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Research Article
Productive Performance of Damascus Dairy Goat's Fed on Rations Containing Extruded Full-Fat Linseed and Soybean Seeds

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Abstract
Background and Objective: Functional foods became important, plus containing essential nutrients to achieves health benefits. So, this study aimed to examine the effects of the inclusion of full-fat linseed and soy seed in an extruded form on the performance of dairy Damascus goats. **Materials and Methods:** Sixty dairy goats divided into 4 groups (40±1 kg live weight, 2nd and 3rd lactation seasons) as follow: (R_1) control ration (CR) consisted of concentrate feed mixture (CFM) and corn silage, (R_2) CR with extruded linseed (ELS) by 2.5% and Extruded Soybean Seeds (ESS) by 2.5% in CFM, (R_3) CR with ELS by 5% in CFM and (R_4) CR with ESS by 5% in CFM. Milk yield recorded, milk composition, fatty acids, digestibility and blood parameters determined. **Results:** Data of total digestible nutrients cleared that R_3 and R_4 were significant (77.14 and 77.15%, respectively). Milk yield recorded an increase with R_4 more than other rations by 23 and 26% with R_1, 18 and 16% with R_2 and 7 and 16% with R_4 as actual and corrected fat. Milk fat was significantly higher with R_3 (3.14%) compare with other rations. Values of linolenic acid C18:3 was higher with R_3 (0.57%, linseed) by 119% compare with R_4 (soybean) followed by R_2 (mix) by 90% then R_1 by 16%. Blood cholesterol was higher with R_4 (34 mg dL^{-1}) followed by R_2 (22 mg dL^{-1}), R_3 (19.20 mg dL^{-1}) and R_1 (9.6 mg dL^{-1}). **Conclusion:** Summing up, the addition of oilseed especially linseed in the extruded form had a positive significant effect on the performance of dairy goats.

Key words: Dairy, goats, extruded, linseed, soybean, milk, fatty acids, blood parameters

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

It is believed that producing healthier milk for consumers back to a positive relationship among essential fatty acids (FAs) composition in the milk and dietary source of fat especially polyunsaturated fatty acids (PUFA) contents such as conjugated linoleic acid (CLA) concentration[1], therefore, the diet fat content as an energy source for dairy animals is the main factor that influences milk fat and fatty acids composition. So, types of fat sources used in dairy rations have been reported when given differential forms such as encapsulated oils[2], calcium salts of palm oil FA[3], whole oilseeds[1], crushed oilseeds[4] as well as oil after extract[5], Moreover, the response of supplementation with plant oils and seeds such as soybean, sunflower, peanut (high linoleic acid) and linseed (high linolenic acid) produced milk with higher vaccenic acid (VA) and CLA contents have been reported[6,7]. Besides, an increase of CLA and VA in milk fat was also observed in experiments that used untraditional oils such as olive oil[7] and canola oil[8].

Linseed (*Linum usitatissimum*) and soy seed (*Glycine max*) are considered common oilseeds in livestock feeds (ruminants, poultry and fish) in different forms (oil or meals) because attracted attention as a lipid supplement for dairy cattle due to their high significant concentrations of alpha-linolenic acid (ALA) (omega-3, C18:3 n-3) and linoleic acid (omega-6, C18:2 n-6), an essential fatty acid that is not synthesized by mammals and resulting in healthier milk for the consumer. Linseed contains about 40% oil (50-70% of α-linolenic acid (ω-3 fatty acids)), 20% protein and 30% neutral detergent fiber[9-11], which makes it an interesting feed ingredient for inclusion in lactating dairy cows' rations as a source of both energy and protein. On the other hand, full-fat soybean is consisting of 17-20% oil and 36-44% protein on a dry matter basis[1] and mainly used in animal diets as meal form because are very palatable and are easily fed in different feeding systems, such as top-dressed on silages, part of the total mixed ration or in a grain mix[12].

Soya bean seeds and linseeds may be successfully fed to dairy animals in raw form (as full-fat seeds), roasted, rolled, crushed or ground. Grinding or rolling processing may increase utilization, depending on the total ration and may make handling easier, however, grinding or rolling may increase the risk of rancidity for raw soybeans and linseeds. The type of processing may affect oil release in the rumen and influence utilization[13]. The oil release in rumen could be a toxic effect of polyunsaturated fatty acids (PUFA) on ruminal microbial growth through bio-hydrogenation processes and decreased the abundance of cellulolytic bacteria[14]. Moreover, increasing inclusion of fats or oil levels in the diets of the ewes and goats resulted in a linear increase of milk fat content whereas, decreased milk protein in cows and ewes but not in goats[15,16]. Other reports by Chilliard *et al.*[17] observed a substantial increase in the VA and CLA content in the milk fat of goats given dietary supplements of free oil from linseed or sunflowers. The use of free oil higher than 2% of the diet is not recommended, because it inhibits rumen microbial activity[18]. The whole crude oilseeds were not as efficient as free linseed or sunflower oils in increasing VA and CLA in goat milk fat[17].

Recently, the extrusion process has been used to increase the ruminal availability of soy oil, in contrast, roasting may slow the rate of release of soy oil into the rumen[19]. In cows, the use of heat-treated oilseeds (e.g., extruded oilseeds) has shown a positive influence on VA and CLA concentration in milk fat compared with raw oilseed[6,20]. Also, the proposed of processing oilseeds with heat may have effects on ruminal lipid digestion could be caused by a modification of the seed coat protection, a reduction of the amount of polyunsaturated fatty acids subjected to bio-hydrogenation or the production of oxidation products[21]. Many investigations are examining the effect of heat-treated soybeans on the performance of dairy cows[19,20,22,23] however, they were primarily designed to examine the effect of the heating process on protein degradability.

Therefore, this study aimed to investigate the effects of extruded full-fat linseed and soybean seeds in the diets of dairy Damascus goat's on milk yield, milk composition and fatty acids profile of their milk, digestibility and blood parameters.

MATERIAL AND METHODS

Study area: This study was carried out at Reda Mansour Farm, in Elnobaria city, Alexandria, Egypt (June-July, 2018) regarding field trial, analysis of feeds, faeces, blood and milk take place in the Department of Animal Production, Faculty of Agriculture, Cairo University, Giza and Department of Dairy Sciences, National Research Centre, Giza, Egypt, through the period from August, 2018-March, 2020.

Experimental oil seeds: Two oilseeds were used in extruded forms (linseed and soybean seeds) in this study. They were exposed to the extruding process for 90 sec at 150°C with 130 rpm speed by using the SX85-II Twin-screw extruder from Shandong LUERYA Machinery Manufacturing Co., Ltd. No. 114, Dougou Industrial Park, Shizhong District, according to Harper[24]. The chemical composition and fatty acids profile of the experimental oilseeds according to Chouinard *et al.*[25] showed in Table 1.

Experimental animals: Sixty dairy Damascus goats in average live weight (40 kg±1 kg), lactation seasons 2nd and 3rd with average daily milk yield 1300 g. Goats were divided into 4 groups each group contained 15 goats according to the season of lactation and live body weight. The experiment took place 60 days divided into the periods, 30 days preparation period then samples collected two times each 15 days. Samples were collected during 3 consecutive days in each period.

Experimental rations: The experimental rations for the experimental animal's groups were as follow: all of the treatments fed corn silage plus concentrate feed mixture (CFM), Roughage: Concentrate ratio was 50:50 in all groups to cover the total requirements of energy and protein needed for dairy goats' maintenance and milk production according to NRC[26]. Formulation of experimental concentrate feed mixtures presented in Table 2. The chemical composition of corn silage used in the feeding trial was as follows 7.2% crude protein, 26.80% crude fibre, 2.30% ether extract, 42.10% neutral detergent fibre and 25.60% acid detergent fibre.

Feeding procedures: The concentrate feed mixtures were offered to all animals after milking time (6 am and 4 pm). Corn silage was offered ad libitum for all animals but the quantities were recorded. Water was always available.

Milk recording and sampling: Goat's milk was obtained by hand milking system two times daily at 6 am and 4 pm. The daily milk yield was individually recorded and corrected to 4% FCM by the following formula according to Gaines[27]:

$$\text{FCM (\%)} = 0.4 * \text{milk yield} + 15 * \text{fat yield}$$

During the 3 days, collection period the milk samples were individually collected from each and stored at (-18°C) for further analysis.

Digestion trials: At the end of the experiment faeces samples were withdrawn by the end of each experimental period at 6 am for three successive days from each animal from the rectum, then dried at 70°C for 24 hrs. Dried faeces samples were kept individually in polyethylene bags for chemical analysis. Digestion coefficients were calculated for all animals by the acid insoluble ash (AIA) method, using silica as an

Table 1: Chemical composition and fatty acids profile of extruded seeds

Items	Full fat linseed	Full fat soy seed
Dry matter (%)	94.00	90.00
Crude protein (%)	22.80	41.70
Lipid (ether extract) (%)	35.00	18.80
Ash (%)	3.96	7.25
Crude fiber (%)	28.55	10.23
Fatty acids		
Palmitic acid, C16:0	5.52	13.90
Stearic acid, C18:0	4.90	5.72
Oleic acid, C18:1n-9	19.40	23.60
Vaccenic acid, C18:1n-7	0.74	1.30
Linoleic acid, C18:2n- 6	14.73	50.36
Linolenic acid, C18:3n-3	53.4	4.53
Arachidic acid, C20:0	0.18	0.40
Gadoleic acid, C20:1n-9	0.13	ND
Behenic acid, C22:0	0.15	0.19
Non identified fatty acids	0.65%	ND

*ND: Not detected

Table 2: Formulation of the experimental concentrate feed mixture (CFM) (gm /100 gm)

	Experimental concentrate feed mixtures			
Items	CFM_1	CFM_2	CFM_3	CFM_4
Yellow corn, 7.8 % CP	56.00	48.50	41.00	56.00
Wheat bran, 14% CP	25.00	32.50	40.00	25.00
Soybean meal 42%	14.50	9.50	9.50	9.50
Limestone	2.00	2.00	2.00	2.00
Salt	1.00	1.00	1.00	1.00
Sodium bi-Carbonate	1.00	1.00	1.00	1.00
*Premix	0.30	0.30	0.30	0.30
Toxin binder	0.10	0.10	0.10	0.10
Yeast, 45% CP	0.10	0.10	0.10	0.10
Extruded linseed, 22% CP	0.00	2.50	5.00	0.00
Extruded soybean, 41.7% CP	0.00	2.50	0.00	5.00
Total	100.00	100.00	100.00	100.00

*Each 3 kg contained vitamin A:7500000 IU, vitamin D_3: 2000000 IU, vitamin E: 25000 mg, Zinc: 40 g, Manganese: 40 g, Iron: 50 g, Copper: 15 g, Iodine: 8 g, Cobalt: 4 g, Selenium: 3 g and carrier CaCo3 up to 3 kg, CFM_1: Control concentrate feed mixtures, CFM_2: With extruded linseed and soy seeds, CFM_3: With linseed and CFM_4: With extruded soybean seeds internal marker according to Van Keulen and Young[28]. Nutrients digestibility were calculated according to the following formula:

$$\text{Digestion coefficient} = 100 - \left[100 \times \frac{\text{Indicator in the feed}}{\text{Indicator in feces}} (\%) \times \frac{\text{Nutrient in feces}}{\text{Nutrient in the feed}} (\%) \right]$$

Nutritive values as total digestible nutrients calculated according to McDonald *et al.*[29] as follows:

$$\text{TDN (\%)} = [\%\ \text{digestible CP} + \%\ \text{digestible CF} + \%\ \text{digestible NFE} + (\%\ \text{digestible EE} * 2.25)]$$

Blood sampling: On the final day of the sampling period, blood samples were individually taken from the jugular vein of individual animals. Blood samples were directly collected into clean dried heparinized glass tubes and centrifuged at 4000 rpm for 20 min. Blood plasma was then transferred into a clean dried glass vial then stored at -18°C until the chemical analysis.

Milk analysis and fatty acids profile: Chemical analysis of milk fat, protein, solids not fat, total solids and ash were determined by using Master Classic Ultrasonic Milk Analyzer. Milkotester Ltd. 49 Hristo Botev Str., 4470 Belovo, Bulgaria. One gram from each milk sample to determine the fatty acids profile was dissolved in 10 mL hexane and 1 mL of sodium methoxide (5.4 M) in methanol solution. After strong vertexing for 1 min, 1 mL of the clear hexane layer was extracted by filtering through PTFE membrane, transferred into 2 mL GCMS vial from which 2 μL was injected for GCMS analysis, Instrument used: GC/MSD 5977A, Agilent, USA, Column used: Agilent, DB225 60 m×250:m×0.25: m. Oven program: 40EC for 1 min then 7.2 EC min^{-1} to 195 EC, 2.3 EC min^{-1} to 230 EC for 15 min Inlet: Split mode, split ratio 25:1 Liner Agilent 5190-2294: 990: L Inlet Temperature: 250 EC. Auxiliary temperature: 250 EC.

Feed and feces analysis: Samples of feeds, rations and faeces were analyzed for DM (A.O.A.C[30], method 934.01), ash (no. 942.05), crude protein (no. 968.06), crude fibre (A.O.A.C. no. 942.05) and ether extract (no. 942.05) according to A.O.A.C.[31]. The Organic Matter (OM) was calculated as the difference between DM and ash contents. Also, nitrogen-free extract calculated by difference according to the following Eq.:

$$\text{NFE (\%)} = 100 - (\%\ \text{secondary moisture} + \%\ \text{ash} + \%\ \text{CP} + \%\text{EE} + \%\text{CF})$$

Neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were analyzed sequentially (Van Soest *et al.*[32]) using the ANKOM200 (ANKOM Technology 2052 O'Neil Road, Macedon NY 14502).

Blood plasma analysis: Blood plasma constituents were determined using commercial kits. Total protein and creatinine were determined as described by Tietz[33] and Walker[34], albumin was determined according to Doumas *et al.*[35], urea was determined according to Patton and Grouch[36]. Blood plasma triglycerides were determined according to Lopes *et al.*[37] and Bucolo and david[38] and plasma cholesterol was measured according to Allain *et al.*[39].

Statistical analysis: Data were analyzed using the general linear model procedure of SAS[40]. One-way ANOVA procedure used to analyze data following the next model:

$$Y_{ij} = \mu + R_{ij} + E_{ij}$$

where, μ is the overall mean of Y_{ij}, R_{ij} is the treatment effect, E_{ij} is the experimental error. The differences among means were separated according to Duncan's New Multiple Range Test (Duncan's[41]).

RESULTS AND DISCUSSION

Chemical composition of the experimental rations: Chemical composition and fibre fractions contents of the experimental rations in the Table 3 cleared that rations were closest in all values except ether extract (EE) content was higher in R_3 (8.94%) followed by R_4 (7.22%) then R_2 (5.77%) compared with control diet R_1 (4.27%). These variances reflected the addition of Full-fat extruded oilseeds, where R_3 contained 5% full-fat linseed with 35% fat mixture and R_2 contained 5% Full-fat soy seeds with 18.8% fat. Ration two contained 2.5% of each type of oilseeds.

Digestibility and nutritive values: Results of digestion coefficients and nutritive values shown in Table 4 revealed that no significant differences among all rations in DM digestibility. however, R_2 (mix of linseed and soy seed) recorded lower significant values in OM, CP, CF, NFE and NDF digestibility comparing with control and other experimental rations. The ratio in R_3 linseed recorded the highest values of fat digestibility (90.71%) compared to the rations. On the other hand, non-significant differences were observed among all ration treatments of ADF digestibility.

Table 3: Chemical composition of the experimental rations

Items	Experimental rations R_1	R_2	R_3	R_4
DM	89.10	89.10	88.97	89.77
OM	93.00	92.10	92.84	90.96
Ash	7.00	7.90	7.16	9.04
CP	14.16	14.16	14.19	14.11
EE	4.27	5.77	8.94	7.22
CF	14.59	14.82	15.13	15.37
NFE	59.99	57.35	54.59	54.27
Fiber fraction				
NDF	36.68	37.43	36.26	34.58
ADF	14.90	14.51	15.32	14.96
ADL	1.80	3.10	2.60	2.20
Hemicellulose	21.78	22.92	20.94	19.62

R_1: Control ration, R_2: Ration with extruded linseed and soybean seeds, R_3: Ration with linseed and R_4: Ration with soybean seeds, DM: Dry matter, OM: Organic matter, CP: Crude protein, EE: Ether extract, CF: Crude fibre, NFE: Nitrogen free extract, NDF: Neutral detergent fibre, ADF: Acid detergent fibre

Table 4: Digestion coefficient and nutritive values of the experimental rations

Items	Experimental rations R_1	R_2	R_3	R_4	±MSE	p-value
Nutrients digestibility (%)						
Dry matter (DM)	77.24	77.35	76.01	79.56	0.63	0.247
Organic Matter (OM)	79.52^{ab}	74.01^{c}	78.53^{ab}	81.46^{a}	1.08	0.059
Crude Protein (CP)	82.18^{a}	74.03^{c}	77.99^{ab}	80.10^{ab}	1.23	0.086
Crude Fiber (CF)	71.81^{a}	57.81^{c}	66.59^{ab}	71.97^{a}	2.14	0.028
Ether Extract (EE)	84.88^{b}	86.70^{b}	90.71^{a}	86.32^{b}	0.67	0.012
Nitrogen Free Extract (NFE)	72.93^{ab}	66.65^{c}	71.37^{ab}	75.36^{a}	1.37	0.127
Neutral Detergent Fiber (NDF)	67.96^{a}	52.20^{c}	60.17^{ab}	64.41^{a}	2.28	0.050
Acid Detergent Fiber (ADF)	51.84	54.73	52.73	52.81	1.50	0.941
Nutritive values (%)						
Total Digestible Nutrients (TDN)	74.65^{ab}	69.06^{c}	77.14^{a}	77.15^{a}	1.26	0.041
Digestible Crude Protein (DCP)	11.70	10.65	11.06	11.30	0.19	0.264

[a,b,c]Means in the same row within each treatment having different superscripts differ (p<0.05). R_1: Control ration, R_2: Ration with extruded linseed and soybean seeds, R_3: Ration with linseed and R_4: Ration with soybean seeds

Meteab *et al.*[1] explained the positive effect of linseed addition by 10% to dairy Damascus goats' rations through the higher possibility of escaping from mastication so, increased passage rate from the rumen and packaging the fat and protein in such a way not to negatively affect rumen function. In the same context, Khorasani *et al.*[42], Syed *et al.*[43] and Kim *et al.*[44], suggested that oilseeds promote feed intake, increase the energy content of the diet and give partial protection versus microbial attack or reduce the impact of oil on ruminal microbial or both, leading to negligible effect on the digestion of fibres as well as improved CP digestibility.

Nutritive values expressed as total digestible nutrients (TDN) and digestible crude protein (DCP) in Table 4 showed that experimental seeds achieved higher values in TDN in case of separate inclusion in the ratio (R_3: 77.14% and R_4: 77.15%) but the (R_2) ration recorded the lower value (69.06%) comparing with control ration (R_1:74.65%). At the same time, no significant differences were observed among treatments in DCP, 11.7, 10.65, 11.06, 11.30 with R_1, R_2, R_3 and R_4, respectively. These results agreed with those findings by Meteab *et al.*[1] when dairy goat ration contained 10% whole linseed.

Milk yield and milk composition: Data in Table 5 cleared that ration three with extruded linseed recorded the highest (p = 0.002) daily milk production (1481 g day) by 19% more than the control ratio followed R_4 and R_2. The same trend of actual milk yield observed fat corrected milk where results being, 1290, 1108, 1080 and 1021 g/day with R_3, R_4, R_2 and R_1 (p<0.05). Results of the chemical composition of milk cleared the positive (p<0.05) effects of linseed in R_3 on milk fat contents 3.14% compared with other rations showed in Table 5. On the other hand, the ratio with soybean seeds recorded a lower value of 2.68% and that was lower than the ratio with a mix of two extruded seeds (R_2:3.08%) and control ratio (R_1:3.00%). Regarding other contents of milk, protein, lactose, lactose, total solids, solids not fat and ash did not observe any significant differences among experimental

Table 5: Milk production and composition

Items	Experimental rations				±MSE	p-value
	R_1	R_2	R_3	R_4		
Milk yield						
Actual, g h^{-1}/day	1201^d	1253^c	1481^a	1382^b	36.10	0.002
4% Fat Corrected Milk (FCM)	1021^d	1080^c	1290^a	1108^b	30.26	0.000
Milk composition						
Fat (%)	3.00^b	3.08^b	3.14^a	2.68^c	0.11	0.020
Fat yield (gm)	36.03	38.59	46.50	37.03	1.27	0.000
Protein (%)	3.28	3.29	3.33	3.33	0.05	0.957
Protein yield (gm)	39.40	41.22	49.31	46.02	1.20	0.000
Lactose (%)	4.97	5.03	5.05	5.06	0.07	0.956
Total Solids (TS)	12.04	12.05	12.33	11.89	0.24	0.930
Solid Not Fat (SNF %)	9.04	9.11	9.19	9.21	0.14	0.957
Ash (%)	0.80	0.79	0.81	0.82	0.01	0.886

[a,b,c]Means in the same row within each treatment having different superscripts differ ($p<0.05$). R_1: Control ration, R_2: Ration with extruded linseed and soybean seeds, R_3: Ration with linseed and R_4: Ration with soybean seeds

rations. Generally, Nudda *et al.*[45] determining factors it could affect the chemical composition of milk, in terms of fat content and its fatty acid profile as follow: diet (composition and availability), animal (breed, lactation stage, body condition) and environmental (especially cold and heat stress). In the same context, Hermansen[46], Dhiman *et al.*[47] cleared that the addition of oilseeds in dairy rations have been many advantages when its inclusion in the diet. The oil in the seed is believed to be slowly released when the seed is masticated, which may help decrease detrimental effects on rumen fermentation (Harfoot and Hazelwood[48]) and increase the efficiency of milk fat synthesis[49,50].

The same trend was observed with Meteab *et al.*[1] when linseed used by 10% in Damascus dairy goats' rations. These results may be due to improvement in nutrients digestibility, which is leading to increased nutrients availability for milk constitutes synthesis. Similar observations were reported by Chilliard and Ferlay[51] who generally observed that increase dietary lipids led to increasing milk yield, Gomez-Cortes *et al.*[52] in ewes, Hurtaud *et al.*[53] in dairy cows and Abd El-Aziz *et al.*[54] in dairy buffaloes with linseed. Also, higher fat corrected milk (FCM) and fat content% in the milk of R_3 fed goats were attributed to high-fat content of linseed consequently high energy source. Moreover, Bernard *et al.*[55] and Bionaz *et al.*[56] found that fats as dietary supplements encourage the nutrient toward the mammary gland instead of toward fat deposition in the adipose tissue and activate the lipogenic gene expression at the mammary gland, leading to an increase in milk fat secretion. Moreover, the use of whole linseed and soybean seeds as protected fatty acids inside a seed coat did not disturb rumen function so, increased mammary lipogenesis because of the increased supply of unsaturated fatty acid (Table 6). Gargouri *et al.*[57] and Nudda *et al.*[58] consistent with the current results, in sheep conversely, Martin *et al.*[59] reported decreased FCM yield and fat content on feeding lactating Holstein cows on extruded linseed and linseed oil diets and they explained these findings by lower DMI and lower digestibility of fibre due to the high level of oil intake. However, Petit[10] reported no change in milk yield with the feeding of (13.3%) whole linseed and Petit and Cortes[60] when feeding of (72 and 36 g kg^{-1} DM) the whole linseed. Increased milk protein concentration numerically in R_3 and R_4 fed goats may be due to the increased CP digestibility (Table 4) and increase blood total protein and albumin (Table 7). Nudda *et al.*[58] agreed with the present results, who reported that linseed supplementation to Saanen goats led to increased milk protein concentrations because of higher protein availability in the intestine. Milk total solids (TS) were increased with an increased level of linseed supply (R_3) than the other groups. This may be due to the increasing content of fat and protein in milk. These results agreed with Silva-Kazama *et al.*[61] with dairy cows.

Milk fatty acids: Data of milk fatty acids profile in Table 6 cleared the positive effects of extruded oil seeds on long-chain fatty acids contents. Whereas the R_4 with soybean seeds recorded higher values ($p<0.05$) with C14, C15 and C16 being 10.18, 1.36 and 34.52%, respectively than other experimental rations. Regarding C18 isomers fatty acids, The R_3 (linseed ration) observed the highest values oleic (C18:1c, 35.70%) and linolenic (C18:3, 0.57%) incomparable with other groups of goats. Many researchers had been explained that the milk fatty acid (FA) profile can be modified to increase the proportion of monounsaturated and unsaturated fatty acids (UFA) and decrease the proportion of medium-chain FA by supplying oilseed to dairy rations[62-64]. A wide range of positive health effects has been demonstrated for PUFA by lowering

Table 6: Effect of the experimental rations feeding on milk fatty acids profile

	Experimental rations					
Items	R_1	R_2	R_3	R_4	±MSE	p-value
Undecylic, C11:0	0.45	0.43	0.31	0.44	0.04	0.567
Lauric, C12:0	4.56[a]	3.09[b]	3.02[b]	3.10[b]	0.20	0.000
Tridecylic, C13:0	1.16[a]	0.64[c]	0.46[c]	0.68 [ab]	0.10	0.055
Myristic, C14:0	10.0[b]	9.19[c]	9.19[c]	10.18[a]	0.15	0.006
Myristoleic, C14:1	1.27[a]	0.85[ab]	0.59[c]	0.75 [ab]	0.11	0.143
Pentadecanoic, C15:0	0.75[c]	1.31[b]	1.05[c]	1.36[a]	0.08	0.000
Pentadecenoic acid (cis-10), C15:1	0.38[a]	0.10[c]	0.37[b]	0.31[c]	0.03	0.000
Palmitic, C16:0	30.57[b]	31.37[b]	30.59[b]	34.52[a]	0.53	0.002
Palmitoleic, C16:1	2.43[a]	1.99[c]	2.24[b]	1.91[c]	0.07	0.000
Margaric, C17:0	0.54[c]	0.84[ab]	1.08[a]	0.64[c]	0.08	0.071
Heptadecanoic C17:1	0.28[a]	0.17[b]	0.03[c]	0.03[c]	0.04	0.006
Stearic, C18:0	7.81	9.23	8.50	8.14	0.40	0.697
Oleic, C18:1c	33.29[ab]	34.15[ab]	35.70[a]	31.50[c]	0.53	0.008
Linoleic, C18:2c	5.88	5.74	5.68	5.86	0.04	0.269
Linolenic, C18:3	0.30[c]	0.49[b]	0.57[a]	0.26[d]	0.04	0.000
Arachidic, C20:0	0.21[c]	0.29[a]	0.28[b]	0.20[c]	0.02	0.026
Gadoleic, C20:1	0.12	0.12	0.16	0.12	0.08	0.180
SFA	56.05[b]	56.39[b]	54.48[b]	59.26[a]	0.58	0.003
USFA	43.95[a]	43.61[a]	45.34[a]	40.74[b]	0.56	0.003
MUFA	37.77[a]	37.38[a]	39.09[a]	34.62[b]	0.55	0.004
PUFA	6.18	6.23	6.25	6.12	0.25	0.998

[a,b,c]Means in the same row within each treatment having different superscripts differ ($p<0.05$). R_1: Control ration, R_2: Ration with extruded linseed and soybean seeds, R_3: Ration with linseed and R_4: Ration with soybean seeds. SFA: Saturated Fatty Acids, USFA: Unsaturated Fatty Acids, MUFA: Monounsaturated Fatty Acids and PUFA: Polyunsaturated Fatty Acids

Table 7: Effect of the experimental rations feeding on blood parameters of lactating animals

	Experimental rations					
Items	R_1	R_2	R_3	R_4	±MSE	p-value
Total protein (g dL^{-1})	3.63	3.46	3.71	3.92	0.18	0.846
Albumin (g dL^{-1})	2.04	2.14	2.15	2.12	0.07	0.959
Triglycerides (mg dL^{-1})	21.23	25.98	29.61	24.58	2.52	0.741
Cholesterol (mg dL^{-1})	9.60[b]	22.00[ab]	19.20[b]	34.00[a]	2.95	0.013
Urea (mg dL^{-1})	10.24	11.52	10.29	15.38	1.07	0.301
Creatinine (mg dL^{-1})	0.74	0.78	0.68	0.69	0.03	0.712

[a,b]Means in the same row within each treatment having different superscripts differ ($p<0.05$). R_1: Control ration, R_2: Ration with extruded linseed and soybean seeds, R_3: Ration with linseed and R_4: Ration with soybean seeds

insulin resistance associated with cardiovascular disease[65,66]. Thus, increasing the concentration of PUFA in milk may be beneficial to public health and enhance the consumption of dairy products.

Blood parameters: Results of blood samples in Table 7 cleared that no significant differences among experimental animal groups with different rations in blood constituents except cholesterol contents. Whereas total protein, albumin and creatinine had the closest values in all experimental groups. Numerically R_3 recorded higher values 29.61 mg dL^{-1} in triglycerides compared with other rations being 25.99, 24.58 and 21.23 with R_2, R_4 and R_1, respectively. On the other hand, blood urea recorded a higher value with R_4 15.38 mg dL^{-1} comparing with 11.52, 10.29 and 10.24 mg dL^{-1} with R_2, R_3 and R_1, respectively. These results agreed with Li *et al.*[67] because the addition of lipid to animal diet generally increased plasma lipid contents. The same trend was observed with Rafalowski and Park[68], when dairy cows fed on diets that contained whole sun flower seeds and amounts increased from 10 to 30% in the concentrate compare with control cows. Also, Cozma *et al.*[69] noticed the increase in total blood lipids when dairy goats fed on hemp seed oil by 4.7% from daily dry matter, at the same time there was a significant difference in lipids fraction in blood.

Generally, the results of the study cleared that oilseeds such as linseed and soybean could be used in the extruded form to replace up to 5% of soybean meal in goat rations. Also, data of digestion coefficients and feeding values confirmed those seeds consider in a full-fat extruded form considered a good source of energy and protein in dairy goats. At the same time, the addition of oilseeds had effects positively on the milk fatty acids profile of goats.

CONCLUSION

Results of milk yield, milk fat and fatty acids profile of milk cleared the significant effects of linseed addition in the extruded form with dairy goats. Results of soybean addition individually were not promising that may be related to fatty acid profile and some of the anti-nutritional factors, so this issue needs more investigation with the Damascus goats. Generally, there were appositive effects of oilseeds on digestibility, milk and fatty acids without any adverse effects on blood parameters, so we suggest using extruded linseed in goats ration to achieve high yield milk production and beneficial milk fatty acids profile for both newcomers and humans and more immune boosters in blood.

SIGNIFICANCE STATEMENT

This study discovers the possible effect of using extruded linseed in dairy goats rations alone or combination with Full-fat soy seeds in milk yield, milk fatty acids profile and blood parameters. Results indicated that the milk fatty acids profile of dairy goats could be changed by changing the feed formula structure to produce functional milk with a high concentration of polyunsaturated fatty acids. This study will help researchers for more investigations on different oilseeds or with different levels for linseeds and soybean seeds.

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