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EFFECT OF PARTURITION AND RECOMBINANT BOVINE SOMATOTROPIN (rBST) ON THE METABOLIC PROFILE OF DAIRY COWS

J. M. Estrada and J. E. Shirley

Summary

Blood samples were collected from 16 Holstein cows around parturition to obtain baseline values of various hormones and metabolites. At 90 ± 3 days postcalving, cows were divided into two groups (8 cows/group) and injected with either saline (control) or 25 mg rBST/d for 28 consecutive days. Blood was sampled on days 0, 1, 5, 10, 15, 30, and 45 after the beginning of treatment and analyzed for insulin, glucagon, growth hormone, glucose, and blood urea nitrogen (BUN). Milk production and composition were recorded as well as body weights and condition scores. Cows receiving rBST had higher milk yields than control cows during the treatment period. Milk lactose percentage also increased for cows on rBST, but other milk components remained unchanged. Plasma insulin decreased, and glucagon, growth hormone, glucose, and BUN increased from 10 days prepartum to 10 days postpartum. During the treatment period, insulin and glucagon decreased slightly for the rBST group, growth hormone increased for both rBST and control groups, and glucose and BUN were similar between rBST and control groups. Body weights and body condition scores decreased after parturition but remained unchanged during the injection period.

Introduction

The ability of somatotropin or growth hormone to stimulate milk production has been known since 1937. With the development of recombinant technologies (biotechnology), substantial amounts of somatotropin are available for large-scale use in dairy cattle. Recombinant bovine somatotropin (rBST) increases milk production in dairy cows by shifting nutrient flow away from body fat stores to meet the needs of the mammary gland for increased milk production. Parturition and initiation of lactation are associated with metabolic and hormonal changes that redirect nutrients required for milk production. Potential use of rBST in commercial dairy herds demands a full understanding of the metabolic and hormonal changes that occur during treatment. The objectives of the present study were: 1) to determine if selected metabolic and hormonal changes normally associated with parturition and initiation of lactation are similar during treatment with rBST and 2) to determine the effect of rBST treatment on milk production and composition, body weight, and body condition score of dairy cows.

Procedures

Blood samples were collected from 16 Holstein cows (8 primiparous and 8 multiparous) on 5, 10, and 15 days before projected calving date, and on days 5, 10, 15, 30, 60, 75, and 82 postcalving to obtain baseline values of various hormones and metabolites. Body weights and condition during early lactation were also noted. Cows were paired at 90 days postcalving according to milk production, days in milk, and milk fat percentage and allotted randomly to two treatment groups: saline (control) or 25 mg rBST/day. Cows were injected for 28 consecutive days, and blood samples were taken at 0,

1, 5, 10, 15, 30, and 45 days after the beginning of treatment. Blood plasma was analyzed for insulin, glucagon, growth hormone, glucose, and blood urea nitrogen (BUN).

Milk yields were recorded daily. Milk composition was analyzed every 3 wk from the beginning of lactation until 90 days postcalving and weekly during the rBST treatment period for milk fat, protein, lactose, and solids non-fat (SNF) percent and for somatic cell counts (SCC). Cows were group-fed twice daily a total mixed ration (TMR) consisting of 50% concentrate mix, 25% corn silage, and 25% alfalfa hay, to meet NRC requirements. Water was available ad libitum. Body weight and body condition score (scale 1 to 5; 1 = extremely thin, 5 = excessively fat) were recorded during every blood sampling and weekly during the injection period.

Results and Discussion

Milk Production and Composition

Four percent fat- corrected milk (FCM) yield showed a typical lactation curve until 90 days postpartum. Fat-corrected milk yield increased ($P<.01$) for cows on rBST when compared to control cows (33.2 vs 28.4 kg/day). Cows on rBST treatment also maintained higher persistency of production through 1 wk after treatment was terminated (Figure 1). Milk lactose percentage increased ($P<.05$) during the treatment period for rBST compared to the control group. Fat, protein, and solids non-fat (SNF) percentages remained unchanged during the injection period. Somatic cell counts (SCC) appeared to be lower for the rBST group than for the control group, but differences were not significant (Figure 2).

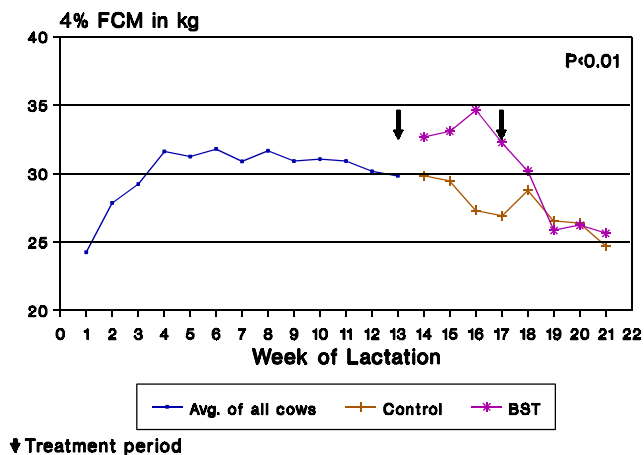


Figure 1. Milk production for control and rBST treated cows (4% FCM).

Hormone and Metabolic Traits

Insulin concentration in plasma decreased significantly from 10 days prepartum to 5 days postpartum, as expected, and then increased ($P<.01$) to prepartum levels by day 30 of lactation. In contrast, glucagon concentration increased 2.5 times from day 5 prepartum to day 10 postpartum ($P<.05$; Figure 3) and then decreased by 50% by day 30 postpartum.

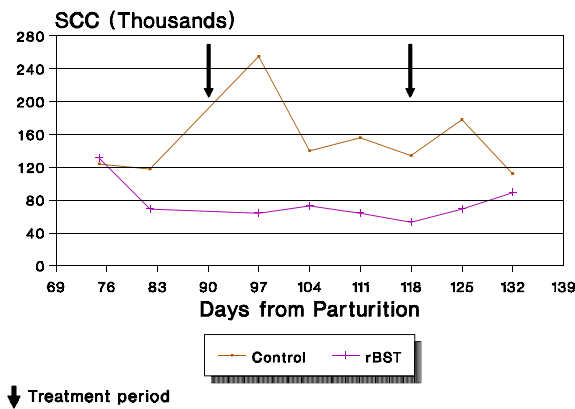


Figure 2. Somatic cell count for control and rBST during treatment period.

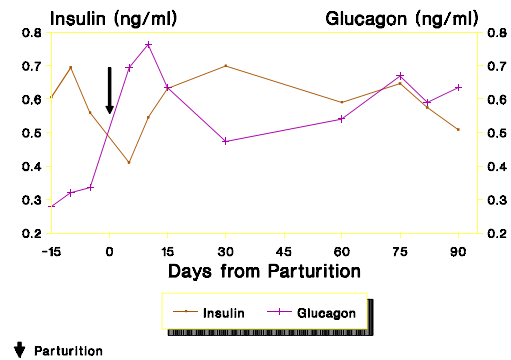


Figure 3. Concentrations of plasma insulin and glucagon periparturient and in early lactation.

Plasma insulin and glucagon (see Figure 3) stabilized at about the same concentration after 60 days postpartum. Plasma insulin and glucagon appeared to decrease for the rBST group compared to the control group (Figure 4). Insulin to glucagon ratios were similar for rBST and control groups during the injection period. Plasma growth hormone (GH) increased abruptly between 10 and 5 days prepartum and continued to increase through day 5 postpartum (Figure 5). Growth hormone declined to prepartum levels by day 15 postpartum. Growth hormone increased from day 1 to about day 15 of treatment for both rBST and control groups, and there was no difference between groups. Growth hormone was not increased for the rBST group because blood was sampled between 20 and 24 hours after injection.

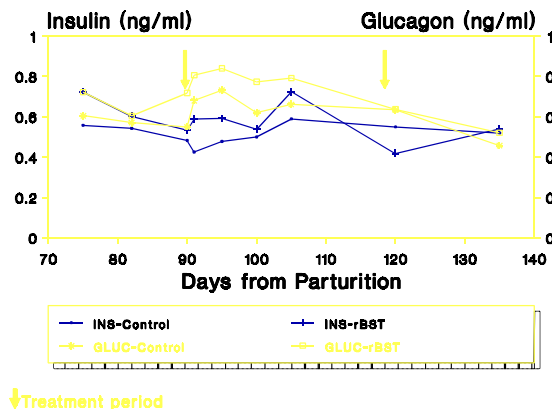


Figure 4. Concentrations of plasma insulin and glucagon during rBST treatment.

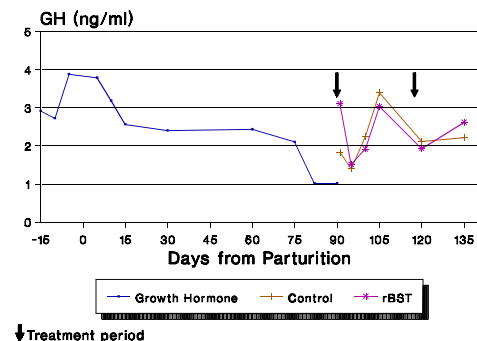


Figure 5. Concentrations of plasma growth hormone periparturient and during rBST treatment.

Plasma glucose concentration decreased slightly at parturition, then increased ($P<.05$) from day 5 postpartum to day 30 postpartum, reflecting the increase in dry matter intake observed. Glucose concentration remained stable from day 30 to day 90. No significant difference was noted between the control and rBST groups relative to plasma glucose concentration (Figure 6). Blood urea nitrogen (BUN) increased ($P<.05$) from day 5 prepartum to day 30 postpartum, reflecting the increase in protein intake that follows parturition. No significant BUN changes occurred during the treatment period for rBST or control groups (Figure 7).

Body Measurements

Body weight appeared to decrease from day 5 prepartum to day 15 postpartum, and then increased slowly during the first part of lactation. Body condition scores decreased ($P=.06$) from day 5 prepartum to day 30 postpartum and increased thereafter. No significant changes were found between control and rBST groups for body weights or body condition scores during the injection period.

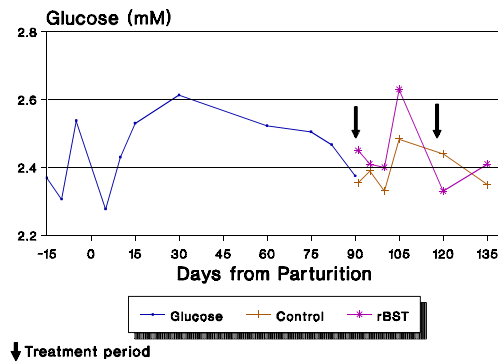


Figure 6. Plasma glucose levels periparturient and during rBST treatment.

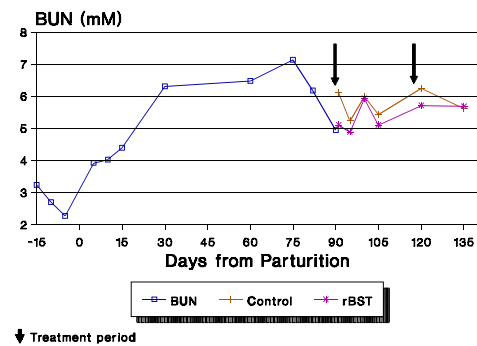


Figure 7. Blood urea nitrogen levels periparturient and during rBST treatment.

Conclusions

Periparturient data indicate the dramatic metabolic changes that occur during parturition and the onset of lactation to accommodate the needs of milk production by shifting from an anabolic to a catabolic state. As illustrated, milk production increased during supplementation with rBST, but these data suggest that the metabolic changes that occur during rBST treatment are not as pronounced as those occurring around parturition. Cows on rBST treatment were able to maintain body weight and body condition score during the injection period. Adequate nutrient supplementation will allow cows to maintain body weight when treated with rBST under the conditions of this study. Full response to rBST will require competent nutritional, reproductive, health, and overall management. Additional information on the mode of action of rBST will be important in determining management systems for commercial dairy herds.