Why All of the Hype About Feeding Canola Meal?

Essi Evans[1], and Brittany Dyck[2]
[1]*Technical Advisory Services*
[2]*Canola Council of Canada*

Abstract

The U.S. dairy industry is the largest user of canola meal worldwide. A survey conducted in 2011 revealed that respondents believed canola meal provides good value, but they indicated that additional research was needed to better understand how to take advantage of this meal.

Introduction

Canola meal is a relatively new feed ingredient. It was developed in the 1970s to maintain the beneficial properties of rapeseed meal and to remove the anti-nutritional factors that were hampering the use of that meal by the livestock feeding industry. As a result, canola meal and its predecessor, rapeseed meal, are the second most widely traded oilseed meals in the world, as well as being Canada's most valuable crop (Casséus, 2009).

Canola has seen steady growth. In 2014, Canada produced more than 15 million metric tonnes (mmt) (www.canolacouncil.org), and the United States produced over 1.1 mmt (www.uscanola.com) of canola seed. After the oil is removed, approximately 56% of the seed remains as meal. Most of the meal produced by both countries is used by the U.S. dairy industry.

The Canola Council of Canada **(CCC)** commissioned a survey in 2011 (Evans and Hodgins, 2012) to assess the current perceptions regarding canola meal, as well as industry needs. The results indicated that more data are needed on the feeding value of this product. Oddly enough, a good portion of those taking the survey found that production results obtained when feeding canola meal appeared to be better than predicted by the profile used in nutritional models. This contrasted with models in 2011 that described canola meal as a protein that was highly soluble, provided lower levels of rumen undegraded protein **(RUP)** than other sources, and was also characterized as being relatively low in energy. There seemed to be a disconnect between calculations by formulators and utilization by cows, and this further underscored the need for additional research to assist the industry. With the rapid growth in canola meal availability and the acceptance of new formulation technologies by the dairy industry, new information was needed to provide accurate feeding values to the industry. As a result, the CCC invested in further research at 5 major North American institutions.

[1]Contact at: 64 Scugog St., Bowmanville, ON L1C3J1, (905) 623-7599, FAX: (905) 623-6841, Email: essievans@sympatico.ca.
[2]Contact at: 400-167 Lombard Ave, Winnipeg, MB, R3B 0T6, (204) 982-7763, FAX: (204) 942-1841, Email: dyckb@canolacouncil.org.

Review of Recent Findings

So, who is right? Results from recent meta-analyses

A meta-analysis is a statistical procedure for pooling results from several studies and getting a fuller picture of what may be taking place. This approach is also useful for pinpointing where additional research resources need to be directed. How the results are used is determined by the questions asked in the first place.

Huhtanen et al. (2011) wanted to know how increasing ration protein using either soybean meal or canola meal compared for dairy cows. Was one meal superior to the other? Their dataset consisted of 292 treatment results published in 122 studies, carefully restricted to include only studies in which increasing protein in the ration was accomplished by adding canola meal as compared to soybean meal. For each additional pound of protein supplied in the diet, milk production increased by 3.4 lb with canola meal, and 2.4 lb with soybean meal, showing a 1-pound advantage for canola meal. The researchers found these results puzzling; they suggested that the RUP of soybean meal relative to canola meal was overestimated and that canola meal could replace soybean meal.

Martineau et al. (2013) posed a somewhat different question. The researchers looked at the effects of replacing protein in the diet from several vegetable sources of protein by using the same amount of protein from canola meal. There were 49 different peer-reviewed trials included in the dataset that they used. The average amount of canola meal tested was 5.1 lb, with the feeding level from 2.2 to 8.8 lb in the various studies. At the average level of inclusion, canola meal increased milk yield by 3.1 lb when all the protein compared were considered, but only by 1.5 lb when canola meal was substituted for soybean meal. Milk protein yield followed the same pattern. Once again, canola meal appeared to be superior to other protein sources when included at the same level of protein.

The same group of researchers (Martineau et al., 2014) then conducted an additional meta-analysis study to compare canola with other proteins with respect to concentrations of plasma amino acids. The responses in these studies proved that canola meal increased plasma concentrations of total amino acids, including total essential and all individual essential amino acids, more so than other vegetable protein meals. Furthermore, blood and milk urea nitrogen concentrations were decreased. This meta-analysis strongly suggests that canola meal feeding increased the absorption of essential amino acids, which was responsible for the increased milk protein secretion and the increased protein efficiency.

Something is off. How in the world do you calculate RUP?

Based on most of the models available, canola meal should not be supplying enough RUP to increase the amino acids available to the cow that were revealed by the last meta-analysis (Martineau et al., 2014). If the same amount of protein is supplied by several vegetable protein sources, but plasma amino acids and milk protein yield are higher with canola meal, then the value being ascribed to it must be wrong. Could something be wrong with the methods used to determine RUP? This could have an impact on how diets are formulated.

Of the various models available, the National Research Council (2001) protein evaluation scheme bares similarities to other methods, but it is the least tedious to review.

The A fraction, determined as soluble protein, is instantly degraded in the rumen and is not available to supply amino acids as RUP. The C fraction is unavailable and indigestible, and by definition, not degraded in the rumen at all. The B fraction is calculated as the difference (100 – (A + C)). Some of this fraction is degraded in the rumen and some becomes RUP. How much of that becomes RUP depends on the rate that the fraction is solubilized by rumen microflora (the rate of digestion (Kd)), along with the rate of passage of particles out of the rumen (Kp).

To put this in terms of an equation:

$$RUP = B\ fraction * (Kp/(Kd + Kp) + C\ fraction$$

It is important to note that the calculation assumes that the entire portion of the A fraction that becomes soluble in the rumen is degraded there and does not contribute to RUP. Some other models calculate that most of the soluble fraction is degraded in the rumen. These models give the A fraction a very high rate of degradation, from 100 to 500%/hr. With such high rates, very little solubilized material would get past the rumen. Newer research suggests that this is in fact not true.

Table 1 provides a case in point. Swedish scientists Hedqvist and Udén (2006) elegantly demonstrated that proteins could be soluble but may not be degraded. These scientists measured the Kd rates on the soluble fraction of the crude protein and found that these Kd rates are actually quite variable among ingredients. Does this matter? The results clearly show that it does.

Hedqvist and Udén (2006) determined that the portion of the soluble protein that does not break down leaves the rumen with the liquid outflow and contributes to the fraction described by the National Research Council (2001) as RUP. The effective protein degraded — or the amount that is actually degraded in the rumen — varied from more than 70% of the protein for wheat distillers' grains and soybean meal, to under 50% for canola meal (or rapeseed meal) and flax meal (Table 2). These calculations show that on a meal basis, canola meal actually does contain a high amount of RUP, just as the researchers concluded from the meta-analyses.

Results from newer feeding experiments

Research conducted at the U.S. Dairy Forage Research Center by Broderick et al. (2012) evaluated the variability of canola meal based upon the source. The type of equipment used to extract the oil and the techniques used can have an impact on the value of the protein to dairy cows. These details can be used to optimize meal production parameters. The researchers also looked at how proteins degrade in the rumen and are re-evaluating the use of traditional in sacco methods.

An interesting study conducted by Brito and Broderick (2007) compared lactational performances of cows given 17% diets in which supplemental protein was supplied by urea, soybean meal, cottonseed meal, or canola meal (Table 3). It was expected that the urea diet would supply the least RUP. Unexpected was the fact that the soybean meal diet provided less RUP than either cottonseed meal or canola meal. Cows given the canola meal diet at the same level of protein produced 2.0 lb/day more milk than their counterparts that were given soybean meal.

Continuing in this vein, Faciola and Broderick (2013) compared diets formulated to supply 15 and 17% CP, using either soybean meal or canola meal as the supplemental source (Table 4). Cows receiving the diets with canola meal again out-produced cows consuming soybean meal by approximately 2.0 lb of milk - unexpectedly, at both levels of protein!

Corn distillers grains are another ingredient that is a good value and widely available, but it is difficult to use in diets that may already be high in corn protein from grain and silage. Two studies have demonstrated that blending distillers with canola meal allows cows to better utilize both ingredients. Mulrooney et al. (2009) learned that milk production and feed efficiency were improved by mixing these 2 vegetable proteins sources (Table 5). Similarly, Swanepoel et al. (2014) evaluated milk production when cows were given either high protein distillers grains or canola meal (Table 6). Both meals have the same amount of protein, and in the treatments, each supplied 20% of the total diet DM with the various combinations of these meals. Once again, the mixtures of the 2 meals were demonstrated to improve milk output, feed efficiency, and gain in body condition score. It would seem that using mixes of canola meal and distillers grains will help dairy producers to get the most from both ingredients.

Canola meal contains more fiber than soybean meal. Because of the fiber content, there was concern that it might not be an appropriate protein for high-forage diets. Schuler et al. (2013) conducted an experiment to compare milk production with diets ranging in forage from 42 to 66% of the total diet DM. All diets utilized canola meal as the supplemental source of protein. As Table 7 shows, there was no loss in energy-corrected milk when cows consumed the high-forage diets.

Canola meal calculator

Canola meal may be ideally suited to dairy rations in a wide range of feeding situations. However, the real value will depend upon the cost relative to other available protein sources. Comparing costs, however, can be a daunting task. Should ingredients be compared on the basis of CP alone or on RUP? Some protein sources are high in energy and others bring a valuable nutrient, like phosphorus, to the table.

Some years back, Howard and Shaver (2004) put together a spreadsheet, FeedVal4, that allowed ingredients to be compared on the basis of their total CP, RUP, energy, fat, calcium and phosphorus contents. With permission, this system was modified to allow costs of feed proteins to be evaluated. Canola meal does not always win on the basis of cost, but the canola meal calculator will provide fair assessments and has been widely received by the industry. It can be found at *canolamazing.com/resources/canola-meal-calculator* and is a free resource for all to use to their best advantage.

References

Brito, A.F., and G.A. Broderick. 2007. Effects of different protein supplements on milk production and nutrient utilization in lactating dairy cows. J. Dairy Sci. 90:1816–1827.

Broderick, G.A., S. Columbini, M.A. Karsli, L. Nernberg, and D. Hickling. 2012. Canola meals from different production plants differ in ruminal protein degradability. J. Dairy Sci. 95 (Suppl. 2):611 (Abstr.).

Casséus, L. 2009. Canola, a Canadian success story. In “Canadian Agriculture at a Glance.” Statistics Canada, Ottawa, ON.

Evans, E., and M.E. Hodgins. 2012. Canola council surveys dairy industry needs. Feedstuffs, Oct. 8, pp. 14–16.

Faciola, A., and G. Broderick. 2013. Effects of replacing soybean meal with canola meal for lactating dairy cows fed three different ratios of alfalfa to corn silage. J. Dairy Sci. 96 (E-Suppl. 1):452.

Hedqvist, H., and P. Udén. 2006. Measurement of soluble protein degradation in the rumen. Anim. Feed Sci. Technol. 126:1–21.

Howard, J.T., and R.D. Shaver. 2004. FeedVal4: Feed comparative values calculated from protein (RUP), TDN, fat, calcium and phosphorus. University of Wisconsin Extension Service.

Huhtanen, P., M. Hetta, and C. Swensson. 2011. Evaluation of canola meal as a protein supplement for dairy cows: A review and a meta-analysis. Can. J. Anim. Sci 91: 529-543.

Martineau, R., D.R. Ouellet, and H. Lapierre. 2013.Feeding canola meal to dairy cows: A meta-analysis on lactational responses. J. Dairy Sci 96: 1701-1714.

Martineau, R., D.R. Ouellet, and H. Lapierre. 2014.The effect of feeding canola meal on concentrations of plasma amino acids. J. Dairy Sci. 97:1603-1610.

Mulrooney, C.N., D.J. Schingoethe, K.F. Kalscheur, and A.R. Hippen. 2009. Canola meal replacing distillers' grains with solubles for lactating dairy cows. J. Dairy Sci. 92:5669–5676.

National Research Council. 2001. Nutritional requirements of dairy cattle. 7th rev. ed. Natl. Acad. Sci., Washington DC.

Schuler, A.M., K.F. Kalscheur, D.P. Casper, and J.L. Anderson. 2013. Determination of the optimum dietary forage concentration when using canola meal as a primary protein source in lactating dairy cow diets. J. Dairy Sci. 96 (E-Suppl.1):397. (Abstr.).

Swanepoel, N., P.H. Robinson, and L.J. Erasmus. 2014. Determining the optimal ratio of canola meal and high-protein dried distillers' grain protein in diets of high-producing Holstein dairy cows. Anim. Feed Sci. Technol. 189:41–53.

Table 1. Rates (Kd) of digestion of the soluble fraction of protein in the rumen for selected ingredients.[1]

Vegetable Protein Source	Soluble protein, % of total CP[2]	Kd,[3] % degraded/hr
Canola meal (rapeseed meal)	20.4	19
Flax (linseed meal)	58.6	18
Lupins	80.2	34
Peas	77.8	39
Soybean meal	16.9	46
Wheat distillers grains	24.3	62

[1]Hedqvist and Udén, 2006.
[2]CP = crude protein.
[3]Kd = rate of digestion.

Table 2. Calculated effective protein degradation, RUP and RUP contributed by meals.[1,2]

	Effective protein degradation, %	RUP, % of CP	Protein, % of meal DM	RUP, % of meal DM
Canola meal (rapeseed meal)	44	56	36.9	20.6
Flax (linseed meal)	46	54	26.8	14.5
Lupins	56	44	33.8	14.9
Peas	71	29	25.0	7.25
Soybean meal	73	27	50.6	13.7
Wheat distillers grains	79	21	37.5	7.9

[1]Hedqvist and Udén, 2006.
[2]RUP = rumen undegraded protein.

Table 3. Comparison between vegetable proteins and urea.[1]

Measurement	Added Protein			
	Urea	Soybean meal	Cottonseed meal	Canola meal
% of ration DM[2]	1.9	12.1	14.1	16.5
Microbial protein, g/day	2,340	2,710	2,710	2,780
RUP[3], g/day	540	990	1,350	1,150
Total protein entering the intestines	2,880	3,700	4,060	3,930
DMI[4], lb/day	48.7	54.3	54.5	54.9
Milk yield, lb/day	72.5	88.2	89.3	90.6
Protein yield, lb/day	2.03	2.71	2.60	2.80
Fat yield, lb/day	2.23	2.69	2.60	2.84

[1]Brito and Broderick, 2007
[2]DM = dry matter
[3]RUP = rumen undegraded protein
[4]DMI = dry matter intake

Table 4. Performance of lactating dairy cows fed low- or moderate-protein diets with canola meal or soybean meal.[1]

Measurement	15% CP		17% CP	
	Soybean meal	Canola meal	Soybean meal	Canola meal
Dry matter intake, lb/day	54.6	55.6	55.4	56.1
Milk yield, lb/day	86.9	88.4	87.8	90.4
Protein yield, lb/day	2.62	2.66	2.66	2.73
Fat yield, lb/day	3.43	3.50	3.52	3.63

[1]Faciola and Broderick, 2013.

Table 5. Synergistic effects between canola meal (CM) and corn distillers grains (DDGS).[1]

Measurement	Diet			
	CM	2/3 CM 1/3 DDGS	1/3 CM 2/3 DDGS	DDGS
DMI,[2] lb/day	55.4	55.9	57.0	55.2
Milk, lb/day	77.4	78.8	79.9	75.5
Milk fat, lb/day	2.95	3.19	3.01	2.90
Protein, lb/day	2.37	2.42	3.21	2.26
Energy-corrected milk (ECM), lb/day	80.7	84.5	79.2	78.5
ECM/DMI	1.46	1.53	1.42	1.44

[1]Mulrooney et al., 2009.
[2]DMI = dry matter intake.

Table 6. Synergistic effects between canola meal (CM) and corn distillers' grains (DDGS).[1]

	Diet			
Measurement	DDGS	2/3 DDGS 1/3 CM	1/3 DDGS 2/3 CM	CM
DMI,[2] lb/day	53.0	53.7	54.6	53.6
Milk, lb/day	99.0	104.5	105.5	104.4
Milk fat, lb/day	3.44	3.62	3.58	3.50
Protein, lb/day	2.87	3.05	3.08	3.04
Milk/Feed	1.87	1.95	1.93	1.95
Change in body score/28 days	0.01	0.03	0.08	0.03

[1]Swanepoel et al., 2014.
[2]DMI = dry matter intake.

Table 7. Evaluation of forage levels in diets containing canola meal as the main source of protein[1]

	Forage, % of DM[2]			
Measurement	42	50	58	66
DMI,[3] lb/day	61.8	59.4	56.8	54.6
Milk, lb/day	88.2	88.9	89.8	86.0
Milk fat, lb/day	2.77	2.81	2.97	3.01
Protein, lb/day	2.61	2.66	2.64	2.51
Energy-corrected milk (ECM), lb/day	83.6	84.5	86.9	85.1
ECM/DMI	1.36	1.44	1.54	1.57

[1]Schuler et al., 2013.
[2]DM = dry matter.
[3]DMI = dry matter intake.