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Replacing dietary soybean meal with canola meal improves production and efficiency of lactating dairy cows[1]

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ABSTRACT

Previous research suggested that crude protein (CP) from canola meal (CM) was used more efficiently than CP from solvent soybean meal (SBM) by lactating dairy cows. We tested whether dietary CP content influenced relative effectiveness of equal supplemental CP from either CM or SBM. Fifty lactating Holstein cows were blocked by parity and days in milk into 10 squares (2 squares with ruminal cannulas) in a replicated 5 × 5 Latin square trial. Five squares were fed: (1) low (14.5–14.8%) CP with SBM, (2) low CP with CM, (3) low CP with SBM plus CM, (4) high (16.4–16.7%) CP with SBM, and (5) high CP with CM; the other 5 squares were fed the same diets except with rumen-protected Met plus Lys (RPML) added as Mepron (Degussa Corp., Kennesaw, GA) and AminoShure-L (Balchem Corp., New Hampton, NY), which were assumed to provide 8 g/d of absorbed DL-Met and 12 g/d of absorbed L-Lys. Diets contained [dry matter (DM) basis] 40% corn silage, 26% alfalfa silage, 14 to 23% corn grain, 2.4% mineral-vitamin premixes, and 29 to 33% neutral detergent fiber. Periods were 3 wk (total 15 wk), and data from the last week of each period were analyzed using the Mixed procedures of SAS (SAS Institute Inc., Cary, NC). The only effects of RPML were increased DM intake and milk urea N (MUN) and urinary N excretion and trends for decreased milk lactose and solids-not-fat concentrations and milk-N:N intake; no significant RPML × protein source interactions were detected. Higher dietary CP increased milk fat yield and tended to increase milk yield but also elevated MUN, urine volume, urinary N excretion, ruminal concentrations of ammonia and branched-chain volatile fatty acids (VFA), lowered milk lactose concentration and milk-N:N intake, and had no effect on milk true protein yield. Feeding CM instead of SBM increased feed intake, yields of milk, energy-corrected milk, and true protein, and milk-N:N intake, tended to increase fat and lactose yields, and reduced MUN, urine volume, and urinary N excretion. At low CP, MUN was lower and intake tended to be greater on SBM plus CM versus SBM alone, but MUN and N excretion were not reduced to the same degree as on CM alone. Interactions of parity × protein source and parity × CP concentration indicated that primiparous cows were more responsive than multiparous cows to improved supply of metabolizable protein. Replacing SBM with CM reduced ruminal ammonia and branched-chain VFA concentrations, indicating lower ruminal degradation of CM protein. Replacing SBM with CM improved milk and protein yield and N-utilization in lactating cows fed both low- and high-CP diets.
Key words: canola meal, soybean meal, milk production, nitrogen efficiency

INTRODUCTION

In recent years, increasing production of canola has given rise to greater availability of canola meal (**CM**) as a protein supplement for livestock feeding (Harker et al., 2012). Greater access to CM has made it a viable alternative to soybean meal (**SBM**) for lactating dairy cows (Hickling, 2008). We observed a numeric increase in milk and protein yields when CM replaced equal supplemental protein from solvent-extracted SBM in 16.5% CP diets fed to dairy cows (Brito and Broderick, 2007). Recent meta-analyses of results published in peer-reviewed journals showed greater DMI and yield of milk and milk components when CM substituted for several commonly fed proteins (Martineau et al., 2013). These meta-analyses reported that replacing SBM with CM significantly increased milk protein yield (Martineau et al., 2013) and increased intake and yield of milk and milk components (Huhtanen et al., 2011).

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The NRC (2001) model indicates ruminal degradation rates of 4.5%/h for SBM protein and 10.4%/h for CM protein, although larger insoluble fractions B and C in CM tend to equalize the predicted RUP and MP value of these proteins. Brito et al. (2007) found that the proportion of RUP in CM was numerically greater than that in SBM. Huhtanen et al. (2011) also concluded that CM contributed amounts of RUP and MP that were at least equal to those from SBM. Lactating dairy cows fed SBM-supplemented diets often respond to rumen-protected Met (e.g., Broderick et al., 2009), and the concentration of Met is greater in CM protein than in SBM (NRC, 2001). This suggests that (1) lactating cows would be less responsive to rumen-protected Met when fed CM than SBM, and (2) the AA pattern in MP from a blend of CM plus SBM might be complementary. Furthermore, recent research has indicated that dietary CP content can be lowered substantially without reducing milk and protein yields in lactating cows (Broderick, 2003; Kalscheur et al., 2006). If MP from CM contributes more absorbed Met than SBM, then CM might prove more effective in low-CP diets.

Therefore, the objectives of this experiment were to (1) determine the relative effectiveness of CM and SBM as supplemental protein sources in both low- and high-CP diets; (2) compare effectiveness of feeding a blend of SBM plus CM versus SBM or CM alone; and (3) evaluate whether lactation performance on diets based on SBM or CM diets would be improved by supplementation with rumen-protected Met plus Lys. Moreover, the design of this study allowed evaluation of relative response to protein source and CP content of primiparous versus multiparous cows.

MATERIALS AND METHODS

Experimental Design

Thirty multiparous Holstein cows, including 10 fitted with permanent 10-cm ruminal cannulas (Bar Diamond Inc., Parma, ID), with mean (SD) 2.5 (0.6) parity, 81 (29) DIM, 47.8 (5.1) kg of milk/d, 620 (50) kg of BW, and SCC = 41 (62) × 10^3 cells/mL, plus 20 primiparous cows with mean (SD) 100 (39) DIM, 36.5 (4.4) kg milk/day, 543 (31) kg of BW, and SCC = 26 (20) × 10^3 cells/mL, were used in the trial. All cows were in good health and, on average, gaining BW at the start of the trial. Cows were grouped into ten 5 × 5 Latin squares to give 6 squares (2 squares ruminally cannulated) of multiparous cows and 4 squares of primiparous cows, all blocked into squares by DIM. Cows were randomly assigned to dietary treatment sequences within 5 pairs of 5 × 5 Latin squares (3 square-pairs of multiparous and 2 square-pairs of primiparous cows) that were balanced such that each square-pair had equal numbers of change-overs among the 5 basic diets. The 5 basic diets were fed as TMR composed of alfalfa silage, corn silage, and high-moisture shelled corn (ground to approximately 1.4-mm mean particle size; Ekinci and Broderick, 1997), plus minerals and vitamins. Dietary protein supplements were solvent-extracted SBM, solvent-extracted CM, or both, fed in the following arrangement: (1) low CP (SBM), (2) low CP (CM), (3) low CP (blend of SBM plus CM), (4) high CP (SBM), and (5) high CP (CM). Rumen-protected Met plus Lys (**RPML**) was fed to 1 square in each square-pair, alternating the supplement such that RPML was fed to the square at later DIM for the first square-pair, and then to the square at earlier DIM for the second square-pair, and so on. Mean (SD) DIM for cows fed without and with RPML supplement were, respectively, 80 (28) and 96 (29) at the start of the trial. To improve distribution of RPML in the TMR, 2 premixes were prepared containing ground shelled corn plus molasses only or ground shelled corn, molasses, plus RPML added as Mepron (Evonik Corp., Kennesaw, GA) and AminoShure-L containing 38% L-Lys (Balchem Corp., New Hampton, NY). Depending on batch size, between 2.2 and 2.4 kg of either the control or RPML premix was added to the TMR batch fed to cows in the square in each square-pair receiving that specific treatment. The RPML supplement provided 15 g/d of chemical DL-Met and 19 g/d of chemical L-Lys; assuming, respectively, 72 and 64% bioavailability (Lee et al., 2012b), this corresponded to 8 g/d of absorbed Met and 12 g/d of absorbed Lys. Mean composition of the major feed ingredients fed during the trial is in Table 1. Compositions of the experimental diets actually fed during the trial (based on daily mean as-fed weights and weekly mean DM contents of each ingredient mixed into the TMR) are in Table 2.

All cows were injected every other week with bST (500 mg of Posilac; Elanco Animal Health, Greenfield, IN) beginning about 60 DIM; injections were synchronized such that animals received a full dose on d 1 of period 1 and continuing at 14-d intervals throughout the trial. Therefore, cows received bST twice during periods 1, 3, and 5 (on d 1 and 15) and once during periods 2 and 4 (on d 8). Because the design was a balanced 5 × 5 Latin square, an equal number of observations were made for each dietary treatment during periods in which bST was injected on both d 1 and d 15 and only once on d 8. This arrangement proved satisfactory in a previous trial (Valadares Filho et al., 2000). Cows were housed in tiestalls and had free access to water.