Canola meal in DAIRY CATTLE DIETS

This article contains extracts from the Canola Council of Canada's website, www.canolacouncil.org, edited by Rex Newkirk of the Canadian International Grain Institute.

Canola meal is widely used in beef and dairy cattle feed and is considered to be a premium ingredient due to its high palatability and high-quality protein for milk production.

Canola meal is a highly palatable source of protein for ruminant animals. Spomdly and Asberg (2006) examined the relative palatability of common protein sources by comparing eating rate and preference in heifers. When fed a mash diet, heifers consumed 221g of canola meal in the first three minutes, while those fed soya bean meal only consumed 96g, demonstrating the highly palatable nature of canola meal. The reasons for the high degree of palatability are unknown, but may be related to the high sucrose content.

When feeding canola meal, it is important to ensure the meal is derived from modern, low-glucosinolate varieties. Some regions such as China and India still produce rapeseed and mustard with relatively high levels of glucosinolates, which can reduce feed intake. Ravichandiran *et al* (2008) examined the impact of feeding rapeseed or mustard meals with varying levels of residual glucosinolates to five-month-old calves.

Calves receiving a concentrate containing low-glucosinolate canola meal (<20µmol/g) consumed the same quantity as the control group without canola meal (1,10 vs 1,08kg, respectively). However, calves fed a concentrate containing high-glucosinolate mustard meal (>100µmol/g) only consumed 0,76kg).

Table 1: Summary of the effective rumen degradability of canola meal dry matter and protein fractions (rumen outflow rate of 5%/h).

	Effective rumen degradability (%)	
	Dry matter	**Crude protein**
Ha and Kennelly (1984)		
Trial 1	57,1	68,5
Trail 2	57,1	65,5
Kirkpatrick and Kennelly (1987)		
Trial 1	63,0	63,2
Trial 2	64,2	72,0
Kendall *et al* (1991)	53,5	51,5
Cheng *et al* (1993)		
Trial 1 (Hay diet)	-	74,9
Trial 2 (Straw diet)	-	72,3
Trial 3 (Grain diet)	-	62,5
Piepenbrink and Schingoethe (1998)	65,1	53,1
Woods *et al* (2003)	60,5	66,7
Sadeghi and Shawrang (2006)		
2%/hr passage rate	78,1	79,3
5%/hr passage rate	66,5	65,2
10%/hr passage rate	59,5	56,9

Rumen degradability

The rumen degradability of canola meal protein has been studied extensively. *Table 1* provides a summary of the effective degradability of the dry matter and crude protein fractions of canola meal, assuming a rumen turnover rate of 5%/h. Ha and Kennelly (1984) reported that the effective degradability of canola meal protein was 65,8%. Effective degradability of soya bean meal and dehydrated alfalfa were 53,6% and 41,4% respectively.

Kendall *et al* (1991) found that the effective degradability of canola meal averaged 51,5%, compared to 59,1% for soya bean meal. Woods *et al* (2003) reported that the effective degradability of canola meal protein was 66,8%, while cottonseed meal was 73,7%, soya bean meal 73,8% and

cotton gluten 73,4%. Piepenbrink and Schingoethe (1998) reported a rumen degradability of canola meal of 53,1%. Cheng *et al* (1993) reported that the effective degradability of canola meal was 62,5% with concentrate diets and 72 to 74% with hay or straw diets.

Increasing the ruminal turnover rate from 2 to 5 and 10%/h reduced effective degradability from 79,3 to 65,2 and 56,9% (Sadeghi and Shawrang, 2006). Therefore, it is important when evaluating such results for ration-formulation purposes to consider the type of diet into which the protein supplement is to be incorporated.

Research at the University of Manitoba in Canada has focused on the digestibility of the amino acids present in canola meal. Kendall *et al* (1991) noted that following twelve hours of rumen incubation, total tract digestibility of amino acids present in canola meal approached 85% or greater. Considerable variation was noted among samples and amino acids in the proportion degraded ruminally or absorbed post-ruminally.

Boila and Ingalls (1992) reported that the amino acid profile of canola meal protein that bypasses the rumen was superior in valine, isoleucine, threonine, phenylalanine, serine, aspartate and alanine, relative to unincubated meal. The magnitude of the enrichment in the bypass fraction ranged from 14 to 33%.

The results, in combination with the data presented in *Table 1*, suggest that a sizeable, but variable, fraction of the protein of canola meal bypasses the rumen. In light of the enriched amino acid content of the bypass fraction, it would appear that canola meal provides a significant contribution to both rumen microbial protein needs and to the digestible amino acids required for animal growth and lactation.

Table 2: Milk production of cows fed canola meal compared to soya bean meal or cottonseed meal.

	Milk yield (kg/day)	
	Control	**Canola**
Ingalls and Sharma (1975)	23,0	23,7
Fisher and Walsh (1976)	24,4	23,0
Laarveld and Christensen (1976)	24,9	26,4
Sharma *et al* (1977)	20,7	20,9
Sharma *et al* (1977)	21,5	21,8
Papas *et al* (1978)	24,3	25,2
Papas *et al* (1978)	23,9	24,6
Papas *et al* (1979)	21,8	22,2
Laarveld *et al* (1981)	26,4	27,7
Sanchez and Claypool (1983)	33,4	37,7
DePeters and Bath (1986)	39,8	41,4
Vincent and Hill (1988)	28,5	28,6
Vincent *et al* (1990)	25,1	26,7
McLean and Laarveld (1991)	17,2	30,7
MacLeod (1991)	17,2	16,9
Emmanuelson *et al* (1993)	21,0	21,9
Dewhurst *et al* (1999)	24,0	24,5
Dewhurst *et al* (1999)	23,7	25,5
Whales *et al* (2000)	21,8	22,3
White *et al* (2004)*	21,7	22,7
Maesoomi *et al* (2006)	27,0	28,0
Johansson and Nadeau (2006)**	35,4	38,4
Brito and Broderick (2007)	40,0	41,1
Mulrooney *et al* (2008)***	34,3	35,2
Average milk yield	**26,4[a]**	**27,4[b]**

*Ruminal-protected canola meals vs lupin
**Canola expeller meal vs commercial concentrate
***Canola meal vs DDGS

Canola meal in dairy rations

Canola meal is an excellent protein supplement for lactating dairy cows. In a summary of 24 research trials with canola meal (*Table 2*), the mean milk-production response was +1,0kg/d when compared to diets containing cottonseed meal or soya bean meal. Recent research with cows producing >40kg/d (Brito and Broderick, 2007) clearly indicates that, even at high levels of production, canola meal is still a superior protein supplement when compared to soya bean meal or cottonseed meal.

Amino acid profile

The amino acid content of rumen microbes, canola meal, soya bean meal, corn gluten meal, cottonseed meal and sunflower meal, expressed as a percentage of the amino acid composition of milk protein, are shown in *Table 3*. Canola meal is an excellent source of histidine, methionine, cystine and threonine.

The abundance of these amino acids and the extent to which they supplement amino acids from other protein sources may, in part, explain the consistent milk-yield response found when canola meal is included in dairy cow rations. Of all the protein sources listed in *Table 3*, canola meal has the best amino acid balance, as indicated by the relatively high level of its first limiting amino acid.

Another commonly used measure of protein quality for dairy cattle is 'milk protein score', which relates the amino acid composition of protein sources compared to the amino acid composition of milk protein. The milk protein score of common ingredients – as calculated by Schingoethe (1991) for a maize-, maize silage- and alfalfa-based diet – is shown in *Figure 1*. Canola meal exhibits the highest score of all the supplemental protein sources (except for fish meal).

Table 3: Ingredient and rumen microbe amino acid composition, compared to milk protein.* (The first limiting amino acid in each protein source is highlighted.)

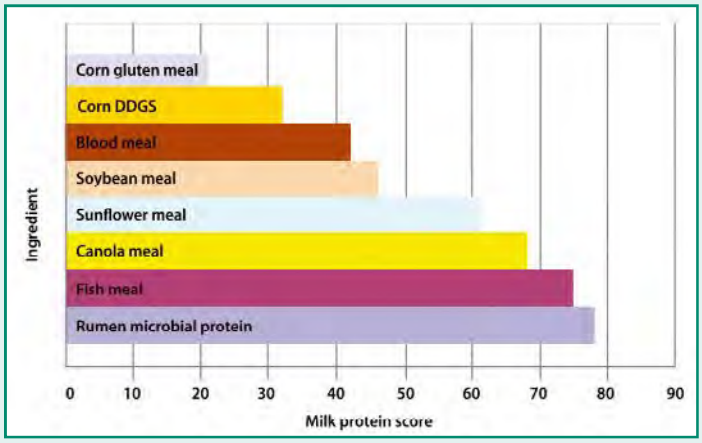
	Amino acid as percentage of milk protein							
	Milk % EAA	Rumen microbe	Canola meal	Soya bean meal	Maize gluten meal	Cottonseed meal	Sunflower meal	Corn DDGS
Arg	7,2	139	197	225	99	361	288	149
His	5,5	**73**	138	111	85	120	113	120
Ile	11,4	107	83	89	80	64	87	86
Leu	19,5	81	**82**	88	190	71	133	130
Lys	16,0	119	84	87	**23**	**61**	**50**	37
Met	5,5	84	95	**58**	95	67	102	87
Phe	10,0	104	103	116	141	125	110	**34**
Thr	10,0	121	113	98	84	85	98	102
Trp	3,0	90	115	93	40	93	97	77
Valine	13,0	85	88	78	79	77	90	96

*NRC, 2001

Microbial protein production

Canola meal optimises the amount of absorbable amino acids for lactating dairy cows, by providing adequate amounts of rumen-degradable protein (RDP) that stimulate microbial protein production in the rumen. Microbial protein is a high-quality protein that accounts for as much as 60% of a dairy cow's metabolisable protein requirements for milk synthesis.

Figure 1: Milk protein score of common feed ingredients for dairy cattle (Schingoethe, 1991).



> ANOTHER COMMONLY USED MEASURE OF PROTEIN QUALITY FOR DAIRY CATTLE IS 'MILK PROTEIN SCORE'.

The high rumen protein degradability of canola meal efficiently provides ammonia, amino acids and peptides, which are essential growth factors for rumen bacteria that can be readily incorporated into microbial protein. A comparative study investigating canola meal, cottonseed meal and soya bean meal as protein supplements for high-producing dairy cows, demonstrated a numerically higher post-rumen flow of microbial protein in cows fed canola meal, compared to those fed cottonseed meal and soya bean meal (Brito *et al*, 2007).

Rumen undegradable protein

The rumen undegradable protein (RUP, bypass protein) fraction in canola meal contains a profile of essential amino acids that closely matches that of milk protein. Recent trials with lactating dairy cows demonstrated that cottonseed meal>canola meal>soya bean meal in post-rumen flow of RUP and total protein and canola meal>soya bean meal>cottonseed meal in milk and milk protein yields (Brito and Broderick, 2007; Brito *et al*, 2007).

Higher milk production that is observed with canola meal, is attributed to the amino acid profile in the bypass fraction of canola meal being complementary to microbial protein (Brito *et al*, 2007). The post-rumen supply of total amino acids, essential amino acids, branched-chain amino acids and limiting amino acids (methionine, lysine, histidine and threonine) when canola meal is used as a protein supplement, is numerically higher or at least comparable to that when diets are supplemented with soya bean meal or cottonseed meal (Brito *et al*, 2007).

Unequivocal research data indicates that when it is used to supplement dairy cow diets, canola meal can meet the rumen-degradable protein (RDP) and RUP requirements of dairy cows, which is reflected by the increase in milk production.