Haryana Vet. (Dec., 2014) **53 (2)**, 92-95

Research Article

EFFECT OF FEEDING LINSEED AND LINSEED MEAL ON MILK PRODUCTION AND FATTY ACIDS PROFILE OF MILK FAT IN SAHIWAL COWS

B.S. TEWATIA*, V.S. PANWAR and D.S. DAHIYA
Department of Animal Nutrition, College of Veterinary Sciences
Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125 004, India

Received: 06.06.2014; Accepted: 16.10.2014

ABSTRACT

Fifteen Sahiwal cows in early lactation were divided into three groups of five animals each to ascertain the effect of feeding linseed and linseed meal for 60 days on fatty acids profile of milk fat. Concentrate mixture of the treatment T_1 comprised of linseed meal (30 kg), barley (27 kg), maize (40 kg), mineral mixture (2 kg) and common salt (1 kg). In treatment T_2, linseed meal was replaced by 20 kg de-oiled groundnut cake along with 10 kg whole linseed while in T_3 treatment linseed meal was replaced by 20 kg de-oiled groundnut cake along with 10 kg ground linseed. Dry matter intake as well as its digestibility was similar in all the treatments. However, highest crude protein digestibility was recorded in T_3 (69.8) followed by T_1 (66.1) and T_2 (62.5). Similarly, significantly higher digestibility of ether extract was recorded in T_3 (77.3) followed by T_1 (72.8) and T_2 (69.4). The total and 4% fat corrected milk yields did not differ among treatments. Milk fat content decreased by 6.1% in treatment T_3 as compared to treatment T_2. Milk urea N concentration (mg/dl) was significantly higher in T_3 (36.54) than T_2 (18.66). Milk cholesterol decreased by 49.9% and 33.8% in T_2 and T_3, respectively than T_1. Total conjugated linoleic acid (CLA's) content in milk fat significantly increased by 82.3% in T_3 as compared to T_1. Concentration of saturated fatty acids as percent of total fatty acid was the lowest (61.7%) in T_3 followed by T_2 (63.2%) and T_1 (70.8%). Results of this study indicated that ground linseed was very effective in decreasing the level of saturated fatty acids and total cholesterol besides increasing total CLA's of milk fat.

Key words: Sahiwal cows, linseed, milk yield, milk fatty acids

The saturated fatty acids present in milk and meat are considered to produce negative effects, whereas unsaturated fatty acids have potential positive effects on human health (Parodi, 2005). In addition, conjugated linoleic acid (CLA) in ruminant milk has anti-carcinogenic and anti-atherogenic properties (Huth *et al*., 2006). Ruminant milk fat content and its fatty acids composition can be modified by supplementation of the dietary fat to make it nutritionally more desirable (Shingfield *et al*., 2008). Linseed is an excellent source of n-3 fatty acids. Feeding linseed to dairy cows contributes to dietary n-3 fatty acids, increases CLA content and decreases the saturated fatty acids (SFA) content of milk (Chilliard *et al*., 2007). Considering these facts in view, the present study was undertaken to investigate the effects of feeding linseed meal and linseed whole or ground on the fatty acids profile of milk fat in dairy cows.

MATERIALS AND METHODS

Fifteen Sahiwal cows (with average body weight of 364 kg) in their 2nd - 3rd lactation were selected on the basis of milk production and lactation days from the Animal Farm of the University. These animals were divided into three groups (T_1, T_2 and T_3) of five animals each and were fed wheat straw, green maize and concentrate mixture as per requirements (Kearl, 1982). Concentrate mixture of the treatment T_1 comprised of linseed meal (30 kg), barley (27 kg), maize (40 kg), mineral mixture (2 kg) and common salt (1 kg). To maintain same level of linseed oil (2% of DM intake) in all the treatments, linseed meal was replaced with 20 kg de-oiled groundnut cake along with 10 kg whole linseed in concentrate mixture of treatment T_2 while linseed meal was replaced with 20 kg de-oiled groundnut cake along with 10 kg ground linseed in concentrate mixture of treatment T_3. All the animals were housed in semi open sheds having facilities for individual feeding and watering. Animals were milked twice a day during the experimental period of 60 days. A digestion trial of five days was conducted at the end of the experimental period. Samples of feed offered, residue left and faeces were analyzed for proximate principles (AOAC, 1995) and cell wall constituents (Goering and Van Soest, 1970).

Milk samples (125g) were taken from each animal in milk sample bottles at weekly intervals. Samples were thoroughly mixed and analyzed for fat by

*Corresponding author: bstewatia44@gmail.com

an electronic milkometer, protein by Micro-Kjeldhal method (AOAC, 1995), total solids, total ash and lactose (Folin and Wu, 1920). Fat for the estimation of fatty acids was extracted from fresh milk as per ISI (1967). Cholesterol content of milk fat was determined as per the procedure described by Bindal and Jain (1973). For estimation of fatty acids profile of milk fat, methyl esters of milk fat were prepared according to the method described by Luddy *et al.* (1968). Fatty acids analysis was carried out using gas liquid chromatography fitted with flame ionization detector (FID; Systronics). Total CLA content in milk fat was determined following the AOAC protocol (1995). Statistical analysis of the data was carried out as described by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The chemical composition of the dietary ingredients i.e. wheat straw, green fodder and different concentrate mixtures is presented in Table 1. Crude protein (CP) content of concentrate mixture in T_1, T_2 and T_3 treatments was 17.95, 18.15 and 18.08%, respectively. The respective values for ether extract were 6.78, 6.82 and 6.85, respectively. Dry matter intake (DMI) kg/d and kg/100 kg b. wt. were similar in all the treatments. No adverse effect of feeding linseed meal and linseed, whole or ground, on DMI was observed in the present study. Digestibility of DM also did not vary significantly among the treatments. Intake of CP (g/ day) was similar among treatments, as a result of similar DMI. However, digestibility of crude protein varied significantly ($P<0.05$) and was the highest ($P<0.05$) in T_3 (69.81) followed by T_1 (66.18) and was the lowest in T_2 (62.34). Similarly, significantly ($P<0.05$) higher digestibility of ether extract (Table 2) was recorded in T_3 (77.34) followed by T_1 (72.33) and T_2 (69.48). Digestibility of other nutrients viz. nitrogen free extract (NFE), neutral-detergent fiber (NDF) and acid-detergent fiber (ADF) did not differ among treatments (Table 2). It has been reported earlier that feeding of ground linseed did not affect DMI (Petit *et al*., 2004; Gonthier *et al*., 2005). However, cows fed whole linseed had higher digestibility of ADF and lower digestibility of CP and ether extract than those fed ground linseed. Lower fiber digestibility was probably due to grinding (Scott *et al*., 1991) and was consistent with the release of oil from the seed into the rumen (Murphy *et al*., 1990).

Milk production (total and 4% FCM yield) did not differ among treatments (Table 3) and the values for total and 4% FCM yield were 9.84, 9.68, 10.54 and 9.78, 9.84, 10.32 in T_1, T_2 and T_3, respectively. These observations are in contrast to those reported by Kennelly (1996) who recorded higher milk yield in cows fed whole linseed. Milk protein, total solids and lactose contents also did not vary due to treatments (Table 3). However, milk fat content decreased by 6.1% in animals fed ground than those fed whole linseed which might be due to more release of oil in the rumen (Mohamed *et al*., 1988) due to grinding of linseed. Milk urea nitrogen (MUN) concentration was

Table 1
Chemical composition of dietary ingredients and concentrate mixtures (% DM basis)

Parameter	Green maize	Wheat straw	Linseed meal	Linseed	Concentrate mixture (T_1)	Concentrate mixture (T_2)	Concentrate mixture (T_3)
Organic matter	88.66	90.15	91.22	95.30	91.40	88.90	88.65
Crude protein	7.65	3.45	34.74	24.68	17.95	18.15	18.08
Crude fibre	23.76	35.15	11.24	16.34	7.48	7.90	7.72
Ether extract	2.85	1.28	12.08	34.80	6.78	6.82	6.85
NFE	54.30	50.27	36.24	19.48	59.18	56.03	56.00
NDF	49.45	67.40	39.18	36.12	36.40	35.95	36.10
ADF	32.12	52.75	16.55	14.45	14.65	14.24	13.86
Fatty acids (g/kg)							
Caprylic acid ($C_{8:0}$)	0.04	0.031	-	-	0.046	0.056	0.061
Capric acid ($C_{10:0}$)	0.07	0.013	-	-	0.068	0.072	0.069
Lauric acid ($C_{12:0}$)	0.07	0.036	-	-	0.040	0.036	0.042
Myristic acid ($C_{14:0}$)	0.09	0.058	-	0.092	0.088	0.112	0.096
Palmitic acid ($C_{16:0}$)	4.233	0.506	5.610	6.044	12.078	5.244	5.682
Stearic acid ($C_{18:0}$)	1.668	0.254	3.734	3.800	16.344	8.256	8.235
Oleic acid ($C_{18:1}$)	0.43	0.404	17.768	18.242	18.476	22.455	21.986
Linoleic acid ($C_{18:2}$)	1.34	0.388	15.416	16.040	14.135	18.608	18.772
Linolenic acid ($C_{18:3}$)	0.82	0.078	57.208	58.340	2.446	18.232	18.332

Table 2
Nutrients intake and digestibility (%) in Sahiwal cows fed linseed or linseed meal

Parameters	Treatments		
	T_1	T_2	T_3
Dry matter intake (kg/d)			
Roughage	6.45±0.34	6.53±0.22	6.32±0.42
Concentrate mixture	4.92±0.12	4.86±0.34	4.96±0.08
Total	11.37±0.56	11.39±0.38	11.28±0.34
DM intake (% b. wt.)	2.93±0.08	2.95±0.11	2.96±0.06
Nutrients digestibility (%)			
Dry matter	62.86^a±1.04	62.49^a±2.81	63.65^a±1.86
Crude protein	66.18^b±2.04	62.34^c±1.06	69.81^a±1.28
Crude fibre	54.35^a±1.66	55.14^a±1.64	54.12^a±1.58
Ether extract	72.33^b±2.14	69.48^c±1.08	77.34^a±1.61
NFE	68.48^a±1.72	66.90^a±2.02	68.38^a±1.64
NDF	53.11^a±1.81	54.20^a±1.66	54.08^a±1.12
ADF	47.56^a±1.08	48.57^a±0.97	47.60^a±0.78

Values bearing different superscripts in a row for a parameter differ significantly (P<0.05)
NFE=Nitrogen free extract; NDF=Neutral-detergent fiber; ADF=Acid-detergent fiber

Table 3
Milk yield and its composition in Sahiwal cows fed linseed meal or linseed

Attributes	Treatments		
	T_1	T_2	T_3
Milk yield (kg/d)	9.84^a±0.70	9.68^a±0.12	10.54^a±0.46
4% FCM Yield (kg/d)	9.78^a±0.34	9.84^a±0.30	10.32^a±0.27
Milk composition (%)			
Protein	3.52^a±0.06	3.38^a±0.10	3.69^a±0.08
Fat	3.98^a±0.11	4.11^a±0.04	3.86^a±0.09
Lactose	4.95^a±0.08	4.92^a±0.14	4.95^a±0.11
Total solids	12.68^a±0.21	12.88^a±0.18	12.51^a±0.34
Total cholesterol (mg/100 g milk)	11.86^a±0.89	5.94^c±0.76	7.85^b±0.26
Milk urea nitrogen (MUN) mg/dl	29.96^b±1.78	18.66^c±0.84	36.54^a±1.67
Total CLA's (mg/g fat)	6.94^b±0.56	7.12^b±0.34	12.65^a±0.22

Values bearing different superscripts in a row for a parameter differ significantly (P<0.05)

higher (P< 0.05) in cows fed ground linseed (T_3) than those fed whole linseed (T_2). Physical breakdown of seeds is known to increase ruminal CP degradability (Stern *et al*., 1994); this might have contributed to the higher urea nitrogen concentration in milk of ground linseed fed (T_3) cows.

Total cholesterol of milk (mg/100g; Table 3)) was significantly higher (P<0.05) in animals fed linseed meal (11.86; T_1) followed by those fed ground (7.85; T_3) and whole linseed (5.94; T_2). Milk cholesterol decreased by 49.9% and 33.8% in animals fed whole linseed (T_2) and ground linseed (T_3) than those fed linseed meal (T_1). Total CLA's content of milk fat (mg/100g fat) was 6.94, 7.12 and 12.65 in T_1, T_2 and T_3 treatments, respectively and it increased by 82.3% in cows fed ground linseed as compared to those fed linseed meal (Table 3). Moreover, grinding of linseed might have increased partial ruminal biohydrogenation of $C_{18:3}$ as shown by higher CLA's in milk fat of cows fed ground as compared with whole linseed.

Concentration of saturated fatty acids, as percent of total fatty acids, was the lowest (61.7%) in cows fed ground linseed (T_3) followed by those fed whole linseed (63.2%, T_2) and linseed meal (70.8, T_1, Table 4). Concentrations of medium-chain and saturated fatty acids decreased while that of long chain fatty acids increased in animals fed ground linseed (T_3). Similar trend in concentrations of milk fatty acids was observed when rolled flax seed was compared with whole linseed (Kennelly, 1996). Grinding of linseed might have contributed to increased availability of fatty acids for absorption and transfer in milk due to rapid rate of

Table 4
Mean fatty acid composition (g/100g) of milk fat of Sahiwal cows fed linseed meal or linseed

Fatty acids	Treatments		
	T_1	T_2	T_3
Caprylic acid ($C_{8:0}$)	2.47	2.66	2.38
Capric acid ($C_{10:0}$)	4.08	4.08	4.36
Lauric acid ($C_{12:0}$)	3.96	3.18	4.08
Myristic acid ($C_{14:0}$)	12.06	10.38	9.65
Palmitic acid ($C_{16:0}$)	29.40	27.07	26.58
Palmitoleic acid ($C_{16:1}$)	1.88	1.92	1.86
Stearic acid ($C_{18:0}$)	18.82	16.44	14.65
Oleic acid ($C_{18:1}$)	20.29	24.65	28.15
Linoleic acid ($C_{18:2}$)	1.72	2.06	1.94
Linolenic acid ($C_{18:3}$)	1.08	1.94	1.27
Total saturated fatty acids	70.79	63.18	61.70
Monounsaturated fatty acids	22.17	26.57	30.01
Polyunsaturated fatty acids	2.80	4.00	3.21

passage through rumen, which would increase concentrations of linolenic acid and n-3 fatty acids in milk. Similarly, Dhiman *et al*. (1999) also suggested that $C_{18:3}$ might also be a substrate for conversion to CLA in the rumen. Chilliard *et al.* (2000) also reported that feeding flaxseed oil resulted in increased production of ruminal *trans*11-18:1, which can be used by the mammary gland for CLA synthesis. Hence, the results of this study indicated that incorporation of ground linseed was effective in decreasing the level of saturated fatty acids and total cholesterol and in increasing the level of total CLA's in cow's milk fat.

REFERENCES

AOAC. (1995). Official Methods of Analysis (16th edn). Association of Official Analytical Chemists, Arlington, VA.

Bindal, M.P. and Jain, M.K. (1973). Determination of cholesterol content of ghee. *J. Indian Chem. Soc*. **50:** 63.

Chilliard, Y., Ferlay, A., Mansbridge, R.M. and Doreau, M. (2000). Ruminant milk fat plasticity: nutritional control of saturated, polyunsaturated, *trans* and conjugated fatty acids. *Ann. Zootech.* **49:** 181-205.

Chilliard, Y., Glasser, F., Ferlay, A., Bernard, L., Rouel, J. and Doreau, M. (2007). Diet, rumen biohydrogenation and nutritional quality of cow and goat milk fat. *Europian J. Lipid Sci. Technol.* **109:** 828-855.

Dhiman, T.R., Anand, G.R., Satter, L.D. and Pariza, M.W. (1999). Conjugated linoleic acid content of milk from cows fed different diets. *J. Dairy Sci*. **82:** 2146-2156.

Folin, O. and Wu, H. (1920). A method for estimation of blood sugar. *J. Biol. Chem.* **41:** 367-374.

Goering, H.K. and Van Soest, P.J. (1970). Forage Fiber Analysis (apparatus, reagents, procedures and some applications), Agricultural Handbook No. 379, United States Department of Agriculture, Washington, DC.

Gonthier, C., Mustafa, A.F., Ouellet, D.R., Berthiaume R. and Petit, H.V. (2005). Feeding micronized and extruded flaxseed to dairy cows: Effects on blood parameters and milk fatty acid composition. *J. Dairy Sci.* **88:** 748-756.

Huth, P.J., DiRienzo, D.B. and Miller, G.D. (2006). Major scientific advances with dairy foods in nutrition and health. *J. Dairy Sci.* **89:**1207-1221.

ISI. (1967). Indian Standard Specifications for Burfi. I.S:4079. Indian Standards Institutions, New Delhi.

Kearl, L.C. (1982). Nutrient Requirements of Ruminants in Developing Countries. International Feedstuffs Institute, Utah Agricultural Experiment Station, Utah State University, Logan, Utah.

Kennelly, J.J. (1996). The fatty acid composition of milk fat as influenced by feeding oilseeds. *Anim. Feed Sci. Technol.* **60:** 137-152.

Luddy, F.E., Barford, R.A. Herb, S.F. and Magdman, P. (1968). A rapid and quantitative procedure for the preparation of methyl esters of butteroil and other fats. *J. American Oil Chemists Soc.* **45:** 549-552.

Mohamed, O.E., Satter, L.D., Grummer R.R. and Ehle. F.R. (1988). Influence of dietary cottonseed and soybean on milk production and composition. *J. Dairy Sci.* **71:** 2677-2688.

Murphy, J., McNeill, G.P., Connolly, J.F. and Gleeson, P.A. (1990). Effect on cow performance and milk fat composition of including full fat soybeans and rapeseeds in the concentrate mixture for lactating dairy cows. *J. Dairy Res*. **57:** 295-306.

Parodi, P.W. (2005). Dairy product consumption and the risk of breast cancer. *J. Amercian Coll. Nutr*. **24:** 556S-568S.

Petit, H.V., Germiquet, C. and Lebel, D. (2004). Effect of feeding whole unprocessed sunflower seeds and flaxseed on milk production, milk composition, and prostaglandin secretion in dairy cows. *J. Dairy Sci.* **87:** 3889-3898.

Scott, T.A., Combs, D.K., and Grummer R.R. (1991). Effects of roast-ing, extrusion, and particle size on the feeding value of soybeansfor dairy cows. *J. Dairy Sci.* **74**:2555–2562.

Shingfield, K.J., Chilliard, Y., Toivonen, V., Kairenius, P. and Givens, D.I. (2008). Trans fatty acids and bioactive lipids in ruminant milk. *Adv. Exp. Med. Biol*. **60:** 63-65.

Snedecor, G. W. and Cochran, W. G. (1994). Statistical Methods. (7th edn.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.

Stern, M.D., Calsamiglia, S. and Endres, M.I. (1994). Dynamics of ruminal nitrogen metabolism and their impact on intestinal protein supply. In: Proc. Cornell Nutr. Conf. New York Ext., Cornell Univ., Ithaca, NY.