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Improvement of milk quality by adding of canola seed in dairy cow diets

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Abstract: This study was done to evaluate the effects of feeding canola seed for enrichment of UFA and milk performance of early lactation dairy cows. Twelve multiparous Holstein cows (635.3±18 kg BW and 36±9 DIM) were assigned to 1 of 3 treatments: 1- Control (CON) without canola seed, 2- 7.5% raw canola seed (CUT), and 3- 7.5% Heat-treated canola seed (CHT) of the total ration. Diets contained same crude protein, but varied in net energy. Diets were composed by basis of corn silage and alfalfa. Cows were milked twice daily for 4 wk. The inclusion of canola seed did not alter DM intake, weight gain, or body condition score of cows. Milk fat from CHT cows had greater proportions of UFA and MUFA ($P < 0.05$). Feeding CUT increased PUFA without significant difference. Milk fat from CHT had a greater proportion of C18 UFA and tended to have a higher proportion of other UFA. FCM milk yields, milk fat and protein percentages and total yield of these components were similar between treatments. Milk urea nitrogen was lower in cows fed CON and CHT. Feeding canola seed to lactating dairy cows resulted in milk fat with higher proportions of healthful fatty acids without adverse affecting milk yield or milk composition.

Keywords: Canola Seed, Fatty Acid, Dairy Cow

1. Introduction

Milk and their by-products provided human fat consumed up 30 per cent (Carriquiry *et al.,* 2009). Try in order less SFA and more PUFA is human aim for increase public health. This aim is provided by modifying the fatty acids profile of cow's milk (Glasser *et al.,* 2008). Milk fat is an important determinant of milk nutritional quality. The SFA produce negative effects when consumed in excess, whereas UFA such as C18:1, C18:2 and C18:3 have potential positive effects on human health (Parodi, 2005). Milk fat content can be extensively modified by nutritional factors, in particular fat supplementation of the diet (Shingfield *et al.,* 2008). The simplest way of altering milk fatty acids composition is to supplement the diets to cows with unsaturated lipids. The main sources of unsaturated lipids are oilseed lipids, among which linseed, rapeseed, soybeans, canola, and sunflower oil seed (Glasser *et al.,* 2008). Supplementing the diet of cows with plant lipids decreased the C16:0 and other SFA and increased UFA content of milk fat. Canola seed is an excellent source of dietary fat and protein for dairy animals. Many studies have used by whole, rolled, crushed or ground crude canola seed (Chichlowski *et al*., 2005 and Beauchemin *et al.,* 2009). The use of free oil in the diet might inhibit rumen microbial activity and affect milk production and composition (Jenkins, 1998). However, only a few studies have compared different physical forms of untreated canola seed versus treated canola seed (Kennelly, 1996; Chichlowski *et al*., 2005; and Beauchemin *et al.,* 2009). Several studies have reported changes in milk FA composition after lipid supplementation of dairy cow diet (Caldari *et al*., 2011; Johnson *et al.,* 2002; and Odongo *et al.,* 2007), but no work has evaluated due to using accompany difference levels and treating methods of canola seed on milk FA composition. Furthermore, we hypothesized that a diet containing ground canola seed would provide linoleic and linolenic acid. Hence, the objective of this study was to investigate the effect of supplementing a dairy cow diet with sources of long chain fatty acid on milk fatty acid and milk performance in lactating dairy cows.

2. Details experimental

2.1. Materials and Procedures

2.1.1. Animals, Treatments, and Sampling

Twelve lactating Holstein cows (635.3±18 kg BW and 36±9 DIM) were used in a complete randomized design. Cows were allotted to four replicates. In each replicates, 4 cows were assigned to 1 of 3 treatments: 1- Control (CON) or without canola seed; 2- CUT or 7.5% raw canola seed; and 3- CHT or 7.5% heat-treated canola seed. Cows in both treatments were fed a similar basal diet, except

for the added canola seed. The dietary protein between treatments was isonitrogenous (17.3% of diet DM). The addition of 3% fat from canola seed represents 5.15% (CUT) and 5.10% (CHT) vs. 3.70% (CON) of ration DM as fat. The part of canola seed were heated at least in 90° C within 10 minutes (Pellet mill equipment made Denmark®, Animal feed factory Co, Daneh Matbu- Saveh, Iran). Feed were mixed and delivered twice daily at 0700 and 1500 h. The experimental diets were formulated by NRC, 2001. Feed ingredients were balanced to contain 17.3% CP and 1.48 to 1.59 Mcal/kg NEl (Table 1). Feed ingredients were analyzed for DM, CP and NDF by AOAC procedure, 2000. The NEl content of TMR was estimated using equations from NRC (2001). Cows were milked twice daily at 0800 and 1600 h. Milk samples were obtained from 2 consecutive milking before the start of the trial and every 2 wk for the duration of the experiment. Fat, protein and lactose in milk were determined by Milkoscan spectroscopy (Infrared Spectroscopy Milkoscan FT 120 Foss analytical A/S Hillerod®, Denmark). An aliquot of milk was frozen for subsequent fatty acid analysis; one Broad Spectrum Microtabs II tablet was added to 40 mL of milk before shipment to laboratory of chemical and feed analysis, Urmia, Iran.

Table 1. Ingredients and chemical composition of experimental diets (DM basis)

	Diet[1]			
Item	CON	CUT	CHT	SEM
Ingredients (% of Diet)				
Corn silage	39.67	37.58	37.58	0.92
Alfalfa hay	6.65	6.45	6.45	0.20
Barley grain	12.82	11.52	11.52	1.85
Corn grain	7.92	6.92	6.92	0.30
Canola meal	2.06	2.06	2.06	0.42
Cottonseed	8.58	7.58	7.58	1.35
Soybean meal	11.96	11.05	11.05	1.47
Wheat bran	8.52	7.52	7.52	0.93
Beet sugar pulp	1.68	1.68	1.68	0.34
Canola seed[2]-UT	0.0	7.50	0.0	6.00
Canola seed-HT	0.0	0.0	7.50	6.00
Dicalcium phosphate	0.06	0.06	0.06	0.0
Salt, Vitamin & Mineral permix	0.06	0.06	0.06	0.0
Chemical Composition (% of DM)[3]				
DM	62.74	61.45	61.15	0.27
NE_L (Mcal/kg DM)	1.48	1.59	1.59	0.03
CP	17.25	17.33	17.33	0.05
Ether extract	3.70	5.15	5.10	0.48
NDF	34.60	33.75	33.80	0.26
Ash	4.52	4.46	4.58	0.22

[1]CON= Diet of Control; CUT= Diet of 7.5% untreated canola seed; CHT= Diet of 7.5% heat-treated canola seed.[2]Canola seed of Okapi variety provided from a farm in Arak, Iran. [3]DM= Dry matter; CP= Crude protein. NEl (Mcal/kg) was determined using the NRC 2001 software.

2.1.2. Fatty Acid Analysis

The fatty acid profiles of milk, canola seed, and experimental diets were determined by gas chromatography. Feed and frozen milk samples were shipped to Urmia University (Laboratory of Chemical and Feed Analysis, Urmia, Iran) for analysis using the following procedures. Feed samples were further ground in a Cyclotec mill (1-mm screen, Toosshekan Co®, Iran). Milk fat was separated by centrifugation (8000. *g*; 45 min), and were extracted with chloroform:methanol (2:1 vol/vol). Methyl esters of fatty acids from feed and milk were prepared by the transesterification procedure of Park and Goins (1994). The internal standard used was 10-undecenoate (Nu-Check Prep, Elysian, MN). The methyl esters of fatty acids were injected by autosampler into an Agilent 6890N gas chromatograph fitted with a flame-ionization detector (Agilent Technologies, Palo Alto, CA). A 100-m .0.25-mm .0.2-μm film thickness fused silica column (CP-Sil 88; Varian, Inc., Palo Alto, CA) was used to separate fatty acid methyl esters. Gas chromatography conditions were as follows: the injection volume was 0.5 μL, a split injection was used (70:1 vol/vol); ultrapure hydrogen was the

carrier gas; and the injector and detector temperatures were 250 and 300° C, respectively. The initial temperature was 70° C (held for 1 min), increased by 5° C per min to 100° C (held for 3 min). Then increased by 10° C per min to 175° C (held for 40 min), and then increased by 5° C per min to 220° C (held for 19 min) for a total run time of 86.5 min. Data integration and quantification were accomplished with Agilent 3365 ChemStation (Agilent Technologies) software.

2.1.3. Statistical Analyses

All results were subjected to least squares ANOVA for a complete randomized design. Data were analyzed by the GLM procedure of SAS (SAS 9.1, 2002®) using the following model:

Yijk= μ+Ti+Hk+Eijk; Where: Yijk= observation; μ= mean; Ti= treatment, i= 1,2,3; j= 1,2,3; Hk= Treating of seed, k= 1,2; and Eijk= residual error. Duncan's tests with significance declared at $P \leq 0.05$ separated least square means.

3. Results and Discussion

3.1. Dietary Composition

The respective CUT, CHT and CON analyses averaged 17.33%, 17.33% and 17.25% CP and 1.59, 1.59 and 1.48 Mcal/kg NEl using NRC (2001) equations. Because diets met or exceeded energy and protein requirements, little difference was expected in milk yield or composition. The dietary protein level of CON was adjusted using soybean meal and cottonseed meal to reduce inherent differences in the amino acid profile when using other protein sources in the diet. The heat-treating of canola seed during the desolventizing process can alter protein degradability resulting in a different relative proportion of RDP to RUP in the diet. The larger proportion of undegradable protein in CON provided 7.45% of additional RUP. Although minor, this excess may have contributed to reduced milk yield associated with the added metabolic energy required to recycle and excrete circulating urea. The CON diet contained 95.88 g/100g of fatty acid (3.7% of diet DM) of fat, whereas the CUT and CHT diet contained 98.18 and 94.21 g/100g of fatty acid (5.15% and 5.10% of diet DM) of fat, resulting in 3.9% more dietary fat in CON. Consequently, the CUT and CHT ration had 0.11 Mcal/kg more NEl than the CON ration. Canola seed is an excellent source of oleic acid. The CUT and CHT diet was higher in oleic acid (C18:1) than the CON diet. Oleic acid was the predominant fatty acid in both rations and was more concentrated in the CUT and CHT than in the CON (52.48 and 52.45 vs. 22.44 g/100g of fatty acid of fat, respectively). The CHT ration contained more linoleic acid, the dienoic fatty acid precursor with demonstrated biological value for ruminal biohydrogenation via the isomerization of *cis*-9,*cis*-12 C18:2 in the presence of the enzyme *Δ12-cis,Δ11-trans* isomerase to produce the *cis*-9,*trans*-11 CLA isomer (Baumgard *et al.,* 2000).

3.2. Intake and Body Weight

Fat, especially from sources high in UFA, can reduce fiber digestibility, alter the ratio of ruminal acetate to propionate, and lower intake, when total dietary level exceeds 6% to 7% DM (NRC, 2001). Variation normally depends on dietary factors that alter the rumen environment (e.g., forage: concentrate ratio and DM intake). The DM intake was not different between CON and other treatments (23.57 vs. 22.37 and 22.47 Kg/d; respectively (Fig.1), even with the addition of 3% dietary fat from canola seed. The diet had 55:45 forage: concentrate ratio. No differences between treatments were apparent in average BW (648 vs. 619 and 649 Kg; $P = 0.38$), and BCS (2.93 vs. 2.83 and 2.85) (Table 2).

Table 2. DM, En, NDF, EE and FA intake and BW and BCS in the cows received experimental diets (Kg/d)

	Diets[1]					
Item[2]	CON	CUT	CHT	*R*[3]	*F*	*<P*[4]
Intake, kg/d						
DMI	23.57	22.37	22.47	L	2.10	NS
NDFI	8.15[a]	7.45[b]	7.59[b]	Q	2.41	0.08
EEI	0.87[a]	1.14[b]	1.14[b]	Q	36.0	0.01
SFAI	0.197[a]	0.139[b]	0.143[b]	Q	3.34	0.03
UFAI	0.636[b]	0.980[a]	0.930[a]	L	2.42	0.02
C18 UFAI	0.632[b]	0.976[a]	0.976[a]	L	2.25	0.03
MUFAI	0.195[b]	0.598[a]	0.597[a]	L	5.44	0.06
PUFAI	0.332[b]	0.442[a]	0.381[a b]	L	3.83	0.04
BW	648	619	642	L	0.9	NS

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[a-b]Within a row, means without a common superscript differ ($P < 0.05$).[1]CON= Diet of Control; CUT= Diet of 7.5% untreated canola seed; CHT= Diet of 7.5% heat-treated canola seed. [2]DMI= DM intake; NDFI= NDF intake; EEI= Ether extract intake. SFAI= SFA intake; UFAI= UFA intake; C18 UFAI= C18 UFA intake; MUFAI= MUFA intake; PUFAI= PUFA intake. BW= Body weight; [3]L= linear; Q= Quadratic. [4]NS: Non-Significant.

3.3. Milk Yield and Milk Composition

Milk composition was shown in Table 3. Fat, protein and lactose (percentage and yield); actual milk and 3.5% FCM were not different (Fig. 2). Milk fat percentage was lower from CON cows than in milk from CUT and CHT cows; but when corrected for total yield of milk fat, the difference was negligible. Aldrich *et al.* (1997) reported that feeding lactating dairy cow diets supplemented with canola (11.2% of DM) maintained or increased milk fat percentages. In the present study, when milk yield was adjusted for fat and protein percentages, the CUT and CHT cows produced less energy-corrected milk. Diets that are supplemented with plant oils can cause a reduction in milk fat secretion in dairy cows. Decreased milk production can often be traced to the interference of fat with ruminal fermentation or to poor digestibility of fatty acids (NRC, 2001). The diversion of energy to fat stores rather than to milk formation does occur, but it is physiologically less common in healthy, high-producing cows. Milk fat depression occurs when rations are high in added fat, especially when all dietary sources are from plant origin (NRC, 2001). In this experiment, cows fed canola seed did not exhibit a depression in milk component yield, despite the fact that all of the added fat was from canola seed. Inclusion of fat supplements in the ration of lactating ruminants has also been shown to reduce the protein content of milk. Delbecchi *et al*. (2001) found that milk protein yield tends to be lower in cows fed canola seed when compared with milk from cows fed 4.8% formaldehyde-protected canola seed. Jahreis and Richter (1994) reported a 10% decrease in milk protein of cows fed 5.5% (of diet DM) ground canola seed. Even though intake tended to be lower during the infusion, DM intake was similar for all treatments in this experiment. Therefore, canola seed likely contributed to the lower milk protein in the present experiment. According to Johnson *et al*. (2002), it is common for cows fed rations containing oilseed to have increased levels of MUN, likely the result of increased nitrogen absorption across the ruminal wall. In our study the CUT and CHT cows received a diet that was similar in CP but higher in NEl than the CON cows; therefore, the milk from CON cows had lower MUN ($P>0.01$).

3.4. Fatty Acid Composition of Feed and Milk

The fatty acid profiles are shown in Table 4. Feeding canola seed increased the proportion of MUFA and PUFA fatty acids in milk fat (Fig. 3). These results agree with reported by Aldrich *et al*. (1997) who used canola seed. Short-chain fatty acids are mainly synthesized in the epithelial cells of the mammary gland of the dairy cow, and their synthesis is susceptible to inhibition when increasing dietary levels of certain long-chain fatty acids. The *trans* double bond in trans fatty acids originates only from bacterial fermentation and increases substantially in cows fed diets that are high in PUFA without depressing milk fat percent, assuming balanced diets containing adequate forage. Baumgard *et al*. (2000) reported that milk fat depression occurs only when the *trans*-10 C18:1 isomer is increased as compared with normal situations where the *trans*-11 C18:1 isomer is the most abundant. The medium-chain fatty acid palmitate can be derived from the ration, or it can be synthesized in the mammary gland. The canola seed used in this study contained less C16:0, so as expected, the concentration of C16:0 in milk fat of CUT and CHT cows was lower than in milk fat of CON cows but non-significant (Table 4). Lowering C14:0 and C16:0 in milk fat by supplementing dairy cow rations with long-chain UFA is touted to add health benefits to dairy products. Our results produced similar changes in the fatty acids profile and therefore accordance with scientific efforts are to improve value of dairy products. Milk fat contains fatty acids derived from de novo synthesis by the mammary gland and from mammary uptake of preformed fatty acids. Recent evidence suggests that certain transient intermediates in the biohydrogenation of PUFA potently inhibit endogenous fatty acid synthesis in the mammary gland. On a molar basis, approximately 80% of the reduction in milk yield of fatty acids is accounted for by the reduction in de novo synthesis of fatty acids when cows received a mixture of linoleic acid isomers (Chouinard *et al*., 1998). The *trans*-10,*cis*-12 linleic acid isomer has been identified as having a potent effect on milk fat synthesis in lactating cows (Baumgard *et al*., 2000). Piperova *et al*.

(2000) reported that in cows fed a high-grain, low forage diet that contained soybean oil (5.0% DM), the increases in *trans*-10 C18:1 and *trans*-10,*cis*-12 CLA in milk fat were associated with significantly lower levels of de novo synthesized fatty acids. In the present study, also measurement of CLA was not provided, but based on the fatty acid composition of milk fat and ruminal fermentation characteristics, it is unclear why milk fat percentage was reduced when adding ground canola seed to the diet. The concentration of C18:0 in milk fat from CUT and CHT cows was approximately 20% and 43% greater (P = 0.012) than that from CON cows, respectively. This may be related to the lower level of C18:0 in the CON ration, the higher levels of unsaturated C18 fatty acids in the CUT and CHT ration, or both. We found that feeding canola seed (7.5% of diet DM; 40% lipid) increased MUFA in milk by nearly 25% (from 18.55 in CON to 22.67 g/100 g of milk fat in CUT and 24.73 g/100 g of milk fat in CHT g/100 g of milk fat) (P = 0.041; Table 4).

The differences in the proportion of MUFA in milk fat between CON and canola treatments in the current study could be attributed to rapid availability of oil in the rumen and its potential to reduce fiber digestibility or to the higher dietary proportion of forage in our study when compared with the Aldrich *et al*. (1997) study. In the present study, the addition of canola seed to lactation rations increased the concentration of C18:3n-3 (P = 0.084) and in milk fat, but it did not alter C18:2 despite higher levels of C18:2 in the diet. This is likely the result of hydrolysis and hydrogenation of C18:2 by ruminal microorganisms (Murphy *et al*., 1990). Dietary canola seed increased the PUFA proportion of n6 and decreased the proportion of n3 (Table 4), thereby increase the n6 to n3 fatty acid ratio but without significant difference. Inclusion of the canola seed in the diet resulted in an intensification in the concentration of C18:2n-6cis with the greatest gain observed for cows fed CUT and CHT. Compared to the control, milk fat from cows fed CUT and CHT had 28.62% and 12.50% more C18:2n-6cis, respectively (Fig. 4).

Table 3. Milk yield and milk composition of the lactating dairy cows received experimental diets

	Diets[1]					
Item[2]	CON	CUT	CHT	R^3	F	$<P^4$
Milk Yield (Kg/d)						
Yield	34.75	34.40	33.10	L	3.08	NS
FCM 4%	31.56	32.43	31.12	Q	3.38	NS
Composition (%)						
Fat	3.39	3.64	3.60	Q	0.82	NS
Protein	3.40	3.09	3.38	L	0.74	NS
Lactose	4.92	4.86	4.70	Q	1.79	NS
TS	12.42	11.57	12.12	L	1.59	NS
SNF	10.14	9.81	9.95	Q	1.35	NS
Yield (kg/d)						
Fat	1.17	1.24	1.19	Q	1.57	NS
Protein	1.19	1.05	1.10	L	1.24	NS
Lactose	1.70	1.68	1.55	Q	5.39	NS
TS	4.31	3.97	4.00	L	5.77	NS
SNF	3.51	3.37	3.28	Q	4.18	NS

[a-b]Within a row, means without a common superscript differ (P< 0.05). [1]CON= Diet of Control; CUT= Diet of 7.5% untreated canola seed; CHT= Diet of 7.5% heat-treated canola seed. [2]FCM= 4% Fat-corrected milk; TS= Total solid; SNF= Solids-not-fat; [3]L= Linear; Q= Quadratic. [4]NS: Non-Significant.

Although added dietary fat increased the linoleic acid (C18:2) content of milk fat. When total C18:2 was considered, adding of canola seed greatly improved the milk C18:2 content, whereas heat treating had only moderate effects or none at all. This confirms the high rumen biohydrogenation of dietary C18:2 observed for oils and seeds (Glasser *et al*., 2008). Similar results were observed for linolenic acid (C18:3). Linolenic acid (C18:3) in milk originates almost entirely from the diet, however, C18:2 can also be found in body stores. Addition of CUT resulted in increases in C18:3n-3 of 8%. By heat process of canola seed, fat coupled with the fiber of the seed hull and PUFA pass to intestine. For n3 linolenic acids was no significant difference among dietary treatments. The concentration of C18:3n-3 in milk from cows fed CUT was higher than from cows fed the CON diet.

These results are similar to those previously reported by Ashes *et al.,* (1995). Based on the assumption of 69% digestibility of fatty acids, oil seed in the diet resulted in the C18:2 and C18:3 being converted in the rumen to either C18:0 or C18:1 since there was no transfer of these fatty acids to milk fat. Heat treatments of canola seed (CHT) did not result in a large transfer of C18:2 and C18:3 into milk fat, less than 1% and 2%, respectively. Also suggesting that these fatty acids were saturated to either C18:0 or C18:1. In the experiments that have compared different in lipid sources without a control diet, which were not included in the models, some researchers have confirmed this observation (Kelly *et al.,* 1996; Petit, 2003 & 2004; Loor *et al.,* 2004). However, others do not report any significant difference between C18:2- and C18:3-rich lipids on milk C18:0 percentage (Chouinard *et al.,* 1998; Ward *et al.,* 2002; Brzoska, 2005). The concentration of C22:0 decline with the inclusion of canola seed in the diets. Significant differences were not observed for total UFA in milk among the dietary treatments. No significant differences were between treatments for change of total n3 fatty acids. The concentration of total n6 in milk fat was increased by canola seed in the diet compared to the control diet, but without significant difference. Milk from cows fed CON and CUT had lowest and highest n3+n6 fatty acid, respectively. C18:0 unsaturated and other unsaturated fatty acids in milk had not significant difference. These results are in agreement with others (Chichlowski *et al.,* 2005), when fat was supplemented at 2% or more in the diets. Palmquist *et al.,* (2005) reported that reductions in mentioned fatty acids by high level oil seed supplementation may be due to lower production of acetate and beta-hydroxy-butyrate in the rumen or as a result of increased uptake of dietary long-chain fatty acids inhibiting de novo synthesis of upper mentioned fatty acids.

Table 4. Milk fatty acids of the lactating dairy cows received experimental diets (g/100 g of total fatty acids).

	Diets[1]					
Fatty acid	CON	CUT	CHT	R^2	*F*	<*P*[3]
14:0	14.47[b]	20.35[ab]	14.41[b]	L	2.48	0.082
14:1n-5	0.97	1.11	0.86	Q	1.15	NS
16:0	36.02	32.68	33.83	L	0.34	NS
16:1n-7	1.73	1.44	1.18	Q	3.62	NS
18:0	9.53[ab]	9.72[ab]	11.87[a]	Q	4.50	0.012
18:1n-7	2.19	1.57	1.43	L	1.38	NS
18:1n-9	18.66	18.54	21.77	Q	1.18	NS
18:2n-6*c*	2.48[b]	3.19[a]	2.79[ab]	Q	0.83	0.05
18:3n-3	0.180[b]	0.196[a]	0.190[ab]	Q	0.48	0.084
18:3n-6	0.115	0.099	0.123	Q	2.28	NS
18:4n-3	0.348	0.342	0.236	L	0.86	NS
20:0	0.146	0.267	0.231	Q	1.19	NS
20:4n-6	0.082	0.017	0.053	L	1.24	NS
20:5n-3	0.047	0.005	0.017	L	2.25	NS
22:0	0.147[a]	0.037[b]	0.067[b]	L	1.85	0.017
22:5n-6	0.076	0.067	0.090	L	1.53	NS
22:6n-3	0.057	0.0	0.032	L	2.08	NS
Total SFAt	60.97	62.39	60.60	L	1.08	NS
Total UFA	26.95	26.60	28.78	Q	1.09	NS
Total n3	0.633	0.544	0.476	L	1.00	NS
Total n6	2.76	3.38	3.05	Q	0.92	NS
n3+n6	3.39	3.92	3.53	Q	0.98	NS
n6:n3	4.36	6.21	6.40	Q	0.45	NS
MUFA	18.55[b]	22.67[a]	24.73[a]	Q	1.12	0.041
PUFA	3.39	3.92	3.53	Q	0.98	NS
Other UFA	23.98	23.94	26.54	Q	1.10	NS
C18 UFA	22.55	22.47	25.25	Q	1.44	NS

[a-b]Within a row, means without a common superscript differ ($P< 0.05$). [1]CON= Diet of Control; CUT= Diet of 7.5% untreated canola seed; CHT= Diet of 7.5% heat-treated canola seed. [2]L= Linear; Q= Quadratic. [3]NS: Non-Significant.

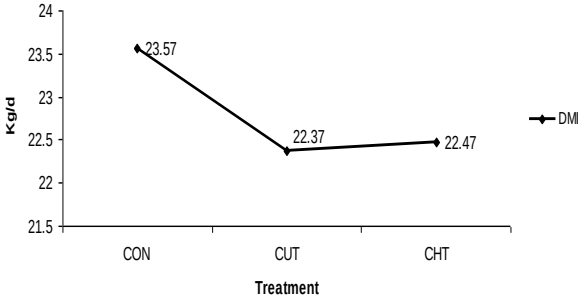

Fig. 1. DMI of cows fed experimental diets

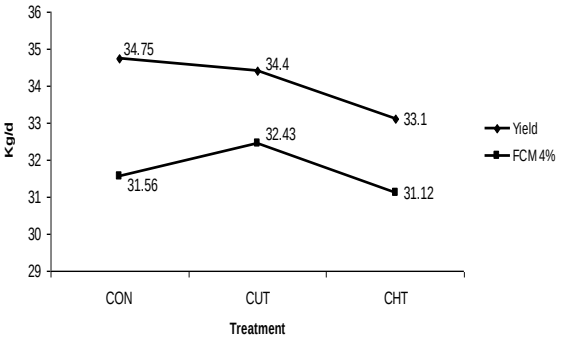

Fig. 2. Milk Yield and FCM of cows fed experimental diets

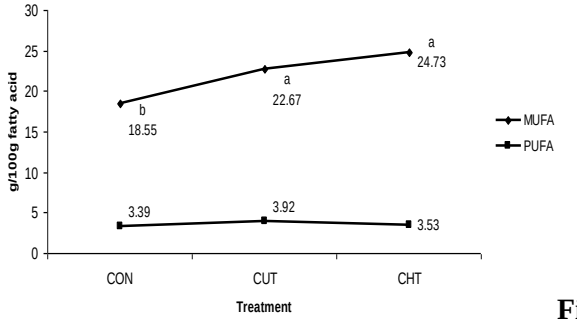

Fig. 3. MUFA and PUFA in milk fat of cows fed experimental diets

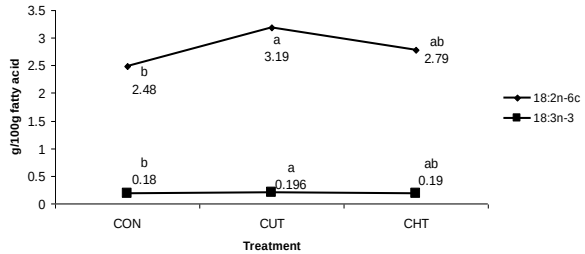

Fig. 4. C18:2n-6c and C18:3n-3 fatty acids in milk fat of cows fed experimental diets

4. Conclusions

The results show that 3% added fat from raw or heat-treated canola seed to lactating cow diets favourably altered the fatty acid profile in milk fat. The changes in fatty acid profile were not associated with reduced milk yield or composition. Adding canola seed to the diets of lactating dairy cows resulted in an increase in the proportions of C18 MUFA and had lower proportions of SFA. Totally, using raw or heat-treated canola seed in 7.5% of diet can be evince the best results for milk fatty acid quality and milk performances in early lactating dairy cows nutrition.

Abbreviation

SFA= saturated fatty acid, UFA= unsaturated fatty acid, MUFA= monounsaturated fatty acids, PUFA= polyunsaturated fatty acid, FCM= Fat corrected milk.

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