Oilseed Co-Products as Alternative Ingredients

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■ Take Home Messages

Who can afford to feed fat(s) to pigs now-a-days? With feed tallow, grease blends, and canola oil prices at record highs, oilseed and biodiesel co-products offer the only cost-effective alternative to supplementing dietary fats in swine diets. Cost per Mcal of residual oil content has changed our paradigm from considering canola as a traditional supplemental protein source to a novel dietary energy source. Expeller-pressed (~12% oil), extruded-pressed (~17% oil), and screw-pressed (> 20% oil) canola meal or cake, the latter two processed locally, offer opportunities to reduce producers' feed cost and beef up dietary energy.

There are also bright opportunities for feeding solvent-extracted canola meal. The recent pork crisis forced us to discover its potential to reduce feed cost by feeding it at unusually high inclusions. The glucosinolate content of commercially sourced canola meal is the lowest ever - so high dietary inclusion rates can be sustained with confidence. Yellow-seeded *Brassica juncea* has a thinner seed coat and therefore lower fibre content and likely a higher energy value than conventional, solvent-extracted, black-seeded *B. napus* canola meal.

■ Introduction

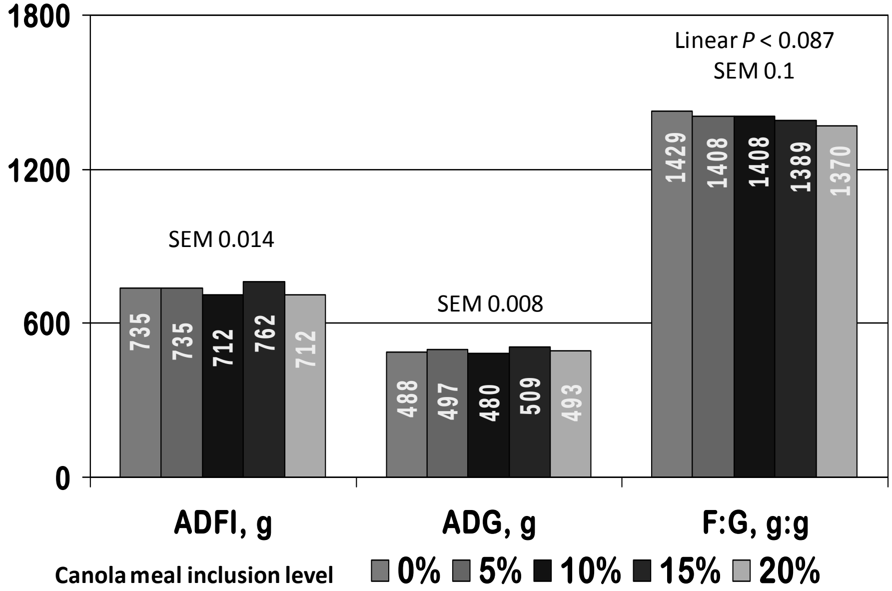
This paper summarizes recent research conducted feeding canola biodiesel co-products to pigs. Canola is Canada's most valuable crop contributing $14 billion to the economy and $5.6 billion in cash receipts to Canadian growers annually (Canola Council of Canada). The most common co-product is solvent-extracted canola meal. Solvent-extracted canola meal (2 to 3% oil) has been fed to livestock in Canada for decades as a supplemental protein source. But more recently we have seen an increase in the availability of canola co-products with higher residual oil content. Our interest in these co-products has shifted from supplemental dietary protein to energy sources. In the last decade we have seen expeller-pressed canola meal (~12% residual oil) become available. More recently, the development of the bio-diesel industry has led to the local production of extruded plus pressed (~17% residual oil) canola meal and screw-pressed (> 20% residual oil) canola cake both from smaller infrastructure plants. Residual oil content in these co-products has made them economically attractive given the escalating cost of traditional feed fats and the opportunity cost of cereal grain starch. Distillers dried grains with solubles (DDGS) is replacing cereal grains in diets at ever greater inclusion rates, but because these are depleted of starch, calories from residual oil from oilseed and biodiesel co-products are a welcome addition to monogastric animal diets.

■ Feeding Solvent-Extracted Canola Meal

Solvent-extracted canola meal has been fed to livestock in Canada for ~35 years. So what's new? The fact is that it has been fed to monogastric animals at conservative levels due to palatability, that affects feed intake, and fibre content, that limits its dietary energy value. Plant breeders have helped us overcome the first of these limitations by reducing total glucosinolate content over the years from ~120–150 in rapeseed to as low as 2 μmol/g, that we have tested recently in commercially-source meal. Formulating diets on the basis of net energy has helped us overcome the second limitation. Increasing feeding levels previously resulted in reduced animal performance as we did not account for greater heat production. Nearly in parallel, international marketing issues related to clubrot and salmonella claims, and increased crushing capacity in Saskatchewan, have placed downward pressure on the price of canola meal. These factors enticed us to push the limits of feeding solvent-extracted canola meal to reduce feed cost.

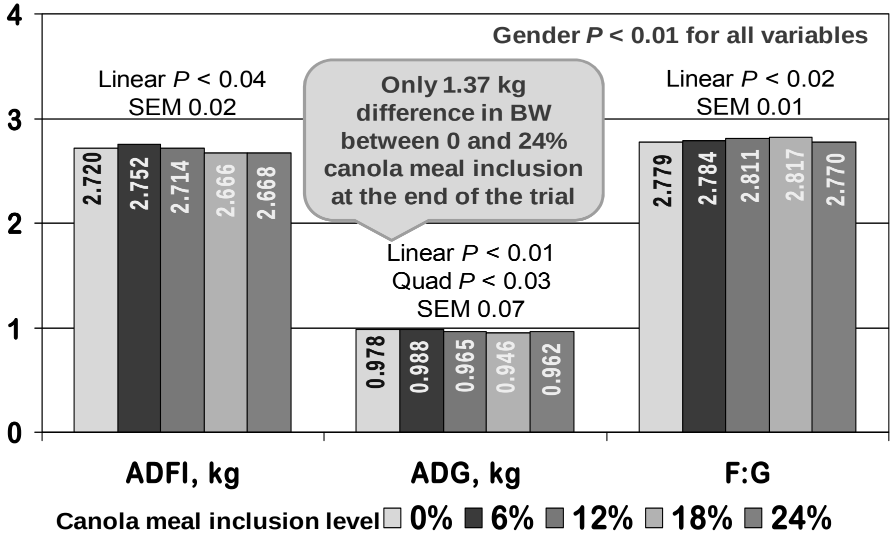
In a recent study at the University of Alberta (Landero et al., 2011a), feeding increasing levels of solvent-extracted canola meal in substitution for soybean meal was evaluated using 220 weaned pigs (8 kg). Five wheat-based diets containing 0, 5, 10, 15, or 20% of canola meal were fed for 4 wk starting 1 wk after weaning at 19 d of age. For d 0 to 28, increasing the dietary inclusion of canola meal did not affect average daily weigh gain (ADG), feed disappearance (ADFI; **Figure 1**), and pig weight at the end of the trial, but there was a trend towards reduced feed efficiency (F:G).

Figure 1. Growth performance of weaned pigs (d 0 to 28) fed diets with increasing level of solvent-extracted canola meal in substitution for soybean meal (Landero et al. 2011a)



We have also pushed the inclusion of solvent-extracted canola meal in hog diets containing DDGS (Seneviratne et al. 2011a). In a commercial-scale study at Lougheed, AB, 550 barrows and 550 gilts (30 kg) housed in 50 pens (22 barrows or gilts) were fed 5 dietary regimens over 5 growth phases. Canola meal (0, 6, 12, 18 or 24%) replaced field pea and soybean meal in diets with 15% wheat DDGS. Increasing dietary canola meal inclusion linearly reduced daily feed disappearance by 19 g for every 6% increase in canola meal inclusion (**Figure 2**). Increasing dietary canola meal inclusion in diets linearly reduced daily weight gain but only by 7 g for every 6% increase in canola meal inclusion. Increasing the level of canola meal inclusion in diets linearly increased feed:gain, but the effect was minor. Pigs fed 24% canola meal reached slaughter weight only 3 d later than pigs fed no canola meal. Increasing dietary canola meal inclusion in diets containing 15% wheat DDGS did not affect carcass weight, dressing percentage, backfat thickness, loin depth, estimated lean yield, or index.

Figure 2. Growth performance of 30kg hogs (d 0 to 90) fed increasing levels of solvent-extracted canola meal in diets containing 15% DDGS (Seneviratne et al. 2011a)

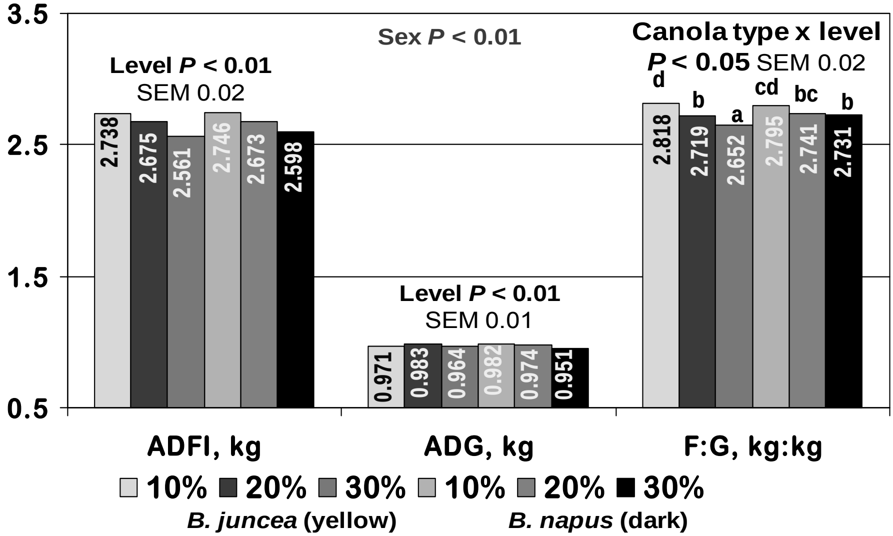


■ Feeding Yellow- vs. Dark-Seeded Canola Meal

Reducing the fibre content of solvent-extracted canola meal has been a priority for monogastric animal feeding. Compared to conventional dark-seeded (*Brassica napus*), yellow-seeded (*B. juncea*) canola meal has tested higher in protein (42% vs. 38%) and phosphorus content (1.4% vs. 1.0 %), but lower in crude fibre content (7.7% vs. 12%). Lower fibre in yellow-seeded canola is due to a thinner seed coat and would permit higher inclusions in practical diets compared to conventional canola meal and further reduce feed cost. Yellow-seeded canola meal does, however, contain higher glucosinolate content (> 10 vs. < 5µmol/g in dark-seeded meal), which is known to affect thyroid function in animals.

To confirm that yellow-seeded canola meal has a higher dietary energy value compared to conventional dark-seeded canola meal, we tested increasing levels of each meal on hog growth performance, dressing percentage and carcass characteristics (Seneviratne et al. 2011b). Both canolas were crushed and the oil solvent-extracted at Bunge (Altona, MB) using similar processing parameters. Barrows and gilts (550 of each, 33 kg) in Lougheed, AB were housed in 48 single-sex pens, 22 pigs per pen. Pigs were fed one of 6 dietary regimens consisting of yellow- or black-seeded canola meal at inclusion levels of 10, 20 or 30% through to market weight (120 kg).

Figure 3. Growth performance of hogs (d 0 to 84) fed increasing levels of yellow- or dark-seed, solvent-extracted canola meal (Seneviratne et al. 2011b)



Feeding increasing level of both types of canola meal reduced feed disappearance by 81 g/d and weight gain by 9 g/d for each 10% increase in canola meal inclusion (**Figure 3**). Feeding increasing level of canola meal, however, reduced feed:gain. And this improvement in feed efficiency was more pronounced for hogs fed the yellow-seeded meal compared to the dark-seeded meal (83 g vs. 32 g less feed per kg of gain for each 10% increase in canola meal inclusion). Final trial body weight was not affected either by canola type or dietary level of inclusion. The number of days on trial, however, increased by 1d for each 10% increase in canola meal inclusion. Increasing the dietary inclusion of either canola meal type reduced carcass weight by 0.46 kg, dressing percentage by 0.4 %-points and loin depth by 0.5 mm for each 10% increase in dietary inclusion. Backfat depth, lean yield and carcass index, however, were not affected by either canola meal type or inclusion level. Increasing dietary inclusion of both canola meal types increased cost per kg of weight gain. This cost increase occurred largely as a result of lower cost wheat DDGS being displaced in formulations as canola meal inclusion level increased. The increase in cost per kg of weight gain was greater for the dark-seeded compared to the yellow-seeded canola meal. Feeding up to 30% of either yellow- or dark-seeded canola meal is therefore feasible in commercial diets with high inclusions of wheat DDGS. Hog performance and carcass traits were adequate, providing evidence that canola meal and wheat DDGS together can make up 50% of commercial hog diets.

Conventional black-seeded canola is primarily grown in the fertile Black and Grey soils of the cool central and northern Prairies. Yellow-seeded canola (*B. juncea*), however, is more heat and drought tolerant, which makes it more suitable for production in the warmer, dryer, Brown and Dark Brown soil zones of the southern Prairies. Increasing canola acreage in these regions would further increase farm cash receipts, and increase the local supply of lower-fibre canola meal, which could help reduce feed cost for livestock producers.

Feeding Expeller-Pressed Canola Meal

Expeller-pressed canola meal contains more residual oil (~12%) than solvent-extracted canola meal (2-3%). It has become an attractive feedstuff in Manitoba due to the proximity to the Ste. Agathe Viterra plant. We have fed the meal from this plant (**Table 1**) in several experiments:

Table 1. Nutrient content of expeller- and extruded + pressed canola meal (93.5% DM)

Nutrient, %	Expeller-pressed[1]	Extruded + pressed[2]
Crude protein	35.27	29.86
Crude fat	12.63	17.31
ADF	15.93	22.58
NDF	19.98	28.09
Calcium	0.59	0.60
Phosphorus	1.03	0.82
Lysine	2.09	1.21
Avail. lysine	1.95	1.04
Methionine	0.68	0.55
TSAA	1.54	1.25
Threonine	1.51	1.17
Tryptophan	0.52	0.39

[1]Viterra Canola Processing, Ste. Agathe, MB
[2]Cansource Bioproducts, Mayerthorpe, AB

In a commercial trial at Lougheed, AB (Seneviratne et al. 2010), 1,100 pigs (25 kg) housed in 50 pens were fed 0, 7.5, 15, and 22.5% or decreasing amounts (22.5, 15, 7.5, and 0%, respectively) of expeller-pressed canola meal over 5 phases to market weight (120 kg). For d 51 to 90, the 22.5% expeller-pressed canola meal regimen was reduced to 18% (22.5/18%) because of decreased ADFI for phases 1 and 2. Overall (d 0 to 90), increasing dietary expeller-pressed canola meal inclusion linearly decreased daily weight gain, feed disappearance and feed:gain. Increasing the dietary inclusion of expeller-pressed canola meal did not affect carcass backfat thickness, loin depth, or jowl fatty acid profile. Pigs fed 22.5/18% expeller-pressed canola meal reached slaughter weight only 3 d later than pigs fed no expeller-pressed canola meal. We concluded that the amount of expeller-pressed canola meal included in hog diets should be targeted to an expected growth performance and carcass quality.

In a more recent experiment conducted at the University of Alberta (Landero et al. 2011b), feeding increasing levels of expeller-pressed canola meal (**Table 1**) in substitution for soybean meal, as an energy and amino acid source, were evaluated using 240 weaned pigs (7.3 kg). Five wheat-based diets containing 0, 5, 10, 15, or 20% expeller-pressed canola meal were fed for 4 wk starting 1 wk after weaning at 19 d of age. Increasing the dietary inclusion of expeller-pressed canola meal linearly reduced the digestibility of energy, dry matter, crude protein and the DE value of the diets. However, increasing the dietary inclusion of expeller-pressed canola meal did not affect daily weight gain, feed efficiency and pig weight at the end of the trial. As expected, feeding more dietary fat due to the residual oil content of the meal quadratically reduced feed disappearance. In conclusion, up to 20% expeller-pressed canola meal can replace soybean meal in late nursery diets without affecting growth performance.

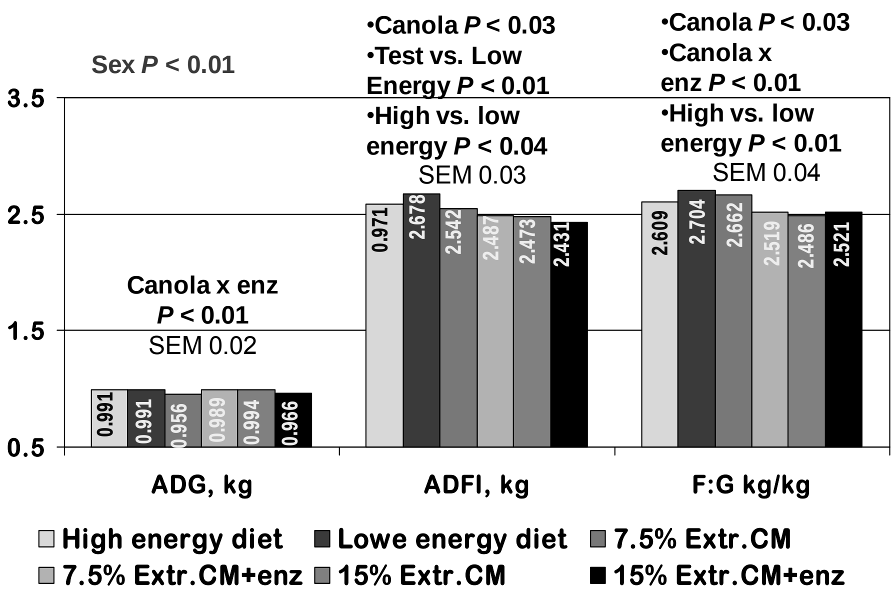
▪ Feeding Extruded and Pressed Canola Meal

Extruded and pressed canola meal contains even more residual oil (~17%) than expeller-pressed meal (~12%; **Table 1**) or solvent-extracted canola meal (2 to 3%). One must keep in mind that the processing focus of local plants is biodiesel, not meal quality and that sourcing lower quality seed (heated, green) affects meal variability from lot-to-lot over time, so test regularly.

In a commercial hog study conducted at Lougheed, AB (Young et al. 2011a) fed pigs (33.5 kg) low energy diets with 7.5 or 15% extruded-pressed canola meal (Cansourse Biofuels, Mayerthorpe) with or without an enzyme complex (Ronozyme VP™, DSM), and compared to pigs fed a high- or low-energy diet. The expectation was that the enzyme would uplift growth performance to that of the high energy diet. The diets were fed over 5 growth phases to market weight (120 kg).

Increasing the feeding level of extruded-press canola meal and enzyme interacted on overall daily weight gain (**Figure 4**). Enzyme increased weight gain at 7.5% extruded meal (+33 g), but decreased weight gain at 15% extruded meal level (-28 g). Increasing dietary meal level decreased overall feed disappearance (115 g/d for each 7.5% extruded meal). Increasing meal level and enzyme interacted on F:G for the overall trial. Enzyme complex increased F:G at 7.5% extruded-press canola meal (+22 g), but decreased F:G at 15% extruded-press canola meal level (-4 g). Feeding extruded+press canola meal to pigs reduced dressing percentage by 0.5 %-units. In conclusion, increasing the energy content of the diets including extruded+pressed canola meal reduced feed disappearance and dressing percentage, but improved feed conversion. Enzyme inclusion was sufficient at the 7.5%, but not at 15% extruded+pressed canola meal inclusion.

Figure 4. Growth performance (d 0 to 77) of hogs fed extruded and pressed canola meal at 7.5 or 15% inclusion with or without enzyme complex vs. a high- or a low-energy diet without enzyme.



▪ Feeding Green Canola Seed

Green canola is the immature seed that contains high levels of chlorophyll. Seed crushing removes the chlorophyll with the oil, but it imparts a greenish, darker colour to the oil that is costly to remove. Green seed is therefore a major discounting factor for canola grading and finding alternative markets for such seed is a challenge. Recently, there has been renewed interest in feeding green canola seed to livestock as it may help to reduce feed cost.

Gowans Feed Consulting recently finished a commercial scale trial (Young et al. 2011b). Eleven hundred hogs (33 kg) were fed 0, 5, 10, or 15% green canola seed (~90% green) or declining green seed level by growth phase to market weight (122 kg). For the overall trial (0 to 83 days), there were no effects of feeding green seed level on daily weight gain, feed disappearance, and feed:gain. However, there was a trend for feed conversion to be better for the pigs fed the control diet compared to those fed green canola seed. Pigs fed 5% green canola seed were heavier on day 83 than controls or those fed declining seed inclusions by phase. Days from first to last pig marketed averaged 23.5 days and were greater only for the hogs fed the maximum 15% green canola seed. Dressing percent was also lower for hogs fed 15% green canola seed, compared to controls, those fed 5% throughout, or fed declining green seed inclusions by phase. Backfat thickness, loin depth, calculated lean yield and index were not different among dietary regimens. Feed cost was higher for hogs fed the control regimen and decreased as green canola seed level increased being lowest at 15% green canola seed inclusion. These results indicated that other than a correctable drop in dressing percentage at high inclusions (≥ 10%), feeding up to 15% green canola seed resulted in reasonable hog performance and carcass traits and can be an alternative channel for marketing green seed that otherwise would be discounted for food oil.

▪ Conclusions and Implications

Differential cost per Mcal NE of residual oil content (**Table 2**) can be used as a guideline to decide the “best buy” among canola co-products to reduce feed cost. The more costly that feed oil and tallow become, the greater the buying opportunities. But co-product variability, due to antinutritional factors, local processing, and seed quality (green, heated,) can become issues that we have come to take for granted when feeding conventional solvent-extracted canola meal.

Table 2. Differential cost[1] per Mcal NE[2] of residual oil content of canola co-products and animal tallow

	Solv.-ext. meal	Expl.-press meal	Extr.-press meal	Scr.-press cake	Green seed	Canola oil
Expl.-press meal	0.82					
Extr.-press meal	0.72	0.88				
Scr.-press cake	1.05	1.28	1.46			
Green seed	0.87	1.07	1.22	0.83		
Canola oil	1.45	1.77	2.03	1.38	1.66	
Tallow	1.26	1.55	1.77	1.21	1.45	0.87

[1]Solvent-extracted canola meal $225, expeller-pressed canola meal $250, extruded-pressed canola meal $230, screw-pressed canola cake $400, green (20%) canola seed $400, canola oil $1000, tallow $800 per 1000 kg
[2]Solvent-extracted canola meal 1.75, expeller-pressed canola meal 2.38, extruded-pressed canola meal 2.50, screw-pressed canola cake 2.97, green (20%) canola seed 3.57, canola oil 5.36, tallow 4.92 Mcal NE/kg

Inclusion of oilseed meal or co-products with residual oil content return the most when fed to pigs during the energy-dependent phase of growth (late nursery and grower phase). But would likely affect fat deposition and hardness if fed to finisher hogs plus would nullify the feed cost saving brought about by feeding lower energy feedstuffs (e.g., barley, distillers dried grains with solubles) as hogs approach market weight. Nonetheless, these provide opportunities to tailor fatty acid enrichment of pork (e.g., camelina, flax) to value-add pork products.

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