMC treatment combination tended to increase FCM 8.8 kg/d compared with Con/DC and Con/HMC by 28 d PP (57.4 vs. 48.6 and 48.5 kg/d, respectively) and increased FCM compared with Con/DC by 42 d PP (59.2 vs. 44.8 kg/d). The CrPr tended to increase milk yield (55.4 vs. 51.9 kg/d) regardless of corn source during the carryover period after treatment ceased. Dry matter intake was not affected by treatment during the PP period, but DMI was generally higher for CrPr/HMC, lower for Con/DC, and intermediate for CrPr/DC and Con/HMC throughout the carryover period.

Transition cow studies generally started Cr supplementation several weeks prepartum but several studies (An-Qiang et al., 2009; Nikkhah et al., 2010; Vargas-Rodriguez et al., 2014) reported benefits of Cr supplementation on DMI and yields of milk or milk components beginning several weeks PP. We recently conducted a study to evaluate effects of timing of Cr supplementation (CrPr, 8 mg Cr/d) during the fresh period (FR) or starting at 23 d PP. Initiating supplementation of CrPr at 23 d PP did not benefit production in our experiment but supplementation of CrPr during FR increased DMI 2.75 kg/d and milk yield 4.5 kg/d. Effects on production diminished over time with no effects of CrPr by 10 weeks PP weather or not CrPr supplementation continued past the fresh period. Results were consistent with putative effects of CrPr on insulin sensitivity with a reduction in plasma concentrations of NEFA and BHBA, lower milk fat concentration, and greater BCS over time during FR compared with control.

In summary, Cr supplementation has benefited productive performance of lactating cows in most studies and variation in production response has been affected by Cr dose, diet starch fermentability, and timing of supplementation relative to parturition. Other factors including comparisons of Cr compound type, other diet treatments, and body condition of cows remain to be investigated.

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