By the Canola Council of Canada

The value of CANOLA MEAL IN SWINE DIETS

Current data clearly indicates that diets containing canola meal, when properly formulated, will support high levels of efficient growth performance. The nutritional value of canola meal for swine is being understood increasingly well, and the major limitation for value and inclusion is the available energy content, especially when measured as nett energy (NE).

Improper feed quality evaluation information for digestible nutrients in canola meal has resulted in certain problems with poorer pig performance in the past. Ultimately, the relationship between ingredient cost and nutrient content will determine the appropriate level of inclusion of canola meal in well-formulated diets.

Feed intake

The effect of a feed ingredient on the feed intake of pigs is difficult to evaluate objectively, given the numerous factors involved (Nyachoti *et al.*, 2004). Variables such as basic palatability of the ingredient, dietary inclusion level and other ingredients in the feed mix, feed energy, fibre content (bulk density) and feed mineral balance will influence feed intake.

For canola meal, several factors with the potential to reduce feed intake exist, such as glucosinolates, tannins, sinapine, fibre and mineral balance. Certainly, glucosinolates represent a major negative influence on feed intake in pigs. Aside from their anti-nutritive effects, glucosinolates have a bitter taste to many animals. Canola meal produced in Canada, with its very low levels of glucosinolates (4,2µmol/g), has a very neutral taste. Other causes than glucosinolates likely play a role in situations in which reduced feed intake of canola meal diets is observed.

Landero *et al.* (2012) conducted feed preference trials with weaned pigs given the choice of either soya bean meal or canola meal. A strong preference was observed for soya bean meal, which agrees with previous literature; however, when no choice was given, canola meal could be included at up to 20% in the diet without impacting feed intake or growth performance. Additionally, Sanjayan *et al.* (2014) successfully fed increasing levels of canola meal with excellent performance results.

Canola meal is often considered as a poor source of energy for swine diets, due to the high amount of fibre and a complex carbohydrate matrix with limited digestibility. Diet formulation based on NE allows for the proper inclusion of canola meal in swine diets so as to not impact performance.

Energy values published by the National Research Council (NRC) in 2012 are given in *Table 1* and are based on historical information. Recently, Maison *et al.* (2015) determined digestible energy (DE) values of 3,378Mcal/kg of dry matter (DM) and 3,127 Mcal/kg of DM for metabolisable energy (ME).

Table 1: Available energy values of canola meal (12% moisture basis for swine).

DE (kcal/kg)	3,154
ME (kcal/kg)	2,903
NE (kcal/kg)	1,821

Source: NRC, 2012

Amino acid digestibility

A key to using high levels of canola meal in swine diets is to balance them correctly for digestible amino acids. The digestibility of key amino acids in canola meal is lower than in soya bean meal. As a result, when canola meal replaces soya bean 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 only.

Diets in earlier feeding trials with canola meal were balanced to the same levels of crude protein, total essential amino acids and energy. However, a lower growth rate compared to soya bean meal-fed pigs was observed because levels of digestible lysine decreased as canola meal inclusion level in the diets increased.

Presently, swine diets are routinely formulated to levels of digestible amino acids rather than total amino acids. Recent feeding trials with canola meal in starter, grower and finisher pigs, in which the diets were balanced to the same levels of digestible lysine, resulted in a growth rate equivalent to what is typically found with soya bean meal as the primary protein source, even at very high inclusion levels of canola meal.

Enzyme addition

Enzyme addition is an avenue to increase the available energy in diets that include canola meal. Multicarbohydrase enzymes have been developed and used as a means to extract energy from the cell wall of non-starch polysaccharides. Sanjayan *et al.* (2014) included multi-carbohydrase enzymes in the diets of weaned pigs fed increasing inclusions of canola meal. Growth performance was not improved, but enzyme addition did increase apparent total tract digestibility (ATTD) of crude protein at 20 and 25% canola meal inclusion in experimental diets.

As with many oilseed meals, much of the phosphorus in canola meal is bound by phytic acid. Phytic acid reduces the availability of the phosphorus to between 25 and 30% of the total (NRC, 2012). It is common practice to add phytase enzyme to diets for pigs and poultry to improve the availability of phosphorus.

Akinmusire and Adeola (2009) determined that the digestibility of phosphorus in canola meal increases from 31 to 62% when phytase is included in the diet. One study (Gonzalez-Vega *et al.*, 2013) also demonstrated that the addition of phytase enzyme increased the availability of calcium in canola meal from 47 to 70%, while increasing phosphorus availability to 63%.

Glucosinolate tolerance

Glucosinolates are animal anti-nutritional factors found in canola meal for swine. In the initial years of feeding canola meal, the maximum level of glucosinolates that pigs can tolerate in the diet was defined by several researchers. In a review of earlier research, a maximum level of 2,5µmol/g of glucosinolates in pig diets was suggested (Bell,1993).

The maximum tolerable level of glucosinolates in swine diets remains of interest, and breeding efforts in canola have focussed on the further reduction of glucosinolates in canola seed. Current levels of glucosinolates are demonstrating few to no limitations for canola meal inclusion in grower-finisher diets.

Starting pigs (6 to 20kg)

Until recently, the most current available literature demonstrated reduced performance in young pigs fed canola meal at levels greater than 5% (Bourdon and Aumaltre, 1990; Lee and Hill, 1983). However, new research has brought to light a very different view on canola meal inclusion in the diets of weaned pigs.

> The relationship between ingredient cost and nutrient content will determine the appropriate level of inclusion of canola meal in well-formulated diets.

Landero *et al.* (2011) demonstrated that canola meal can be fed to weaned pigs, with an initial body weight of 8,1kg, at levels of up to 200g/kg without negatively impacting performance. This was demonstrated again in 2014 by Sanjayan *et al.*, where canola meal was included at 25% of the diet in weaned pigs (initial body weight of 7,26kg), with highly acceptable performance results after the first week of the trial. The main difference concerning these two studies when compared to earlier research, is that both research groups formulated diets based on NE and standardised ileal digestible (SID) amino acids.

Finishing pigs (20 to 100kg)

In the growing and finishing phases of pig growth, canola meal can be used at high dietary levels and will support excellent performance. An array of studies have shown that when diets are balanced for NE and SID amino acid levels, performance is the same as with soya bean meal with dietary inclusion levels of canola meal up to 25%.

The Canola Council of Canada sponsored a series of feeding trials with growing and finishing pigs in Canada, Mexico and the Philippines to demonstrate that balancing the diets to digestible amino acids will improve performance results. Smit *et al.* (2014b) fed grower-finisher pigs, with an initial weight of 29,9kg, five-phase diets containing varying levels of canola meal of up to 240g/kg, while also including 150g/kg of dried distillers' grains (DDG) with solubles in all diets.

Pigs fed 240g/kg versus those fed 60g/kg reached their market weight three days later, but showed no difference in carcass traits. Smit *et al.* (2014a) then fed growerfinisher pigs canola meal at up to 300g/kg. There was a slight reduction in performance and carcass traits between pigs fed 200g/kg and those fed 300g/kg, although feed efficiency was improved.

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 the reproductive performance of gilts through one litter.

Studies at the University of Alberta (Lewis *et al.*, 1978) have shown no difference in the reproductive performance of gilts through two reproductive cycles when fed diets containing up to 12% canola meal. More recently, levels of 20% canola meal did not affect the performance of lactating sows (King *et al.*, 2001).

The results suggest that canola meal may represent the main 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, however, producers are now accepting canola meal as an appropriate alternative supplemental dietary protein source for sows. Still, there is some unfounded concern over the daily feed intake of nursing sows fed canola meal-based diets. These concerns, however, are not supported by research.

Feeding canola expeller meal

Canola expeller meal is an excellent source of energy and protein in swine rations. Bran *et al.* (2001) studied the effects of adding canola expeller cake to the grower-finisher rations. The diets were composed of as much as 29,2% expeller meal. No effects on feed intake, feed conversion or live weight gain were found, indicating that the meal is an effective ingredient.

In 2012, Landero *et al.* fed increasing levels of expeller-pressed canola meal to young pigs one week post weaning, and determined that when diets were formulated to equal NE and SID values, expeller meal can replace soya bean meal at a level of 200g/kg. As is the case with other species, it is important to have the fat content of the meal analysed prior to formulation and the energy content assigned accordingly.

The fat content of expeller meals varies between and within sources, therefore the product should be routinely tested and the energy value adjusted accordingly. Woyengo *et al.* (2009) determined there was a DE of 4,107kcal/kg for expeller canola meal, with 12% fat on a DM basis. The energy content of the meal in kcal/kg can be calculated as DE = 2,464 + (%fat * 63), ME = 2,237 + (%fat * 62), and NE can be calculated using the following equation: 1,800 + (%fat * 70) = kcal/kg. For example, a meal with 10% fat would have an NE of 1,800 + (10 * 70) = 2,500kcal/kg. Woyengo *et al.* (2009) likewise assessed the SID of amino acids in expeller canola meal.

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, although 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 be effectively fed raw, although heat treatment may prove beneficial as long as excessive heat is not used during processing, which will reduce amino acid digestibility. A nutrient analysis should also be conducted on canola seed, as it may be seed that is unsuitable for canola processors.

Montoya and Leterme (2010) estimated an NE content of full-fat canola seeds of 3,56Mcal/kg (DM basis), but noted a possible underestimation due to a demonstrated reduction in feed intake and performance at dietary inclusion levels above 10% for growing pigs.

Practical inclusion levels

The recommended practical inclusion levels for canola meal in swine diets, together with the reasons, are given in *Table 2*.

Table 2: Recommended practical inclusion levels (%) of canola meal in pig diets.

Animal diet type	Inclusion level	Reasons for inclusion level
Pig starter	20	High performance results reported at 20% inclusion.
Hog grower/finisher	25	High performance results reported at 25% inclusion.
Sow lactation	20	No data available beyond 20% inclusion.
Sow gestation	–	No data available.
Boar breeders	–	No data available.

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