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Effect of Feeding Canola Cake as A replacement for Mustard Cake on Milk Production Efficiency in Lactating Crossbred Cows

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ABSTRACT

The study was carried out to evaluate the effect of feeding canola cake on the lactation performance of 14 lactating crossbred cows. The cows were randomly divided into two treatments seven each and allocated in two dietary supplements containing mustard cake and canola cake, respectively as a major protein source for a period of120 days. The daily intake of DM and OM by lactating crossbred cows did not differ significantly (P>0.05) irrespective of the dietary treatments. The digestibility coefficient (%) of DM, OM, CP, EE and NDF was not also significantly (P<0.05) different. However, the digestibility of ADF was found to be significantly (P<0.05) higher in canola cake concentrate as compared to mustard cake concentrate. The daily dry matter intake (DMI) expressed as (kg/d) or per kg live weight (% LW) and the nutrient intake (kg/d) of composite diets in terms of DCPI and TDNI did not differ significantly (P>0.05) irrespective of dietary treatments by lactating crossbred cows. Feeding of mustard cake based supplement to cows resulted in numerically decreased daily milk yield, 4% FCM (kg/d), fat and protein yield (g/d) and total milk production (kg), as compared to canola cake fed cows. The efficiency of milk production was also numerically better in canola cake group as compared to mustard cake group. Canola cake was found to be cost effective. Hence, it may be concluded that mustard cake can be replaced completely by canola cake as a protein source without compromising the lactation performance of lactating crossbred cows.

Introduction:

Despite the presence of large and diverse animal genetic resources, the productivity of livestock remains low in many developing countries where India is no exception. In tropical countries oilseed cakes are used as the major protein sources in the ruminant ration. Canola and mustard cakes are commonly used in animal feeds around the world. Rapeseed is a member of the cabbage family (Brassicaceae) grown in cold regions usually unsuitable for growing soybean and

cottonseed, such as Northern Europe, China, India, Canada, and higher and colder areas of South America. The term "canola" (Canadian oil low acid) was coined in order to differentiate canola from rapeseed. Canola contains approximately 42-43% oil, which is extracted for use as a premium edible vegetable oil. The remaining canola cake is a widely used protein source in animal feeds. During the 1980's, significant changes were made to rapeseed through breeding programs to produce canola (CCC, 2009).

Canola cake is widely used in feed for dairy cattle and is considered to be premium ingredient due to its high palatability and the high quality of its protein for milk production. Canola cake provides an important contribution to both rumen microbial protein needs and to the digestible amino acids required for animal growth and lactation. In a summary of 24 research trials with canola cake, the mean milk production response was plus 1 kg/d when compared to diets containing cottonseed cake or soybean cake. Canola cake is an excellent source of histidine, methionine, cysteine and threonine. The abundance of these amino acids and the extent to which they supplement amino acids from other protein sources may in part, explain the consistent milk yield response found when canola cake is included in dairy cow rations (Yildiz and Todorov, 2014).

Inclusion of canola cake as protein supplement in the ration of lactating cows was found to be adequate without any adverse effect on lactation (Emanuelson *et al*., 1993). However, information is scanty in India on the effect of feeding canola cake to lactating crossbred cows. The studies with respect to the effect of the dairy cow performance and other parameters when fed on a ration consisting of a concentrate mixture formulated by replacing mustard cake (which is predominantly used by Indian farmers for formulating concentrate mixture) with canola cake are lacking. Keeping this in view, the present study was undertaken to ascertain the relative value of canola cake as protein supplement substituting traditional mustard cake on milk production performance in lactating crossbred cows.

Materials and Methods:

Animals and diet

Fourteen freshly calved lactating crossbred cows (Karen Fries) in their first parity with average milk yield of 14.43±1.09 kg/d and with a mean live weight of 366.74±9.32 kg were selected and randomly divided in to two homogeneous group (seven in each group) on the basis of milk production and body weight. They were randomly allocated into two dietary supplements, canola cake and mustard cake concentrates mixture, respectively as a major protein source (Table 1).All the cows had a common nutritional and management exposure at Livestock Production Management Division, Livestock Research Center of NDRI, Kernal prior to the experiment. The amount of concentrate mixture and green fodder was adjusted fortnightly as per the milk yield of each animal.

Table (1) Ingredients and chemical composition of feeds fed to lactating crossbred cows

Attributes	Concentrate mixture		Green oat	Straw
	Mustard cake	Canola cake		
Ingredients (%)				
Maize grain (Yellow/Red)	28	28	-	-
Groundnut cake	19	19	-	-

Mustard cake	14	-	-	-
Canola cake	-	14	-	-
Cotton seed (whole)	4	4	-	-
De-oiled Rice bran	8	8	-	-
Wheat bran (coarse)	20	20	-	-
Barley	2	2	-	-
By-pass fat (Prill)	2	2	-	-
Min. Mixture (BIS)	2	2	-	-
Common salt	1	1	-	-
Chemical composition (% DM basis)				
DM	90.25	90.69	17.50	90.30
OM	95.05	94.89	90.40	89.70
CP	21.59	21.86	12.80	3.20
EE	6.27	6.04	2.70	1.20
ADF	12.43	8.97	28.70	49.20
NDF	24.89	20.27	52.10	76.20
Ash	4.95	5.11	9.60	10.30

Experimental procedure:

The animals were penned under asbestos roofing and well ventilated stall having facilities for individual feeding with free access to fresh water and allowed exercise out-doors in an adjacent dry paddock daily. Healthy surroundings and proper sanitary conditions were maintained throughout the experimental period. During this period, mangers, floor and walls were cleaned regularly, so as to keep the cows free from any infection. An adaptation period of 15 days before the start of experimental feeding was given to both groups of cows and at the end of the experimental feeding a follow up period of 15 days was included.

The animals were fed as per the feeding schedule followed at NDRI, ICAR for optimum milk production. The concentrate mixture was formulated by replacing the mustard cake (14 parts) with the same amount of canola cake. The rest of the ingredients of the concentrate mixtures remained the same. However, soybean was not included in the concentrate ration, instead whole cotton seed was used to substitute the soybean meal.

Green fodder was provided ad-lib and concentrate and wheat straw was offered at 5 kg/day and 2 kg/day, respectively. The main green fodder was chopped oat (*Avena sativa*). Feed was offered in two instalments, 8:00 AM and 3:00 PM for a period of 120 days.

Daily milk yield of individual cow was recorded morning, noon and evening as per NDRI milking practice, while milk samples of morning and evening were obtained on fortnightly

interval for the analysis of milk components viz. fat, protein, lactose and solids not fat. Each time 50 ml milk sample was collected in plastic bottles after uniformly mixing of milk of each cow.
A digestion trial was conducted towards the mid of the feeding experiment for seven days during which daily feed intake and fecal outputs from individual cows were recorded. Suitable sub-samples of faeces were collected daily from each cow and preserved with 25% sulphuric acid for nitrogen estimation. Another sub-sample of the daily faecal output was dried at 100±5^{o}C for 24 h in a forced-draft oven for the estimation of dry matter content. Samples of the dried feeds, refusals and faeces were pooled over 7 days and preserved in airtight polythene bags for further chemical analysis.

Chemical and statistical analysis:

Samples of feeds, faeces and residues were milled to pass through a 1.0 mm sieve and analyzed for their proximate constituents (AOAC, 1995). The fiber fractions, NDF and ADF were estimated as per Van Soest *et al*. (1991). Milk samples were analyzed for milk fat, protein, SNF and lactose as per standard of AOAC (2005) by automatic milk analyzer (Lactostar).
The results obtained of all experimental data were analyzed to test for significance differences between means of variables of diets using the t-test, as described by Snedecor and Cochran (1989).Significance of treatments with respect to different characters was declared at $P<0.05$.

Results and Discussion:

Chemical composition of feeds

The proximate composition of green oats and wheat straw used in the experiment was comparable to the values reported by earlier researchers (Ganie, 2014; Sachin, 2012).The values of crude protein (CP) and total ash (TA) content were numerically higher in canola cake while organic matter (OM), ether extract (EE), crude fiber (CF), acid detergent fiber (ADF) and neutral detergent fiber (NDF) were higher in mustard cake as compared to canola cake similar as reported by earlier researchers (Newkirk, 2009; Tayo *et al*., 2011). In the present study the CP content of canola cake which was found to be 37.04% is in line with the trading rule setup by Canadian Oilseed Processors Association (COPA) in 1999, which stated that canola meal on as-fed basis should contain minimum of 34% CP and 2% EE. The concentrate mixtures of the two experimental groups were also analyzed for proximate composition and fiber fractions and the data obtained is presented in (Table 2). However, the experimental concentrate mixtures were iso-nitrogenous.

Feed intake and its digestibility:

The daily dry matter intake (DMI) expressed as (kg/d)or per kg live weight (% LW) by lactating crossbred cows did not differ significantly ($P>0.05$) among the dietary treatments (12.46+0.13 in T I, mustard cake group and 12.52+0.08 in T II, canola cake group). Present results are in agreement with the findings of Tayo *et al*. (2011) and Sharma *et al*. (1977)who reported no adverse effect on DM intake by lactating cows given concentrate mixtures containing canola quality rapeseed meal (0-0) or commercial HG variety at 25% level. Though the values were statistically non-significant ($P>0.05$), a numerical increase in DMI in T II group, was attributed to an increase in palatability of canola cake. Similarly, Sanchez and Claypool (1983) observed that feeding of canola meal in the concentrate mixture at 26% level did not reveal any negative effect on concentrate intake by lactating cows and can be included in supplements at 20-30% level with no risk of feed refusal (Mawson *et al*.,1993).The DMI showed an increasing trend in the two groups as the lactation period progressed. This was due to the increased milk production

which increased the nutrient demands for high milk output. After peak period DMI also showed a decreasing trend due to lesser nutrient demand for lower milk production.

Table (2) Effect of feeding canola cake as replacement for mustard cake on intake and utilization of nutrients by lactating crossbred cows

Attributes	Treatments		P value
	Mustard cake	Canola cake	
Intake (kg)			
Dry matter (kg/d)	12.46±0.13	12.52±0.08	0.505
Dry matter (g/kgW$^{0.75}$)	144.22±3.40	156.33±4.37	0.471
Dry matter (% LW)	3.26±0.10	3.63±0.13	0.439
Digestibility coefficient (%)			
Dry matter	67.15±1.15	68.27±0.82	0.26
Organic matter	69.41±0.91	70.41±0.76	0.504
Crude protein	71.48±1.90	72.11±0.99	0.106
Ether extract	82.11±1.72	72.28±1.51	0.883
Neutral detergent fiber	53.31±1.87	52.56±2.11	0.896
Acid detergent fiber	42.16^{a}±2.46	44.36^{b}±1.37	0.024
Nutrient digestibility (%)			
DCP	11.09±0.30	11.35±0.16	0.132
TDN	67.71±1.08	68.08+0.67	0.298
Nutrient intake (kg/d)			
DCPI	1.38±0.05	1.42±0.02	0.123
TDNI	8.44±0.20	8.52±0.10	0.132

The digestibility coefficient of DM, OM, CP, EE and NDF did not differ significantly ($P<0.05$) irrespective of dietary treatments. The results indicate that difference in the level of GLS intake did not adversely affect nutrient digestibility, this is in agreement with earlier reports (Kumar *et al*., 2002; Ravichandiran *et al*., 2008). Similarly, this is in line with the digestibility coefficients of DM, OM, CP and NDF of cows fed canola, mustard and soybean meal which did not differ significantly (Tayo *et al*., 2011). However, the digestibility of ADF was found to be significantly ($P<0.05$) higher in canola cake concentrate as compared to mustard cake concentrate. This result corroborates with the data of Sharma *et al*. (2007) who showed that 36% canola vs 42% mustard cake in the concentrate affected digestion of ADF in growing cross bred calves.

Nutritive value and plane of nutrition:

The average DMI per kg milk yield was 1.09+0.09 and 1.01+0.10 in TI and T II, respectively. Similarly, DMI kg, CPI g and TDNI kg per kg milk was1.09+0.09, 165.92+14.25 and 0.74+0.06 for T I and 1.01+0.10, 155.35+15.88 and 0.69+0.07 for T II, respectively which was not statistically influenced by the two diets. However, the DMI kg, CPI g and TDNI kg per kg milk yield was 7.34%, 6.37% and 6.67% less in canola cake compared to mustard cake. Similarly DMI, CPI and TDNI per kg 4% FCM were also similar among the two treatments which corroborates the findings of Tayo *et al*. (2011) where no significant (P>0.05) variation was recorded for nutrient intake (g/kg $W^{0.75}$) of composite diets in terms of DCP and TDN of lactating cows. The observations recorded during the present study are also in conformity with the earlier reports indicating no adverse effect of inclusion of mustard cake or canola cake on nutrient intake and utilization by cows (Sanchez and Claypool, 1983; *Claypool et al*., 1985; Depeters and Bath, 1986).The study undertaken by Pailan and Singhal (2006) also indicated that dietary glucosinolate through mustard cake affect the palatability of diet, without any adverse effect on nutrient utilization in lactating goats.

Lactation performance:

The average daily milk yield (kg/d) was 11.92±1.03 for T I and 12.98±1.01 for T II, where T II was numerically higher by 1.06 kg/d as compared to T I. The average 4% FCM (kg/d) was 11.71+0.94 for T I and 12.83+0.98 for T II, where the values for TII were numerically higher by 1.21 kg/d than TI with no significant difference. This result corroborates with Emanuelson *et al*. (1993) and Kratochvil and Kohout (1995), who did not indicate any adverse effect in the feeding of low glucosinolate or high glucosinolate containing rapeseed meal on daily milk yield in lactating cows. However, many workers compared the effects of feeding canola quality meal either with soybean meal or cottonseed meal and reported higher average milk yield (4%) in canola ration than the control (Vincent and Hill, 1988; MacLean and Laarveld, 1991).

Table (3). Effect of feeding canola cake as replacement for mustard cake on milk yield and composition by lactating crossbred cows

Attributes	Treatments		P value
	Mustard cake	Canola cake	
Milk yield (kg/d)			
Whole milk	11.92±1.03	12.98±1.01	0.907
4% FCM	11.71+0.94	12.83+0.98	0.944
Fat yield (g/d)	0.47±0.03	0.51±0.04	0.867
Protein yield (g/d)	0.40+0.04	0.44+0.04	0.844
EMP (kg DMI/kg milk)	1.09+0.09	1.01+0.10	0.772
EMP (kg DMI/kg FCM)	1.11+0.09	1.02+0.10	0.922
Total milk yield (kg)	1251.9±107.77	1362.6±105.92	0.907
Milk composition (%)			

Fat	3.95+0.07	3.97+0.03	0.214
Protein	3.38+0.04	3.40+0.02	0.238
Lactose	4.57+0.03	4.70+0.04	0.511
SNF	9.30+0.09	9.41+0.15	0.501

In a summary of 21 research trials with canola meal, the mean milk production response was +1.0 kg/d when compared to soybean meal. Recent research with cows producing 40 kg/d (Brito and Broderick, 2007) clearly indicates that, even at high levels of production, canola is still a superior protein supplement when compared with soybean or cottonseed meal. Improved milk production that is observed (Brito and Broderick, 2007; Brito *et al*., 2007) with rapeseed meal is attributed to the amino acid profile in the bypass fraction of rapeseed meal being complementary to microbial protein (Brito *et al*., 2007).In the present study, lower milk yield in mustard cake group may be attributed to relatively lower intake of DM, CP and TDN as compared to cows given canola cake supplement.

The fat and protein yield (g/d) as well as milk fat and protein contents (%) did not differ significantly (P>0.05) irrespective of dietary treatments. Similarly, the efficiency of milk production (kg DMI/kg milk yield and kg DMI/kg 4% FCM) by crossbred lactating cows was also non-significant. However, canola cake was numerically efficient as compared to mustard cake. This result is in line with Tayo *et al*. (2011) where milk fat and protein contents did not differ significantly irrespective of dietary treatments in lactating cows.

Cost of feeding:

The cost of per kg mustard cake and canola cake supplements was found to be ~Rs 19.21 and 22.71 per kg, respectively. The cost of canola cake based supplement (~Rs/kg) was higher by ~Rs.0.49/- per kg relative to mustard cake based concentrates. The cost of green fodder (~Rs 1.5/kg) and cost of straw (~Rs 4/kg) remained the same for all the groups.

The cost of feed intake for 105 days varied in the two groups due to variation in feed intake. Based on the DM consumption from each component of diet, the cost of feed per liter milk production (~Rs/kg) was worked out to be ~Rs. 13.84 and 13.01 in mustard cake and canola cake groups, respectively. The minor difference in the cost of milk production is an indication of difference in per kg milk produced in this trial. The cost of daily milk production may be reduced by ~Rs.0.83/- per kg milk. This can be supported by Tayo *et al*. (2011) where the cost of daily milk production was reduced by ~Rs.0.37/- per kg milk by feeding canola meal as compared to soybean meal and mustard cake, where the cost of per kg soybean meal, mustard cake and canola meal supplements was found to be ~Rs 12.7, 12.1 and 12.0, respectively.

Conclusion:

From the present study it may be concluded that the replacement of mustard cake with canola cake in the ration of lactating cross bred cows during early lactation was cost effective. Hence, mustard cake can be replaced completely by canola cake as a protein source without compromising the lactation performance of lactating crossbred cows.

References:

1.AOAC. (1995). Official Methods of Analysis, 16th ed. Association of Official Analytical Chemists, Washington, DC.

2.AOAC, (2005). Association of Official Analytical Chemists, 16th ed. pp. 4.1 – 4.17. Association of Official Analytical Chemists, Washington DC, USA.
3.Brito, A. F., and G. A. Broderick. (2007). Effects of different protein supplements on milk production and nutrient utilization in lactating dairy cows. *J. Dairy Sci.* 90:1816-1827.
***4.*Brito, A. F., Broderick, G. A. and S.M. Reynal, (2007).** Effects of different protein supplements on omasal nutrient flow and microbial protein synthesis in lactating dairy cows. *J. Dairy Sci. 90:1828-1841.*
***5.*CCC (2009).** Canola Standards and regulations. *Vol. 2013. Canola Council of Canada, http://www.canola-council.org/ind_definition.aspx.*
***6.*Claypool, D.W., C.H. Hoffman, J.E. Oldfield and H.P. Adams. (1985).** Canola meal, cottonseed and soybean meals as protein supplements for calves. *J. Dairy Sci. 68:67-70.*
***7.*DePeters, E.J. and D.L. Bath. (1986)**. Canola meal versus cottonseed meal as a protein supplement in dairy rations. *J. Dairy Sci. 69:148-154.*
8.Emanuelson, M., K.A. Ahllin and H. Wiktorsson.(1993). Long-term feeding of rapeseed meal and full-fat rapeseed of double low cultivars to dairy cows. Livestock. Prodn. Sci. 33:199-214.
9.Ganie, A.A. (2014). Evaluation of whole and expeller processed cotton seed in lactating cross bred cows. Ph.D. Thesis. National dairy Research Institute, Karnal, India.
10. Kratochvil, L., Kohout, V., (1995) Influence of extracted rapeseed oil meal on the composition of cows' milk. Nutr. Abstr. Rev. (B) 65, 263 (abstract).
11. Kumar, G.K.A., Panwar, V.S., Yadav, K.R. and Sihag, S. (2002). Mustard cake as a source of dietary protein for growing lambs. Small Ruminant Research, 44: 47–51.
12. McClean, C. and B. Laarveld. (1991). Effect of somatotropin and protein supplement on thyroid function of dairy cattle. Can. *J. Anim. Sci.* 71:1053-1061.
13. Mawson, R., Heany, R.K., Zdunczyk, Z. and Kozlowska, H. (1993). Rapeseed meal-glucosinolates and their antinutritional effects. Part II. Flavor and palatability. Die Nahrung, 37: 336-344.
14. Newkirk, R. W., (2009). "Canola Meal: Feed Industry Guide." Canadian Canola Council, Canada.
15. Pailan, G.H. and Singhal, K.K. (2007). Effect of dietary glucosinolates on nutrient utilization, milk yield and blood constituents of lactating goats. Small Ruminant Research, 71: 31-37.
***16.* Ravichandiran, S., Sharma, K., Dutta, N., Pattanaik, A.K., Chauhan J.S. and Agnihotri, A. (2008).** Comparative assessment of soybean meal with high and low glucosinolate rapeseed-mustard cake as protein supplement on performance of growing crossbred calves. *Journal of the Science of Food and Agriculture, 88: 832-838.*
17. Sachin, G. (2012). Effect of raw or full fat soybeanseeds as a partial replacement of ground nut cake in lactating cows. M.V.Sc. Thesis. National Dairy Research Institute, Karnal, India.
18. Sanchez, J.M. and D.W. Claypool. (1983). Canola meal as a protein supplement in dairy rations. *J. Dairy Sci.* 66:80-85.
19. Sharma, K., Dutta, N., Patra, A.K., Singh, M., Pattanaik, A.K., Ravichandiran, S., Chauhan, J.S., Agnihotri, A. and Kumar, A. (2007). Effect of replacing soybean meal with Indian canola quality or high glucosinolate rapeseed-mustard meal on performance of growing crossbred calves. Livestock Research for Rural Development, 19(10) 2007 http://www.llrrd.org/lrrd19//10/shar19142.htm

20. Snedecor, G.W. and Cochran, W.G. (1989). Statistical methods. 8th ed. Iowa State University Press, Ames, Iowa, USA.
21. Tayo, T., Dutta, N., Sharma, K., Pattanaik, A.K. Singh, A., Narang, A. and Kumar, A. (2012). Effect of feeding canola quality meal on the performance of lactating cows. Animal Nutrition and Feed Technology, 12: 373-381.
22. **Van Soest, P.J., Robertson, J.B. and Lewis, B.A. (1991).** Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science, 74: 3583-3597.*
23. Vincent, I.C. and R. Hill. (1988). Low glucosinolate rapeseed meal as a protein source for milk production. Anim. Prod. 46:505.
24. Yildiz, E. and N. Todorov, (2014). The comparison of the main protein sources for dairy cows. A review. Bulg. *J. Agric. Sci.*, 20: 428-446.