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Effects of chromium propionate supplementation during the periparturient period and early lactation on metabolism, performance, and cytological endometritis in dairy cows

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ABSTRACT

Multiparous Holstein cows (n = 61) were used to determine the effects of chromium propionate (Cr-Pro) supplementation during the periparturient period and early lactation on metabolism, performance, and the incidence of cytological endometritis (CE). After a 1-wk preliminary period, cows were assigned randomly to 1 of 2 treatments from 21 d before expected calving through 63 d postpartum: (1) control (n = 31) and (2) Cr-Pro (n = 30) administered by daily topdress at a rate of 8 mg/d of Cr. A tendency was detected for increased dry matter intake (DMI) during the prepartum period for cows fed Cr-Pro. Moreover, cows fed Cr-Pro tended to have lower plasma concentrations of nonesterified fatty acids during the prepartum period. However, effects of Cr-Pro supplementation on postpartum DMI and milk yield were not significant. Cows fed Cr-Pro tended to have higher urea N concentrations in milk. An interaction of treatment and day existed during the postpartum period, such that cows fed Cr-Pro had lower plasma glucose concentrations within the first day postpartum compared with controls. Plasma haptoglobin concentration was not affected by treatment during the postpartum period. Blood neutrophil glycogen concentrations were not affected by treatment when sampled at either 7 d postpartum or on one day between 40 and 60 d (48 d ± 0.44 standard error) postpartum. Evaluation of endometrial cytology by low volume lavage at 7 d postpartum (first lavage) and on one day between 40 and 60 d (second lavage) postpartum revealed that cows fed Cr-Pro tended to have a higher percentage of neutrophils at first lavage and decreased incidence of CE as assessed at second lavage. In conclusion, supplementation with Cr-Pro resulted in trends for increased DMI and lower plasma nonesterified fatty acids prepartum. Postpartum production and energy metabolism were not affected by treatment; however, Cr-Pro supplementation tended to affect the postpartum influx of neutrophils into the uterus and decreased the incidence of CE, suggesting positive effects of Cr-Pro supplementation on uterine health.

Key words: chromium, transition cow, cytological endometritis

INTRODUCTION

Chromium is essential to normal carbohydrate, lipid, and protein metabolism (Vincent, 2004; Pechova and Pavlata, 2007) and has been demonstrated to affect energy metabolism through modulating tissue responses to insulin (Vincent, 2004). The demand for Cr is typically increased during different forms of nutritional, metabolic, and physical stress (Pechova and Pavlata, 2007). Several studies conducted during the transition period and early lactation have demonstrated that cows fed supplemental Cr have increased milk yield (Hayirli et al., 2001; Smith et al., 2005; Sadri et al., 2009) and improved energy metabolism, as measured by lower circulating concentrations of NEFA or BHBA (Smith et al., 2008; Soltan, 2010; Sadri et al., 2012).

In addition to its effects on nutritional metabolism, several studies suggest that Cr may also have immunomodulatory effects in cattle. Chromium supplementation has affected cell-mediated immunity such that mitogen-stimulated blastogenic responses in peripheral blood mononuclear cells were elevated in cows fed Cr (Burton et al., 1993). Cows fed Cr had higher humoral immune responses such as increased anti-ovalbumin antibody (Burton et al., 1993) and tetanus toxoid-specific antibody (Faldyna et al., 2003) responses compared with control cows. Positive effects of Cr on innate im-

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munity have not been demonstrated to date (Chang et al., 1996; Spears, 2000); however, the possibility still exists that Cr affects innate immune responses because the level of serum cortisol was significantly decreased in stressed calves fed Cr (Mowat et al., 1993), and neutrophil function is known to be negatively affected by glucocorticoids in cattle (Burton et al., 1996).

Recent work has established linkages between energy metabolism during the periparturient period and reproductive performance (Butler et al., 2006; Roche et al., 2009; Ospina et al., 2010). Elevated concentrations of NEFA and BHBA in blood during the transition period were associated with decreased reproductive performance in a large field study (Ospina et al., 2010). One could speculate that these associations can be explained partly by the potential development of cytological endometritis (**CE**) because the odds of having CE were 3.9 times higher in cows with ketosis (Cheong et al., 2011). Further, the development of CE has been shown to negatively affect reproductive outcomes: lower first-service conception rate and longer days to pregnancy in a study conducted in 5 commercial dairy farms (Gilbert et al., 2005), and lower odds for pregnancy at first insemination and longer median days open in another study conducted in 779 cows from 38 herds (Cheong et al., 2011) in cows with CE compared with cows without CE. Uterine defenses are known to initially rely on innate immunity rather than adaptive immunity (Wathes et al., 2009). Therefore, it is possible that Cr supplementation affects the incidence of CE through its effects on either energy metabolism or immune function.

Given the potential effects of Cr supplementation on both energy metabolism and immune function, we hypothesized that Cr supplementation during the periparturient period and early lactation would improve aspects of metabolism and performance and decrease the incidence of cytological endometritis in cows. Therefore, the objective of this experiment was to evaluate the effect of Cr supplementation to cows during the periparturient period and early lactation on performance, metabolism, inflammatory response, and the incidence of CE in dairy cows.

MATERIALS AND METHODS

Experimental Animals, Treatments, and Procedures

All procedures involving animals were approved by the Cornell University Institutional Animal Care and Use Committee (Ithaca, NY) before the onset of the experiment. Holstein cows (n = 61) entering second lactation or greater from the Cornell University Teaching and Research Center Dairy were enrolled in this experiment at 28 d before expected calving to allow for covariate data collection between d 28 and 21 before expected calving and then assigned at 21 d before expected calving to 1 of 2 topdress treatments with randomization restricted by 305-d mature-equivalent milk production in the previous lactation. Treatments were administered from 21 d before expected calving through 63 d postcalving: (1) control (no topdress) and (2) chromium propionate (**Cr-Pro**; KemTRACE chromium propionate; Kemin Industries Inc., Des Moines, IA) administered by daily topdress at a rate of 8 mg of Cr/d immediately after feeding. All cows were housed in individual tie-stalls and fed the same basal diet during the prepartum period and also fed the same basal diet during the postpartum period.

Ingredient and chemical composition of the diets fed during the experiment are described in Table 1. Both prepartum and postpartum diets were typical of those fed in the northeastern United States. All nonforage ingredients were blended by a commercial feed mill into separate concentrate mixtures, and diet mixing at the farm consisted of mixing the component forages with the appropriate concentrate mixture. Fresh feed was provided each morning at 0800 h, orts were weighed and recorded daily, and water was made available at all times by individual water cups. Samples of the forages and concentrate mixtures were obtained weekly throughout the experiment, and DM content was determined by drying at 55°C until static weight was obtained. Amounts of individual feed components in the TMR were adjusted weekly based on changes in the DM content of these feed components. The DM content of each TMR was used in calculating the DMI for the corresponding week. The weekly samples of forages, concentrate mixtures, and TMR were composited into 4-wk composite samples and submitted to a commercial laboratory to analyze for Cornell Net Carbohydrate and Protein System/Cornell-Penn-Miner profiles (Cumberland Valley Analytical Services, Hagerstown, MD). Samples were analyzed for DM (AOAC International, 2000; method 930.15), CP (AOAC International, 2000; method 990.03), soluble protein (Krishnamoorthy et al., 1982), ADF (AOAC International, 2000; method 973.18), NDF (Van Soest et al., 1991), starch (Hall, 2009), sugar (DuBois et al., 1956), ether extract (AOAC International, 2006; method 2003.05), ash (AOAC International, 2000; method 942.05), and minerals (AOAC International, 2000; method 985.01).

Cows were milked twice per day (0900 and 2100 h) and milk yields were recorded at all milkings for the 63-d postpartum treatment period. Milk samples were collected on the same day each week from all milk-