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The Effects of Replacement of Soybean Meal by Mechanically-Processed Sesame Meal on Performance and Milk Fatty Acids Profile in Lactating Holstein Dairy Cows

Research Article

V. Ashjae[1], A. Taghizadeh[2*], Y. Mehmannavaz[1] and A. Nobakht[1]

[1] Department of Animal Science, Maragheh Branch, Islamic Azad University, Maragheh, Iran
[2] Department of Animal Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran

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*Correspondence E-mail: ataghius@yahoo.com

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ABSTRACT

The aim of this study was to determine the effect of replacement of soybean meal (SBM, solvent extracted meal, 40% CP) with different levels of sesame meal (SSM, mechanically processing meal, 43.91%) on performance, milk composition, blood metabolites and profile of milk fatty acids in lactating dairy cows. Thus, eight Holstein dairy cattle were used in a replicated 4 × 4 latin square design during four 28-days periods. Treatments were control (no SSM supplementation) or replacement of 50, 75 or 100% of SBM with SSM. Cows were fed a total mix ration (TMR). The results showed that dry matter intake (DMI), total solid (TS), fat to protein ratio (FPR), milk protein yield (MP), milk lactose yield, and blood cholesterol, glucose and calcium concentrations were not affected (P>0.05) by experimental diets. However, milk yield average, fat corrected milk (FCM), feed efficiency (FE), milk fat (MF), solids non-fat (SNF) content, milk urea nitrogen (MUN), blood urea nitrogen (BUN) and triglyceride (TG) concentrations differed (P<0.05) among treatments. The concentration of cis-C18:1 in the milk of cows fed SSM diets were numerically greater compared with cows fed the control diet. Polyunsaturated fatty acids (PUFA) and total unsaturated fatty acids in milk of cows fed SSM diets were more than the control diet. Concentrations of C16:0 and saturated fatty acids in MF in the control diet were greater than those achieved for the SSM diets. Regardless of the SSM/SBM ratio, cows fed SSM had more unsaturated fatty acids in milk. Replacing SBM with SSM decreased (P<0.05) concentration of medium (MCFA) and long chain saturated fatty acids (SFA) and increased (P<0.05) long-chain polyunsaturated fatty acid (PUFA). Generally, SSM improved milk fatty acids profile, as a health index of human nutrition, but regarding the rate of milk production, 75% substitution of soybean with sesame is appropriate.

KEY WORDS blood metabolites, lactating Holstein cow, milk fatty acids, sesame meal.

INTRODUCTION

One of the most significant problems in supplying animal products around the world is the lack of enough feed to meet the nutritional needs of animal populations, which is also associated with high costs of feedstuffs. Feed costs constitute a major part of the total costs of livestock farming, which causes studies to focus on using local feedstuffs and agro-industrial by-products of oil extraction in the feeding ruminant livestock. Thus, producers in some area such as east and north America attempt to use any available agricultural and industrial by-products, such as citrus pulp (Lashkari and Taghizadeh, 2015), oak nuts (Al Jassim *et al.* 1998), olive cakes (Alcaide *et al.* 2003; Chiofalo *et al.* 2004), tomato pomace (Denek and Can, 2006), date palm (Mahgoub *et al.* 2007), mustard cake (Panwar *et al.* 2002), and *Prosopis juliflora* pods (Abdullah and Abdalhafes, 2004; Obeidat *et al*. 2008). Currently, there is a significant increase in the prices of typical feedstuffs along with occasional fluctuation in their availability. This problem is especially observed in feeds containing high concentrations of protein and/or amino acids. There are great efforts to identify new feedstuffs that could decrease the cost of feeding livestock. Furthermore, these feedstuffs can maintain the integrity of animal health and welfare, as well as having high nutritive value. An important category of these feedstuffs is the agro-industrial by-product feeds that are usually not used as human food but can be utilized potentially as animal feed. Excessively-sorted sesame seeds, refused by industry, could be used as a potential ingredient to formulate ruminant rations (Shirzadegan and Jafari, 2014).

The best sources of plant-based protein are edible seed meals, which are degraded highly in cattle rumen. Among oil seeds, soybean meal (SBM) is considered the most desirable plant-based protein supplement that has quite suitable amino acid pattern in addition to high protein content. The concentration of lysine, a required alpha-amino acid for protein biosynthesis, is high in SBM; however, methionine content is low in SBM. In the soils containing moderate nitrate, the proportion of nitrogen derived from SBM is about 50%; in loam soils, this rate increased to 75%. From this rate, 95% is true protein and is suitable for livestock nutrition. Ruminal protein degradation in SBM is 50 60% (Jahani-Moghadam *et al*. 2009).

SSM is another source for supplying the protein requirement of ruminants. SSM is obtained from the oil extraction of a sesame seed. In order to prepare SSM, the oil seeds could be extracted without peeling. In this state, the SSM remaining can be used as a plant source for providing protein in poultry and livestock nutrition. Depending on the method of processing (mechanical or extracting with solvent), protein content in SSM is about 23-31%. The true protein in SSM is 45% and it contains essential amino acids. Regarding the low concentration of lysine in SSM and low concentration of methionine in SBM, simultaneously use of these two protein supplements improves increase feed efficiency. Unlike lysine, the concentration of methionine amino acids and arginine of SSM are very high (19.6 g glutamic acid per 100 g crude protein and 12.5 arginine per 100 g crude protein) and due to this, it has the nutrient value of 90-95% of SBM. SSM also is a suitable source for supplying dietary requirements of methionine as limiting amino acids. SSM is rich fat-soluble vitamins and phosphorus, and therefore it can be considered a great supplement for feeding livestock (Ghorbani *et al*. 2018).

Hassan *et al*. (2013) studied the feeding effect of feeding difference concentrations of sesame cake on Sudan desert sheep. Their results indicated that adding 20% of sesame cake leads to suitable efficiency of carcass yield. In studying growing lambs and calves, Mahmoud *et al*. (2014) suggested that SSM is a suitable protein source and could be used as the only source for providing protein for livestock and, thus, could also improve profitability. In Awassi lambs, Obeidat *et al*. (2009) found that replacement of 12.5-25% SBM and barley bran with SSM improved the milk yield. In other research, Omar (2002) suggested that replacement of 20% of SBM with SSM, improved animal performance and reduced feed cost. However due to the absence of information for nutritive value of SSM, it's applying in ruminant nutrition is limited regarding the low cost of using SSM, replacement of SBM with SSM may be necessary to reduced feed costs and improve profitability. Thus, the objective of this research was to study the effect of replacing varying amounts of SBM with SSM obtained from mechanical processing on milk yield, milk composition and milk fatty acids profile of lactating Holstein dairy cows.

MATERIALS AND METHODS

The trial was conducted at Ashjaei Farm, Astara, Guilan, Iran. The range of temperatures was from 4.9 ˚C to 25.4 ˚C. The total rainfall during the experimental period was 215 mm. The performance study consisted of eight lactating Holstein cows, which were blocked based on the average milk yield during the three weeks preceding the trial (20.4±3.1 kg/day) and days in milk (55±15 days), with average body weight (BW) of 550 ± 50 kg. Cows were randomly assigned by lactation number (2.5±0.5) to one of two replicated 4 × 4 latin squared with 28. Experimental diets included: control with all SBM (T1); 50% of SBM replaced with SSM (T2); 75% of SBM replaced with SSM (T3); 100% of SBM replaced with SSM (T4). All SSM fed was obtained by processing through the mechanical method. Cows on the experiment were then distributed to diets based on a latin square design for a continuous lactation trial over 28 days (Table 1). A 14-day adaptation period was implemented before data collection. Cows were milked twice daily at 06:00 and 18:00, and milk yield was automatically recorded at each milking using a dairy master swing-over milking machine. Mixed samples of the different milking sessions were obtained after 2 h feeding as daily during the second week and preserved for milk composition analyses. After milk sampling, values for milk characteristics such as protein, lactose, fat, fatty solids and total fatty matter were determined using a Foss conveyor, Electric 4000. Measurements of fatty acid profiles were made using a 6890 Hewlett Packard gas chromatography system with a BPX column at a temperature of 198 ˚C (Ziaeian Nourbakhsh *et al*. 2012).

Table 1 The feed ingredients and chemical composition of experimental diets

Ingredient*	T1 (Control)	T2 (50%)	T3 (75%)	T4 (100%)
Legume forage hay, mature	18.04	18.04	18.04	18.04
Corn grain, ground, dry	8.94	8.94	8.94	8.94
Barley grain, rolled	10.27	10.27	10.27	10.27
Wheat bran	6.67	6.67	6.67	6.67
Corn gluten feed	7.66	7.66	7.66	7.66
Sesame, meal	0.0	9.72	14.58	19.44
Grass hay, C-3, mature	15.22	15.22	15.22	15.22
Fish meal	3.99	3.99	3.99	3.99
Soybean meal, 44% CP	19.44	9.72	4.86	0.0
Beet sugar pulp, dried	5.95	5.95	5.95	5.95
Salt	0.4	0.4	0.4	0.4
Calcium carbonate	0.57	0.57	0.57	0.57
Vegetable oil	1.77	1.77	1.77	1.77
Vitamin/mineral premix	0.57	0.57	0.57	0.57
Total	100	100	100	100

T1: control with all soybean meal ratio (SBM); T2: 50% of SBM replaced with sesame meal (SSM); T3: 75% of SBM replaced with SSM and T4: 100% of SBM replaced with SSM.

* Neutral detergent fiber (NDF): 33.9 (% DM); Acid detergent fiber (ADF): 19.8 (% DM); Nonfiber carbohydrates (NFC): 32.1(% DM); Undiscounted total digestible nutrients (TDN): 71 (% DM); Metabolizable energy (ME): 2.62 (Mcal/kg DM); Net energy lactation (NE_L): 1.67 (Mcal/kg DM); Crude protein (CP): 18 (% DM); Ca: 0.8 (% DM); P: 0.6 (% DM); Ether extract: 4.1 (% DM) and Dietary cation-anion difference (DCAD): 177 (mEQ/kg).

Blood samples were obtained 2 h after morning feeding. Determination of glucose concentration, blood urea nitrogen (BUN), and cholesterol and triglyceride levels were performed using special kits in the laboratory (Belbaskis and Tsirgogianni, 1996).

Statistical analysis

Statistical analyses of data were conducted by the GLM procedure of SAS (SAS, 2000). The difference between means was compared by Tukey's test and considered significant at P < 0.05. Test data were analyzed using a 4 × 4 replicated Latin square design as the following model:

$$y_{ij}(k)m = \mu + SQ_m + period(SQ)_{im} + cow(SQ)_{jm} + \tau(k) + \varepsilon_{ij}(k)_m$$

i, j, k= 1, ..., 4; m= 1, 2

Where:

$y_{ij}(k)_m$: observation $ij(k)_m$.

μ: overall mean.

SQm: effect of square m.

Period(SQ)im: effect of period i within square m.

Cow(SQ)jm: effect of cow j within square m.

$\tau(k)$: effect of treatment k.

$\varepsilon_{ij}(k)_m$: random error with mean 0 and variance σ2.

The experiment designed as two Latin squares with 4 treatments in 4 periods. This is also a change-over design with the effect of squares defined as blocks and so df= 1. This is same to blocking by sex (male and female). For more details see this reference (Kaps and Lamberson, 2004).

RESULTS AND DISCUSSION

There was no significant difference between the treatments for DMI; however, replacement of SBM with SSM affected (P<0.05) total milk yield, FCM, and FE (Table 2). As shown in Table 2, high milk production and FCM were observed for the diet containing 75% and 100% SSM compared with other diets, whereas lower FE was obtained for this treatment. Milk fat (%), solids non-fat (%) and MUN (mg/dL) were influenced (P<0.05) by SSM/SBM ratio, but there was no effect (P>0.05) for F/P ratio, lactose (%), milk protein (%) and total solid (%) during the experimental period (Table 3). In the current study, milk protein (MP) was reduced by enhancing the ratio of SSM to SBM, but TS was greater in the control diet. On the other hand, SSM to SBM ratio influenced (P<0.05 some blood metabolites (i.e., BUN, cholesterol and TG)), where the highest BUN (16.41 mg/dL) was present in cows on the control diet and higher cholesterol (203.5 mg/dL) and TG (16.82 mg/dL) was related to diet containing 75% SSM to SBM ratio. The glucose and calcium concentration in blood serum did not differ (P>0.05) among the experimental diets (Table 4). There was no significant difference among experimental groups for individual short-chain fatty acid (SCFA) and MCFA (Table 4).

Table 2 Effect of SSM/SBM ratio on dry matter intake, milk yield and FE of dairy cows

Item	T1 (Control)	T2 (50%)	T3 (75%)	T4 (100%)	SEM	P-value
Dry matter intake	21.6	21.1	21.3	21.0	0.2	0.3
Total milk yield	31.8^{a}	30.8^{c}	31.4^{b}	29.2^{d}	0.02	< 0.0001
4% FCM[2]	30.21	30.15^{a}	30.93^{a}	28.91^{b}	0.22	0.000
Feed Efficiency (FE)	1.44^{ab}	1.45	1.47	1.38^{b}	0.14	0.005

T1: control with all soybean meal ratio (SBM); T2: 50% of SBM replaced with sesame meal (SSM); T3: 75% of SBM replaced with SSM and T4: 100% of SBM replaced with SSM.
Fat corrected milk (FCM)= 0.4 × milk yield (kg) + 15 × fat yield (kg).
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 3 Effect of SSM/SBM ratio on milk composition in dairy cows

Item	T1 (Control)	T2 (50%)	T3 (75%)	T4 (100%)	SEM	P-value
Milk fat (%)	3.78	3.84	3.89	3.92	0.04	0.22
Milk fat (kg/day)	1.182^{ab}	1.18^{ab}	1.22^{a}	1.14^{b}	0.01	0.02
MP (%)	3.08	3.24	3.11	2.98	0.13	0.61
MP (kg/day)	0.96	1.0 01	0.97	0.87	0.04	0.18
F/P ratio[2]	1.23	1.19	1.26	1.32	0.06	0.52
TS (%)	11.83^{a}	11.62^{ab}	11.58^{ab}	11.44^{b}	0.07	0.02
TS (kg/day)	3.69^{a}	3.58^{b}	3.64^{ab}	3.34^{c}	0.02	< 0.0001
SNF (%)	8.31^{a}	7.86^{b}	8.42^{a}	7.42^{c}	0.08	< 0.0001
SNF (kg/day)	2.59^{a}	2.42^{b}	2.64^{a}	2.17^{c}	0.02	< 0.0001
Lactose (%)	4.28	4.26	4.36	4.23	0.08	0.67
Lactose (kg/day)	1.33^{a}	1.31^{ab}	1.33^{a}	1.24^{b}	0.01	0.009
MUN (mg/dL)	14.72^{a}	14.48^{ab}	14.24^{bc}	14.01^{c}	0.09	0.0008

T1: control with all soybean meal ratio (SBM); T2: 50% of SBM replaced with sesame meal (SSM); T3: 75% of SBM replaced with SSM and T4: 100% of SBM replaced with SSM.
MP: milk protein yield; F/P: fat to protein ratio; TS: total solid; SNF: solids non-fat and MUN: milk urea nitrogen.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 4 Effect of SSM/SBM ratio on blood metabolites in dairy cows

Item	T1 (Control)	T2 (50%)	T3 (75%)	T4 (100%)	SEM	P-value
BUN (mg/dL)	16.41	16.06	15.92	15.61^{b}	0.359	0.4815
Glucose (mg/dL)	52.74^{c}	54.20^{b}	55.23^{a}	55.48^{a}	0.1658	< 0.0001
Cholesterol (mg/dL)	199.003^{b}	199.35^{b}	203.500^{a}	199.84^{b}	0.3048	< 0.0001
TG (mg/dL)	15.25^{c}	16.08^{b}	16.82^{a}	15.81^{b}	0.1452	< 0.0001
Calcium (mg/dL)	11.78^{a}	11.52^{ab}	11.13^{b}	10.47^{c}	0.1437	< 0.0001

T1: control with all soybean meal ratio (SBM); T2: 50% of SBM replaced with sesame meal (SSM); T3: 75% of SBM replaced with SSM and T4: 100% of SBM replaced with SSM.
BUN: blood urea nitrogen and TG: triglyceride.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

For the cows fed the control diet, the content of C12:0, and C16:0 in milk were greater, whereas C18:0 was less. Compared with the other treatments, enhancing the proportion of SSM to SBM reduced (P<0.05) the concentration of C16:0 fatty acid in milk (Table 5), which can be due to differences in C16:0 and C18:0 fatty acids concentrations in SSM and SBM. There were high contents of C18:0 and cis-C18:3 in the cows fed SSM compared with cows fed the control diet.

Because the proportion of C18:0 to cis-C18:3 is normally transformed through the activity of Δ_9- desaturase in the mammary gland (Dhiman *et al*. 2005), the results obtained in the current study indicated that Δ_9-desaturase may be inhibited by one or more C18 fatty acids in the cows fed SSM. Although treatment had no effect on total SCFA, total MCFA was greater (P<0.05) for cows on the control diet compared with those on the diets with SSM (46.92% *vs*. 39.0%, Table 5).

Table 5 Effect of SSM on fatty acids in dairy cows

Item	T1 (Control)	T2 (50%)	T3 (75%)	T4 (100%)	SEM	P-value
C12:0	2.44	2.26	2.58	2.19	0.1907	0.4738
C14:0	9.46[a]	8.76[b]	9.01[ab]	8.18[b]	0.1548	0.0227
C16:0	32.27[a]	25.13[b]	25.26[b]	24.89[b]	0.2386	< 0.0001
C18:0	10.74[d]	14.52[a]	11.67[c]	12.44[b]	0.1350	< 0.0001
Cis-C18:1	25.12[c]	26.74[a]	25.75[bc]	26.14[ab]	0.1868	0.0002
SCFA	9.42[a]	7.84[c]	9.49[a]	8.56[b]	0.1351	< 0.0001
MCFA	46.92[a]	39.43[b]	39.84[b]	37.89[c]	0.233	< 0.0001
LCFA	43.94[d]	55.43[a]	51.36[c]	53.08[b]	0.2714	< 0.0001
MUFA	26.31[b]	27.26[a]	27.82[a]	27.63[a]	0.1686	< 0.0001
PUFA	5.16[c]	6.66[b]	8.21[a]	7.66[a]	0.1358	< 0.0001
SFA	63.53[a]	58.32[b]	57.33[c]	56.68[c]	0.2166	< 0.0001
UFA	31.84[c]	34.22[b]	36.81[a]	33.54[b]	0.1876	< 0.0001

T1: control with all soybean meal ratio (SBM); T2: 50% of SBM replaced with sesame meal (SSM); T3: 75% of SBM replaced with SSM and T4: 100% of SBM replaced with SSM.
SCFA: hort-Chain Fatty Acid; MCFA: medium-chain fatty acid; LCFA: long-chain fatty acid; MUFA: mono unsaturated fatty acids; PUFA: poly unsaturated fatty acids; SFA: saturated fatty acids and UFA: unsaturated fatty acids.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

In contrast, long-chain fatty acid (LCFA) was enhanced (P<0.05) by the SSM diets (53.29% *vs.* 43.94%). MCFA is largely synthesized de novo in the epithelial cells of the mammary gland; therefore, by increasing the dietary provision of certain LCFA, their synthesis may be prevented (Grummer, 1991). Considering human health, decreasing MCFA may be suggested as an improvement of the fatty acid concentrations of milk because MCFA constitutes the hypercholesterolemic portion of milk fat (Shingfield *et al.* 2013). Contents of PUFA, mono unsaturated fatty acids (MUFA) and unsaturated fatty acids (UFA) were enhanced (P<0.05) in the milk of cows fed increasing dietary SSM, whereas SFA for control cows was greater (P<0.05) than in cows consuming diets containing SSM.

Shirzadegan and Jafari (2014) found that replacement of SBM with SSM in dairy cows had no effect on BUN, DMI, MUN, glucose, and cholesterol. It was revealed that by adding of SSM into cattle diets, a significant difference would be observed in milk, milk fat, protein content of milk and SNF concentration.

Replacing SBM with SSM had no significant effect on cow's feed intake. Obeidat and Aloqaily (2010) reported that despite reducing feed costs, using 10-20% SSM had no effect on performance. While working with Awassi lambs, these researchers reported that replacement of 12.5-25% of SBM with SSM and barley seed reduced feed cost without any negative effect on performance. In broiler chicks, Farran *et al.* (2000) found that increasing the sesame hull level to 12% of the diet had a negative effect on feed conversion (FC) and weight gain (WG). In their research, the optimum level of SSM was suggested to be 8%. Khan *et al.* (1998), studied the effect of replacement of 50-100% poultry excreta with SSM cake on the development of bull calves.

Their results indicated that using SSM cake led to enhanced calf weight. In their research, Shirzadegan and Jafari (2014) suggested that increasing SSM levels in the diets of calves results in an enhancement of MF and TS, but caused a reduction of MP and SNF concentrations.

By increasing SSM/SBM from 50% to 75%, the amount of milk production was increased, however, this procedure was deductive for increasing SSM/SBM from 75% to 100%. The yield of milk fat was increased by increasing SSM/SBM in the level of 75%. Buttchereit *et al.* (2012) found that fat to protein ratio in milk indicates energy balance status in a lactation regimen and F/P was introduced as an appropriate variable for the adaption of cows with early lactation problems. In this regard, Paura *et al.* (2012) and Čejna and Chládek (2005) reported the optimum proportion of fat to protein as 1.1-1.5, and 1.2-1.4, respectively. In the present study, this rate was in normal range. Low F/P reported subclinical ruminal acidosis and a high incidence of acidosis was indicative of not receiving enough energy and potential or subclinical ketosis. In their research with Nordic Red cattle, Negussie *et al.* (2013) reported that the highest F/P ratio is obtained during early lactation; however, this rate is reduced during the mid-lactation period. Vlček *et al.* (2016) reported an F/P ratio during 30-50 DIM of about 0.30 ± 1.32. Based on the high C18:0 in milk, the cows fed SSM in the current study, milk fat content of cis-C18:1 was not influenced by experimental diets; however, the greatest content of this fatty acid was present in the 25% SSM/SBM diet (Table 5). The activity of Δ9-desaturase in the mammary gland normally transforms a portion of C18:0 to cis-C18:1 (Dhiman *et al.* 2005). The results of this study indicated that Δ9-desaturase may be inhibited by one or more of the C18 fatty acids absorbed by cows fed SSM diets (Rennó *et al.* 2013).

Treatment differences were not significant for any of the other trans fatty acids existing in milk fat. Treatments had no effect on total SCFA, but total MCFA was greater ($P<0.05$) for control (46.92% *vs.* 38.91%) than diets with SSM (Table 5). Conversely, LCFA in milk and taken up by the mammary gland from the blood were increased ($P<0.05$) by the SSM diets (53.29% *vs.* 43.94%). The MCFA are extensively synthesized de novo in the epithelial cells of the mammary gland; therefore, their synthesis can be prevented when the dietary provision of LCFA is increased (Grummer, 1991). In the terms of human health, reduction of MCFA may represent an improvement in the fatty acid profile of milk because MCFA constitutes the hypercholesterolemic portion of milk fat (Shingfield *et al.* 2013). Contents of UFA and PUFA were increased in the milk of cows fed by the SSM diets ($P<0.05$), whereas SFA was greater ($P<0.05$) for control than the SSM diets.

Treatments had no effect on contents of MUFA. The increased PUFA in the mammary gland caused in reduction of MCFA in milk from cows fed by SSM. The PUFA competed for esterification with MCFA synthesized in the mammary gland, causing a feedback inhibition of lipogenic enzymes (Caroprese *et al.* 2011). Liu *et al.* (2008) also observed a reduction in the milk concentrations of SCFA and MCFA when cows were fed diets containing SSM.

In current research glucose, cholesterol and calcium, there is no significant difference between test diets (Table 4); however, there was a significant difference among experimental diets for BUN and TG. Low concentration of BUN in the serum of cows fed SSM can be related to the low content of protein in SSM compared with SBM. Also, fat content in SSM can cause impairment of rumen function, and feeding of SSM tended to reduce protein digestion and ammonia-nitrogen concentration in the rumen resulting in a significant reduction in BUN. High concentration of TG in cows received SSM can be related to high concentration of fat content in SSM (Mohebbi-Fani *et al.* 2006).

In the current research, mechanically-processed SSM was used for the first time in feeding dairy cows, resulting in decreased feed cost. Based on the results of this study, it can be concluded that the inclusion of SSM in the diet did not affect DMI, whereas it resulted in significant differences in milk yield, milk fat, fat to protein ratio, SNF concentration. SSM significantly decreased concentration of MCFA and SFA but increased LCFA, PUFA, and UFA.

CONCLUSION

Overall, using SSM enhanced dairy cow performance significantly. The blood serum concentration of glucose, calcium, and cholesterol were not influenced significantly. Based on the economic benefit, SSM could be used for the replacement of SBM in the diet of lactating Holstein dairy cows. SSM improved milk fatty acids profile, as a health index of human nutrition, but regarding the rate of milk production, 75% substitution of soybean with sesame is appropriate.

REFERENCES

Abdullah A.Y. and Abdalhafes B.Y. (2004). Inclusion of Prosopis juliflora pods in finishing Awassi lamb diets. Pp. 373-375 in Proc. 11th AAAP Anim. Sci. Congr. Kuala Lumpur, Malaysia.

Al Jassim R.A.M., Ereifej K.I., Shipli R.A. and Abudabos A. (1998). Utilization of concentrate diets containing acorns (*Quercus aegilops* and *Quercus coccifera*) and urea by growing Awassi lambs. *Small Rumin. Res.* **29,** 289-293.

Alcaide M.E., Ruiz Y.D.R., Moumen A. and Garc M.A.I. (2003). Ruminal degradability and *in vitro* intestinal digestibility of sunflower meal and *in vitro* digestibility of olive by-products supplemented with urea or sunflower meal: Comparison between goats and sheep. *Anim. Feed Sci. Technol*. **110,** 3-15.

Belbaskis N.G. and Tsirgogianni D. (1996). Effect of dried citrus pulp on milk yield, milk composition and blood component of dairy cows. *Anim. Feed Sci. Technol*. **60,** 93-120.

Buttchereit N., Stamer E., Junge W. and Thaller G. (2012). Genetic parameters for energy balance, fat/protein ratio, body condition score and disease traits in German Holstein cows. *J. Anim. Breed. Genet*. **4,** 280-288.

Caroprese M., Albenzio M., Bruno A., Fedele V., Santillo A. and Sevi A. (2011). Effect of solar radiation and flaxseed supplementation on milk production and fatty acid profile of lactating ewes under high ambient temperature. *J. Dairy Sci*. **94,** 3856-3867.

Čejna V. and Chládek G. (2005). The importance of monitoring changes in milk fat to milk protein in Holstein cows during lactation. *J. Cent. Europ. Agric*. **4,** 539-546.

Chiofalo B., Liotta L., Zumbo A. and Chiofalo V. (2004). Administration of olive cake for ewe feeding: Effect on milk yield and composition. *Small Rumin. Res*. **55,** 169-176.

Denek N. and Can A. (2006). Feeding value of wet tomato pomace ensiled with wheat straw and wheat grain for Awassi sheep. *Small Rumin. Res*. **65,** 260-265.

Dhiman T.R., Nam S.H. and UreA. L. (2005). Factors affecting conjugated linoleic acid content in milk and meat. *Crit Rev Food Sci. Nutr*. **45,** 463-482.

Farran M.T., Uwayjan A.M., Miski A., Akhdar N.M. and Ashkarian V.M. (2000). Performance of broilers and layers fed graded levels of sesame hull. *Poult. Sci*. **9,** 453-459.

Ghorbani B., Teimouri Y.A. and Jafari S.A. (2018). Effects of sesame meal on intake, digestibility, rumen characteristics, chewing activity and growth of lambs. *South African J. Anim. Sci*. **48,** 151-161.

Grummer R.R. (1991). Effect of feed on the composition of milk fat. *J. Dairy Sci*. **74,** 3244-3257.

Hassan H.E., Elamin K.M., Elhashmi Y.H.A., Tameem E., Elbushra M.E. and Mohammed M.D. (2013). Effects of feeding different levels of sesame oil cake (*Sesamum indicum*) on performance and carcass characteristics of Sudan desert sheep. *J. Anim. Sci*. **3,** 91-96.

Jahani Moghadam M., Amanlou H. and Nikkhah A. (2009). Metabolic and productive response to ruminal protein degradability in early lactation cows fed untreated or xylose treated soybean meal based diets. *J. Anim. Physiol. Anim. Nutr*. **93,** 777-786.

Kaps M. and Lamberson W.R. (2004). Biostatistics for Animal Science. CABI Publishing, Wallingford, United Kingdom.

Khan M.J., Shahjalal M. and Rashid M.M. (1998). Effect of replacing till oil cake by poultry excreta on growth and nutrient utilization in growing bull calves. *Asian-Australasian J. Anim. Sci*. **4,** 385-390.

Lashkari S. and Taghizadeh A. (2015). Digestion kinetics of carbohydrate fractions of citrus by-products. *Vet. Res. Forum*. **6,** 41-44.

Liu Z.L., Yang D.P., Chen P., Lin S.B., Jiang X.Y., Zhao W.S., Li J.M. and Dong W.X. (2008). Effect of dietary sources of roasted oilseeds on blood parameters and milk fatty acid composition. *Czech J. Anim. Sci*. **53,** 219-226.

Mahgoub O., Kdim I.T., Al-Busaidi M.H., Annamalai K. and Al-Saqri N.M. (2007). Effects of feeding ensiled date palm fronds and by-product concentrate on performance and meat quality of Omani sheep. *Anim. Feed Sci. Technol*. **135,** 210-221.

Mahmoud A.E.M. and Bendary M.M. (2014). Effect of whole substitution of protein source by Nigella sativa meal and sesame seed meal in ration on performance of growing lambs and calves. *J. Glob. Vet*. **13,** 391-396.

Mohebbi-Fani M., Shekarforoush S.S., Dehdari M. and Nahid S. (2006). Changes of milk fat, crude protein, true protein, NPN and protein/fat ratio in Holstein cows fed a high concentrate diet from early to late lactation. *Iranian J. Vet. Res*. **7(2),** 31-37.

Negussie E., Strandén I. and Mäntysaari E.A. (2013) Genetic associations of test-day fat: Protein ratio with milk yield, fertility, and udder health traits in Nordic Red cattle. *J. Dairy Sci*. **96,** 1237-1250.

Obeidat B.S., Abdullah A.Y. and Al-Lataifeh F.A. (2008). The effect of partial replacement of barley grains by *Prosopis juliflora* pods on growth performance, nutrient intake, digestibility, and carcass characteristics of Awassi lambs fed finishing diets. *Anim. Feed Sci. Technol*. **146,** 42-54.

Obeidat B.S., Abdullah A.Y., Mahmoud K.Z., Awawdeh M.S., AL-Beitawi N.Z. and Al-Lataifeh F.A. (2009). Effects of feeding sesame meal on growth performance, nutrient digestibility, and carcass characteristics of Awassi lambs. *Small Rumin. Res*. **82,** 13-17.

Obeidat B.S. and Aloqaily B.H. (2010). Using sesame hull in Awassi lamb's diets: Its effect on growth performance and carcass characteristics and meat quality. *Small Rumin. Res*. **91,** 225-230.

Omar A.J.M. (2002). Effect of feeding different levels of sesame oil cake on performance and digestibility of Awassi lambs. *Small Rumin. Res*. **46,** 187-190.

Panwar K., Yadav R. and Sihag S. (2002). Mustard cake, as a source of dietary protein for growing lambs. *Small Rumin. Res*. **44,** 47-51.

Paura L., Jonkus D. and Ruska D. (2012). Evaluation of the milk fat to protein ratio and fertility traits in Latvian brown and Holstein dairy cows. *Acta Agric. Slovenia*. **3,** 155-159.

Rennó F., De Freitas E., Filho M., Verdurico C. and Barletta V. (2013). Effect of unsaturated fatty acid supplementation on digestion, metabolism and nutrient balance in dairy cows during the transition period and early lactation. *Rev. Bras. Zootec*. **42,** 813-823.

SAS Institute. (2000). SAS®/STAT Software, Release 8.1. SAS Institute, Inc., Cary, NC. USA.

Shingfield K.J., Bonnet M. and Scollan N.D. (2013). Recent developments in altering the fatty acid composition of ruminant-derived foods. *Animal*. **7,** 132-162.

Shirzadegan K. and Jafari M.A. (2014). the effect of different levels of sesame wastes on performance, milk composition and blood metabolites in Holstein lactating dairy cows. *Int. J. Adv. Biol. Biomed. Res*. **2,** 1296-1303.

Vlček M., Žitný J. and Kasarda R. (2016). Changes of fat-to-protein ratio from start to the mid lactation and the impact on milk yield. *J. Cent. Europ. Agric*. **17,** 1194-1203.