Small Ruminant Research 121 (2014) 368–375

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Somatotropin supplementation decreases feed intake in crossbred dairy goats during the early phase of lactation

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ARTICLE INFO

Article history:
Received 10 January 2014
Received in revised form 7 July 2014
Accepted 8 July 2014
Available online 16 July 2014

Keywords:
Growth hormone
Food intake
Dairy goat
Feed efficiency
Leptin

ABSTRACT

Recombinant bovine somatotropin (rbST) has been shown to increase milk yield in dairy goats, especially during late lactation. The galactopoietic effect of rbST appears to derive mainly from the partitioning of nutrients to the mammary gland. Previously, this effect has been shown to coincide with an increase in feed intake. To test whether rbST has concomitantly an effect on milk yield and feed intake during the early lactation period, ten crossbred dairy goats during the peri-parturition period were selected and divided into two groups of five animals each. Two consecutive injections of sesame oil or rbST were performed at day 7 and 22 post-parturition (PP-7 and PP-22). Dry matter intake (DMI), water intake (WI) and milk yield of the individual animals were measured throughout the experiment. Blood was collected daily from day 6 post-parturition (PP-6) and throughout the first rbST injection period. Milk yield from the rbST supplemented group was slightly higher than the control group during the second rbST supplementation. Supplementation with rbST decreased significantly DMI per body weight. DMI digestibility from the second rbST injection did not differ between the treatments. The concentration of plasma IGF-1, insulin and glucose increased within 24 h after rbST injection. Importantly, plasma leptin also increased after rbST supplementation and this preceded the feed intake effect of rbST supplementation. The present results suggest that rbST induces a decrease in feed intake in dairy goats during early lactation, which relates to increase in the concentration of plasma leptin and in combination with galactopoietic effects of rbST, IGF-1 and insulin.

1. Introduction

Somatotropin (ST) or growth hormone is known for its galactopoietic effect in dairy animals. Commercial rbST has been launched and used in dairy cattle as hormonal supplementation. Cows supplemented with rbST showed a significant increase in milk yield with minor changes in milk composition. The effect of rbST on milk yield appeared to come mainly from both, the partitioning of nutrients to the mammary gland and increase in the activity of the mammary gland epithelial cells (Bauman, 1992; Etherton and Bauman, 1998). In the temperate zone,

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http://dx.doi.org/10.1016/j.smallrumres.2014.07.005
0921-4488/

increase in milk production in dairy cattle was not associated with an increase in feed intake during short term rbST supplementation (Peel and Bauman, 1987; Tyrrell et al., 1988). However, during long term rbST supplementation, feed intake gradually increases to support the higher milk production (Peel and Bauman, 1987; Bauman, 1992). Experiments conducted in the tropical zone have revealed a similar phenomenon. Long term supplementation with rbST increased milk yield together with feed intake in both crossbred Holstein cattle and crossbred dairy goats (Polratana, 2004; Chaiyabutr et al., 2005; Chanchai et al., 2010). Interestingly, plasma leptin in dairy cattle was reduced during long term rbST supplementation (Chanchai, 2010). It is hypothesized that changes in feed intake during rbST supplementation in dairy goat are associated with changes in plasma leptin concentration. The aim of the present study was to investigate whether supplementation with rbST during high energy demand influences plasma leptin and subsequently affects feed intake. The present experiment was performed by applying the short term rbST-supplementation model, during the early lactation period in crossbred dairy goats.

2. Materials and methods

2.1. Animals and management

Ten late pregnant crossbred dairy goats weighting 29.2 ± 2.3 kg were selected and housed in an individual cage (50 cm × 150 cm × 80 cm) in a shaded barn. The temperatures of the experimental area in the morning (0900) and in the afternoon (1500) were 18.19 ± 0.65 °C and 32.38 ± 0.29° C, respectively. The percentages of relative humidity from both periods in the morning and the afternoon were 80.12 ± 1.25 and 44.50 ± 1.30%, respectively. The temperature and humidity indexes (THI) calculated from above information were 65.61 ± 0.95 and 80.75 ± 0.43, respectively (Chanchai et al., 2010). All goats had ad libitum access to water and were fed a total mixed ration (TMR) twice daily (at 0730 and 1530) to maintain a moderate body score condition at 2.5 (1–5 scale). The TMR used in the current experiment was prepared from corn silage and concentrate according to the national research council recommendation (NRC, 1981). The TMR samples were collected once a week throughout the experiment to determine dry matter (DM). The TMRs were adjusted weekly to account for the changes in DM concentration. Other TMR subsamples were kept frozen at −20 °C for later chemical analysis according to AOAC (1990) including organic matter (OM) and nitrogen (N). The neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed by the procedure of Van Soest et al. (1991). The TMR (percentage of DM basis) ingredients consisted of 46% of corn silage, 30% of ground corn, 20% of soybean meal, 3% of molasses and 1% of mineral mix. The DM concentration of the TMR was 41.8%. The chemical compositions of the TMR were estimated as per DM basis for OM (94.3%), CP (23.8%), NDF (33.4%), and ADF (19.9%).

The animals were divided into control ($n = 5$) and rbST supplemented groups ($n = 5$). After parturition, the individual animals were manually milked twice daily at 07.00 am and 15.00 pm. The amount of feed and water offered and refusal were recorded daily. Daily milk yield and dry matter intake (DMI) from PP-1 to PP-34 were used to calculate the efficiency for milk (FE_{milk}). The body weight from each animal was measured once per week. At day six after parturition (PP-6), blood samples were collected via the jugular vein at 09:00 for hormone analysis as a pre-treatment sample. The blood glucose was measured immediately using a glucometer (Accu-Chek Adv II, Roche diagnostic GmbH, Manheim, Germany), while the main portion of the blood sample was placed in an EDTA tube (BD Vacutainer®, BD, NJ, USA) and kept in crushed ice. The plasma sample was separated and stored at −20 °C until analysis. At day 7 after parturition (PP-7), each animal was treated either with rbST (250 mg Posilac®, Monsanto Company, MO, USA) or the vehicle (sesame oil). The dose of rbST used in the present experiment was based on a previous experiment that had been done during late lactation (Polratana, 2004). After the first rbST supplementation, blood and milk samples were collected daily with the same procedure as described until PP-21. With the same animal group, the second rbST supplementation (PP-22) was conducted to study the effect of rbST on dietary digestibility. All experimental procedures were approved in accordance with recommendations given by the ethics committee of the Faculty of Veterinary Science, Chulalongkorn University.

2.2. Determination of plasma concentration of IGF-I, insulin and leptin

The plasma concentrations of IGF-I and insulin were determined by immunometric chemiluminescent assay (IMMULITE® DPC, CA, USA). The intraassay coefficient of variation (CV) was 6.16 and 7.44%, respectively. Plasma concentration of leptin was determined using a radioimmunoassay kit specific for multi-species hormone (Linco Research, Inc., MO, USA) with 2.43% of the intraassay CV.

2.3. Measurement of dietary digestibility

DMI digestibility was measured using the total fecal collection technique. After the second rbST injection (PP-22), total fecal were daily collected and mixed for a 10 day period from PP-25 to PP-35. The subsample (about 10% of total amount) from each animal was kept under −20 °C. The fecal samples were analyzed for DM, OM, N, NDF and ADF levels as previously described. Calculation of the percentage of apparent digestibility was done by dividing the difference between the amount of nutrient in feed and fecal excretions by the amount of nutrient in feed.

2.4. Statistical analysis

All data were reported as the mean ± SEM. Because of the similarity of 2 days consecutive data of milk yield and DMI, the average of 2-days data was calculated and used in the present experiment. All data were analyzed with the repeated two-way ANOVA. The mean comparison was done with the Bonferroni and Bonferroni–Holm follow-up test (Holm, 1979). Differences were considered significant when $P < 0.05$.