# TRUE VALUE OF FEEDING CANOLA MEAL

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Canola meal has been described in the past as a protein source that was readily degraded in the rumen, highly fibrous, poorly digested, low energy, and sometimes poorly palatable. Values in feed tables and feed formulation programs in general would not encourage use of this meal. In spite of such apparently poor quality, the use of canola meal by the dairy industry in the USA has been accelerating, with imports more than doubling in the last 10 years (Figure 1).

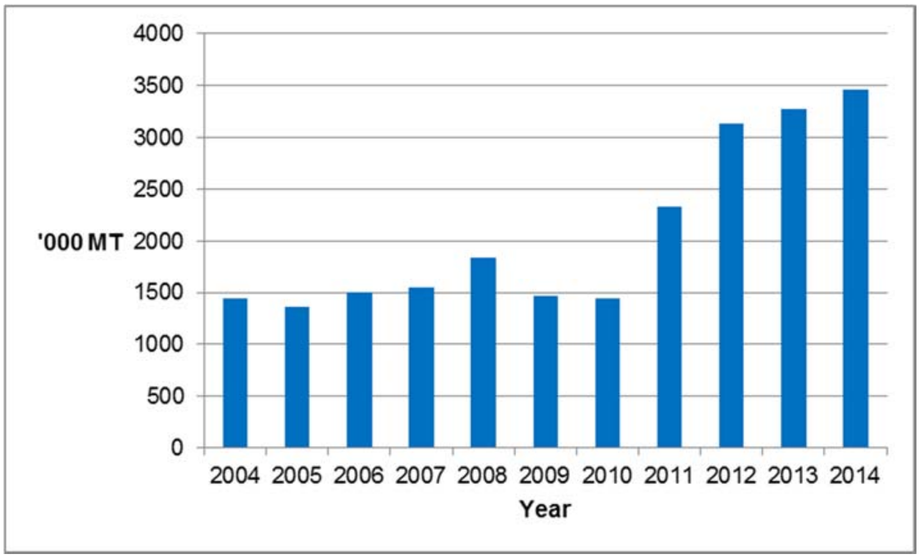


Figure 1. Export of Canadian canola meal to the USA by year

This increased rate of usage suggests that dairy nutritionists are using the meal, but possibly not the nutritive values at hand. A survey commissioned by the Canola Council of Canada in 2011 (Evans and Hodgins, 2012) confirmed that dairy nutritionists had a lot more respect for canola meal than tabular data suggested that they should have. Over 80% of the dairy nutritionists surveyed had used canola meal and 92.4% perceived the meal as being an excellent or good source of protein for dairy cows. The results revealed that 65.0% of canola meal users believed that the protein content should be higher. Surprisingly, only 10.3% stated that rumen solubility was a critical issue, and 46.1% stated that the rumen escape value was the most positive attribute of the meal. These responses along with other responses to the survey indicated, and in some cases stated, that users were largely satisfied with the meal, and were using nutrient values that differed from those published in NRC (2001) and feed formulation databases.

## UNDERTAKING TO ADDRESS THE ISSUE

It was obvious to Canola Council that the needs of the industry were not being met with respect to understanding the true value of canola meal. In response to both the increasing demand for canola meal as well as the results of the survey, the Canola Council of Canada with financial assistance from Agriculture and Agrifoods Canada set out to research and assess the value of canola meal, and to describe the value in terms that can readily be used by the dairy feeding industry.

Research programs aimed at identifying various characteristics of canola meal for dairy cows were established at the University of California, University of Nevada, University of Saskatchewan, South Dakota State University, the University of Manitoba, the US Dairy Research Center in Wisconsin, and the Agriculture and Agrifoods Research Center, Quebec.

## META-ANALYSES

One of the first undertakings commissioned was a review and meta-analysis of past research. Fortuitously, while this research was under way, Huhtanen et al (2011) published results from 122 studies in which dietary protein was elevated using either soybean meal (SBM) or canola meal (CM) and the higher protein concentrations were increased at the expense of grains.  For every 1 kg increase in crude protein consumed, milk production increased by 3.4 kg with canola meal, and 2.1 kg with soybean meal, resulting in a net gain of 1.3 kg with canola meal. Much like the survey indicated, the authors concluded that “the current feed protein evaluation methods based on determination of RUP [rumen undegraded protein] by the in situ procedure fail to evaluate relative values of SBM vs. CM and untreated vs. heat-treated CM correctly”.

Members of the canola science cluster Martineau et al. (2013) compared the effects of replacing a protein source with the same amount of protein from CM. There were 49 trials in the data set, and CM intakes varied from 1 to 4 kg/cow/day. At the average level of inclusion (2.3 kg/day) of CM, milk yield increased by 1.4 kg when compared to all protein sources. The improvement was less when CM was compared to SBM (0.7kg). The researchers concluded “These data also indicate an underestimation of MP (metabolizable protein) supply associated with CM inclusion in dairy rations using the National Research Council (2001) model”.

In a follow up meta-analysis Martineau et al. (2014) compared response in plasma amino acids to changes in protein source in the diet. Essential amino acids were higher and urea nitrogen was lower when cows received CM than when they were given other vegetable proteins. The conclusion “…these results indicate that CM feeding increased the absorption of all EAA (essential amino acids)…”

Results from all three analyses underscored the need to supply the dairy feeding industry with more useful, and accurate feeding values for this ingredient.

## CANOLA MEAL NUTRITIONAL VALUE SURVEY

The purpose of this study was to provide the feed industry with a complete and up to date set of nutrient values, using the most current methodology. To assess nutrient composition and quality, meal samples were collected from 12 crushing facilities across Canada. Three samples were collected from each plant for 4 consecutive years (2011-2014), and were analyzed for an extensive range of nutrients and anti-nutritional factors at the University of Manitoba and the US Dairy Forage Research Center. All samples were analyzed for rates of protein digestion and RUP using methods that would provide results that were consistent with NRC (2001). A subset of these samples was also provided to Cornell University for analysis by the method developed by Ross et al. (2013).

Results for an extensive list of nutrients have been published in the Canola Meal Feed Industry Guide (2015). This publication is available to download from the Canola Council of Canada website.

Table 1. Rumen undegraded protein (RUP) values as calculated by methods consistent with the NRC (2001) and the CNCPS 6.5 (2015) models

| Reference | Canola Meal | Soybean meal |
|---|---|---|
| Broderick et al, 2015 | 35.5 | 25.7 |
| Ross, 2015 | 52.3 | 45.2 |

As Table 1 shows, unlike results published in the past, newer methods of analyses show that the RUP value of solvent extracted CM protein is higher than untreated solvent extracted SBM. Clearly, this explains why, at equal amounts of protein, CM elevates plasma levels of all essential amino acids relative to SBM.

## FIBER DIGESTIBILITY

Canola meal contains a considerable amount of lignin. Survey data revealed that CM contains 6.6% lignin and 10.1% total lignin plus polyphenols (DM basis). With 28.8% neutral detergent fiber (NDF), older models using a derivative of lignin to compute indigestible NDF indicated that the potential digestibility of NDF was extremely low. Early studies ((Mustafa, et al., 1996, 1997) indicated that approximately half of the NDF from CM was actually digested, which indicated that the potential digestibility is even greater. This was recently corroborated by Cotanch et al. (2014) who determined that the potentially digestible NDF in CM was 63%.

The difference between the determined digestibility values and the lignin method of estimation has an impact on the prediction of available energy. Recent feeding studies have not been able to demonstrate a noticeable lower energy value for diets where CM has been substituted for SBM or DDGS, as the data below will demonstrate. Studies are currently underway to assess the potential digestibility of NDF using the survey samples available.

## MILK PRODUCTION

When canola meal is substituted for other vegetable proteins, there appears to be a slight milk production advantage favoring diets with canola meal, and no difference in feed efficiency. In a recent study, Broderick et al. (2015a) measured a consistent increase in energy corrected milk production when CM was substituted for SBM and corn in diets with 15 and 17% protein. There were no differences in energy corrected milk to dry matter in this study. Milk urea nitrogen (MUN) concentrations were lower when canola meal was provided in the diet.

Table 2. Evaluation of diets containing soybean meal (SBM) or canola meal (CM) at two levels of crude protein (CP) on milk production in Holstein cows

| | **Treatment** | | | |
|---|---|---|---|---|
| | **15% CP** | | **17% CP** | |
| **Item** | **SBM** | **CM** | **SBM** | **CM** |
| Dry matter intake (DMI), Kg/day | 24.8 | 25.3 | 25.2 | 25.5 |
| Weight gain, Kg/day | 0.23 | 0.55 | 0.50 | 0.41 |
| Energy Cor. Milk (ECM), Kg/day | 38.5 | 39.2 | 38.7 | 39.9 |
| ECM/DMI | 1.55 | 1.55 | 1.56 | 1.58 |
| MUN | 9.9 | 8.7 | 13.2 | 12.0 |

In an earlier evaluation (Table 3), Brito and Broderick (2007) compared urea, SBM, cottonseed meal (CSM) and CM in diets for lactating dairy cows. Concentrating on the vegetable protein diets and ignoring the urea treatment, cows receiving the diet with CM produced more fat corrected milk than cows given the diets with SBM or CSM. Efficiency values were similar for the vegetable protein treatments.

Wheat distillers' grains with solubles (W-DDGS) were compared to CM at two protein levels in a recently completed experiment (Mutsvangwa and Doranalli, 2014). Again, milk yield favored the use of CM, with milk to dry matter values in a similar range for all treatments (Table 4). Protein yields were higher with the CM diets at each level of protein.

Table 3. Evaluation of diets containing urea, soybean meal (SBM), cottonseed meal (CSM) or canola meal (CM) on milk production in Holstein cows

| | **Treatment** | | | |
|---|---|---|---|---|
| **Item** | **Urea** | **SBM** | **CSM** | **CM** |
| Dry matter intake (DMI), Kg/day | 22.1 | 24.2 | 24.7 | 24.9 |
| Weight gain, Kg/day | 0.58 | 1.23 | 1.00 | 1.25 |
| Fat Cor. Milk (FCM), Kg/day | 30.6 | 37.1 | 36.8 | 38.8 |
| FCM/DMI | 1.39 | 1.53 | 1.58 | 1.55 |
| MUN | 16.9 | 12.0 | 10.0 | 11.6 |

Table 4. Evaluation of diets containing wheat distillers' grains (W-DDGS) or canola meal (CM) at two levels of crude protein (CP) on milk production in Holstein cows

| | Treatment | | | |
|---|---|---|---|---|
| | 15% CP | | 17% CP | |
| **Item** | **W-DDGS** | **CM** | **W-DDGS** | **CM** |
| Dry matter intake (DMI), Kg/day | 31.6 | 31.4 | 31.5 | 31.0 |
| Milk , kg/day | 42.2 | 43.2 | 43.2 | 44.2 |
| Fat Yield, Kg/day | 1.47 | 1.51 | 1.48 | 1.51 |
| Protein yield, Kg/day | 1.36 | 1.39 | 1.39 | 1.42 |
| Milk/DMI | 1.33 | 1.38 | 1.37 | 1.42 |

One probable reason for the higher milk and milk protein yields in these and other studies would be the amino acid balance provided by canola meal. Mutsvangwa and Doranalli (2014) measured the abomasal outflow of amino acids in the study described in Table 4. The CM diets showed a 20, 0, 28, 25 and 5 g/day advantage over W-DDGS for lysine, methionine, histidine, threonine and tryptophan, respectively. In a study comparing SBM, CM, W-DDGS and high protein corn distillers' grains (C-DDGS), Maxin et al (2013) found that the metabolizable protein provided when CM was fed to cows producing 35 kg of milk resulted in no amino acid deficiencies. In contrast, the supply of methionine was low with SBM, histidine was low with W-DDGS, and lysine was marginal with C-DDGS as the primary sources of supplemental protein. Brito et al (2007), in a continuation of the experiment described in Table 3, found that the abomasal outflow of lysine and methionine were highest when cows received the CM diet (Table 5).

Table 5. Evaluation of diets lysine and methionine outflow with diets containing urea, soybean meal (SBM), cottonseed meal (CSM) or canola meal (CM)

| | Treatment | | | |
|---|---|---|---|---|
| **Item, g/day** | **Urea** | **SBM** | **CSM** | **CM** |
| Protein entering intestines | 2880 | 3700 | 4060 | 3930 |
| Lysine entering intestines | 147 | 194 | 196 | 201 |
| Methionine entering intestines | 51 | 68 | 70 | 74 |

RUMEN PRODUCTION AND METABOLISM

With the higher RUP, and the apparent greater contribution of amino acids from canola meal beyond the abomasum, it would seem possible that the rumen nitrogen requirements might not be met. Recent studies suggest that this is not of major concern, and additional research is underway. De Paula et al (2015) compared SBM to two sources of CM in a duel flow continuous culture system. Rumen ammonia levels, total volatile fatty acid (VFA) concentration as well as molar percentages of acetate, propionate, butyrate, and isobutyrate were not affected by treatments. There were, however, differences in the branched chain VFA.  Molar proportion of valerate was lower with the SBM diet, whereas molar proportions of isovalerate, and total branched chain VFA were lower for CM diets (Table 1). Microbial growth did not appear to be affected by these changes in that study.

Based on the meta-analysis of Martineau et al (2014), CM feeding results in lower plasma urea nitrogen than other vegetable protein meals. This could be due to either less urea being generated in the rumen, or less being produced post absorption due to the inefficient use of absorbed amino acids. Ouellet et al (2015) determined little difference in rumen urea production from SBM, CM, C-DDGS and W-DDGS, with lowest values obtained with W-DDGS. Urinary excretion of urea was significantly lower with the CM diet than with diets containing the remaining protein sources, indicating an efficiency advantage with the CM diet. In addition to this important finding, the researchers reported a considerable entry of urea back into the gut, which is then available to support microbial growth.

## FEEDING LEVEL

There appears to be no practical restrictions to the amount of canola meal that can be included in diets for lactating dairy cows and several recent studies have illustrated this. Swanepoel, et al. (2014) provided dairy cows with diets that contained 20%CM, in replacement for 20% high C-DDGS. Milk production increased from 45.0 to 47. 5 kg/ cow/day with no difference in intake.. Brito, et al., (2007) replaced 12% soybean meal and 4.5% corn meal with 16.5% canola meal in diets for high-producing cows. Dry matter intake increased by 0.3 kg, while milk yield increased by 1.1 kg. Maxin et al (2013) compared a diet with 20.8% canola meal in place of SBM and corn grain. These researchers found no differences in dry matter intakes, milk yield, or milk component yield for cows producing 35 kg of milk/day.

Under practical feeding situations, canola meal can be included in formulations for dairy cows with no restrictions, and is a well-balanced source of RUP.

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