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Review Article

A Point on Nutritive Value of Camelina Meal for Broilers: A Review

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ABSTRACT

Camelina *sativa* which is known as false flax of the *Brassicaceae* family is an alternative oilseed crop. Special fatty acid composition of camelina oil is of paramount significance. The ratio of unsaturated fatty acids, especially omega-3 fatty acids, to saturated ones is distinctively high compared to most common vegetable oils such as soybean, sunflower and rapeseed. Camelina meal is a by-product of biodiesel production process and could be used as an alternative feedstuff in poultry nutrition. With the inclusion of camelina meal into broiler diets, omega-3 fatty acids level in poultry meat and meat quality might increase. The review summarized that nutritive value such as fatty acid composition and antinutritional factors of camelina meal and its effects on performance and meat quality of broilers. This data shows beneficial effect of camelina *meal* in the production of broilers and some interesting functional aspects that might be interesting for nutritionists and the poultry companies.

Key words: Broiler, Camelina meal, Meat quality, Performance, Poultry

INTRODUCTION

Poultry meat is a major source of animal protein considering that consumers` preferences for its' nutrient composition, convenient cooking and relatively low price. Polyunsaturated fatty acids are found abundantly in poultry meat and these fatty acids, especially omega-3 fatty acids such as linolenic acid, are considered as beneficial for human health. Omega-3 fatty acids must be obtained from the diet (11, 14). Bond *et al*., 1997 indicated that the omega-3 content of poultry meat may be increased by this fatty acid content of broiler diets.

Polyunsaturated fatty acids exist in poultry meat. These fatty acids, especially omega-3 fatty acids such as linoleic acids are not synthesized in human body. Therefore, omega-3 fatty acids must be present in human diets (Cunnane *et al*., 1995; Grashorn, 2007). Broiler meat would be an omega-3 source for humans and trials are underway to enrich its' omega-3 fatty acid content. The important point of the strategy that is enrichment of poultry meats with omega-3 through dietary application would be occurred without affecting broiler performance traits (Ajuyah *et al*., 1991; Aziza *et al*., 2010a). Studies have reported that the gastrointestinal system can influence the efficiency of omega-3 deposition in poultry and a new protein sources such as camelina meal moderated the gastro intestinal tract structure as well as increment of duodenum fatty acid concentration (Nain *et al*., 2012; Aziza *et al.,* 2014). Additionally, Aziza *et al*. (2014) reported that weight gain of broilers fed with camelina meal increased compared to control.

Camelina sativa, which is known as "false flax" or "German sesame" of the *Brassicaceae* family, contains high concentrations of linolenic acid, and is an important alternative oilseed crop. Camelina meal, native to Europe and to Asian areas, is a by-product that biodiesel production process and could be used as an alternative omega-3 fatty acid providing feedstuff to poultry diets (Putnam *et al*., 1993; Zubr, 1997). It is well known that there is an increasing interest for using by products from the industry for the valuable sources with peculiarities of nutritional (Schieber *et al*., 2001). Camelina meal has had more attention because of a low input crop of its and there is no feed application like biodiesel (Budin *et al*., 1995; Zubr, 1997). Camelina meal includes some anti-nutritional factors and understanding the composition of these compounds in the meal is important to use it at the appropriate levels in the diet. Additionally, it is rich in

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antioxidant compounds and tocopherols that are important in meat quality (Aziza *et al*., 2010a; Quezada and Cherian, 2012).

The aim of this paper was to examine the nutrient value of camelina meal, effects on poultry meat quality and its potential use as an ingredient in poultry diets.

Chemical components

Camelina meal, by-product of biofuel production, has been investigated in order to ascertain its' nutritive value as a feedstuff. Nutrient composition of camelina meal ranges depending on the many different variables. Camelina meal's nutritive values ranges between 23,46-37.2% for crude protein, 4.9-18.5% for oil, 4.9-9.9% for fiber and 4.16-5.1 MCal/kg for gross energy (Putnam *et al*., 1993; Budin *et al*., 1995; Cunnane *et al*., 1995; Bond *et al*., 1997; Matthäus, 1997; Acamovic *et al*., 1999; Matthäus and Angelini, 2005; Cherian *et al*., 2009; Pekel *et al*., 2009; Aziza *et al*., 2010a; Aziza *et al*., 2010a; Moriel *et al*., 2011; Nain *et al*., 2012; Puzio *et al*., 2012; Thacker and Widyaratne, 2012; Ayasan, 2014). Nutrient composition of camelina meal is provided in Table 1.

Amino acids

As a protein source amino acid composition of camelina meal has also been investigated in order to ascertain its biological value. Despite having similar crude protein levels, lysine and sulphur containing amino acid level camelina meal is lower than those of the canola meal. On proportional basis sulphur containing amino acid level of camelina meal is higher than the sulphur containing amino acid level of soybean meal. However, lysine proportion in the soybean meal is higher than the camelina meal's lysine proportion (Thacker and Widyaratne, 2012). Table 2 shows the essential amino acid composition of camelina meal (Pekel *et al*., 2009).

Fatty acids

Fatty acid composition of the camelina meal is unique in terms of its essential fatty acid content. High levels of the unsaturated and essential fatty acids in the camelina meal make it different from most of feedstuffs. Compared to soybean meal and canola meal, proportion of α-linoleic and gadoleic acid in camelina meal is higher (Thacker and Widyaratne, 2012). Oil extract of camelina meal contains 29.6% α-linoleic acid, 23.4% linoleic acid and 32.7% total monounsaturated fatty acids. The fatty acid composition of camelina meal showed in Table 3 (Cherian *et al*., 2009).

Antinutritional factors in camelina meal

As a member of *Brassiacaceae* family, camelina seeds are also expected to contain antinutritive compounds such as glucosinolates and sinapine. It has been suggested that concentration of antinutritional compounds in the seed is associated with the genotype of the plant. Glucosinolate level in camelina seeds from different genotypes ranges between 15.2 and 24.6 mmol/kg (Puzio *et al*., 2012). Aziza *et al*. (2010b) also reported similar level of glucosinolate level (24.4 mmol/kg) for camelina meal as well. However, another study indicated (Table 4) higher level (34.4 mmol/kg) of glucosinolate for the camelina meal (Thacker and Widyaratne, 2012). It has been suggested that camelina meal contains higher concentration of glucosinolates than the seed itself. While seeds of camelina contains 9-19 mmol/kg of glucosinolates, camelina meal produced from the same type of seeds contains 14.5-23.4 mmol/kg glucosinolate (Matthäus and Zubr, 2000).

Sinapine has been detected in the different plants which belong to *Brassicaceae* family (Matthäus, 1997). Sinapine is the component which imparts bitter taste to oilseeds. Camelina seeds contain 4 mg/g sinapin (Matthäus and Angelini, 2005). Sinapin content of camelina meal has also been investigated and very different results (1.7-4.2 mg/g) have been reported depending on the location and growing season of the seed which is used for oil extraction (Matthäus and Angelini, 2005).

Condensed tannin level in camelina meal is lower than the seed itself and reported between 1.0-2.4 mg/g depending on the sample (Matthäus and Zubr, 2000). Camelina oil contains 2-4% erucic acid which is higher than the level in canola oil (Putnam *et al*., 1993). Camelina meal would compete to soybean meal in animal feed, because its glucosinolate level is lower than the other species in Brassicaceae family and it contains very small amount of volatile isothiocyanates (Pilgeram *et al*., 2007).

It is reported that camelina meal would be incorporated into the broiler diets only up to 10% by FDA (The Food and Drog Administration, 2009) because of antinutritional substances its oil contains (Ayasan, 2014).

Effects of camelina meal on broiler performance

Studies have revealed that inclusion of camelina meal into broiler feed at the level of 10-20% have a negative impact on the performance (Ajuyah *et al*., 1991). Georgeta *et al*., (2007) studied the effects of camelina seed inclusion into the finisher diets of broilers on performance. They reported that camelina seed has no impact on feed conversion and live performance and reduced the level of carcass fat while increasing total protein. Camelina seed oil and conjugated linoleic acid can be substituted for sunflower oil with a positive effect on the performance and increased femur, humerus and tibia weights in broilers (Jaśkiewicz *et al*., 2010; Puzio *et al*., 2012).

Effect of camelina meal on broiler performance has been also studied by many researchers (Pekel *et al*., 2009; Aziza *et al*., 2010b; Quezada and Cherian, 2012; Aziza *et al*. 2014). Camelina meal constituted 10% of the diet at the expense of soybean meal. Live weight of birds fed on camelina meal was reported to be lower than the birds fed without camelina meal. Reduced feed consumption was reported for the broilers which had 10% camelina meal in their diets (Pekel *et al*., 2009).

Aziza *et al*. (2010b) has reported lower feed efficiency with the inclusion of camelina meal in the broiler diet during the first 21 days of the trial. However, feed efficiency in the grower period (22 - 42 days) was higher in the birds which were fed with camelina meal. Reduction in the body weight gain of the birds have manifested itself at the 2,5% inclusion rate of camelina meal in the diet and effect remained constant up to 10% level.

Table 1: Chemical composition of camelina meal

Parameters	Min.	Max.	Mean
DM, %	88.00	92.02	90.01
CP, %	23.46	37.20	30.33
Oil, %	4.90	18.50	11.70
Ash , %	5.67	7.01	6.34
Fiber, %	4.90	9.90	7.40
Gross Energy (MJ/kg)	4.16	5.10	4.63

DM= Dry Matter; CP= Crude Protein

Table 2: Essential amino acid composition of camelina meal

Essential amino acids	Amount (% of protein)
Arginine	2.86
Histidine	0.83
Isoleucine	1.25
Leucine	2.20
Lysine	1.59
Methionine	0.59
Phenylalanine	1.44
Threonine	1.34
Valine	1.75

Table 3: Fatty acid composition of camelina meal

Fatty acids	Amount (% of ether extract)
Palmitic (16:0)	9.00
Palmitoleic (16:1)	0.20
Stearic (18:0)	2.50
Oleic acid (18:1)	20.20
Linoleic (18:2n-6)	23.40
α-Linolenic (18:3n-3)	29.60
Eicosenoic (20:1)	10.10
Eicosadienoic (20:2)	1.40
Eicosatrienoic (20:3)	1.20
Erucic (22:1)	1.70

Table 4: Glucosinolate level in camelina meal

Items	Amount (mmol/kg)
9-(methyl-sulfinyl) nonyl (glucoarabin)	9.04
10-(methyl-sulfinyl) decyl (glucocamelinin)	21.59
11-(methyl-sulfinyl) undecyl	3.80
Total glucosinolates	34.43

Ryhanen *et al*. (2007) reported a retarded growth in broilers fed with camelina meal. Study has also shown that inclusion of camelina meal to the diet decreased feed intake during the early stage of growth (1-14 days). Feed efficiency was reduced in the broilers fed with diets which contain camelina meal. Aziza *et al*. (2014) also reported that the final (at 42 day) body weight and total feed intake (0-42 day) of broilers did not changed by the inclusion of camelina meal in their diets. However, they addressed that the camelina meal may have an effect on gut physiology and biochemistry due to increment in long chain omega-3 fatty acids storage in the duodenum. It seems that use of camelina meal up to 10% in the broiler diets is viable so it would be evaluated as an alternative feedstuff.

Effects of camelina meal on broilers meat quality

Inclusion of camelina meal in the poultry diets has been investigated in order to ascertain its possible effects on different meat characteristics (Aziza *et al*., 2010a; Aziza *et al*., 2010b). It has been reported that the addition of camelina meal into broiler diets at the level of 10% increased the antioxidant capacity of breast and thigh meat. Tocopherol level of the thigh meat has also been increased with the inclusion of camelina meal. However, same tendency for tocopherol level was not observed in the breast meat. There was not any change in the meat's phenolic compounds concentration with the inclusion of camelina meal.

Use of camelina meal in the broiler diets did not change the fat content of breast or thigh muscle (Aziza *et al*., 2010a). However, some effects on the fatty acid composition of the meat have been observed. Concentration of α-Linolenic acid in the breast meat, thigh meat and liver has been increased with the addition of camelina meal into diet. Ratio of omega-6 : omega-3 in muscles were significantly reduced because of the increased omega-3 level in the muscles.

Ryhanen *et al*. (2007) reported that inclusion of different levels of camelina meal in broiler diet has linearly increased omega-3 fatty acid concentrations in the broiler meat. This result confirm the findings of other studies (Aziza *et al*., 2010a; Aziza *et al*., 2010b). Saturated fatty acids level in the meat has been reduced with the inclusion of 10% camelina meal to diet. Erucic acid content of the broiler meat was low in the broilers fed with camelina meal so meat produced from those animals is safe for human consumption. However, gondoic acid content of the meat has been increased with the usage of camelina meal in diets.

Studies on the fatty acid composition in broilers have shown that incorporation of camelina meal into broiler diets has enhanced the omega-3 fatty acid content of the broiler meat. This finding reveals that camelina meal would help to produce a functional broiler meat via animal nutrition. Besides, camelina meal increases the antioxidant capacity of broiler meat which can be a functional food in human nutrition.

Conclusion

Global consumption of the broiler meat has been increased drastically in the last decade. Broiler meat producers seek new raw feed materials in order to reduce their production costs. A by-product of biofuel production, *Camelina sativa* meal, could be incorporate into broiler diets as a low cost alternative feed compound. However, studies on its nutrient availability in broilers need to be done. Further studies on the assessment of individual amino acid availability of camelina meal would provide more information to nutritionist formulating broiler diets. Besides, use of camelina meal in broiler diets would change the nutritional composition of broiler meat. Studies show that inclusion of camelina meal to broiler diets would increase omega-3 fatty acid and γ-tocopherol content of the meat. Camelina meal would have a potential to produce functional meat production. It has been shown that camelina meal in broiler diets reduce the lipid oxidation products in the meat. It has been suggested that glucosinolate content of camelina meal have a detrimental effect on the performance of broilers. Glucosinolate concentration in the meal has been measured in a very broad range depending on the location and the genotype of the product. So it would be beneficial to carry out researches in order to reduce anti-nutritional compound content of the seed by selecting suitable genotypes. Reduction in the level of anti-nutrient content of the camelina meal might increase its value as a feedstuff in broiler nutrition.

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