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Case Study: Effects of body weight gain and bovine somatotropin treatment of postpartum beef cows on concentrations of IGF-1, insulin, and glucose in blood plasma; luteal activity; and calf growth[1]

M. J. Cooper-Prado, I. Rubio,[2] N. M. Long,[3] M. P. Davis,[4] L. J. Spicer, and R. P. Wettemann,[5] PAS
Department of Animal and Food Sciences, Oklahoma Agricultural Experiment Station, Stillwater 74078-0425

ABSTRACT

Angus × Hereford cows (2 and 3 yr of age, n = 37) were used to evaluate the effects of postpartum BW gain and treatment with bovine somatotropin (bST) on concentrations of IGF-I, glucose, and insulin in plasma during early lactation; luteal activity; and calf growth. Cows (456 ± 52 kg, BCS = 4.6 ± 0.4) were stratified based on calving date and BCS and randomly assigned to a 2 × 2 × 2 factorial: weight gain ≤0.4 kg/d (MWG) or >0.4 kg/d (HWG) during 24 to 59 d postpartum, injection with bST or saline (CON) on d 31 and 45 postpartum, and 2 or 3 yr of age. Concentrations of IGF-I in plasma before bST treatment were greater ($P = 0.02$) for HWG compared with MWG cows, and IGF-I was greater ($P < 0.01$) after bST in HWG bST cows compared with MWG bST, MWG CON, or HWG CON cows. Concentrations of glucose in plasma were greater ($P \leq 0.01$) in HWG bST cows compared with HWG CON, MWG CON, and MWG bST cows after bST treatment. Weight gain and treatment with bST did not influence the percentage of cows with luteal activity by 59 d after calving. Average daily gain of calves to 140 d of age was greater ($P < 0.01$) for HWG-treated and tended to be greater ($P = 0.06$) for bST-treated cows compared with MWG and CON cows, respectively. Weight gain of young lactating beef cows increased plasma concentrations of IGF-I and glucose after treatment with bST.

Key words: beef cow, body weight gain, calf growth, insulin like growth factor-I, somatotropin

INTRODUCTION

Postpartum nutrient intake and BCS can influence reproductive performance of primiparous beef cows because greater weight gain decreases the postpartum anestrous interval compared with less weight gain (Spitzer et al., 1995; Ciccioli et al., 2003). Increased nutrient intake increases IGF-I in plasma of heifers during 16 wk before puberty (Yelich et al., 1995), primiparous beef cows (Lalman et al., 2000; Ciccioli et al., 2003), and gestating beef cows (Lents et al., 2005). Nutrient restriction of cows decreases serum concentrations of IGF-I (Houseknecht et al., 1988; Richards et al., 1991). Plasma IGF-I is positively associated with incidence of estrous cycles (Roberts et al., 1997), and concentrations of IGF-I were greater in postpartum cows that resumed estrus by 20 wk after calving compared with anestrous cows (Ciccioli et al., 2003). Selection of beef cows for greater concentrations of IGF-I could result in increased conception rate (Zhang et al., 2013). Plasma concentrations of insulin, IGF-I, and glucose are associated with resumption of ovarian activity in postpartum beef cows (Wettemann et al., 2003). Treatment with recombinant bovine somatotropin (**bST**) increases concentrations of IGF-I in plasma of dairy (Bilby et al., 1999, 2004) and lactating beef cows (Armstrong et al., 1995; Flores et al., 2008). Treatment with bST also increases milk production in dairy (Bauman and Vernon, 1993) and beef cows (Armstrong et al., 1995), and milk production of beef cows is positively correlated with weaning weight of calves (Neville, 1962; Rutledge et al., 1971). Beef cows with a greater weight gain after calving, and treated with bST, may have greater plasma concentrations of IGF-I and a shorter postpartum interval to ovulation and estrus.

We hypothesized that greater BW gain of primiparous postpartum beef cows and treatment with bST would have

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[2] Present address: Centro de Enseñanza, Investigación y Extensión en Ganadería Tropical, Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México, Tlapacoyan, Veracruz, 93650, México.

[3] Present address: Animal and Veterinary Sciences, Clemson University, Clemson, SC 29634.

[4] Present address: Cedar County University of Missouri Extension Center, 113 South Street, Stockton, MO 65785.

[5] Corresponding author: bob.wettemann@okstate.edu

synergistic effects to increase concentrations of IGF-I, glucose, and insulin in plasma; reduce the postpartum anovulatory period; and increase ADG of calves. The objectives of this study were to evaluate the effects of weight gain and treatment with bST of primiparous postpartum beef cows on concentrations of IGF-I, glucose, and insulin in plasma during early lactation; resumption of luteal activity; and calf growth.

MATERIALS AND METHODS

Animals, Diets, and Treatments

The Oklahoma State University Animal Care and Use Committee approved all the experimental procedures used in this study (AG046). Spring-calving primiparous Angus × Hereford cows [456 ± 52 kg, BCS = 4.6 ± 0.4, 2 (n = 15) and 3 (n = 22) yr of age] were stratified at calving by age, BCS, and calving date and randomly assigned to 1 of 2 weight gain groups. Commencing on the day of calving, cows were managed as 2 groups to obtain different weight gains. Cows had ad libitum access to prairie hay (6% CP) and were supplemented to achieve a moderate (**MWG**, ≤0.4 kg/d, n = 18) or high weight gain (**HWG**, >0.4 kg/d, n = 19). In addition to hay, cows in the MWG group received 1.8 kg/d of a 38% CP supplement that consisted of 81% cottonseed meal, 11% soybean meal, and 8% wheat mids (as fed), whereas HWG cows had ad libitum access to a high energy ration (1.61 Mcal of NE_m/kg of DM, 0.9 Mcal of NE_g/kg of DM, and 11.1% CP) composed (DM basis) of rolled corn (39.7%), ground alfalfa pellets (35.5%), cottonseed hulls (22%), sugar cane molasses (2.5%), and salt (0.3%) in a self-feeder. Cows on HWG consumed on average 11 kg (DM) of the high energy ration per head per day; cows on MWG consumed 1.6 kg (DM) of the 38% CP supplement per head per day. After d 60 after calving, all cows grazed native range pasture (*Andropogon scoparius*, *Andropogon gerardii*) without supplementation and were exposed to 2 fertile bulls for 60 d. Bull calves (n = 19) were castrated at birth by banding (Lents et al., 2006).

Cows in each weight gain group were randomly assigned to receive bST (250 mg, s.c., POSILAC, Elanco Animal Health, Indianapolis, IN, one-half standard dose) or saline (0.5 mL, s.c.) on d 31 ± 4 and 45 ± 4 after calving. Injections were administered s.c. in the depression on the side of the tailhead. The first treatment was administered on the right side, and the second treatment was administered on the left side. Calves remained with dams 24 h every day until weaning (220 d of age).

BW and BCS

Body weight of cows, after being denied water and feed for 16 h (shrunk), and BCS (1 = emaciated to 9 = obese; Wagner et al., 1988) were recorded on d 24 ± 4 and 59 ± 4 postpartum. Body weights (nonshrunk) of calves were recorded at birth and at approximately d 59, 140, and 220 of age. All cows had sucking calves until 220 d of age. Body weight was not available for 3 calves at weaning.

Blood Samples, Hormones, and Assays

Blood samples (a total of 11 from each cow) were collected every 3 or 4 d from d 24 to 70 after calving. Samples (10 mL) were taken by puncture of caudal veins and collected into vacutainer tubes containing EDTA [0.1 mL of a 15% solution (wt/vol)]) that were stored on ice and centrifuged at 2,500 × g for 20 min at 4°C within 3 h after collection. Plasma was recovered and stored at −20°C until being analyzed. On the days of bST or saline treatments, blood was collected before treatment.

Plasma concentrations of IGF-I and glucose were quantified in samples collected from d 24 to 59 after calving, and insulin was determined in weekly samples and at 3 d after both administrations of bST or saline. Plasma concentrations of progesterone were quantified in samples taken every 3 or 4 d from 35 to 70 d after calving. The criterion for luteal activity was 2 or more consecutive plasma samples with concentrations of progesterone greater than 1 ng/mL (Wettemann et al., 1972).

Concentrations of IGF-I in plasma were determined after acid ethanol extraction (16 h at 4°C) by RIA (Echternkamp et al., 1990); intra- and interassay CV (n = 5 assays) were 9 and 17%, respectively. Plasma concentrations of glucose were quantified with an enzymatic colorimetric procedure (Thermo DMA, Louisville, CO; Richards et al., 1989; Maciel et al., 2001); intra- and interassay CV (n = 10 assays) were 3 and 6%, respectively. Concentrations of insulin in plasma were quantified with a solid phase RIA for human insulin (Coat-A-Count Insulin Kit, Diagnostic Products Corp., Los Angeles, CA; Bossis et al., 1999) with bovine pancreatic insulin as the standard (Sigma Chemical Co., St. Louis, MO). Intra- and interassay CV (n = 5 assays) were 5 and 18%, respectively. Concentrations of progesterone in plasma were quantified with a solid phase RIA (Coat-A-Count Progesterone Kit, Diagnostic Products Corp.; Vizcarra et al., 1997) in one assay, and the intraassay CV was 16%.

Statistical Analyses

Body weight, ADG, and BCS of the cows were analyzed as a completely randomized design with a 2 × 2 × 2 factorial treatment structure using the GLM procedure of SAS (SAS Institute Inc., Cary, NC). The model included cow age, weight gain, bST, and the interactions. Birth weight, BW, and ADG of the calves at 59, 140, and 220 d of age were analyzed as a completely randomized design with a 2 × 2 × 2 factorial treatment structure (weight gain ≤0.4 or >0.4 kg/d; bST or control; 2 or 3 yr of age) using the GLM procedure of SAS. The model included weight gain of the dam, bST, calf sex, and the interactions. Interactions that were $P > 0.30$ were deleted from the final models.