CANOLA MEAL IN PIG DIETS

Amino Acid Digestibility

A key to using high levels of canola meal is to balance the diets to digestible amino acid minimums. The digestibility of key essential amino acids is lower in canola meal than in soybean meal (Heartland Lysine, 1998) are shown in Table 1.

Table 1 **Swine true ileal digestibility coefficients of some key essential amino acids in canola meal and soybean meal (Heartland Lysine, 1998)**

Amino acid	Canola meal digestibility (%)	Soybean meal digestibility (%)
Lysine	78	90
Methionine	86	91
Cystine	83	87
Threonine	76	87
Tryptophan	75	90

Canola meal is a very cost effective ingredient in pig diets almost everywhere in the world. However, in some countries its use has been limited by unfounded opinions that it is toxic and unpalatable. The concerns about toxicity and palatability are valid for high glucosinolate rapeseed meal but they are not valid for canola meal. Also, a failure by some users to properly account for the nutrient digestibility in canola meal has led to some problems with poorer pig performance. Current data clearly show that canola meal, when properly formulated, in pig diets will support high levels of feed intake and efficient performance.

When canola meal replaces soybean meal in the diet, the overall levels of digestible amino acids, especially lysine and threonine, will decrease if the diet is balanced to total amino acid levels. It is only since the late 1980's and early 1990's that pig diets have routinely been formulated to levels of digestible amino acids rather than total amino acids. This is the reason why earlier feeding trials with canola meal resulted in lower pig growth rate compared to soybean meal fed pigs. A random summary of research studies from that period (Baidoo et al., 1987; Bell et al., 1988; Bell et al., 1991 and McIntosh et al., 1986) shows the effect of decreasing levels of digestible lysine in the diet on pig performance (Figure 1). These diets were balanced to the same levels of crude protein, total essential amino acids and energy. But as canola meal inclusion level in the diets increased, the levels of digestible lysine decreased. This is clearly correlated with the decrease in pig growth rate. On the other hand, recent feeding trials with canola meal, where the diets were balanced to the same levels of digestible lysine, (Hickling, 1994; Hickling, 1996; Mateo et al., 1998; Patience et al., 1996; Raj et al., 2000; Robertson et al., 2000; Siljander-Rasi et al., 1996) resulted in a soybean meal equivalent growth rate, even at very high inclusion levels of canola meal (Figure 2).

Figure 1 **Early feed trial results of relative pig growth rate versus levels of digestible lysine in the diet**

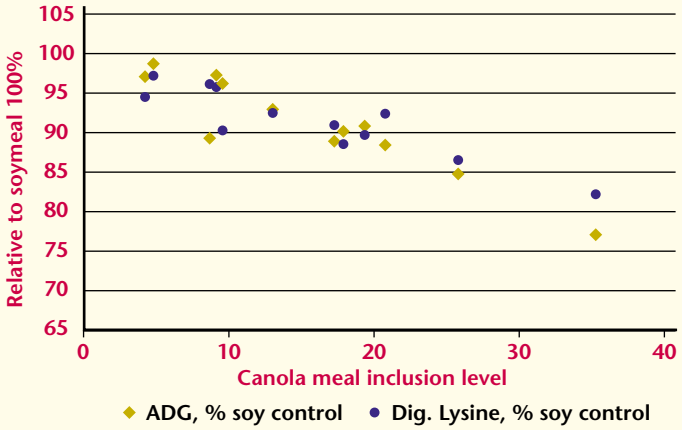
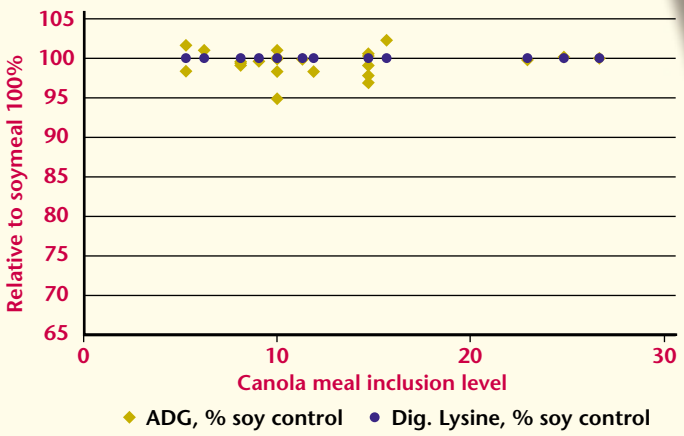


Figure 2 Recent feed trial results of relative pig growth rate versus levels of digestible lysine in the diet



Glucosinolate Tolerance

The maximum tolerable level of glucosinolates in pig diets is of interest in order to facilitate least cost diet formulation. High glucosinolate rapeseed meal and low glucosinolate canola meal are sometimes used at the same time in the same feed. Rather than restricting the inclusion levels of both rapeseed meal and canola meal, it is preferable to formulate to a maximum level of glucosinolates in the diet and let the computer choose the least cost optimum combination of rapeseed meal and canola meal.

Several researchers have specifically looked at the maximum level of glucosinolates that pigs can tolerate in the diet. In a review of earlier research on canola meal, Bell (1993) suggested a maximum level of glucosinolates in pig diets of 2.5 µmol/g. Recent work (Schone et al., 1997a, 1997b) generally supports this recommendation. In the first experiment, Schone et al. (1997a) fed growing pigs from approximately 20 kg to 50 kg bodyweight a variety of diets containing the same levels of canola meal, but varying in total glucosinolate content from 0 to 19 µmol/g. They concluded that greater than 2.4 µmol/g of glucosinolates in the diet had negative effects on feed intake, growth rate and thyroid function. In the other study (Schone et al., 1997b), they determined that the maximum safe glucosinolate level is 2.0 µmol/g of diet. Given that Canadian canola meal contains on average 16 µmol/g of glucosinolates, this would correspond to a maximum canola meal inclusion level of 12.5% in growing pig diets. This may be an overly cautious recommendation since pigs will perform well on diets containing greater than 20% canola meal, which would result in a dietary glucosinolate content of more than 3 µmol/g.

Feed Intake

The effect of a feed ingredient on feed intake of pigs is one of the most difficult things to objectively evaluate given the many factors involved. Variables such as basic palatability of the ingredient, dietary inclusion level, other ingredients in the feed mix, feed energy content, feed fibre content (bulk density), and feed mineral balance will influence feed intake. For canola meal, there are several potential negative influences on feed intake including glucosinolates, tannins, sinapine, fibre and mineral balance. Certainly the major negative influence of high glucosinolate rapeseed meal on feed intake is glucosinolates. Aside from their anti-nutritive effects, they have a bitter taste to many animals. Canola meal, with its very low levels of glucosinolates, has a neutral taste. It is likely that there are causes other than glucosinolates in situations (baby pigs, for example) where reduced feed intake of canola meal diets is observed.

Starting Pigs (6 to 20 kg)

For starting pigs, limit dietary levels of canola meal. Liveweight performance of young pigs tends to deteriorate as dietary levels of canola meal increase. This is likely due to fibre levels and the presence of tannins, sinapine and (perhaps) glucosinolates in the meal (Bourdon and Aumaître, 1990; Lee and Hill, 1983). Generally, producers resist the extensive use of canola meal in pig starter diets up to 20 kg bodyweight.

Growing and Finishing Pigs (20 to 100 kg)

In the growing and finishing phases of pig growth, canola meal can be used at high dietary levels and it will support excellent pig performance. Recent studies (Hickling, 1994; Hickling, 1996; Mateo et al., 1998; Patience et al., 1996; Raj et al., 2000; Robertson et al., 2000; Siljander-Rasi et al., 1996) have shown that when diets are balanced for digestible amino acid levels, performance is the same as with soybean meal (Figure 2).

Two of these studies are presented in detail. The Canola Council of Canada sponsored a series of feeding trials with growing and finishing pigs to demonstrate that balancing the diets to digestible amino acids will improve pig performance results. Trials were conducted in Canada, Mexico and the Philippines.

Canadian Feeding Trials

Three feeding trials were conducted in western Canada – one each in Manitoba, Saskatchewan and Alberta. The trials were conducted at different times of the year and with different genetics of pigs. The overall diet compositions were similar between the three locations. The diets were balanced to digestible lysine and threonine minimums, which were considered to be the first and second limiting amino acids (the diets were balanced to ideal protein amino acid composition). Supplemental lysine HCl was used to meet digestible lysine minimums. The digestible threonine minimums were met from higher natural sources in the diet – the level of crude protein increased in the canola meal treatment diets. The diets were isocaloric and this was achieved by increasing the amount of wheat relative to barley in the canola meal treatment diets. The diet composition and combined results of the three feed trials are shown in Table 2 (Hickling, 1994). Pig performance was equivalent, both numerically and statistically, for all three diets. Contrary to popular belief, there was no decrease in feed intake with increasing canola meal levels in the diet. There was no difference in the quality of the pig carcasses as measured by dressing percentage and backfat index.

Mexican Feeding Trials

Three feeding trials were conducted in three Mexican states – Nuevo Leon, Sonora and Michoacan (Hickling, 1996). The objective was to duplicate the performance found in the Canadian feeding trials, but using Mexican ingredients (two of the feed trials used sorghum as the grain base in the diet and one trial used corn) and Mexican

TABLE 2 **Canadian Feeding Trial Results – average performance of growing pigs (20 to 60 kg) and finishing pigs (60 to 100 kg) fed diets supplemented with soybean meal (SBM) and canola meal (CM) (Hickling, 1994)**

Item	Grower			Finisher		
	SBM	MED CM	HI CM	SBM	MED CM	HI CM
INGREDIENTS (%)						
Barley (CP 10.5%)	62	53	48	60	48	40
Wheat (CP 13.5%)	13	20	24	19	29	35
Soybean meal (CP 46.5%)	20	16	13	16	10	5
Canola meal (CP 34.5%)	-	6	10	-	8	15
Canola oil	1	1	1	1	1	1
L-lysine	.04	.07	.10	.06	.12	.15
Other	4	4	4	4	4	4
Total	100	100	100	100	100	100
NUTRIENTS						
Crude protein (%)	17.6	17.8	17.9	16.4	16.5	16.6
DE (kcal/kg)	3200	3200	3200	3200	3200	3200
Total lysine (%)	.94	.94	.95	.81	.82	.83
Digest. lysine (%)	.75	.75	.75	.65	.65	.65
Total met + cys (%)	.61	.64	.66	.54	.59	.63
Digest. met + cys (%)	.49	.52	.54	.43	.48	.51
Total threonine (%)	.66	.66	.67	.56	.58	.59
Digest. threonine (%)	.47	.47	.47	.40	.40	.40
PERFORMANCE						
Avg daily feed, kg	1.905	1.928	1.887	3.061	3.113	3.083
Avg daily gain, kg	.756	.765	.767	.841	.830	.822
Feed/gain ratio	2.52	2.52	2.46	3.64	3.75	3.75

TOT. PERIOD (20-100 KG) KG	SBM	MED CM	HI CM
Avg daily feed, kg	2.461	2.498	2.465
Avg daily gain, kg	.799	.798	.795
Feed/gain ratio	3.08	3.13	3.10
Dressing %	78	78	78
Carcass backfat index	107	107	107

conditions (environment, pig genetics and management). Also, the canola meal used in the trials was produced by Mexican oilseed crushers from Canadian canola seed. The design was very similar to the Canadian trials. Three dietary treatments were used – a control, a medium canola meal diet and a high canola meal diet. The diets were balanced for minimum digestible amino acids, ideal protein and equal energy levels. The diets and results are shown in Table 3. As with the Canadian results, equivalent growth, feed efficiency and carcass quality performance was observed on all three dietary treatments. As with the Canadian results, there was variability in performance between locations due mainly to pig genetics and seasonal effects.

TABLE 3 **Mexican feeding trial results. Average performance of growing pigs (20 to 60 kg) and finishing pigs (60 to 100 kg) fed diets supplemented with soybean meal (SBM) and canola meal (CM) (Hickling, 1996)**

Item	Grower						Finisher					
	SBM		MED CM		HI CM		SBM		MED CM		HI CM	
INGREDIENTS (%)												
Sorghum	72	-	68	-	667	-	76	-	72	-	70	-
Corn	-	72	-	67	-	66	-	76	-	72	-	70
Soybean meal	24	24	19	20	16	17	20	19	13	12	10	9
Canola meal	-	-	8	8	12	12	-	-	10	10	15	15
Tallow	-	-	1	1	2	1	-	-	1	1	2	1
L-lysine	-	-	.33	-	.47	-	-	-	.50	.50	.70	.70
Other	4	4	4	4	4	4	4	5	4	5	3	5
Total	100		100		100		100		100		100	
NUTRIENTS												
Crude protein (%)	17.6		17.7		17.9		16.0		16.2		16.4	
DE (kcal/kg)	3150		3150		3150		3160		3160		3160	
Total lysine (%)	.92		.93		.94		.81		.82		.83	
Digest. lysine (%)	.75		.75		.75		.65		.65		.65	
Total met + cys (%)	.58		.63		.65		.55		.58		.61	
Digest. met + cys (%)	.45		.47		.49		.41		.44		.46	
Total threonine (%)	.71		.71		.72		.63		.63		.64	
Digest. threonine (%)	.53		.53		.53		.47		.47		.47	
PERFORMANCE												
Avg daily feed, kg	2.17		2.23		2.18		3.22		3.21		3.12	
Avg daily gain, kg	.778		.773		.764		.851		.833		.824	
Feed/gain ratio	2.78		2.87		2.86		3.79		3.85		3.79	
TOT. PERIOD (20-100 KG) KG	**SBM**			**MED CM**			**HI CM**					
Avg daily feed, kg	2.72			2.74			2.67					
Avg daily gain, kg	.818			.807			.797					
Feed/gain ratio	3.32			3.39			3.35					
Meat yield, %	48.6			48.8			49.3					
Carcass backfat, cm	2.38			2.33			2.15					

Breeding Swine

Canola meal has been readily accepted in diets for sows and gilts both in gestating and lactating periods. Flipot and Dufour (1977) found no difference in reproductive performance between sows fed diets with or without 10% added canola meal. Lee et al. (1985) found no significant difference in reproductive performance of gilts through one litter. Studies at the University of Alberta (Lewis et al., 1978) have shown no difference in reproductive performance of gilts through two reproductive cycles fed diets containing up to 12% canola meal. The results suggest that canola meal may represent the only supplemental protein source in gilt and sow diets for all phases of reproduction. Canola meal may be restricted in sow diets that are formulated to maximum fibre levels in order to limit hind gut fermentation.

For the most part, producers are now accepting canola meal as an appropriate alternative supplemental dietary protein source for sows. There is, however, still some unfounded concern over daily feed intake of nursing sows fed canola meal based diets. These concerns are not supported by research.

Feeding Canola Seed and Oil

Canola oil is routinely fed to all types of pigs. Crude canola oil is often an economical energy source as well as a dust suppressant in the feed. Canola seed is also fed as a protein and energy source, however, it is usually limited to 10% dietary inclusion since higher levels will result in softer fat in the carcass (Kracht et al., 1996). Canola seed should be ground before feeding. It can effectively be fed raw, although heat treatment may prove beneficial – as long as excessive heat is not used during processing, which will reduce amino acid digestibility.

Canola Meal Maximum Inclusion Levels

The recommended maximum inclusion levels for canola meal in pig diets, together with the reasons why, is given in Table 4.

Table 4 Recommended maximum inclusion levels (%) of canola meal in pig diets

Animal diet type	Max inclusion level	Reasons for maximum inclusion level
Pig starter	5	Palatability
Hog grower/finisher	No limit	
Sow lactation	15	Reduce hind gut fermentation
Sow gestation	No limit	

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