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Effect of cysteamine hydrochloride supplementation on the milk performance of dairy cow

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ABSTRACT

Cysteamine (CS) can increase serum growth hormone concentrations and the growth performance of broiler, sheep, and pigs. However, information of CS supplementation on the milk performance of dairy cows is limited. An experiment was conducted to investigate the effect of dietary cysteamine hydrochloride (CSH) supplementation on lactation performance of dairy cows. Forty-eight multiparous mid-lactation Holsteins were fed a control diet or supplemented with 15, 30, or 45 g/d CSH preparation (cysteamine HCl 20%) for 63 d, including 7 d for adaptation. The base diet was formulated to meet the nutrient requirements of lactating dairy cows according to the Chinese feeding standard (China Standard NY/T 34,Feeding standard of dairy cattle 2004 Issued by Ministry of Agriculture of People's Republic of ChinaBeijing) and the DMI, milk yield, milk composition, and plasma parameters were measured. Milk yield was 7.1% and 6.3% higher for the two higher supplementation amounts (SEM = 0.50, $P < 0.05$), and milk protein content was 7.7%, 8.7%, and 8.1% higher for the three supplemented groups (SEM = 0.077, $P < 0.05$), respectively, than the control. Plasma urea *N* were lower for the 30 and 45 g/d CSH groups than for the control. Level of plasma somatostation was reduced and plasma growth hormone was enhanced in CSH groups compared with that of control ($P < 0.01$). Supplementation of CSH preparation at 30 g/d increased milk production of dairy cows while 15 g/d has no positive effect on milk yield or milk efficiency.

1. Introduction

Growth hormone (GH) is an important growth regulator in animals. The neuroendocrine regulation of GH secretion is multifactorial, with a balance of stimulatory and inhibitory neurohormones acting on pituitary somatotrophs (McLeod et al., 1997). Short or long term (6 d–26 wk) administration of recombinant bovine somatotropin (bST) and synthesized bovine GH to lactating dairy cows increases milk production and feed utilization efficiency (Bauman, 1992). While widely used in the US and other countries, bST is prohibited in China and Europe.

Cysteamine (mercaptoethylamine, CS) is a somatostatin (SS) inhibitor. The most noted role of SS is as an inhibitor of pituitary secretion of GH (Yang et al., 2006a). By depleting SS, CS stimulates GH secretion, thus enhancing growth (Szabo and Reichlin, 1981; Millard et al., 1986; McLntosh, et al., 1988). Growth hormone has an important and well-established galactopoietic effect on the bovine

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mammary gland (Molento et al., 2002). Thus, CS can be a viable alternative in promoting the lactating performance of dairy cows. Several commercial products of cysteamine have become available to the animal industry. The CSH preparation used in the present study has an excellent stability that is realized by coating with nano-molecular sieves and biodegradable materials. Preliminary testing showed that the CSH preparation has a survival rate of 96% after 24 mo air exposure, compared to 6.8% for untreated cysteamine after 30 d of exposure (data unpublished).

Cysteamine has been shown to increase serum GH concentrations and the growth rate of broiler, fish, sheep, and pigs (McLeod et al., 1997; Xiao and Lin, 2003; Yang et al., 2005; Yang et al., 2006a). Despite the extensive research that has been conducted on the regulation of CS on GH and SS secretion, there has not been sufficient information on the effects of CS on the milk performance of dairy cows. Our hypothesis is that CS increases GH by suppressing SS, thereby increasing milk efficiency and milk yield. The objective of this study was to determine the effect of CS on regulation of SS and GH, and also the lactation performance of dairy cows.

2. Materials and methods

2.1. Animals, diets, and experimental design

The use of animals was approved by the Animal Care Committee, Zhejiang A & F University, Hangzhou-Lin'an, China. Forty-eight multiparous Holsteins (previous lactation milk yield, BW, parity and DIM was 6924 ± 106.0 kg, 589 ± 38.0 kg, 2.6 ± 0.30, and 113 ± 9.0, respectively, at the beginning of the experiment) were stratified into 12 blocks of 4 and allocated within block to four dietary treatments. A basal diet (Table 1) was used as the control and its supplementation with SunnCys® (cysteamine hydrochloride (CSH), 20% active substance, Zhejiang University Sunny Nutrition Technology Co., Ltd.) at 15, 30, or 45 g/d, estimated to provide 3.0, 6.0, and 9.0 g/d of CS, formed three additional dietary treatments. CSH preparation was fed individually at each feeding and top dressed onto the diet. The intake of CSH preparation were monitiored at each feeding. The diet was formulated to meet the nutrient requirements of lactating dairy cows according to the Chinese feeding standard (China Standard NY/T 34, 2004), using corn silage, alfalfa, and grass hay as the forage sources; the concentrate to roughage ratio was 45:55.

The experiment lasted 9 wk, with the first week as adaptation and 8 wk for data and sample collection. Therefore, day 1 in the statistical analysis was after the adaptation. Cows were housed in a tie-stall barn and milked at 0630, 1430, and 2100 h when receiving diets. Diets were offered as a TMR for *ad libitum* consumption (5–10% refusal). All animals had free access to drinking water. Health status was monitored and diseases were declared by an experienced veterinarian.

2.2. Sampling, measurement, and analysis

The amounts of TMR offered and refused were weighed for 3 consecutive days weekly to determine DMI. The diet was sampled weekly and samples were dried in a forced-air oven at 60 °C for 48 h and composited for analysis of DM, CP, ash, and ether extracts (AOAC, 1990; Wang et al., 2010). In preparation for analyses, dried samples were ground through a 2 mm screen (Thomas-Wiley Laboratory Mill), then through a 1 mm screen in a Cyclotec mill (Tecator 1093, Hoganas, Sweden). Sample DM was determined by drying a sub-sample at 105 °C for 24 h. Ash concentration was determined by combustion in a muffle furnace at 600 °C for 8 h. Samples were also analyzed for ADF and NDF using heat stable α-amylase and Na_2SO_3 according to the procedure described by Van Soest et al. (1991).

Milk yield was recorded daily and milk was sampled for 2 consecutive days in each week by Waikato Milking System Meters (Waikato Milking Systems NZ Ltd., Hamilton, New Zealand). A 50 ml subsample was analyzed for fat, protein, lactose and SCC by infrared analysis (Foss-4000, Foss, Hillerød, Denmark). The BW of the cows was measured every other week on 2 consecutive days from the beginning to the end of the experiment.

Blood samples (10 ml) were taken from the coccygeal vein 3 h after feeding on days 1, 30, and 60 of experiment, and were immediately transferred into heparinized tubes following the sampling procedure of Wang et al. (1999, 2010). The samples were centrifuged at 3000*g* for 10 min, and analyzed for glucose (GLU; McCutcheon and Bauman, 1986), NEFA (McCutcheon and Bauman, 1986), BUN (Rahmatullah and Boyde, 1980), glutathione peroxidase (GSH-Px; Zhang et al., 2006), superoxide dismutase (SOD; Zhang et al., 2006), malondialdehyde (MDA; Zhang et al., 2006), SS (Wang et al., 1999) and GH (McLeod et al., 1995) by Nanjing Jiancheng Bioengineering Institute (Nanjing, China).

2.3. Calculations and statistic analysis

Milk efficiency was calculated as milk yield/DMI. Milk net energy output (MJ/d) was calculated as 4.2 × milk yield (kg/d) × (0.00929 × fat + 0.00563 × protein + 0.00395 × lactose) (g/kg), as described by NRC (2001). Intake of NE_L was calculated by multiplying the net energy value of the diet by DMI, and energy balance (EB, MJ/d) was calculated as NE_L intake-((0.08 × 4.2 × $BW^{0.75}$) + milk net energy output (MJ/d)), as described by NRC (2001).

All data except for BW change and incidence of health problems were analyzed using the PROC MIXED of SAS software system (SAS Institute, 2000) with covariance type AR (1). The model included week, treatment and interaction of treatment × week as fixed effects, and cow within treatment as a random effect. The milk yield before trail were included as a co-variate. Block was included in the model but omitted in the presentation due to lack of significance. Experimental week was included as a repeated measure. Data on BW change were analyzed using PROC GLM of SAS. The statistic model was the same as described above except that week and treat week were omitted.