J. Dairy Sci. 97:1603–1610
http://dx.doi.org/10.3168/jds.2013-7125

The effect of feeding canola meal on concentrations of plasma amino acids

R. Martineau, D. R. Ouellet, and H. Lapierre[1]
Dairy and Swine Research and Development Centre, Agriculture and Agri-Food Canada, Sherbrooke, Quebec, Canada J1M 0C8

ABSTRACT

An initial meta-analysis on isonitrogenous experiments where a protein source was replaced by canola meal (CM) showed that CM feeding increased yields of milk and milk protein and apparent N efficiency. The objective of the current study was to determine if these responses were related to increased changes in plasma AA concentrations. Although only half of the experiments of the initial meta-analysis reported concentrations of plasma AA and could be used in the current meta-analysis, lactational responses to CM feeding were similar to those reported previously. In the current meta-analysis, CM feeding increased plasma concentrations of total AA, total essential AA (EAA) and all individual EAA, but decreased concentrations of blood and milk urea-N. The current meta-analysis suggests that CM feeding increased the absorption of EAA, which would be responsible for the increased milk protein secretion and the increased apparent N efficiency.
Key words: amino acid, canola meal, metabolizable protein, blood urea-N

INTRODUCTION

Two meta-analyses were recently published to evaluate the production responses to canola meal (**CM**) feeding in dairy cows. Huhtanen et al. (2011) compared mostly separate experiments where different proportions of either CM or another protein source were fed at different rates in the diet (i.e., 2 or more dietary CP concentrations). In contrast, Martineau et al. (2013) examined the effects of CM feeding when CM replaced another protein source in isonitrogenous rations (i.e., in the same experiment). Although different methodologies and databases were used in these meta-analyses, the inclusion of CM in dairy rations increased yields of milk and milk protein. In addition, some concerns were expressed about the accuracy of MP estimations from NRC (2001) in both meta-analyses. Huhtanen et al. (2011) reported that milk protein yield (**MPY**) was better predicted by CP intake compared with estimated MP supply (**$\mathbf{MP_{supply}}$**) based on the residual variance and the variability of the random slope. Martineau et al. (2013) reported that CM feeding decreased estimated MP_{supply} but increased MPY, suggesting that MP_{supply} was underestimated when CM was fed to dairy cows because MP_{supply} is a key factor that determines milk protein secretion (NRC, 2001; Broderick et al., 2010).

The hypothesis of the current meta-analysis was that the increased MPY observed with CM inclusion in dairy rations was associated with a concomitant increase in plasma AA concentrations. Therefore, the main objective of the study was to determine the effect of CM feeding on plasma AA concentrations through a meta-analysis. In addition, another objective was to evaluate the changes in estimated MP_{supply} and digestible flows of each EAA with CM feeding.

MATERIALS AND METHODS

The database used in the current meta-analysis included the experiments from the initial meta-analysis (Martineau et al., 2013) that reported plasma or serum AA concentrations. Plasma AA concentrations were reported in most experiments, except Laarveld and Christensen (1976) and Piepenbrink et al. (1998); therefore, "plasma" will be used for "plasma or serum" AA concentrations hereafter. The database also included the isonitrogenous experiments of Choi et al. (2002) and Vanhatalo et al. (2004). These experiments were not included in Martineau et al. (2013) because CM was compared with protein sources highly soluble in the rumen (Choi et al., 2002) and field peas (*Pisum sativum* L.; Vanhatalo et al., 2004), a protein source not commonly fed to dairy cows (NRC, 2001). However, given the scarcity of isonitrogenous experiments reporting concentrations of plasma AA, Choi et al. (2002) was included because soluble NAN flows entering the omasal canal did not differ between protein sources, suggesting that a considerable proportion of free AA, peptides, and proteins in the liquid phase of digesta escaped ruminal degradation. Vanhatalo et al. (2004) was also included because field peas contain 24% CP (DM basis; INRA, 2007) and meet the minimal CP threshold set for a protein supplement in Martineau et al. (2013).

Received June 12, 2013.
Accepted November 24, 2013.
[1]Corresponding author: Helene.Lapierre@agr.gc.ca

Because the number of studies available for the current meta-analysis was more limited compared with the initial meta-analysis, diets were defined as isonitrogenous if the difference in CP concentration between control and CM diets did not exceed 1.5% (DM basis; instead of 1.0% CP, as set in the initial meta-analysis). This small difference allowed the inclusion of the comparison between CM and soybean meal (**SBM**) from Oba et al. (2010). Some AA data in Christen et al. (2010) were corrected by inverting reported values of Asn for Asp and Glu for Gln (D. Schingoethe, South Dakota State University, Brookings, personal communication). Overall, the database included 21 experiments reported in 10 studies (Table 1).

As in Martineau et al. (2013), responses included DMI, yields of milk (**MY**) and ECM (Sjaunja et al., 1990) in kilograms per day; percentages of milk protein, fat, and lactose; yields of milk protein, fat, and lactose in grams per day; efficiency of milk production (i.e., ECM/DMI) in kilograms per kilogram; and apparent N efficiency (i.e., N in milk/N intake) in grams per kilogram. Specifically for the current meta-analysis, responses included plasma concentrations of individual AA, branched-chain AA (**BCAA**; Ile, Leu, and Val), urea cycle AA (Arg, Cit, and Orn), total EAA and NEAA in micromolar concentrations, BUN and MUN (both in millimolar concentrations). In addition, responses also included estimated flows of MP and digestible individual EAA in grams per day (NRC, 2001).

The methodology used in the current study was similar to that reported in Martineau et al. (2013). Briefly, all regressions were conducted on responses or changes (Δ: the value from the CM diet minus the value from the control diet), forced through the origin (no intercept in the model), and weighted by sample size. Regressions were forced through the origin because responses were assumed to be zero when CM intake was zero (Glasser et al., 2008; Martineau et al., 2013). Besides changes in dietary concentration of CP between CM and control diets, regressions also included changes in DMI as a covariate in the model. Only the effect of the dietary proportion of CM expressed as 100 g/kg (DM basis) is reported in the current meta-analysis; therefore, the coefficient of CM was the response expected for each increment of 1 unit of 10% inclusion of CM in the ration (e.g., 2 kg of CM per 20 kg of DMI) in models controlling for variations in DMI and in dietary concentration of CP. The effect of qualitative factors (e.g., type of forage and protein source or treatment of canola) could not be tested with accuracy in the current meta-analysis because of the limited number of observations.

The range of inference for this meta-analysis is limited to the domain of the specific experiments in the

Table 1. Summary of studies included in the meta-analysis

Study	No. of experiments	Protein source[1]	Breed (no. of cows)[2]	Forage type (% of dietary DM)	Reference
1	4	Untreated or treated CM vs. skim milk powder or wet distillers solubles	Ayrshire (5)	Grass silage (41 to 44%)	Choi et al. (2002)[3]
2	3	CM vs. SBM, regular or high-protein dried distillers grains with solubles	Holstein (12)	Corn silage (27%) and alfalfa hay (27%)	Christen et al. (2010)
3	1	CM vs. SBM	Holstein (6)	Bromegrass hay (50%)	Laarveld and Christensen (1976)
4	1	CM vs. dried distillers grains with solubles	Holstein (12)	Corn silage (27%) and alfalfa hay (27%)	Mulrooney et al. (2009)
5	3	CM vs. SBM, corn or triticale dried distillers grains with solubles	Holstein (12)	Barley silage (35%) and alfalfa hay (10%)	Oba et al. (2010)
6	1	CM vs. SBM	Holstein (15)	Alfalfa hay (37%) and corn silage (12%)	Piepenbrink and Schingoethe (1998)[3]
7	2	Treated CM vs. SBM (2 levels of supplementation)	Ayrshire (5)	Red clover silage (31%) and timothy-fescue silage (31%)	Rinne et al. (2006)
8	3	Treated CM vs. SBM (3 levels of supplementation)	Ayrshire (16)	Mixed grass silage (58 to 61%)	Shingfield et al. (2003)
9	1	CM vs. SBM	Ayrshire (20)	Grass silage (57%)	Vanhatalo et al. (2003)
10	2	CM vs. formic acid-treated ensiled crimped peas or dried field peas	Ayrshire (4)	Grass silage (59 to 64%)	Vanhatalo et al. (2004)

[1]Untreated canola meal (CM) was used unless specified; SBM = soybean meal.
[2]Ayrshire and Holstein cows were used in European and North American studies, respectively.
[3]Amino acid composition of CM is reported in Choi and Choi (2003) and Piepenbrink et al. (1998).