CANOLA MEAL IN POULTRY DIETS

Canola meal is used in all types of poultry feeds. However, because of its relatively low energy value for poultry, it tends to be economically favoured in egg layer and turkey feeds rather than in high energy broiler feeds. Also, some feed users have expressed biases against using canola meal in poultry feeds due to health and performance problems that they have experienced, including hemorrhagic liver in egg layers, small egg size, leg problems in broilers, reduced feed intake and reduced growth rate. This negative view of canola meal is undeserved since virtually all of these problems can be eliminated, or at least managed effectively, once a few key points in the areas of amino acid digestibility, glucosinolate effects and dietary mineral balance are understood.

Amino Acid Availability

A key to using high levels of canola meal in poultry feeds 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) as shown in Table 1.

Table 1 **Poultry true 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	79	91
Methionine	90	92
Cystine	73	84
Threonine	78	88
Tryptophan	82	88

These differences in amino acid digestibility can be significant in practical feed formulation and, at high canola meal inclusion levels in feed, if not allowed for could result in a 5 to 10% decrease in bird performance (growth rate). The issue of the lower amino acid digestibility in canola meal compared to soybean meal is not as relevant today as it was previously. Since the early 1990's most feed users around the world have been balancing diets on the basis of digestible rather than total amino acid levels.

Enzymes

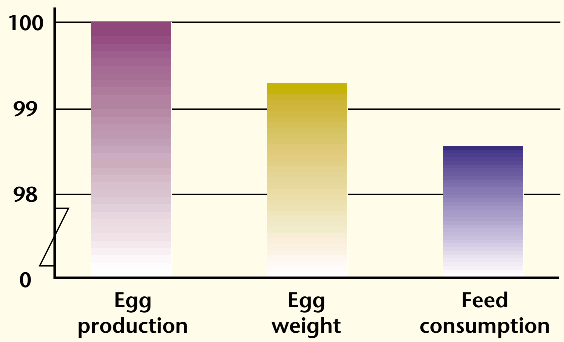
Several researchers have used dietary enzymes in attempts to increase protein, phosphorus and carbohydrate digestibility in canola meal (Kocher et al., 2000; Simbaya et al., 1996; Slominski and Campbell, 1990). In these studies, enzyme use has resulted in moderate increases in canola meal nutrient digestibility, especially in soluble NSP digestibility, but these improvements have not been accompanied by increased bird performance. Practically, the use of dietary enzymes is very common in poultry feeds, especially those containing barley and wheat. These same enzyme cocktails are almost certainly increasing the nutrient digestibility of canola meal when it is included in these feeds, although it is currently difficult to quantify the canola meal digestibility improvement and, therefore, adjust nutrient values appropriately.

Layers

Canola meal is a commonly used and economically effective feed ingredient in commercial layer diets. Various studies have looked at the effects of canola meal on egg production and associated parameters over the entire production cycle (Kiiskinen, 1989; Nasser et al., 1985; Robblee et al., 1986). The results from these studies were pooled and shown in Figure 1. Canola meal supports high levels of egg production and has no effect on the number of eggs produced. Feed intake and egg size also show no significant difference when canola meal is fed although there is a small numerical decrease in both when canola meal is added to the diet. A negative effect of canola meal on feed intake and egg size has been noted in short-term studies with young layers (Summers et al., 1988a, b). These researchers speculated that the decrease in egg size is due to a decrease in energy intake. The reason for the decreased feed intake is unknown but it is thought that the phytic acid in canola meal may reduce calcium availability and in turn decrease feed intake (Summers et al., 1988b).

FIGURE 1 **Effect of including canola meal in layer diets on full cycle egg production, egg weight and feed consumption per bird***

**Pooled results of Kiiskinen, 1989; Nasser et.al., 1985; Robblee et.al., 1986; expressed as percentage of control diet. Average canola meal inclusion level was 10%.*



Some caution is indicated in using canola meal in layer diets. There is an association between a low level of liver hemorrhage mortality and feeding canola meal to egg layers. Butler et al. (1982) showed that the deaths are associated with hepatocyte degeneration, abnormalities in the biliary system and leakage of cellular enzymes into the plasma. The causative agent is unknown, but a lower incidence is found at lower levels of dietary glucosinolates. It is a difficult problem to study because it is coincident with fatty liver syndrome, which can be influenced by many factors. A study by Campbell and Slominski (1991) is interesting because they were able to effectively isolate the glucosinolate effect. They fed different cultivars of canola meal, varying in glucosinolate content, at a level of 25% in wheat and barley based diets. The results show a linear increase in liver hemorrhage mortality with increasing glucosinolates up to a plateau (Table 2). There was no effect on egg production or feed consumption. Thyroid weight increased with increasing glucosinolates as did liver glutathione content. The increase in glutathione activity may be due to an induction of liver detoxification mechanisms.

TABLE 2 **Effect of dietary glucosinolates on layer performance and liver hemorrhage mortality for 196 days (Campbell and Slominski, 1991)**

Diet	Glucosinolates µmoles/g	Egg Production %	Liver hemorrhage mortality %	Thyroid wt. mg/100 g BW
1	0.00	87.7	0.0	9.5
2	0.19	87.0	0.0	9.6
3	0.71	85.9	0.7	9.5
4	1.43	87.5	1.3	11.7
5	2.08	88.7	2.0	13.2
6	2.84	87.1	2.6	15.8
7	3.46	87.2	2.6	15.7
8	3.84	84.0	2.6	19.2

The relationship between dietary glucosinolates and liver hemorrhage mortality in layers is apparently inconsistent. Martland et al., (1984) were not able to show a clear relationship between dietary glucosinolate content and liver hemorrhage. Campbell and Slominski (1999) in a follow-up to the 1991 study, did not observe any liver hemorrhage mortality even at canola meal dietary inclusion levels of 25% (3.0 µmoles/g of glucosinolates in the diet). Furthermore, recent studies (Trappett, 2001; Roth-Maier, 1999) using canola meal at up to 20% inclusion levels in layer diets have demonstrated excellent hen performance with regard to egg production and feed conversion efficiency. On balance, some caution is advised and it is therefore recommended that a maximum of 10% canola meal be added to layer diets with the provision that higher inclusion levels (15 or 20%) could reasonably be tried. It should also be noted that since glucosinolate levels in canola meal continue to decrease through breeding, the future prospects for higher canola meal inclusion levels in layer diets are good.

An interesting effect of canola meal and rapeseed meal on brown-shelled layers is the incidence of fishy flavour in the eggs (Butler et al., 1982). Brown shelled layers apparently produce lower levels of trimethylamine oxidase than white leghorns. Therefore, trimethylamine cannot be metabolized and instead passes into the yolk, imparting a fishy flavour. Canola and rapeseed are susceptible because they have higher levels of choline and sinapine (precursors of trimethylamine) than other ingredients. As well, goitrin and tannins inhibit the enzyme. Consequently, in North America, a limit of 3% canola meal or rapeseed meal should be used in brown-shelled layer diets. In some other countries, higher levels are used (5% or higher) because high levels of fishmeal have been historically used in feeds, and the consumer is accustomed to fishy tasting eggs.

Breeding Chickens

Canola meal has no negative effects on egg fertility or hatchability for leghorn breeders (Kiiskinen, 1989; Nasser et al., 1985). The results of the first study are shown in Table 3. The average weight of the day old chick decreased with increasing canola meal and the weight of the thyroid gland of one-week old chicks is higher with increasing canola meal levels. The decrease in chick weight did not result in impairment of productive function of the chicks during their subsequent egg production. Due to the effect on egg and chick weight, many feed manufacturers do not use canola meal, or limit it to low inclusion levels in poultry breeder feeds.

TABLE 3 Effect of canola meal in breeder diets on egg fertility and hatchability and chick quality. (Kiiskinen et al., 1989)

Measurement	Control	Canola 5%	Canola 10%
Egg production, %	79.5	79.8	80.3
Egg weight, g	58.9	58.2	57.7
Fertility, %	95.9	94.4	94.0
Hatchability, %	86.8	88.8	87.8
Live chicks/365 d	242	244	242
Chick weight, g	40.1	38.5	37.5
Thyroid wt, mg/100g BW	7.53	8.30	8.97

Broiler Chickens

The remaining low levels of glucosinolates in canola meal do not have any effect on broiler mortality, unlike the situation with layers. However, in Western Canada, canola meal is only used to a limited extent in broiler feeds. Normally, the lower energy in canola meal compared to other protein sources such as soybean meal economically limits its use in high energy broiler feeds. In least cost wheat and barley based diets, canola meal is normally used at less than 10% due to its lower energy level. In corn based feeds, the economical inclusion level of canola meal is higher.

It has been known for a long time that feeding rapeseed meal (high glucosinolate) to broilers results in a high incidence of leg problems, especially tibial dischondroplasia. The leg problems have been alleviated somewhat, but not completely, by feeding canola meal. This indicates that glucosinolates were partially but not entirely responsible. Summers et al. (1990, 1992) showed that the situation is related more to sulphur levels (a component of glucosinolates) rather than to the toxic effect of glucosinolates themselves. They noted that feeding organic sulphur, in the form of cystine, caused a higher incidence of leg problems. It is well known that sulphur interferes with calcium absorption. Supplementing with extra calcium helps to a certain extent, but care is advised since too much dietary calcium will depress feed intake. Further work by Summers and Bedford (1994) showed that the problem is further complicated by the electrolyte balance, or more accurately the cation-anion balance in canola meal diets. Canola meal contains less potassium (1.2%) than soybean meal (1.9%), so that the electrolyte balance level is lower in a canola meal compared to a soybean meal based diet. Further, when total cation-anion balance is considered, the higher sulphur and phosphorus levels in canola meal result in an even lower positive balance of dietary cations. The authors showed that feed intake in broilers is positively correlated with cation-anion balance. This suggests that the commonly observed decrease in feed intake when including canola meal in broiler feeds is related to cation and anion levels in the diet. This further suggests that increasing levels of dietary cations will correct the problem. Attempts to do this by adding extra calcium carbonate have had marginal success, probably due to the feed intake depressing effects of calcium. It would likely be preferable to add potassium bicarbonate to the diet since this corrects the problem at its source.

One final point of concern about feeding canola meal to broiler chickens is related to the processing of the chicken itself. Canola seed hulls are present in canola meal, and these concave particles have a tendency to stick to the inside of the digestive tract. If the GI tract is torn during processing, then the black canola hulls can stick to the carcass causing it to be downgraded. The solution, common in industry, is to exclude canola meal from the feed during the last five days before market. This is usually accomplished by not including canola meal in the coccidiostat withdrawal finisher feed.

Turkeys

A study by Waibel et al. (1992) demonstrated that canola meal is an excellent protein source for growing turkeys. Indeed it is common commercial practice to feed high levels of canola meal to growing and finishing turkeys. The Waibel study is interesting because the results illustrate the importance of balancing rations appropriately when substituting protein sources. When canola meal was added at 20% of the diet without maintaining equal energy and essential amino acid levels, growth and feed conversion efficiency was decreased. However, when extra animal fat was added and amino acid levels kept constant, performance was equal to or superior to the control diet.

Ducks and Geese

Canola meal is commonly fed to ducks and geese and there are no issues in addition to feeding other types of poultry. In fact, geese have a greater digestive capability than other types of poultry and appear to digest canola meal more efficiently (Jamroz et al., 1992).

Feeding Canola Seed and Oil

Canola oil is routinely fed as an energy source for broiler chickens. In addition to its energy value, it is a good source of linoleic acid. Broiler starter diets that are based on barley or wheat instead of corn can be deficient in linoleic acid – especially when the other dietary fat sources are saturated, for example tallow. In these situations, it is common to add 1.0 to 1.5% canola oil to the diet.

Full fat canola, after heat treatment and particle size reduction, is a mainstay protein and energy ingredient in broiler feeds in some countries – Denmark for example.

Canola Meal Maximum Inclusion Levels

The recommended maximum inclusion levels, together with the reasons why, for canola meal usage in poultry diets are listed in Table 4. These are cautious recommendations, but based on appropriate feed formulation techniques – accounting for amino acid digestibility and cation-anion balance. Higher canola meal inclusion levels may be warranted if economically attractive.

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

Animal diet type	Max inclusion level	Reasons for maximum inclusion level
Chick starter	5	
Broiler grower	15	Cation-anion balance
Turkey grower	20	
Egg layer	10	Hemorrhagic liver-glucosinolates
Breeder	5	Smaller egg size and chick weight
Duck and goose	15	

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