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Short Communication

Effects of replacement of alfalfa silage with corn silage and supplementation of methionine analog and lysine-HCl on milk production and nitrogen feed efficiency in early lactating cows

Chen Yanting[a], J.H. Harrison[b,*], L.D. Bunting[c]

[a] Department of Animal Science, Washington State University, Pullman, WA, USA
[b] Department of Animal Science, Washington State University, Puyallup, WA, USA
[c] Archer Daniels Midland Co., Decatur, IL, USA

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ABSTRACT

The objective of this experiment was to study effects of replacement of alfalfa silage with corn silage in diets with sufficient metabolizable protein (MP) and balanced metabolizable lysine and methionine on milk production and nitrogen feed efficiency in early lactating cows. Thirty-six cows were blocked by similar body weight at calving, parity and predicted transmitting ability of milk yield, and randomly assigned into 3 dietary treatments from calving to 15 wk postpartum. Dietary treatments included 1) alfalfa silage diet (AF, 186 g/kg CP), 2) a diet replacing alfalfa silage with corn silage and supplemented with rumen undegradable protein and 2-hydroxyl-4-methylthino-butanoic acid (HMB) (CS-M, 160 g/kg CP), 3) CS-M + lysine − HCl (CS-ML, 160 g/kg CP). Metabolizable protein was similar among treatments and approximate 110 g/kg of DM. Metabolizable Met and Lys were 2.2 and 6.3% of MP in AF; and were 2.5 and 6.2% of MP in CS-M; and were 2.5 and 6.9% of MP in CS-ML. Dry matter intake, MP intake, body weight and body condition score were not affected by treatments. Nitrogen intake was less (~ 100 g/d) in CS-M and CS-ML than AF, but milk yield, milk protein percentage and yield were similar among treatments. The percentage and yield of milk fat and milk fat corrected milk were greater in AF and CS-ML than CS-M. From 8 to 15 wk postpartum, CS-M had a moderate milk fat depression (milk fat < 30 g/kg). Compared with AF, CS-M and CS-ML had greater nitrogen feed efficiency and less milk urea nitrogen. Concentrations of lysine and leucine in blood were greater in CS-M and CS-ML, and valine tended to be greater in CS-M and CS-ML than AF. Overall, the replacement of alfalfa silage with corn silage in the diet with adequate MP and balanced metabolizable lysine and methionine could improve nitrogen feed efficiency without compromising milk production in early lactation. In addition, unbalanced ratio of metabolizable Lys to Met could depress milk fat percentage and yield.

1. Introduction

Serious nitrogen (N) pollution and high cost of protein feeds require dairy cows to produce milk efficiently (Ruddy et al., 2006;

Abbreviations: N, nitrogen; MP, metabolizable protein; RDP, rumen degradable protein; RUP, rumen undegradable protein; AA, amino acids; DM, dry matter; TMR, total mixed ration; ADF, acid detergent fiber; NDF, neutral detergent fiber; ADIN, acid detergent insoluble nitrogen; NDIN, neutral detergent insoluble nitrogen; CP, crude protein; BCS, body condition score; BW, body weight; SNF, soilds non-fat; SCC, somatic cell count; MUN, milk urea nitrogen

* Corresponding author.
E-mail address: jhharrison@wsu.edu (J.H. Harrison).

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USDA-NASS, 2015). Since alfalfa silage has high degradable protein and fermentable fibers (Broderick, 2001), alfalfa silage is commonly used in dairy ration to benefit milk production (Benchaar et al., 2007). However, because of alfalfa silage also containing excess of rumen degradable protein and less non-fermentable carbohydrates, feeding alfalfa silage also greatly increases urinary N excretion without effectively improving N feed efficiency in milk protein synthesis (Hassanat et al., 2013). Compared with alfalfa silage, corn silage is a less cost and contains relatively balanced degradable N and fermentable carbohydrates (Benchaar et al., 2007; Broderick, 2001, 1985). In previous studies, replacement of alfalfa silage with corn silage was observed to decrease urinary N excretion and increase N feed efficiency (Broderick, 1985; Dhiman and Satter, 1997; Valadares et al., 1999), but milk and milk protein yields are often decreased in the replacement partially due to the deficient rumen undegradable protein (RUP) in corn silage diets (Broderick, 1985; Dhiman and Satter, 1997). Therefore, supplementation of RUP source to increase metabolizable protein (MP) could be beneficial to the success of replacement of alfalfa silage with corn silage.

Lysine and Met have been identified as limited amino acids (AA) in milk protein synthesis (Rulquin et al., 1993; Schwab et al., 1992a, 1992b). A meta-analysis conducted by Robinson (2010) reported that cows fed diets with balanced metabolizable Met and Lys produced 1.4 kg/d more milk with 2.7% of increase in milk protein percentage. Therefore, we hypothesized that the replacement of alfalfa silage with corn silage in diets with adequate MP and balanced metabolizable Met and Lys could improve N feed efficiency without compromising milk and milk protein productions in early lactation.

2. Material and methods

2.1. Animals

Animals were cared for and handled according to the guidelines of the Washington State University Animal Care and Use Committee. Thirty-six Holstein cows including 15 primiparous and 21 multiparous cows were blocked by similar body weight at calving, parity and predicted transmitting ability of milk yield, and randomly assigned into 3 dietary treatments from calving to 15 wk postpartum. Prior to the experiment, cows were trained to adapt to individual feeding system. Each treatment had 12 cows. Cows were housed in a free stall barn with free access to water and milked twice daily (0010 and 0022). Cows were fed individually once a day (0012) through a Calan head gate system (American Calan, Northwood, NH, USA). Feed intake was adjusted daily to allow refusals to 50 to 100 g/kg of as feed intake.

2.2. Diets and treatments

Ingredient composition of dietary treatments is summarized in Table 1. Dietary treatments included an alfalfa silage diet (AF); replacement of alfalfa silage with corn silage and supplemented with RUP and a Met analog (CS-M); and CS-M + Lys − HCl (CS-ML). Briefly, approximately 266 g/kg of alfalfa silage and 17 g/kg of soybean meal in AF were replaced with 291 g/kg of corn silage in CS-M and CS-ML. Rumen protected fish meal (Prolak; H.J. Baker & Bro. Inc., Westport, CT, USA) and soy protein (Arsoy; ADM, Decatur, IL, USA) as RUP sources to increase the MP, Lys and Met in CS-M and CS-ML. Besides that, HMB (2-hydroxyl-4-methylthino-butanoic acid; Alimet, Novus, St Charles, MO, USA) and Lys − HCl were supplemented in the CS-M and CS-ML diets to change the ratio of metabolizable Lys to Met. HMB is a Met analog and converted to L-Met in body tissues (Lobley et al., 2006). HMB and Lys − HCl were mixed with mineral and vitamin premix before incorporated into the TMR. Metabolizable protein, Lys and Met in diets were estimated by AMTS.Cattle.Pro (CNCPS model version 4.1.4; AMTS LCC, New York, NY, USA).

2.3. Sample collection and laboratory analysis

The TMR was sampled weekly and dried in a forced air oven at 55 °C for dry matter (DM) analysis. Dried samples were ground through 1 mm screen in a Wiley mill (Arthur H. Thomas, Philadelphia, PA, USA), and composited monthly. The composites were sent to Cumberland Valley Analytical Service (Hagerstown, MD, USA) for chemical analyses, including crude protein (CP) (984.13), crude fat (954.02), acid detergent fiber (ADF) (973.18), ash (942.05) and minerals (AOAC, 2000) according to AOAC (2000). In addition, neutral detergent fiber (NDF) (Van Soest et al., 1991), soluble CP (Krishnamoorthy et al., 1982), lignin (Goering and Van Soest, 1970), neutral detergent insoluble N (NDIN) and acid detergent insoluble N (ADIN) (Leco FP-528, Nitrogen Analyzer, Leco Instruments Inc., St. Joseph, MI, USA) were also analyzed.

Milk samples were obtained weekly and collected from the a.m. (0011) and p.m. (0023) milking, and mixed together based on the proportion of weight. Milk samples were immediately sent to the local DHIA laboratory (Burlington, WA, USA) for milk protein, fat, lactose, solids non-fat (SNF), and somatic cell counts (SCC) analyses by a Fossomatic 4000 Combi mid-infrared analyzer (Eden Prairie, MN, USA). Milk samples obtained from 6 cows in each treatment at 2, 4, 6, 8, 10 and 12 wk postpartum were analyzed for MUN (Crocker, 1966). Body weight was recorded weekly every morning before milking, and body condition score (BCS) was estimated by 2 individuals weekly. Estimation of BCS was utilized a 5 point scoring system with 0.25 point increment (Edmonson et al., 1989). NE_l was estimated according to the guidelines of NRC (2001).

Blood samples were taken from the coccygeal tail vein into heparinized tubes at 2 and 6 wk postpartum. Blood samples were mixed with 500 ul of 10% sulfosalicylic acid and 5 u*M* norvaline solution, and centrifuged at 14,000 x g for 10 min at 4 °C. Supernatant plasma was frozen at - 20 °C until for AA analyses. The AA concentration was analyzed by Waters Ultra Performance Liquid Chromatograph Mass Trak AA analysis solution developed by Waters Corporation (ACQUITY Ultra Performance LC, Milford, MA, USA).