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# Effects of replacing soybean meal with canola meal or treated canola meal on ruminal digestion, omasal nutrient flow, and performance in lactating dairy cows

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## ABSTRACT

Extrusion treated canola meal (TCM) was produced in an attempt to increase the rumen-undegraded protein fraction of canola meal (CM). The objective of this study was to evaluate the effects of replacing soybean meal (SBM) with CM or TCM on ruminal digestion, omasal nutrient flow, and performance in lactating dairy cows. To assess performance, 30 multiparous Holstein cows averaging (mean ± SD) 119 ± 23 d in milk and 44 ± 7 kg of milk/d and 15 primiparous cows averaging 121 ± 19 d in milk and 34 ± 6 kg of milk/d were blocked in a randomized complete block design with a 2-wk covariate period and 12-wk experimental period (experiment 1). Dietary ingredients differed only in protein supplements, which were SBM, CM, or TCM. All diets were formulated to contain (dry matter basis) 30% alfalfa silage, 30% corn silage, 4% soy hulls, 2.4% mineral-vitamin premix, and 16% CP. The SBM diet contained 25% high-moisture shelled corn and 8.6% SBM; the canola diets contained 22% high-moisture shelled corn and either 11.2% CM or 11.4% TCM. To assess ruminal digestion and omasal nutrient flow, 6 rumen-cannulated cows were blocked into 2 squares of 3 cows and randomly assigned within blocks to the same 3 dietary treatments as in experiment 1 in a replicated 3 × 3 Latin square design (experiment 2). Data were analyzed using the MIXED procedure of SAS (SAS Institute, Cary, NC). Orthogonal contrasts were used to compare effects of different protein supplements: SBM versus CM + TCM and CM versus TCM. In experiment 1, compared with SBM, apparent total-tract digestibilities of dry matter and nutrients were greater in cows fed both CM diets, and there was a tendency for nutrient digestibilities to be higher in cows fed CM compared with TCM. Diets did not affect milk yield and milk components; however, both canola diets decreased urinary urea N (% of total urinary N), fecal N (% of total N intake), and milk urea N concentration. In experiment 2, compared with SBM, both canola diets increased N intake and tended to increase rumen-degraded protein supply (kg/d) and N truly digested in the rumen (kg/d). Diets did not affect ruminal digestibility, efficiency of microbial protein synthesis, and rumen-undegraded protein flow among diets. Results from this experiment indicate that replacing SBM with CM or TCM in diets of lactating cows improved digestibility and may reduce environmental impact. Moreover, under the conditions of the present study, treating CM by extrusion did not improve CM utilization.
**Key words:** canola meal, extrusion, nitrogen metabolism, rumen-undegraded protein

## INTRODUCTION

Canola meal (**CM**) is widely used in North America as a protein supplement for lactating dairy cows. Previous studies comparing the effects of soybean meal (**SBM**) or other protein supplements versus CM have shown that CM diets increase nitrogen (N) utilization and performance when fed to lactating dairy cows (Huhtanen et al., 2011; Broderick et al., 2015). Improvement in N utilization and performance using CM in dairy cows diets may be attributable to an increase in microbial protein synthesis or a greater MP supply from the RUP fraction (Maxin et al., 2013a). However, it is still unclear whether responses observed when CM is fed are due to a ruminal effect, a postruminal effect, or a combination of both.

Chemical and physical treatments are strategies used to increase the RUP fraction of protein supplements with the goal of increasing AA availability for absorption in the small intestine and consequently optimizing

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the performance of dairy cows (Santos et al., 1998; Huhtanen et al., 2011). This strategy has been widely used with SBM, and many SBM-based commercial products have been developed as a consequence. However, studies evaluating the response of treated CM (**TCM**) on the performance of dairy cows have been inconsistent. For instance, Rinne et al. (1999) found no difference between the effect of rapeseed meal and heat-moisture-treated rapeseed cake on yields of milk. Conversely, Wright et al. (2005) found an increase in milk yield in cows fed heat-treated CM plus lignosulfonate compared with untreated CM.

In a meta-analysis, Huhtanen et al. (2011) did not find differences in DMI, digestibility, and milk yield when comparing regular CM versus heat-treated CM. Paula et al. (2017) did not find differences in RUP and microbial protein synthesis flow when comparing CM differing in RUP content in an in vitro study using a dual-flow continuous culture system. Furthermore, Ahvenjärvi et al. (1999) did not observe differences in omasal NAN and microbial NAN flow in cows fed either rapeseed meal or heat-moisture-treated rapeseed cake. Similarly, Khorasani et al. (1993) did not find differences in ruminal CP degradability in cows fed CM or CM treated with acetic acid. However, to our knowledge, no studies have measured omasal nutrient and microbial protein flow when TCM is fed as the major protein supplement in corn- or alfalfa silage-based diets to lactating dairy cows.

In the present study, CM was treated by extrusion in an attempt to increase its RUP content. We hypothesized that (1) feeding TCM would improve RUP flow to the small intestine, N utilization, and performance of dairy cows compared with regular solvent-extracted CM and (2) both CM diets would improve N utilization and performance of dairy cows compared with regular solvent-extracted SBM. Therefore, the objectives of the present study were (1) to evaluate the effects of SBM, CM, and TCM on ruminal digestion and omasal nutrient flow and (2) to measure total-tract digestibility, N metabolism, and production performance of lactating dairy cows.

## MATERIALS AND METHODS

Care and handling of all experimental animals, including ruminal cannulation, were conducted under protocols approved by the University of Wisconsin Institutional Animal Care and Use Committee.

### *Experiment 1*

Experiment 1 was designed to avoid potential carryover effects from reversal experiments; moreover, it allowed cows to stay on the same diet longer, which could have the potential to better reflect the effects of the protein supplement on milk production. At the beginning of the study, 30 multiparous Holstein cows averaging (mean ± SD) 2.5 ± 0.6 parity, 660 ± 55 kg of BW, 119 ± 23 DIM, and 44 ± 7 kg of milk/d and 15 primiparous cows averaging 592 ± 34 kg of BW, 121 ± 19 DIM, and 34 ± 6 kg of milk/d were blocked into groups of 3 by parity and DIM to obtain 10 multiparous blocks and 5 primiparous blocks in a randomized complete block design study. Cows were fed a control diet for a 2-wk covariate period and then switched to the experimental diets for a 12-wk study. The control diet contained (DM basis) 30% alfalfa silage, 30% corn silage, 22.2% high-moisture shelled corn (**HMSC**), 4.3% SBM, 5.8% regular CM, 5.3% soy hulls, and 2.4% mineral-vitamin premix. The CM was treated by extrusion, with added molasses (2–3%) to promote the browning reaction. The meal was preconditioned with steam containing reducing sugars and a proprietary blend of carbohydrases to a moisture level of 15%, then treated using a HTST annular gap expander (Kahl GmbH, Reinbek, Germany). The expander had a cone pressure of 13 bars. The same batch of meal was used for CM and TCM during the entire experimental period. Chemical composition of the fermented feeds and protein supplements fed is shown in Table 1. All diets contained (DM basis) 30% alfalfa silage, 30% corn silage, 4% soy hulls, and 2.4% mineral-vitamin premix plus one of the following protein supplements: SBM (8.4%), CM (11.2%), or TCM (11.4%). The HMSC was decreased from 25% in the SBM diet to 22% in both CM diets. Dietary CP contents were approximately 16% for all diets (Table 2).

All cows were injected biweekly with recombinant bST (500 mg of Posilac, Elanco Animal Health, Greenfield, IN). Cows were housed in tiestalls and had free access to water during the experiment.

Diets were offered once daily at 1000 h. Orts were collected and weights were recorded at 0900 h, and feeding rate was adjusted daily to yield orts between 5 to 10% of intake. Weekly composite samples (500 g) were taken from daily samples of corn silage, alfalfa silage, HMSC, TMR, and orts and stored at −20°C until analysis. Weekly samples of SBM, CM, TCM, and soy hulls were also taken and stored at room temperature. The DM content was determined in weekly composites of corn silage, alfalfa silage, and HMSC by drying at 60°C for 48 h and in weekly samples of SBM, CM, TCM, and soy hulls at 105°C according to AOAC (1990). Weekly samples of feed ingredients were also analyzed for total N using a combustion assay (Leco FP-2000 N Analyzer, Leco Instruments Inc., St. Joseph, MI) according to AOAC (2005) method 990.13. Ingredient DM and