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The Effect of Different Levels of Sesame Wastes on Performance, Milk Composition and Blood Metabolites in *Holstein* Lactating Dairy *Cows*

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Abstract

The objective of this study was to determine the effect of different levels of *sesame* wastes (SW) on performance, milk composition and blood metabolites in lactating dairy *cows*. In this order, eight multiparous *Holstein* dairy *cows* were used in a replicated 4×4 Latin square design in four periods of 21 days. Treatments were control (no Sesame meal supplementation), and supplemented with 5, 10 and 15 % (dry matter [DM] basis) Sesame wastes respectively. Each period of experiments included 14 days for adaptation to diets and 7days for sampling. *Cows* were fed as total mix ration (TMR). The results showed that DMI, milk lactose, MUN, BUN and blood glucose and cholesterol were not affected by experimental diets (P>0.05). Nevertheless, milk yield average, milk fat, protein percentage, milk TS, SNF percentage, blood Ca and TG showed significant differences (P<0.05) between treatments and was the highest in control treatment. In addition, dry matter (DM) and organic matter (OM) digestibility were affected by adding sesame waste in diets (P<0.05) and was the highest in control treatment. Generally, showed that sesame waste (as a byproduct) has not obviously positive effects in *cows* nutrition.

Keywords: Lactating *Holstein cow*, *Sesame* waste, Digestibility, Blood metabolites

Introduction

The unprecedented jump in feed ingredient prices has directly affected many livestock producers because the government has scaled down the subsidy on *barley*, and market prices of milk do not compensate for the extra production cost. Therefore, producers are geared to use any available agro-industrial by-products such as *acorns* (Al Jassim et al. 1998), *olive* cakes (Alcaide et al. 2003; Chiofalo et al. 2004), *tomato* pomace (Denek et al. 2006), date *palm* (Mahgoub et al. 2007), *mustard* cake (Panwar et al. 2002), and *Prosopis juliflora* pods (Abdullah et al. 2003; Obeidat et al. 2008). Furthermore, a few studies have evaluated the effect of using *sesame* meal in livestock rations. In this case, reported that addition of *sesame* oil cake at levels 10% and 20% of diet, improves digestibility of protein and fiber in animals. Average the use of such by-products in livestock production will partially help producers to alleviate the effect of globally increasing feed costs, especially if there is no detrimental effect of inclusion on growth performance characteristics. *Sesame* seed is almost free of anti nutritional factors except high amount of

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oxalate and *phytic acid* it contains (Narasinga, 1985) which reduces the physiological value of calcium from the seed. Dehulling reduces the *oxalic acid* contents of the seed. The *sesame* seed contains about 50% oil and 20-25% protein (Obeidat et al. 2008). The residue *sesame* oil cake contains on an average 32% crude protein, 8-10 % oil, total oil and *albuminoids* of 40-42% and rich in essential amino acids namely methionine and cystine (Johri et al. 1988). Hence, the aim this research was to evaluate the feeding value of *sesame* wastes (SW) on performance and blood metabolites in lactating dairy *cow*.

Materials and methods

Cows, diet and treatments

Eight *Holstein* lactating dairy *cows* (60±15days in milk) with an average body weight (BW) of 650 kg were randomly assigned in a replicated 4×4 Latin square design with a 21-days period according to the parity. Each experimental period had 14 days of adaptation followed by 7 days for data collection. The experiment was carried out at the dairy barn of the Department of Natural Resources and Agricultural Research center of *Mazandaran*, Iran.

Table 1. Ingredient and chemical composition of diets[1]

Ingredient (% DM)	(0 % SW)	(5% SW)	(10% SW)	(15% SW)
Alfalfa hay	15	15	15	15
Corn silage	20	20	20	20
Wheat straw	5	5	5	5
Barely	23.6	26.1	26.6	27
Wheat bran	8.6	6.5	6.5	6.5
Cottonseed meal	12.3	8.8	5.3	1.8
Soybean meal	7.8	5.2	2.6	0.2
Sugar beet pulp	4.9	5.8	6.7	7.6
Sesame waste	0	5	10	15
Calcium-carbonate	0.93	0.69	0.45	0.2
DCP	0.1	0.1	0.05	0.04
Na HCO_3	0.7	0.7	0.7	0.7
Vita/Min premix[2]	0.6	0.6	0.6	0.6
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100

[1] Estimated from tabular values (NRC, 2001).
[2] (Vit/Min was as 50:50 mix), the mineral mix composition was as follows (amounts in 10 g): 0.5 g Mg, 0.3 g S, 1.0 g Na, 1.6 g Cl, 6.0 mg Cu, 0.3 mg I, 45.0 mg Fe, 58 mg Mn, 0.2 mg Se, and 22 mg Zn. The vitamin mix composition was as follows (amounts in 10 g): 4000 IU vitamin A palmitate, 1000 IU cholecalciferol, 53 IU vitamin E acetate, 0.5 mg menadione sodium bisulfite, 0.4 mg biotin, 11 µg cyanocobalamin, 2 mg folic acid, 30 mg nicotinic acid, 15 mg calcium pantothenate, 7 mg pyridoxine-HCl, 6 mg riboflavin, and 6 mg thiamin HCl.
(Na HCO_3 = *Sodium bicarbonate*).

Cows were placed in individual pens with concrete floors that were cleaned regularly and fed a total mixed ration (TMR) *ad libitum* intake. Diet consisted of 20 % *corn silage*, 15 % *alfalfa hay*, 5 % *wheat straw* and 60 % concentrate mix (dry matter [DM] basis) (Table 1). Treatments were control (no *sesame* meal supplementation), and supplemented with 5, 10 and 15 % (dry matter [DM] basis) *sesame* wastes respectively. *Cows* were fed twice daily at 08:00 and 1800: h allowing for 50–100 g orts/kg DM offered, which were weighed daily. The experiment was carried out at the dairy barn of the Department of Natural Resources and Agricultural Research center of *Mazandaran*, Iran. *Cows* were placed in individual pens with concrete floors that were cleaned regularly and fed a total mixed ration (TMR) *ad libitum* intake.

Water and mineralized salts stone were available for cows through the entire experiment. The diet was formulated to meet or exceed the recommendations of the NRC (2001). Sampling and chemical analyses individual ingredients (*alfalfa hay, corn silage* and concentrate mixtures) and the TMRs were sampled daily during the last 7 days of each period and composited by period. Orts were sampled daily during the last 7 days of each period. Samples were oven-dried at 55^{O} C for 48 h, ground through a- 1mm screen in a Wiley mill and analyzed for organic matter (OM), crude protein (CP) and neutral detergent fiber (NDF). Analytical DM content of the samples was determined by drying at 110^{O} C (ID 934.01; (AOAC, 2000) and OM content was calculated as the difference between DM and ash contents, with ash determined by combustion at 550 ^{O}C for 6 h. Neutral detergent fiber (NDF) without a heat stable *amylase* and expressed inclusive of residual ash was measured (Tecator, Fibertec System, 1010 heat extractor) according to the methods of a author (Van Soest, 1991). Fat was determined by extraction with ether using a *Soxtec* system HT apparatus (Tecator, 1043, Denmark) according to the Method 920.39 (AOAC, 2000) .Content of N in the samples were determined by *Kjeldahl* method in an automated *Kjelfoss* apparatus (Foss Electric, Copenhagen, Denmark). Body weight was measured at the beginning of the trial and the end of each period.

Blood metabolites

In the end of each experimental period has got 10 cc blood from each *cow* for consideration of blood parameters and immediately shipped to laboratory for analyze of glucose, cholesterol, triglyceride (TG), BUN and calcium.

Milk yield and samples

Cows milked three times per day at 04:00, 12:00 and 20:00 h. Daily milk yields were recorded throughout the experiment. Milk samples were collect on last 2 days of each experimental period for determining milk composition and analyzed for fat, protein, lactose, SNF and TS using Milko-Scan (133B Foss Electric). Milk urea nitrogen (MUN) was measured by official method of analysis (ID 967.07; (AOAC, 2000). Yields of 4% FCM were computed using the formula of 4% FCM = (0.265 x milk yield (kg) + 10.5 x. fat yield (kg) as stated by (Omar et al. 2002).

Digestibility measuring

In this experiment used the Cr_2O_3 5g/kg feed (that it is one of the external indicator) for identify of dry and organic matter digestibility. The next of 24h, sampled 500g from lately feces, sited into nylon bags, and maintained in 18^{O}C. Then with determine of indicator and dry and organic matters digestibility, definite the samples appear digestibility.

Feed conversion rate

Feed conversion rate was calculated as the amounts of dry matter intake required to produce 1 kg 4% FCM.

Statistical analysis

Data were analyzed using the GLM procedure of SAS® (SAS, 2000). Duncan's New Multiple Range Test (Duncan, 1955) was used to test mean differences at (P<0.05). The experimental data were analyzed as a 4×4 replicated Latin square design using the following model:

$$Y_{ijk\,(l)}=\mu +S_k + R_{i(k)} + C_{j(k)} +T_{(l)} +e_{ijk(l)}$$

Where $Y_{ijk(l)}$ was the amount each observation, μ is the overall mean, S_k is the effect of square, $R_{i(k)}$ is the effect of row, $C_{j(k)}$ is the effect of column, Ti is the effect of the treatments (i=1, 2 and 3) and $e_{ijk(l)}$ is the experimental error. Effects of the treatments were declared significant at (P<0.05).

Results

Performance

In this study, no significant differences were observed among the treatments regarding DMI, and FCM, but the MYN, MYN, MYA, total milk yield and FCR were affected by SW supplementation as significantly (P<0.05) (Table 2), which the highest milk yield and the lowest FCR were related to control group.

Table 2. Effect of sesame waste on dry matter intake, milk yield and FCR of dairy cow

Items	Control	5[1]	10	15	SEM
Dry matter intake	20.88 ± 1.6	21.18 ± 2.1	21.78 ± 1.2	21.30 ± 1.0	1.14
MYM (kg/day)	11.38^{a} ± 2.4	10.50^{ab} ± 0.5	10.88^{ab} ± 1.1	10.38^{b} ± 1.1	0.26
MYN (kg/day)	10.50^{a} ± 1.9	10.13^{ab} ± 1.0	9.75^{b} ± 0.8	9.63^{a} ± 0.9	0.12
MYA (kg/day)	9.35^{ab} ± 1.2	10.25^{a} ± 1.1	9.50^{ab} ± 1.0	9.25^{b} ± 1.7	0.26
Total milk yield	31.25^{a} ± 1.8	30.88^{ab} ± 2.7	30.13^{ab} ± 1.8	29.25^{b} ± 0.8	1.14
4 % FCM	29.60 ± 1.2	29.71 ± 3.2	29.13 ± 1.7	28.72 ± 1.0	2.49
FCR	0.67^{b}	0.69^{b}	0.72^{ab}	0.73^{a}	0.01

1- Levels of *sesame* wastes.

MYM: Milk yield in morning; MYN: Milk yield in noon; MYA: Milk yield in afternoon; FCR: Feed conversion rate.

Means with different superscript within a row are different significantly (P<0.05).

Milk composition

The SW had a significant effect on the milk fat (%), milk protein (%), TS (kg/day) and SNF (P<0.05)., but had no any significant influence on the lactose and MUN during experiment (P>0.05) (Table 3). This study, sesame wastes (SW) decreased the TS and SNF and increased the milk fat in *cows* followed by control.

Blood metabolites

On the other hand, some of the blood metabolites (calcium and TG) were affected by SW administration in diet (P<0.05), that the highest calcium (11.42 mg/dl) and the lowest TG (15.25 mg/dl) were belong to control, but there was no significant different for BUN, glucose and cholesterol between groups (P>0.05) (Table 4).

Table 3. Effect of sesame waste on milk composition in dairy cow.

Items	Control	5[1]	10	15
Milk fat (%)	3.65^{c} ± 0	3.75^{b} ± 0.28	3.78^{b} ± 0.1	3.88^{a} ± 0.1
Milk fat (kg/day)	1.14 ± 0	1.16 ± 0.15	1.14 ± 0	1.13 ± 0
MP[2] (%)	3.08^{ab} ± 0	3.25^{a} ± 0.45	2.88^{ab} ± 0.1	2.83^{b} ± 0
MP (kg/day)	0.96^{a} ± 0	1.00^{a}± 0.10	0.87^{b} ± 0	0.83^{b}± 0
TS[3] (%)	11.87 ± 0.3	11.70 ± 0.24	11.22 ± 0.3	11.24 ± 0.4
TS (kg/day)	3.71^{a} ± 0.1	7.61^{ab} ± 0.22	7.38^{bc} ± 0.1	7.29^{c} ± 0
SNF[4] (%)	8.22^{a} ± 0.2	7.96^{ab} ± 0.31	7.43^{b} ± 0.2	7.36^{b} ± 0.3
SNF (kg/day)	2.57^{a} ± 0.1	2.46^{a} ± 0.22	2.24^{b} ± 0.1	2.15^{b} ± 0
Lactose (%)	4.25 ± 0	4.27 ± 0.10	4.24 ± 0.1	4.23 ± 0.2
Lactose (kg/day)	1.33 ± 0	1.32 ± 0.15	1.28 ± 0	1.24 ± 0
MUN (mg/dl)	14.95 ± 1.1	14.30 ± 2.84	14.21 ± 2.4	13.68 ± 3.2

1- Levels of *sesame* wastes. 2- MP: Milk protein 3- Total solid. 4- Solid non fat. Means with different superscript within a row are different significantly (P<0.05).

Table 4. Effect of sesame waste on blood metabolites in dairy cow

Items (mg/dl)	Control	5[1]	10	15	Pooled SEM
BUN	16.48 ± 1.5	16.10 ± 0.9	15.93 ± 2.9	15.58 ± 2.8	0.481
Glucose	52.50 ± 5.6	53.75 ± 6.5	54.50 ± 5	55.00 ± 7.4	17.145
Cholesterol	198.7 ± 15	199.0 ± 11	200.7 ± 11	199.2 ± 13.5	31.137
TG[2]	15.25^{a} ± 1.2	16.00^{ab}± 0.9	16.75^{bc} ± 1.2	17.75^{c}± 1.5	0.645
Calcium	11.42^{a} ± 0.9	11.14^{a} ± 0.5	11.01^{a} ± 0.6	10.66^{a} ± 1.1	0.629

1- Levels of *sesame* wastes. 2- Triglyceride

Means with different superscript within a row are different significantly (P<0.05).

Dry and organic matter digestibility

Furthermore, the different levels of SW induced a significant effect on the dry and organic matter digestibility's in cows (P<0.05) (Table 5). So that, the highest and the lowest ingredients (dry and organic matter) digestibilities were related to control and 15% SW treatments respectively.

Discussion

The achieved data from investigation of effect of substitution of the *sesame* wastes (SW) in diet on dry matter intake of dairy *cows* represents, the *cows* fed with control diet to 20.88 kg/day had the lowest DMI and *cows* fed with 10 % SW to 21.78 kg/day had the highest DMI among groups. Although, there was the null hypothesis for performance parameters, this study similar to others has shown the substitution of *barley* grain and *soybean* meal with *sesame* wastes reduces the unit production cost of the diets and thus improved profitability. It is due to the low cost of *sesame* wastes compared to the current price of *barley* grain and *soybean* meal. Therefore, this study has shown the economic advantages of using *sesame* wastes in the diets of lactating dairy *cow*. As well as, Obeidat et al. (2010) reported also a reduction in cost when *sesame* hull was included at levels of 12.5% and 25% in diets of *Awassi lambs* is also one of the obtained similar results. In (Table 2) showed that there are significant different in FCR and milk yield between treatments. *Cows* fed with control diet and 10% SW had the lowest (20.88 kg/day) and the highest (21.78) dry matter intake respectively, that was not significant (P>0.05). *Sesame* wastes inclusion in the diet of dairy cow improved dry matter intake in 10% SW fed groups compared to 0% and 15% SW groups.

Table 5. Effect of sesame waste on digestibility in dairy cow.

		Treatments			
Studied Characteristics	Control	5[1]	10	15	SEM
Dry matter Digestibility (g/kg DM)	68.35^{a} ± 4.3	66.12^{b} ± 3.9	64.23^{c} ± 3.2	61.15^{d} ± 4.8	0.947
Organic matter Digestibility (g/kg DM)	70.52^{a} ± 2.8	68.42^{ab} ± 3.5	67.11^{b} ± 3.1	62.46^{c} ± 3.7	2.504

1- Levels of *sesame* wastes.

Means with different superscript within a row are different significantly (P<0.05).

Thus, it is safe to conclude that the presence of SW at a 10% level in the diet, did not affect on palatability. A done research by Obeidat et al. (2009) reported similar results when *sesame* meal was fed to *Awassi lambs* at 8% of the diet. Obeidat et al. (2010) investigated the effect of feeding sesame hull in *Awassi lambs* and found that intake improved when included at levels of 12.5 and 25%.
In addition, the groups fed with control diet have shown the highest milk production and the best FCR and the groups fed with 15 % SW diet have shown the lowest milk yield and the worst FCR. It seems the main cause in milk yield reduction with increase of SW replicating in diet be due to dry matter intake reduction in animals. Likewise, Farran et al. (2000) found that weight gain and feed conversion ratio of starter *broiler chicks* was reduced when the level of sesame hull in their diets increased to 12%. Similarly, when *sesame* hull was fed to laying *hens* at up to 28% of the diet, body weight and egg production decreased and feed conversion ratio increased. In contrast, Khan et al. (1998) evaluated the effect of replacing *til* (*sesame*) oil cake with *poultry* excreta on growth and nutrient utilization at levels of 50 and 100% in growing *bull calves*. They found that animals fed with *til* oil cake gained more live weight than those fed the control diet. Furthermore, found that body weight change was similar when sesame meal was fed at a level of 200 g/d in goats (Herano et al. 2002). During a study, Omar et al. (2002) reported that sesame meal addition at 10% and 20% levels improved digestibility of crude protein and fiber, average daily gain, feed conversion ratio, and cost of feed/kg gain in growing *Awassi lambs* when compared to a commercially fed ration. However, in our study dry matter digestibility was not affected by the inclusion of *sesame* oil cake (Omar et al. 2002). The achieved data from investigation of effect of substitution of the *sesame* wastes in diet on milk composition of dairy *cows* indicated there are significant variations in milk fat, milk protein, TS and SNF among various treatment groups during the experiment period. The cows fed diet containing 15 % SW with 3.88 percent the highest and cow fed control diet with 3.65 percent had the lowest milk fat. Grain in dairy cows diet could be effective premier source on digestible energy requirement for maintenance of high milk production. Overfed grain in spite of milk production stimulate reduce the milk fat percentage and outcomes changes in milk fatty acids. However, in this study the grain amount was equal. About of 60 % long chain fatty acids milk fat generated from diets and SW are contain high levels these fatty acids, which can arises milk fat (Omar et al. 2002).
Furthermore, this study was showed no significant variation in lactose among various treatment groups during the experiment periods. MUN is one of the milk normal ingredients and constitute almost 20 to 70 % of milk NPN. As well, MUN concentrations in milk could be affected by the diets nutrient density and nutrient availability for rumen *microorganisms*. However, in present experiment the MUN not affected by *sesame* wastes substitution in diets. The cow received 5 % SW and 15 % SW had the highest and the lowest milk protein percent as significantly. Decrease of milk protein density in this study could be related to high fat intake that it induces an *insulin* resistance in amino acids absorption. According to Table 5, probably reduce in milk total solid (TS) in supplemented diets with SW were because of milk calcium decreasing. *Cows* fed diets containing 15% SW and control had the highest and the lowest SNF respectively. Of the effective factors in this case can implies to *forage*: *concentrate* ratio and season effects. However, the season in present study was similar for all groups
Our study was showed no significant variation in blood glucose, cholesterol and BUN among various treatments during the experiment period. According to Table 3, the highest blood urea nitrogen (BUN) was produced by *cows* fed 15 % SW and the lowest was related to control *cows*. The lowest glucose and cholesterol was also produced by control diet. Can indicate that fats inducing a disorder in rumen functions and as result decreased protein digestion and ammonia density in rumen and lastly occurs BUN reduction. Meantime, the highest and the lowest calcium were observed in control and 15 % SW respectively. The reasons of this decrease is probably for unnutritional effects of oxalic acid and phytic acid in sesame wastes that inducement a complex to calcium and as a result reduced the calcium absorption.
In the current study, results indicated that the digestibilities of DM, OM were affected by inclusion of *sesame* wastes in diets of lactating dairy *cow*. The lowest and the highest dray and organic matters

digestibility were observed by cow fed 15 % *sesame* wastes and control diets respectively. Omar et al. (2002) reported that the digestibilities of CP and CF were greater in *lambs* fed diets containing *sesame* oil cake, whereas DM digestibility was not affected. Khan et al. (1998) found that when *til* oil cake was replaced by *poultry* excreta, the DM and nitrogen-free extract digestibilities were not affected, but CP and CF digestibilities were higher in the group supplemented with *til* oil cake. In addition, digestibilities of DM, OM, CP, and EE were not affected when *Awassi lambs* were fed with sesame meal (Obeidat et al. 2009). Moreover, found that DM digestibility was higher when *goat kids* were fed *sesame* oil cake supplemented with mineral mixture. Thus, it is clear that using *sesame* hull as an alternative feed ingredient is applicable in feeding black *goat kids* without affecting nutrient digestibility (Hossain et al. 1989). In our study, seems that unnutritional factors (such as *oxalic acid* and *phytic acid*) in *sesame* wastes are main reason in decrease of organic and dry matters digestibility.

Conclusion

From the results of the present study, it can be conclude that inclusion of *sesame* wastes in diet of dairy *cows* not affects on the DMI, BUN, MUN, glucose, and cholesterol. But, induced significant different on the milk yield average, milk fat, protein percentage, milk TS, SNF percentage, blood Ca and TG. Furthermore, the milk fat percent, milk protein percent, milk production average, TS and SNF in control diet were higher than supplemented diets. Overall, in spite of slightly decrease in *cows'* performance following to *sesame* waste consumption, SW had not heavy negative effects on the dairy *cows*. So it could be substitutions instead of soybean quantities in diet.

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