J. Dairy Sci. 93:5397–5407
doi:10.3168/jds.2010-3411

Effects of corn silage hybrids and dietary nonforage fiber sources on feed intake, digestibility, ruminal fermentation, and productive performance of lactating Holstein dairy cows[1]

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ABSTRACT

This experiment was conducted to determine the effects of corn silage hybrids and nonforage fiber sources (NFFS) in high forage diets formulated with high dietary proportions of alfalfa hay (AH) and corn silage (CS) on ruminal fermentation and productive performance by early lactating dairy cows. Eight multiparous Holstein cows (4 ruminally fistulated) averaging 36 ± 6.2 d in milk were used in a duplicated 4 × 4 Latin square design experiment with a 2 × 2 factorial arrangement of treatments. Cows were fed 1 of 4 dietary treatments during each of the four 21-d replicates. Treatments were (1) conventional CS (CCS)-based diet without NFFS, (2) CCS-based diet with NFFS, (3) brown midrib CS (BMRCS)-based diet without NFFS, and (4) BMRCS-based diet with NFFS. Diets were isonitrogenous and isocaloric. Sources of NFFS consisted of ground soyhulls and pelleted beet pulp to replace a portion of AH and CS in the diets. In vitro 30-h neutral detergent fiber (NDF) degradability was greater for BMRCS than for CCS (42.3 vs. 31.2%). Neither CS hybrids nor NFFS affected intake of dry matter (DM) and nutrients. Digestibility of N, NDF, and acid detergent fiber tended to be greater for cows consuming CCS-based diets. Milk yield was not influenced by CS hybrids and NFFS. However, a tendency for an interaction between CS hybrids and NFFS occurred, with increased milk yield due to feeding NFFS with the BMRCS-based diet. Yields of milk fat and 3.5% fat-corrected milk decreased when feeding the BMRCS-based diet, and a tendency existed for an interaction between CS hybrids and NFFS because milk fat concentration further decreased by feeding NFFS with BMRCS-based diet. Although feed efficiency (milk/DM intake) was not affected by CS hybrids and NFFS, an interaction was found between CS hybrids and NFFS because feed efficiency increased when NFFS was fed only with BMRCS-based diet. Total volatile fatty acid production and individual molar proportions were not affected by diets. Dietary treatments did not influence ruminal pH profiles, except that duration (h/d) of pH <5.8 decreased when NFFS was fed in a CCS-based diet but not in a BMRCS-based diet, causing a tendency for an interaction between CS hybrids and NFFS. Overall measurements in our study reveal that high forage NDF concentration (20% DM on average) may eliminate potentially positive effects of BMRCS. In the high forage diets, NFFS exerted limited effects on productive performance when they replaced AH and CS. Although the high quality AH provided adequate NDF (38.3% DM) for optimal rumen fermentative function, the low NDF concentration of the AH and the overall forage particle size reduced physically effective fiber and milk fat concentration.

Key words: brown midrib corn silage, nonforage fiber source, alfalfa hay, lactational performance

INTRODUCTION

Typical lactating dairy diets in the Intermountain West (i.e., Utah, Idaho, Wyoming, Montana, and parts of Arizona and Nevada) contain more alfalfa hay (**AH**) than corn silage (**CS**), and baled AH is commonly fed to provide 50 to 75% of the dietary forage with total forage levels averaging 45 to 55% of the dietary DM. Although both forages provide the needed fiber components, alfalfa and CS complement each other nutritionally: CS is high in energy, whereas alfalfa is high in protein. Howard (1994) suggested that factors such as forage particle length, diet DM, protein degradability, dietary starch concentration, and calcium levels are important factors to consider when determining the optimum balance of alfalfa and CS in rations. Making decisions on the dietary ratio between alfalfa and CS on a nutrition basis is becoming more complicated because many corn hybrids have been developed with specific plant traits that enhance their value as a nutrient source, such as the brown midrib (**BMR**) CS hybrid. The BMRCS is characterized by its lower lignin concentration and

Received May 6, 2010.
Accepted July 6, 2010.
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higher fiber digestibility than conventional CS (**CCS**; Oba and Allen, 1999). Although concerns with lower yields of the BMR hybrids exist (Eastridge, 1999), the lower yield can be somewhat offset by the higher forage quality having more digestible fiber. This allows cows to be fed more forage and less concentrate, which will increase ruminal pH and improve overall ruminal functionality. In most the studies done on BMRCS, lactating dairy cows were fed the BMR hybrid CS at high dietary proportions, but only a few studies included alfalfa as hay or silage at low proportions (Ebling and Kung, 2004; Kung et al., 2008). Because high quality AH is more readily available than CS in the Intermountain West, the nutritional benefits of feeding BMRCS must be assessed with a relatively high dietary proportion of AH in lactating dairy rations.

Feed costs account for 35 to 50% of the total costs to produce milk (Ipharraguerre and Clark, 2003). Thus, dairy producers attempt to minimize the costs of feeding their herds, particularly when milk prices are low, to maximize the efficiency of production. Nonforage fiber sources (**NFFS**) are plant byproducts produced by extraction of starch, sugar, or other valuable nonfibrous constituents. In many areas of the United States, NFFS are readily available at competitive prices. Hence, feeding these byproducts to dairy cows may represent an excellent opportunity to reduce feed costs. Traditionally, NFFS have been used as sources of concentrate, because many NFFS have relatively high NE_L and moderate CP concentrations (Stern and Zeimer, 1995). Alternatively, NFFS can be successfully used as a source of fiber in rations for dairy cattle when forages are either of poor quality or in short supply. In view of the aforementioned reasons and others, it appears that feeding NFFS to dairy cows is a practice that will continue to increase in popularity among dairy nutritionists and producers.

We hypothesized that BMRCS would have limited effects on digestibility, ruminal pH and fermentation measurements, and lactational performance when fed with a relatively high dietary proportion of high quality AH. The objectives of this study were to assess nutritive merits of BMRCS compared with CCS when fed to high forage lactating diets, and to determine if NFFS would be effectively used in CCS-based diet to maintain similar productive performance in cows fed BMRCS-based diet.

MATERIALS AND METHODS

The dairy cows used in this study were cared for according to the Live Animal Use in Research Guidelines of the Institutional Animal Care and Use Committee at Utah State University.

Cows and Experimental Diets

Eight multiparous lactating Holstein cows were used; 4 cows were surgically fitted with ruminal cannulas. Days in milk ranged from 26 to 42 d and from 32 to 39 d for noncannulated and cannulated cows, respectively, at the start of the experiment. Average BW was 633 ± 83.6 kg at the beginning of the experiment and 666 ± 80.6 kg at the end of the experiment.

The design of the experiment was a double 4 × 4 Latin square, with each period lasting 21 d (14 d of treatment adaptation and 7 d of data collection and sampling). The cows were allocated to squares according to whether they were surgically cannulated, and the 2 squares were conducted simultaneously. Within square, cows were randomly assigned to a sequence of 4 diets. A 2 × 2 factorial arrangement was used; CCS or BMRCS (Table 1) was combined without or with NFFS to form 4 treatments: CCS-based diet without NFFS, CCS-based diet with NFFS, BMRCS-based diet without NFFS, and BMRCS-based diet with NFFS (Table 2). Nonforage fiber sources consisted of a 50:50 (DM basis) blend of ground soyhulls and pelleted beet pulp. The diets that contained NFFS had 48.6% forage, 43.0% concentrate, and 8.4% NFFS, and the forage consisted of 48.5% AH and 51.5% CS on a DM basis (Table 2). The diets without NFFS had 57.0% forage and 43.0% concentrate with the forage consisting of 45.5% AH and 54.5% CS on a DM basis (Table 2). The diets are typical for high-producing dairy cows in northern Utah with the inclusion of Rumensin (Elanco Animal Health, Greenfield, IN) and Megalac (Church & Dwight Co. Inc., Princeton, NJ). Rations were formulated based on NRC (2001) recommendations to provide sufficient NE_L, MP, vitamins, and minerals to produce 40 kg/d of milk with 3.5% fat and 3.0% true protein.

Brown midrib corn hybrid (Mycogen F2F569, Mycogen Seeds, Indianapolis, IN) and a conventional corn hybrid (Pioneer 37K84, Pioneer Hi-Bred International Inc., Johnston, IA) were planted during spring 2009 on private property near Logan, Utah. Corn silages were harvested using a self-propelled forage harvester (model 6850, John Deere, Moline, IL) that applied lactic acid bacteria containing 90,000 cfu/g (Promote LC, Cargill, Minneapolis, MN) at a rate of 1.1 g/t of fresh forage. A theoretical chop length of 0.95 cm was used with mechanical processing during harvesting. The mechanical processing was done using an automatic roller mill (Jaguar 900 model, Claas Ltd., Hansewinkel, Germany) designed for processing corn plants, which was attached to the forage harvester. Approximately 28 t of each silage was placed in bag silos (Ag/Bag International Ltd., Warrenton, OR) and ensiled for 60 d. Alfalfa hay was prepared in large round bales and finely chopped