Canola Meal, a Proven Advantage in Various Diet Formulations

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Introduction

The past decade has given rise to a shift in the paradigm around feeding protein to dairy cattle. This can be attributed to a greater understanding of dairy cattle protein requirements, desire to reduce ration costs through increased efficiency, and reduction in the environmental impact of dairy cattle waste. The use of oilseed crop by-products as animal feed is an effective way to feed dairy cattle and supply required nutrients, specifically protein. While soybean meal has long been a staple in North American dairy rations, the popularity of canola meal inclusion is on the rise due to an increase in canola production, particularly in Canada. The increased availability of this quality animal feed has necessitated research efforts to evaluate its value in dairy production systems.

Canola is a variety of rapeseed. A member of the Brassica genus, it is bred to produce an edible oil fraction and protein feed suitable for livestock. Two endemic compounds to rapeseed, glucosinolates and erucic acid, negatively impact the use of oil and meal fractions for human or animal consumption via toxicity and decreased palatability (Tripathi and Mishra, 2007). It was not until the mid-1970's that Canadian plant breeders were able to develop cultivars low in these two compounds, increasing the use of canola products (Stefansson and Kondra, 1975). The nomenclature "canola", "double-low" rapeseed, or "double-zero" rapeseed is used to identify these improved varieties from their less desirable counterparts. Meal glucosinolate levels of <30 µmol/g and oil erucic acid levels of <2% are maintained to denote high quality rapeseed (Canola Council of Canada, 2015).

Nutrient composition

Canola meal has been shown to be a quality protein by-product when used as an animal feedstuff. Its position in the marketplace and use in dairy cow rations will be supported by evaluating the production response of cows fed canola meal compared directly to other protein by-products and how the nutrient fractions of canola meal behave in the dairy cow. In an evaluation of solvent-extracted canola meal from 11 different North American plants, crude protein ranges 40.6 to 43.7% of DM over a 4-year period (Table 1; Adewole et al., 2016). Soybean meal values range between 46.3 and 55.9% DM (Table 1; Dairy One, 2017). Canola has a considerably larger NDF fraction (Table 1; 27.4 to 30.9% of DM; Adewole et al., 2016), whereas soybean meal tends to fall within 7.8 to 19.2% NDF, % of DM (Table 1; Dairy One, 2017). The RUP fraction of canola ranged from 32.3 to 46.1% of CP, with a mean of 41.0% RUP, % of CP when evaluated *in situ* (Table 1; Jayasinghe et al., 2014). A comparison sample of solvent extracted soybean meal was tested and RUP fraction was 31.0% or CP (Table 1; Jayasinghe et al., 2014). When similar samples were evaluated in vitro the mean RUP was slightly higher approximately 44.0% RUP, % of total N compared to solvent extracted soybean meal with 34.9% RUP, % total N (Broderick et al., 2016). While a higher proportion of canola meal crude protein reaches the small intestine, the availability of this protein fraction is less than soybean meal. Intestinally digestible protein (IDP) ranged from 71.6% to 77.4% when evaluated using a modified 3-step *in situ/in vitro* procedure, whereas soybean meal was 94.5% IDP, % of RUP (Table 1; Jayasinghe et al., 2014). These values are similar to those determined by the National Research Council, 75% for canola meal and 93% for soybean meal (NRC, 2001).

Feeding studies

The majority of the feeding studies evaluating the inclusion of canola meal in dairy cow diets on production responses have been used in two published meta-analyses. In the 2011 meta-analysis, which included 292 treatment means from 122 peer-reviewed studies, DMI, milk yield, and energy-corrected milk were greater for canola meal-fed cows, compared to those fed soybean meal (Huhtanen et al., 2011). Dry matter intake, milk yield, and energy-corrected milk were greater for cows fed diets formulated with canola meal versus soybean meal. A second meta-analysis conducted by Martineau et al. (2013) compared the substitution of canola meal with various vegetable protein sources (soybean meal, corn gluten meal, cottonseed meal and distillers grains). Milk yield, 4% fat-corrected milk, milk protein yield, and

dry matter intake increased as canola meal replaced all protein sources. When comparing canola meal directly with soybean meal, milk protein yield increased, however, 4% fat-corrected milk yield was not different. In a third meta-analysis evaluating the response of plasma amino acids and milk urea nitrogen (MUN) to changes in the protein sources in the diet, Martineau et al. (2014) found that essential amino acids were higher and MUN was lower when cows were fed canola meal compared to all other protein sources.

More recently, canola meal has been included in a variety of different diet formulations to evaluate whether it performs similarly to alternative protein sources. Several studies were conducted evaluating canola meal at two protein concentrations versus an alternative protein source. Broderick et al. (2015) evaluated the inclusion of canola meal compared to soybean meal formulated at 14.7 or 16.5% CP in the diets (on a DM basis). They found that replacing soybean meal with canola meal increased DMI 0.88 lb/d, increased milk yield 1.98 lb/d and true protein yield 0.66 lb/d. In addition, MUN and urinary nitrogen excretion were lower for cows fed canola meal compared to cows fed soybean meal consistent with findings from Martineau et al. (2014). In this study, CP concentration did not affect DMI, milk yield or true protein yield. Acharya et al. (2015) evaluated the inclusion of canola meal compared to distillers dried grains with solubles (DDGS) formulated at 14.3 or 16.3% CP in the diet (on a DM basis). They found that DMI, milk yield and true protein yield was the same regardless of protein source; however, MUN was lower for cows fed the canola meal compared to cows fed DDGS. In this study, cows fed the higher protein diet (16.3% CP) were higher in DMI, milk yield, and milk protein yield compared to cows fed the lower protein diet (14.3% CP). When replacing DDGS with canola meal at the same protein concentration, Mulrooney et al. (2009) found that DMI, milk production, and milk composition was similar regardless of the protein supplement. On the other hand, Swanepoel et al. (2014) found that cows fed a diet with a mixture of canola meal (67%) and DDGS (33%) out-performed diets formulated with canola meal or DDGS alone.

To evaluate the inclusion of canola meal across a range of different diet formulations, several experiments were conducted to determine how forage inclusion or changes in starch source or concentration may affect dairy cow performance when canola meal is included in the diets. Schuler et al. (2013) evaluated the optimum dietary forage concentration when using canola meal as the primary protein source. Forage (70% corn silage and 30% alfalfa haylage) was included in the diet at 42, 50, 58, and 66% of the diet (DM basis). Canola meal was included at a constant 11% of the diet (DM basis). As forage increased in the diet, DMI decreased linearly, while milk yield and energy-corrected milk remained the same across all 4 diets. As a result, feed efficiency (ECM/DMI) increased linearly as forage increased from 42 to 66% of the diet.

Two studies were conducted to investigate whether starch source or starch concentration would affect lactation performance in dairy cow diets formulated with canola meal. To evaluate whether starch source affects lactation performance, Jayasinghe et al. (2015) fed diets varying in proportions of ground corn and rolled barley. No differences in DMI, milk yield, or milk protein were found when starch source varied. To evaluate whether starch concentration and protein source affects lactation performance, Sanchez-Duarte et al. (2016) fed diets with two protein sources (canola meal and soybean meal) at two dietary starch concentrations (21 and 27%, DM basis). Cows fed the high starch diets formulated with canola meal performed similarly to cows fed the SBM diets, but had greater DMI and milk yield compared to cows fed the low starch diets formulated with canola meal. It was thought that increasing dietary starch concentration in diets with canola meal seem to improve protein utilization compared to cows fed lower dietary starch concentrations.

While studies conducted on dairy cows at and after post-peak milk production have demonstrated similar or slightly more milk production for cows fed canola meal compared to other protein sources, there has been very little research investigating the use of canola meal in early lactation dairy cows. To determine the impact of feeding canola meal in early lactation, Moore and Kalscheur (2016) conducted an experiment with 79 multiparous Holstein cows that received diets formulated to be high protein, 17.6% CP (% of DM) or low protein 15.4% CP (% of DM) provided by either canola or soybean meal. Cows were enrolled at calving and production was followed for 16 weeks of lactation. Cows fed canola meal out-performed those that received soybean meal, producing (mean ± SEM) 122.8 vs 112.9 ± 2.14 lb/d of milk, respectively. While cows fed canola meal diets tended to have a higher DMI compared to cows fed soybean meal diets (56.9 vs 55.1 ± 0.75 lb/d, respectively), this additional DMI was not fully responsible for the improvement performance. More research on transition and early lactation dairy cows is needed to further investigate how canola meal improves production.

Conclusions

While changes in market dictate when canola, soybean meal, or another protein source can be favorably incorporated into dairy cow diets, there are potential benefits for using canola meal as a protein source in the diets of lactating dairy cows. Mid-lactation dairy cows result in similar or slightly greater performance when canola meal is included in their diets, but there appears to be great potential of including canola meal in the diets of early lactation dairy cows. Canola meal is a proven protein source that can be formulated in a wide range of lactating dairy cow diets.

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Table 1. Canola versus soybean meal nutrient composition and digestibility					
	Canola meal			Soybean meal	
Item	**Mean**	**Range**		**Mean**	**Range**
Crude protein	41.7[a]	40.6 - 43.7[a]		51.1[b]	46.3 - 55.9[b]
Ether extract	3.5[a]	2.8 - 4.0[a]		4.38[b]	0.0 - 9.1[b]
Ash	7.5[a]	7.2 - 8.0[a]		7.3[b]	5.9 - 8.6[b]
NDF	29.4[a]	27.4 - 30.9[a]		13.5[b]	7.8 - 19.2[b]
RDP, % of CP	59.0[c]	53.9 - 67.7[c]		69.0[c]	-
RUP, % of CP	41.0[c]	32.3 - 46.1[c]		31.0[c]	-
IDP,[1] % of RUP	74.8[c]	71.6 - 77.4[c]		94.5[c]	-
[1]Intestinally digestible protein.					
[a]Adewole et al. (2016).					
[b]Dairy One (2017).					
[c]Jayasinghe et al. (2014).					