



J. Dairy Sci. 100:1–17
<https://doi.org/10.3168/jds.2016-11737>
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Effects of treatment of periparturient dairy cows with recombinant bovine somatotropin on health and productive and reproductive parameters

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ABSTRACT

The objectives of the current experiment were to evaluate the effects of treating periparturient dairy cows with recombinant bovine somatotropin (rbST) on incidence of postpartum diseases and performance. Holstein (HO) and Jersey (JS) cows from 2 herds were enrolled in the experiment at 253 ± 3 d of gestation and assigned to the control ($n = 432$) and rbST125 ($n = 437$) treatments. Cows in the rbST125 treatment received 125 mg of rbST, weekly, from -21 to 21 d relative to calving. Blood sampled weekly, from -21 to 21 d relative to calving, from a subsample of cows was used to determine the concentrations of growth hormone (GH, HO = 106) and insulin-like growth factor 1 (IGF-1, HO = 147 and JS = 49). Cows were scored for body condition (BCS) at enrollment and at 1 ± 3 , 30 ± 3 , and 60 ± 3 d in milk (DIM). Cows were milked thrice daily and energy-corrected milk (ECM) yield was recorded for the first 30 DIM. Treatment of cows with rbST resulted in greater concentrations of GH during the prepartum ($\log_{10}$ back-transformed concentrations of GH: HO-control = 7.83 and HO-rbST125 = 10.36 ng/mL) and postpartum ($\log_{10}$ back-transformed concentrations of GH: HO-control = 10.45 and HO-rbST125 = 18.47 ng/mL) periods. Similarly, IGF-1 concentrations were higher during the prepartum (HO-control = 115.1 ± 4.9 , HO-rbST125 = 137.7 ± 4.7 , JS-control = 120.2 ± 8.3 , JS-rbST125 = 167.1 ± 8.1 ng/mL) and postpartum (HO-control = 61.3 ± 4.0 , HO-rbST125 = 75.2 ± 3.8 , JS-control = 35.5 ± 6.9 , JS-rbST125 = 54.6 ± 6.9 ng/mL) periods for rbST-

treated cows. During the prepartum period, BCS was not affected by treatment, but during the postpartum period, BCS was reduced for rbST-treated cows (HO-control = 3.00 ± 0.03 , HO-rbST125 = 2.90 ± 0.03 , JS-control = 2.64 ± 0.02 , JS-rbST125 = 2.61 ± 0.02). Cows from the rbST125 treatment tended to have lower incidence of retained fetal membranes (HO-control = 14.3, HO-rbST125 = 6.1, JS-control = 1.5, JS-rbST125 = 1.2%) and had reduced incidence of metritis (HO-control = 26.2, HO-rbST125 = 16.6, JS-control = 19.9, JS-rbST125 = 13.3%) compared with control cows. Ketosis incidence tended to be higher for rbST125 cows (HO-control = 9.4, HO-rbST125 = 11.3, JS-control = 8.5, JS-rbST125 = 13.4%) compared with control cows. The interaction between treatment and herd tended to affect yield of ECM during the first 30 DIM because HO cows treated with rbST during the periparturient period had greater yield than control HO cows (HO-control = 35.5 ± 1.0 vs. HO-rbST125 = 39.4 ± 1.0 kg/d), but treatment with rbST did not affect yield of ECM of JS cows (JS-control = 26.7 ± 0.6 vs. JS-rbST125 = 27.8 ± 0.6 kg/d). Treatment of periparturient dairy cows with 125 mg of rbST decreased the incidence of uterine disorders in HO and JS cows and increased yield of ECM during the first 30 DIM among HO cows, despite slightly increasing the incidence of ketosis.

Key words: dairy cow, somatotropin, health, performance

INTRODUCTION

Feed intake of dairy cows is reduced by approximately 30% from the beginning of the dry period to the last week before calving (Hayirli et al., 1998). The decreased feed intake combined with the increased energy demands from the nonlactating to the lactating state, an increase of approximately 13 Mcal/d of net energy for lactation (NRC, 2001), results in negative energy

Received July 14, 2016.

Accepted November 14, 2016.

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balance (**NEB**) from late gestation up to 10 to 12 wk postpartum (Bertics et al., 1992; Grummer, 1995). In periods of NEB, dairy cows have increased concentrations of growth hormone (**GH**), coupled with insulin resistance, that are associated with a coordinated increase in lipolysis and a decrease in glucose uptake and oxidation by peripheral tissues so that nutrients are more readily available for lactogenesis (Bell and Bauman, 1997). Severe NEB, however, leads to excessive lipolysis and elevated concentrations of fatty acids in the plasma, which may predispose cows to hepatic lipidosis, compromised liver function, and elevated plasma BHB concentrations due to incomplete fatty acid oxidation (Grummer et al., 2004). Under these conditions, periparturient cows may develop metabolic disorders such as fatty liver, ketosis, and displacement of abomasum (Oetzel, 2004). Periparturient dairy cows are also predisposed to infectious diseases (Cai et al., 1994; Kimura et al., 2002; Hammon et al., 2006) because hormonal changes (Burton et al., 1995; Moreira da Silva et al., 1998), shortages in major energetic fuels and minerals (Kehrli et al., 1989a,b; Kimura et al., 2006), and elevated concentrations of fatty acids and products of oxidative stress (i.e., reactive oxygen species; Contreras et al., 2012) alter the structure and function of immune cells (Kehrli et al., 1989a,b). Therefore, it is not surprising that approximately 75% of health disorders in dairy cows (e.g., milk fever, ketosis, retained fetal membranes, metritis, mastitis, and displacement of abomasum) are diagnosed in the first 30 d postpartum (LeBlanc et al., 2006). Strategies that improve immune function and glucose and lipid metabolism of periparturient dairy cows may reduce the incidences of infectious and metabolic diseases.

Treatment of dairy cows with recombinant bST (**rbST**) is associated with increased liver gluconeogenesis, suppression of insulin's inhibitory effect on gluconeogenesis (Peel and Bauman, 1987), and increased complete oxidation of fatty acids in bovine liver slices (Pocius and Herbein, 1986). Although treatment of periparturient cows with rbST may increase glucose availability for lactogenesis and other key functions, such as immune competence, its effects on health and productive responses are variable. Cows treated with 500 mg of rbST every 14 d during the prepartum period had increased DMI and glucose concentration, reduced concentrations of fatty acids and BHB around the time of calving, and greater milk yield in the first 42 d of lactation compared with control cows (Putnam et al., 1999). In contrast, Jersey cows treated with 500 mg of rbST every 14 d from -28 to 14 d postpartum had reduced fat-corrected milk yield (Eppard et al., 1996). Cows treated with 325 mg of rbST every 14 d during

the prepartum period had increased glucose concentration during the peripartum period, but no differences in DMI, incidence of postpartum diseases, or reproductive performance were observed (Gohary et al., 2014). A low dose of rbST (142.8 mg) given every 14 d from -21 to 42 d postpartum increased peripartum concentrations of IGF-1, glucose, and insulin; increased milk yield; and decreased the incidences of ketosis, mastitis, and digestive problems (Gulay et al., 2003, 2004, 2007). The effects of rbST treatment of periparturient dairy cows on incidences of retained fetal membranes and metritis are more controversial (Eppard et al., 1996; Putnam et al., 1999; Gulay et al., 2007; Gohary et al., 2014), perhaps because some of the cited experiments lacked appropriate sample size or because of differences in rbST treatment frequency and dose.

Insulin-like growth factor 1 stimulates growth, differentiation, and functionality of several cell types, including immune cells (Heemskerk et al., 1999). In a recent experiment, treatment of Holstein cows with 125 mg of rbST, every 7 d, from -21 to 28 d relative to calving, increased IGF-1 concentrations, increased the intensity of expression of adhesion molecule, the intensity of phagocytosis and oxidative burst by PMNL, and the concentration of IgG anti-ovalbumin (Silva et al., 2015). Furthermore, cows treated with 125 mg of rbST had reduced incidence of metritis compared with control cows and tended to produce more milk during wk 3 and 5 of lactation than control cows (Silva et al., 2015). The hypotheses of the current experiment were that weekly treatment of periparturient dairy cows from -21 to 21 d relative to calving with 125 mg of rbST would decrease the incidence of infectious (e.g., metritis and mastitis) and metabolic (e.g., ketosis and displacement of abomasum) diseases, improve cow survival and reproductive performance, and increase yield of energy-corrected milk and milk components during the first 30 d of lactation. Objectives of the current experiment were to evaluate the effects of rbST treatment of periparturient dairy cows on postpartum health and reproductive and productive performances. In this experiment, we explored a new strategy of rbST treatment, with more frequent applications (weekly) and reduced doses (125 mg) than previously published research (Eppard et al., 1996; Putnam et al., 1999; Gulay et al., 2004, 2003, 2007; Gohary et al., 2014).

MATERIALS AND METHODS

The procedures conducted during this experiment were approved by the Institutional Animal Care and Use Committee from the University of Minnesota (protocol #1505-32580A).

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