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Effects of chromium supplementation to beef cows during gestation on beef cow performance and progeny development before weaning[1]

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ABSTRACT

Angus-cross cows (n = 66) were fed 1 of 2 supplements through mid and late gestation: (1) 1.81 kg/d of corn as fed (control) or (2) 1.81 kg of corn fortified with 3 mg/d of Cr as fed (Chrom). Chromium supplementation did not affect ($P \geq 0.24$) pre- or postpartum cow BW or BCS, or BW and BCS change. There was an interaction ($P < 0.01$) of days in gestation and Cr supplementation for glucose concentrations only. During mid gestation, plasma glucose concentrations in cows fed Chrom decreased 0.282 mmol/L compared with cows fed control; however, by late gestation, glucose concentrations in cows fed Chrom increased 0.321 mmol/L compared with cows fed control. Supplementation with Cr did not affect ($P \geq 0.58$) insulin concentrations or insulin:glucose; however, insulin and glucose concentrations were reduced (time effect; $P < 0.01$) as days in gestation increased, regardless of Cr supplementation. There was no effect of dam treatment on calf BW at birth ($P = 0.40$) or weaning ($P = 0.56$). Chromium supplementation did not affect ($P \geq 0.20$) estimated 24-h milk weight in mid or late lactation. Milk composition was not affected ($P \geq 0.25$) by Cr at mid lactation. In late lactation, cows fed Chrom had greater ($P = 0.01$) milk urea nitrogen compared with cows fed control, with no other differences observed ($P \geq 0.23$). In this experiment, supplemental Cr during gestation did not affect cow BW, BCS, milk production, or calf birth and weaning BW. Regardless of treatment, as cows neared parturition, plasma glucose and insulin concentrations of cows decreased.

Key words: beef, chromium, cow, fetal programming

INTRODUCTION

Adequate maternal nutrition is critical for proper fetal development and has lasting effects on progeny development later in life (Barker, 1997). During gestation, maternal nutrient deficiencies are common, particularly in minerals, because of nutrient allocation to fetal development (Anderson, 1998). Chromium is an important trace mineral in animal nutrition because of its role in carbohydrate and lipid metabolism (Vincent, 1999). Chromium supplementation has been shown to improve immune response, decrease morbidity, and improve ADG and DMI in transported, newly received calves (Moonsie-Shageer and Mowat, 1993; Mowat et al., 1993; Kegley and Spears, 1995; Kegley et al., 1996). In addition, Cr supplementation increased insulin function and altered glucose metabolism in newly received steer calves (Kegley et al., 2000), growing heifers (Spears et al., 2012), and mature dairy cows (Leiva et al., 2014) and increased ADG and DMI in young calves (Moonsie-Shageer and Mowat, 1993; Kegley et al., 1997). Furthermore, feeding Cr during gestation reduced postpartum BW loss in 2- and 3-yr-old cows (Stahlhut et al., 2006b) and increased postpartum BW gain (Aragon et al., 2001). In dairy cows, Cr increased milk production (McNamara and Valdez, 2005; Smith et al., 2005). However,

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limited research has been conducted on the effects of prepartum Cr supplementation on beef cow BW, BCS, or milk production. We hypothesized that Cr would improve insulin and glucose metabolism during mid and late gestation and, therefore, improve cow BW and BCS and increase milk production. In turn, this improvement in glucose and insulin sensitivity would increase calf BW at weaning. Therefore, objectives of this experiment were to determine the effects of gestational Cr supplementation to beef cows on glucose and insulin concentrations, cow BW and BCS, milk production, and the effects on resulting progeny birth and weaning BW.

MATERIALS AND METHODS

Animal and Diet Management

All animal procedures in this experiment followed guidelines recommended in the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (FASS, 2010).

Angus-cross cows (n = 83; primiparous, n = 18; multiparous, n = 48; age = 2 to 13 yr) were used in an experiment at the Eastern Agricultural Research Station in Belle Valley, Ohio, beginning on October 31, 2012 (164 ± 13 d prepartum). Cows were bred to 1 of 5 Angus bulls. Cows were removed (n = 17) from the experiment for reasons unrelated to Cr supplementation: open (n = 7), calving difficulties or birth defects (n = 4), and not calving within the 51-d season (n = 6), leaving 66 cows (from an original 83) to be used in the experiment. Cows were stratified by age and randomly assigned to 1 of 2 treatments: (1) 1.81 kg/d of pelleted corn as fed (control) or (2) 1.81 kg of pelleted corn fortified with 3 mg/d of Cr as fed (**Chrom**, supplied as Cr propionate; KemTRACE Cr, Kemin Industries Inc., Des Moines, IA). Treatments were fed for 133 d, from 164 ± 13 d to 32 ± 13 d prepartum (until March 12, 2013).

Background concentrations of Cr in the corn ranged from 0.5 to 1.6 mg/kg of DM as determined by inductively coupled plasma electrophoresis (OARDC STAR laboratory, Wooster, OH). When reported, corn Cr concentrations in previous literature have varied from 0.004 to 0.91 mg of Cr/kg of DM, largely due to differences, and difficulties, with accurate Cr analysis (EFSA, 2009; Spears, 2012; Bunting, 2015).

Cows were managed as 2 separate groups throughout the trial and were grazed on mixed-grass–legume pasture until fall forage was depleted in late November. Although there was a lack of replicated pastures in this experiment, cows within treatment group were rotated among adjacent pastures 3 times per week to reduce any potential location effects on treatment due to pasture. When forage in the pasture began to be depleted and was not sufficient to meet animal maintenance needs, round baled, mixed-grass hay was offered. Hay intake was regulated by limiting access and limit feeding when necessary to maintain acceptable BW gain and BCS throughout gestation, for approximately 4 mo. Limiting access was accomplished by allowing 6-h access to round baled hay racks Monday through Friday. On weekends, cows were allowed access for 24 h to reduce labor requirements. Hay rings remained in the pastures; thus, the same rings and hay were used for both treatment groups as cows were rotated among pastures throughout the week. Cows were offered free-choice mineral supplement throughout the trial (Table 1). Initial cow BW were taken at 0800 h (before daily supplementation) at the start of the trial (163 ± 13 d prepartum) and then approximately every 4 wk until the termination of Cr supplementation (32 ± 13 d prepartum; Figure 1). Final cow BW were taken 39 ± 13 d prepartum (1 wk before the end of Cr supplementation). Cow BCS was also recorded approximately every 4 wk. The same, trained Ohio State University personnel measured cow BCS throughout the trial using a whole numbered scale of 1 to 9 with 1 = all ribs visible, visible spine, no brisket fat, no tail head fat, and muscle loss; 5 = 1 to 2 visible ribs, spine not visible, no brisket fat, no tail head fat, no muscle loss; and 9 = no visible ribs, no visible spine, abundant brisket fat, abundant tail head fat, and no muscle loss. The first calf was born on March 24, 2013, and the last calves were born on May 15, for a 51-d calving season and an average calving date of April 13. Corn and Cr supplementation ended 32 ± 13 d prepartum, and all 66 cows were grouped together.

To determine progeny differences, calf weights were recorded once within 24 h of birth and once at weaning, which was approximately 6 mo of age (184 ± 13 d postpartum), immediately after removal from cow. Steer calves were castrated, and steer and heifer calves were vaccinated with Alpha 7-MB-1 (Boehringer Ingelheim, Ingelheim, Germany) and Lepto-ferm-5 (Zoetis, Florham Park, NJ) on May 23, 2013. On July 22, 2013, 12 wk before weaning, calves received Bovi-Shield Gold FP 5L5 (Zoetis) and Ultrabac 7/Somubac (Pfizer Animal Health, New York City, NY). On August 22, approximately 7 wk before weaning, calves received Bovi-Shield Gold FP 5L5 booster, Ultrabac 7/Somubac booster, and One Shot Ultra (Zoetis).

Sampling and Analysis

Feed and hay core samples were collected monthly and composited for nutrient analysis. Composite samples were analyzed, and results were used to record nutrient composition of the diets (Table 1). All samples were analyzed for DM (24 h at 105°C), ADF and NDF (using Ankom Technology method 5 and 6, respectively; Ankom^{200} Fiber Analyzer, Ankom Technology, Macedon, NY), CP (method 930.15; AOAC International, 1996), and fat (using Ankom Technology method 2; Ankom Technology).

Cows were bled from the jugular vein (K_2 EDTA Vacutainer tubes, REF 366643, BD Vacutainer, Franklin Lakes, NJ) for plasma insulin and glucose on 3 separate days: 163 ± 13, 95 ± 13, and 39 ± 13 d prepartum. Cows were moved from their respective pastures to a dry lot 4 h after