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Review: New Findings Regarding the Feeding Value of Canola Meal for Dairy Cows

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Abstract

In the last decade, a considerable amount of new research has been conducted regarding the feeding value of canola meal, and its importance as a feed ingredient to the dairy industry. This review provides updated nutrient profiles, new information on protein degradation in the rumen, as well as feeding trial findings. This information will direct feed formulators to sources of information that will allow them to make accurate assessments of the feeding of canola meal to dairy cows.

Introduction

Canola is Canada's most valuable crop. It differs from its parent crop, rapeseed, by having much lower levels of erucic acid and glucosinolates [1].The oil is highly valued as cooking oil, and the residual meal is used in diets for ruminants, swine, poultry and a number of fish species. Together with rapeseed meal, canola meal is the second most widely traced vegetable protein in the world.

Quality of the meal can be either enhanced or diminished by altering processing conditions. Minimum processing temperatures are required to deactivate the myrosinase enzyme, which, if not destroyed, will break down glucosinolates into toxic metabolites in the animal's digestive tract [2]. The heat generated during processing additionally destroys 30–70% of glucosinolates in the meal [1]. However, if temperatures are too high for too long, then the protein quality of the meal can decrease. In Canada, major processors have very similar processing conditions, and canola meal quality does not vary to any large extent [3].

Typical Composition

Recently, the Canola Council of Canada commissioned a survey of the 12 Canadian meal processing plants. Samples were obtained 3 times per year for 4 consecutive years, beginning in 2011 [4]. Proximate results are from this study are provided in Table 1.

Component	Average
Crude Protein (CP), %	41.7
Lysine, % of CP	5.92
Methionine, % of CP	1.94
Histidine, % of CP	3.39
Acid Detergent Fiber, %	18.4
Neutral Detergent Fiber, %	28.8
Lignin, %	5.8
Fat, %	3.75
Linolieic Acid, %	0.76
Linolenic Acid, %	0.37
Erucic Acid, %	0.05
Calcium, %	0.74
Phosphorus, %	1.13
Glucosinolates, uMol/g	4.2

Table 1: Typical Chemical Composition of Canola Meal (DM Basis)[4].

Although the protein content of the meal is lower than some other vegetable protein meals available to the livestock industry, canola meal makes up for the lower protein with a superior amino acid profile. Canola meal is particularly well endowed with the sulfur amino acids methionine and cysteine (1.94 and 2.37% of crude protein). Schingoethe [5] found that canola meal's amino acid profile more closely matched the amino acid requirements for milk than other vegetable proteins, and canola meal was given the highest milk protein score.

Fiber concentrations are higher in canola meal than many other vegetable proteins, averaging 18.4 and 28.8% acid detergent fiber and neutral detergent fiber, respectively (dry matter basis) with a fairly high lignin content. Much of the non-structural carbohydrate is composed of sucrose [4].The fat content of canola meal averages 3.75% of the dry matter of the meal. Generally gums (phospholipids) extracted from the refined oil are added to the meal, and that contributes to the relatively high fat content [5]. As Table 1 further shows, canola meal is an excellent source of phosphorus. Like many vegetable proteins, the phosphorus in canola meal is largely in the form of phytic acid. This form is available to ruminants, as rumen bacteria rapidly degrade phytic acid to release the elemental phosphorus [6].

New Values for Rumen Undegraded Protein

In the past, soluble protein was assumed to be largely degraded in the rumen. Because a large portion of the protein in canola meal is soluble, it was considered to be a better source of rumen degraded protein (RDP) than rumen undegraded protein (RUP). Newer research has clearly demonstrated that a portion of soluble protein from feed ingredients remains undegraded, and that this varies with the protein source. For canola meal, the undegraded soluble fraction is high.

Hedqvist and Udén [7] first revealed that portions of the soluble-protein fraction were not degraded in the rumen for some vegetable proteins. This has been confirmed at other institutions [8-10]. The extent of degradation of the soluble fraction for canola meal and rapeseed meal was shown to average only 40% of the total, with the undegraded contributing to the RUP fraction.

Even more relevant to the feeding value of canola meal are comparisons of RUP values between canola meal and soybean meal. Hedqvist and Udén [7] reported RUP values for canola (rapeseed) meal of 56.0%, compared with 27.0% for soybean meal. Maxin et al [11] calculated similar RUP values for canola meal (52.5%) but somewhat higher values for soybean meal (41.5%).

This new insight into the rumen metabolism of protein has allowed diets to be formulated with lower concentrations of protein. Canola meal has been particularly advantageous when diets are formulated on the basis of amino acids.

Meta Analyses of Feeding Value

Since 2011, there has been three meta analyses conducted comparing canola meal with other vegetable proteins in diets for lactating dairy cows. These studies support the fact that the RUP value of the meal is high, and that canola meal has a unique amino acid profile that readily supports milk protein production.

Huhtanen et al. [12] published results from 122 studies where supplemental protein was supplied by either soybean meal or canola meal. In all cases, the added protein replaced grain and the forages were kept constant. The analysis revealed that for each kg increase in crude protein consumed, milk production increased by 3.4 kg with canola meal and 2.1 kg with soybean meal. The researchers concluded that canola meal was generally undervalued when compared to soybean meal.

Using somewhat different data selection criteria, Martineau et al. [13] compared the effects of replacing vegetable proteins in the diet with the same amount of protein from canola meal. At the average inclusion level (2.3 kg per day) of canola meal, milk yield increased by 1.4 kg across the 49 studies used in the analysis.

In the most recent evaluation, Martineau et al. [14] compared the response in plasma amino acids to changes in the protein source in the diet. Essential amino acids were higher and milk urea nitrogen (MUN) was lower when cows received canola meal compared to all other sources of protein. These differences indeed reflect the importance of the amino acid profile of canola meal as it relates to the needs of the lactating dairy cow.

New Feeding Studies

In North America, soybean meal is readily available and widely accepted as an excellent protein source for dairy cows. Many new feeding studies have been conducted comparing canola meal with soybean meal as sources of protein for high producing dairy cows.

Brito and Broderick [15] formulated diets to 16.5% crude protein found that cows produced 40.0 kg of milk with 3.09% butterfat with the soybean meal control diet. Cows produced 41.1 kg pf milk with 3.14% butterfat with the canola meal diet. There were no differences in body weight gain, milk urea nitrogen, feed efficiency, or efficiency of protein use for milk synthesis between these two diets. In a continuation of the same study, Brito et al.[16] determined that there were no differences in rumen microbial protein synthesis between these two sources of protein. Abomasal flow of methionine, lysine and histidine averaged 68, 194 and 62 g/cow/day with the soybean-based diet, and 74, 201 and 68 g/cow/day with the diet containing canola meal.

In another study conducted at the same research station [17], researchers provided lactating cows with diets containing either 14.7% or 16.5% crude protein, with the supplemental protein provided by either soybean meal or canola meal. They concluded that replacing soybean meal with canola meal resulted in higher dry matter intakes (24.1 as compared to 23.7 kg/cow/day) and higher milk yields (38.5 Vs. 27.4 kg/cow/day). MUN and urinary nitrogen excretion were lower when cows received canola meal than when they were given soybean meal as the supplemental protein source.

Swedish researchers [18] provided cows with diets that contained 0, 7.0, 14.0 or 21.0% canola meal, displacing an equivalent amount of protein from soybean meal. Milk yield, protein yield and nitrogen efficiency were all improved with canola meal relative to soybean meal. Methane emissions per unit of energy corrected milk were lower when cows received canola meal than when they were given soybean meal.

The recent surge in production of ethanol from feed grains has resulted in large quantities of distillers' dried grains with solubles (DDGS) becoming widely available to the feed industry in many parts of the world. Although protein concentrations are high, the amino acid profile of corn DDGS is poor, resulting in formulation difficulties, and often the need for supplemental rumen protected amino acids.

Two studies have shown that canola meal can be effectively used in combination with DDGS to restore amino acid balance and maximize lactational performance [19,20]. In both studies, mixtures of 66% canola meal and 34% corn DDGS improved performance compared to canola alone, or corn DDGS alone. Blends of canola meal and wheat DDGS have also been demonstrated to support high levels of milk production [21,22] and provide an improved amino acid profile.

Conclusions

New feeding values have been determined for the RUP and amino acid composition of canola meal. Taking advantage of this newer information will allow formulating nutritionists to use this ingredient with confidence when there are economic opportunities to do so.

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