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Canola meal replacing distillers grains with solubles for lactating dairy cows

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ABSTRACT

A study was conducted to determine the response to feeding diets containing canola meal (CM) as a protein supplement in place of all or portions of dried distillers grains with solubles (DDGS). Twelve lactating Holstein cows (4 primiparous and 8 multiparous) were fed in a 4 × 4 Latin square design over 4-wk periods. Data were collected wk 3 and 4 of each period. Diets were formulated in which CM was 100, 66, 33, and 0% of the supplemental protein replacing the protein from DDGS. All diets (averaged 15.1% crude protein and 4.5% ether extract) contained 55% forage and 45% concentrate, with the forage being 50% corn silage and 50% alfalfa hay. Dry matter intake (25.4 kg/d) was similar for all diets. Milk production (35.2, 35.8, 34.5, and 34.3 kg/d, respectively, for 100, 66, 33, and 0% CM) was similar for all diets, but tended to be greater with higher proportions of CM. Milk protein concentration (3.04%), fat concentration (3.92%), and fat yield (1.37 kg/d) were similar for all diets, whereas protein yield (1.08, 1.10, 1.05, and 1.03 kg/d, respectively, for 100, 66, 33, and 0% CM) tended to be greater with increasing amounts of CM in the diet. Feed efficiency (1.46 kg of energy-corrected milk/kg of dry matter intake) was similar for all diets. Lysine was the first limiting amino acid for milk protein synthesis when CM or DDGS were fed, whereas methionine was first limiting when the combination diets were fed. Concentrations of ammonia and volatile fatty acids in ruminal contents were similar for all diets. Canola meal is a suitable replacement for DDGS in dairy cow diets.
Key words: canola meal, distillers grain with solubles, lactating dairy cow

INTRODUCTION

Continual growth of the ethanol industry has resulted in large quantities of byproducts available for livestock feed, such as dried distillers grains with solubles (**DDGS**). When DDGS is fed to lactating cows, milk production is usually equal to or higher than production achieved with other protein supplements such as soybean meal (Nichols et al., 1998; Anderson et al., 2006; Schingoethe, 2008). Canola meal (**CM**), produced primarily in Canada and the northern United States, is a good-quality protein supplement that is becoming increasingly available (Piepenbrink and Schingoethe, 1998). Unlike DDGS and other corn-based products, which are limiting in Lys (Nichols et al., 1998; Schingoethe, 2008), CM, although degraded more extensively in the rumen, has one of the highest biological values of all vegetable protein supplements available (Schingoethe, 1996; Piepenbrink and Schingoethe, 1998). When Sánchez and Claypool (1983) compared CM, cottonseed meal, and soybean meal as a protein source for cows during early lactation, they observed a tendency for cows fed the CM to have higher milk production but milk components and feed intake were not affected. Maesoomi et al. (2006) reported higher milk protein percentages and higher digestibility of DM and CP when CM replaced cottonseed meal in the diet. Piepenbrink et al. (1998) observed similar milk production when CM was fed as the protein supplement as when CM was fed in combination with other high-quality protein sources that included blood meal, corn gluten meal, and fish meal. When Brito and Broderick (2007) compared urea to soybean meal, cottonseed meal, and CM for potential benefits of the various protein supplements, the latter 3 true protein supplements were superior to urea as CP sources, improving feed intake and yields of milk fat and protein.

When it comes to rumen degradability, the protein in DDGS (RUP = 55–65% of CP; Kleinschmit et al., 2007a; Schingoethe, 2008) may degrade less in the rumen than desired for optimal protein utilization, whereas CM (RUP = 28–40% of CP; Piepenbrink and Schingoethe, 1998; NRC, 2001) is more ruminally degradable. This, in addition to the Lys limitation of DDGS and the generally more desirable biological value of the protein in CM (Schingoethe, 1996), causes one to consider that some combination of DDGS and CM as protein sources may be optimal for milk protein production. Thus, this research was conducted to determine whether either CM or DDGS alone or a combination of the 2 sources

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Table 1. Ingredient composition of experimental diets

Item, % of DM	Diet[1]			
	CM	2/3CM	1/3CM	DDGS
Corn silage	27.50	27.50	27.50	27.50
Alfalfa hay	27.50	27.50	27.50	27.50
Corn grain, ground, dry	34.92	33.90	33.00	31.76
Canola meal, 44% CP	6.63	4.59	2.29	0.00
DDGS, 31% CP	0.00	3.24	6.63	10.40
Trace mineral salt[2]	0.60	0.61	0.62	0.61
Fat[3]	1.60	1.41	1.21	1.00
Limestone	0.60	0.60	0.60	0.60
Dicalcium phosphate	0.40	0.40	0.40	0.40
Vitamin A, D, and E mix[4]	0.20	0.20	0.20	0.20
Vitamin E mix[5]	0.05	0.05	0.05	0.05

[1]Diets include canola meal (CM); 2/3 canola meal and 1/3 dried distillers grains with solubles (2/3CM); 1/3 canola meal and 2/3 dried distillers grains with solubles (1/3CM); and dried distillers grains with solubles (DDGS).

[2]Guaranteed analysis (mg/kg): 940,000–985,000 NaCl, 387,000 Na, 2,000 Fe, 3,500 Zn, 2,000 Mn, 300 Cu, 70 I, and 50 Co.

[3]Energy Booster 100, Milk Specialties Co., Dundee, IL.

[4]Mix included 2,500 kIU/kg of vitamin A, 400 kIU/kg of vitamin D, and 1,000 IU/kg of vitamin E.

[5]Mix included 44,000 IU/kg of vitamin E.

would be the most effective for increasing milk production of lactating cows.

MATERIALS AND METHODS

Experimental Plan

Eight multiparous (111 ± 18 DIM) and 4 primiparous (106 ± 8 DIM) lactating Holstein cows were used in a trial to evaluate and compare different proportions of CM and DDGS used as protein supplements. Cows were blocked into squares based on parity, DIM, and milk production, and within blocks were randomly assigned to 1 of 4 experimental diets in a replicated 4 × 4 Latin square design. Cows were housed in a freestall barn and fed diets as a TMR with a Calan Broadbent feeder door and box system (American Calan Inc., Northwood, NH) and were cared for in accordance with the South Dakota State University Animal Care and Use policy. Prior to the start of the trial, there was a 10-d period for the cows to adapt to the feeding system. Experimental periods were 4 wk long, with the initial 2 wk for adaptation and wk 3 and 4 for data collection.

Four dietary treatments were used to evaluate supplemental proteins as follows: canola meal as the sole source of supplemental protein (CM), 2/3 canola meal and 1/3 DDGS (**2/3CM**), 1/3 canola meal and 2/3 DDGS (**1/3CM**), and DDGS. Diets (Table 1) were formulated to be similar in CP (16.0%) and ether extract (**EE**; 4.7%) and to meet or exceed suggested requirements (NRC, 2001) for various minerals and vitamins. Diets were balanced for equal fat content so that comparisons between CM and DDGS would be truly on the protein contents of both ingredients. All diets had a forage:concentrate ratio of 55:45, with the forage DM equally from alfalfa hay and corn silage. Forages for all diets were premixed in a vertical mixer wagon (1999 NDE 500, Westside Implement, Clark, SD). Concentrate mix was added to the Calan Data Ranger (American Calan Inc.) after addition of the forage premix.

Experimental Measures

Feed intake for individual cows was measured daily using the Calan Broadbent feeder door system and Data Ranger. At the end of each week, samples of corn silage, alfalfa hay, DDGS, CM, concentrate mixes, and diets were collected and stored at −20°C until analysis. The DM concentrations were determined weekly by drying samples of wet feed components at 105°C for 2 to 4 h according to AOAC method 930.15 (AOAC, 2002) so that as fed amounts of ingredients could be adjusted to ensure proper inclusion of ingredients. All samples were composited by period and dried at 55°C for 48 h in a Despatch oven (style V-23, Despatch Oven Co., Minneapolis, MN). Composites were first ground through a 4-mm screen on a Wiley mill (model 3, Arthur H. Thomas., Philadelphia, PA) and then reground through an ultracentrifuge mill with a 1-mm screen (Brinkman Instruments Co., Westbury, NY). All feed samples were analyzed for true DM, ash, NDF, ADF, EE, and CP. Additionally, total study composites were made of CM, DDGS, and all TMR and analyzed for Ca, P, Mg, K, and S contents by spectroscopic method and Corning Direct Reading Chloride/Salt analyzer (AOAC, 2002; methods 965.09 and 985.01).

True DM of samples was determined by drying approximately 1 g of sample at 105°C for 2 to 4 h. Ash was determined by heating samples for 8 h at 450°C in a muffle furnace (Understander et al., 1993). Samples were analyzed sequentially for NDF and ADF via Ankom filter bag analysis system (Ankom Technology Corp., Fairport, NY). The NDF analysis was based on procedures described by Van Soest et al. (1991) that use heat-stable α-amylase and sodium sulfite; ADF analysis was based on procedures described in Robertson and Van Soest (1981). Ether extract was determined using the Ankom filter bag analysis system (Ankom Technology Corp.) according to procedure AM 5–04 (AOAC, 2002). Crude protein was determined using Elementar rapid N-cube N determination (Elementar Americas Inc., Mt. Laurel, NJ), based on AOAC method 993.13 (AOAC, 2002).

Cows were milked daily at 0600, 1400, and 2100 h, and individual milk production was recorded at each