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Research Article
Quality Enhancement of Edam-Like Cheese Made From Goat's Milk

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Abstract
In the present work, Edam-like cheese was made from Zaraibi goats' milk. The milk originated from goats fed on diets supplemented with low canola seeds (LCS, 5%) and high canola seeds (HCS, 10%), low sunflower seeds (LSFS, 7%) and high sunflower seeds (HSFS, 14%) of concentrated feed, the control goats fed without oil seeds. The Results indicated that hexanoic acid, 4-methyl octanoic acid, 4-ethyl octanoic acid, nonanoic acid, 3-methylbutanoic acid and decanoic acid significantly ($p<0.05$) decreased in the most treatments compared to the control of goat's milk. During ripening of Edam-like cheese, fresh samples had negligible increment of goaty flavor compounds that decreased after 15 weeks of storage. The HSFS cheese yield was the highest followed by LSFS, LCS, HCS treatments then control, the weight loss% took an opposite direction. Compared to the control, experimental Edam-like cheese had lower hardness, total viable, lipolytic, proteolytic bacteria, mold and yeast counts, salt/DM% and higher ripening indices, moisture, fat/DM, protein% and pH-values. The HSFS Edam-like cheese exhibited the highest organoleptic scores followed by LSFS, HCS and HCS then the control.

Key words: Oilseeds, goat's milk, Edam-like chees, goaty flavour compounds

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

INTRODUCTION

Edam cheese is a semi-hard cheese that originated in the Netherlands, Edam which has aged for at least three months. Edam ages, travels well and doesn't spoil; it only hardens. These qualities (among others) made it the world's most popular cheese. Recently, Edam cheese production locally increased due to increment of demand for it.

Daily, there is an increase number of children suffering from intolerance to cow's milk (Zweifel *et al*., 2005), goats milk has therapeutic (e.g., higher digestibility and lower allergenic properties) and nutritional benefits (Haenlein, 2004). The national US dairy products judging procedures list "goaty" as one of the four odor characteristics of bad versus good milk and dairy products. Well-produced and well-handled goat's milk is indistinguishable in taste and odor from quality cow milk. Although, goat's milk has a higher content of the strong smelling caproic, caprylic and capric acids than cow's and buffalo's milk (Park *et al*., 2007). Goat's milk fat normally has 35% of medium chain fatty acids (C6-C14) compared to cow milk fat 17 percent and three strong smelling are named after goats: caproic (C6), caprylic (C8), capric (C10) and totaling 15% in goat milk fat versus only 5% in cow milk fat. These volatile acids liberate with improper producing and handling because of thinness and friable fat globule membrane of goat's milk which is easily broken and then enzymes are liberated that can produce odors (Haenlein, 2002). Several aroma compounds responsible for the specific "Goaty flavour" have been identified: 3-methylbutanoic acid, octanoic acid, 4-methyloctanoic acid, 4-ethyloctanoic and nonanoi acid. These fatty acids are released by lipolysis (Carunchia Whetstine *et al*., 2003).

However, goat's milk cheese now is a fashionable commodity in many countries. In Egypt, many consumers do not prefer it because of its irritating or pungent flavor.

Many attempts were done to decrease the irritating or goaty flavor. Whereas it can be affected by feeding, environmental conditions, the presence of the belly while milking and the type of milk treatment. Heat treatment resulted in a general increase of volatile compounds of milk, leading to changes in flavour characteristics (Contarini and Povolo, 2002). Therefore, this research was an attempt to quality enhancement of Edam-like cheese made from zaraibi goats milk as affected by adding some oil seeds to goat rations.

MATERIALS AND METHODS

In a previous study (Abou Ayana and El-Shabrawy, 2015), 35 lactating Zaraibi goats were randomly divided into 5 groups (7 does each) and received 1 of 5 experimental diets (Table 1). Diets were formulated to contain (% of DM) 40% berseem hay and 60% Concentrate Feed Mixture (CFM) (control, diet 1), Low Canola Seeds (LCS, 5% of CFM as DM, diet 2), High Canola Seeds (HCS, 10% of CFM as DM, diet 3), low sunflower seeds (LSFS, 7% of CFM as DM, diet 4) and high sunflower seeds (HSFS, 14% of CFM as DM, diet 5). The CFM consisted of 22% yellow maize, 26% wheat bran, 32% undecorticated cotton seed cake, 5% linseed meal, 9% rice bran, 3% molasses, 2% limestone and 1% sodium chloride. Fresh resulting goats milk was obtained from the 5 groups of lactating goats, canola seeds (*Brassica napus*), variety Serw4 used in this study are characterized by free erucic acid in oil, low glucosinolate in the seeds, produced in EL-Serw, Agriculture Research Station, oil crops section, Agricultural Research Center, Ministry of Agriculture, Egypt. Sunflower seeds were also obtained from there.

Commercial culture: *Lactococcus lactis* subsp. *lactis*, *Lactococcus lactis* subsp. *diacetylactis*, *Lactococcus lactis* subsp. *cremoris* citrate positive and *Leuconostoc mesenteroides* subsp. *cremoris* and powder calf rennet (Ha-LA) were obtained from Chr. Hansen's Laboratory, Copenhagen, Denmark. Clean, food grade, cooking salt was obtained from local market; calcium chloride and solution annatto and a solution mixture of wax composed of white soft paraffin wax, pellet honey and medical vaslin at a ratio of 1:1:0.2, respectively were purchased from El-Gomhoria Co., Cairo, Egypt.

Table 1: Treatments of Edam-like cheese based on formulation of the experimental diets for lactating goats (% of DM)

	Experimental diets (%)*				
Ingredients	Control (diet 1)	LCS (diet 2)	HCS (diet 3)	LSFS (diet 4)	HSFS (diet 5)
Berseem Hay (BH)	40	40	40	40	40
Concentrated Feed Mixture (CFM)	60	55	50	53	46
Canola Seeds (CS)	-	5	10	-	-
Sunflower seeds (SFS)	-	-	-	7	14

*LCS: Low canola seeds (5%), HCS: High canola seeds (10%), LSFS: Low sunflower seeds (7%) and HSFS: High sunflower seeds (14%)

Milk portions were well mixed; 500 mL was taken from each batch for determine goaty flavor compounds and chemical analysis of milk portions (Table 2).

Cheese manufacture: The procedure of Edam-like cheese was used for making described by Scott (1981), making with some modifications. The milks were heated to 72°C for 15 sec and then cooled to 30°C, annatto solution was added (6 mL/100 kg milk), inoculated with 1% of commercial culture (*Lactococcus lactis* subsp. *lactis*, *Lactococcus lactis* subsp. *diacetylactis*, *Lactococcus lactis* subsp. *cremoris* citrate positive and *Leuconostoc mesenteroides* subsp. *cremoris*) and thoroughly mixed with the milk. After that, calcium chloride was added at the rate of 0.02% of cheese milk. When the acidity reaches 0.19%, rennet was added at the rate of 3 g powder rennet per 100 kg cheese milk. As the curd become firm enough, almost within 30 min it was cut. Scalding was accomplished by raising the temperature gradually to 37°C in about one hour with continuous stirring. This led to the curd to be sufficient firm and the acidity of whey reached 0.12%, the curd was drawn to one end of the vat and whey was drained off. A slight pressure was applied on the curd to help the whey to run of easily. The curd was put in molds of about 8 cm in depth and about 10 cm in diameter with four holes in the bottom for drainage and have around cover. After that the molds were covered and put in pressed for 3 h with a direct pressure of 150 lb in-2. The cheese was turned once every hour during pressing. After complete pressing the cheese was immersed in 20% brine for 24 h at 5°C. After salting the green cheese was weighed and placed for 2 days in a ripening room for surface drying. The cheese was carefully coated with wax. Resultant cheese was kept in the ripening room at 8-12°C, at 80-85% relative humidity for 15 weeks.

Goaty flavour compounds were determined as described by Metcalfe and Schmitz (1961) gas liquid chromatography using Varian 370 (4% OV-101+6% OV-210). The condition of separation were as following; Column type: chromw H P 80/100 2 m×0.35 mm; Carrier gas: helium or nitrogen; Flow rate: 25mg min^{-1} Column temp: 80-200°C; Loading: 0.1-0.2 µL detector temp.: 200°C and programming gradient: 8 °C min^{-1}.

Chemical and microbial analysis of Edam-like cheese samples were conducted according to AOAC (2003) include moisture%, protein%, pH, Dry Matter (DM), fat, salt, Total Nitrogen (TN), Soluble Nitrogen (SN), None Protein Nitrogen (NPN), Amino Acid Nitrogen (AAN) soluble tyrosine, soluble tryptophane and Total Volatile Fatty Acids (TVFA). However, methyl esters of fatty acids of milk lipids were analyzed according to the method described by Chouinard *et al.* (1997). Microbial testes include total viable, proteolytic, lipolytic bacterial counts, moulds and yeasts counts. Spore-forming bacteria, coliform group, *Staphylococcus aureus* and *Salmonella* spp. and *L. monocytogenes* were determined too on selective media.

The organoleptic properties of cheese samples were examined as described by ADSA (1987) with maximum score points of 50, 35 and 15 for flavour, body and texture and appearance respectively). Data were subjected to statistical analysis by the computer program of SAS (1996) using the General Linear Model (GLM).

RESULTS AND DISCUSSION

Goaty Flavour Compounds (GFC): The effects of feeding lactating goats on supplemented rations with canola seeds (LCS, 5% and HCS, 10%) or sunflower seeds (LSFS, 7% and HSFS, 14%) on milk Goaty flavor compounds were summarized in Table 3. Hexanoic acid, 4-methyl octanoic acid, 4-ethyl octanoic acid, decanoic acid, nonanoic acid and 3-methylbutanoic acid significantly ($p<0.05$) decreased in all treatments compared to the control (ration without oil seeds). The LSFS or HSFS sharply decreased these compounds against LCS, HCS or control, a significant difference was not detected between HCS and control in the most compounds. Moreover, HSFS milk had the lowest level of these compounds (5.31, 0.37, 0.21, 40.13, 1.84 and 0.59, respectively). Conversely, control

Table 2: Milk composition of portions of goat's milk made Edam-like cheese

		Treatments (experimental diets)*				
Constituents	Control	LCS	HCS	LSFS	HSFS	±SE
Fat (%)	3.65[d]	3.72[b]	3.81[a]	3.74[b]	3.76[a]	0.021
Protein (%)	2.88[b]	3.23[a]	3.14[a]	3.20[a]	3.22[a]	0.075
Lactose (%)	4.55[a]	4.40[d]	4.41[d]	4.38[e]	4.41[d]	0.040
Total Solids (TS)	11.58[d]	12.18[a]	12.02[c]	12.09[b]	12.26[a]	0.041
Solids Not Fat (SNF)	7.93[d]	8.46a[b]	8.21[c]	8.35[b]	8.50[a]	0.039

*LCS: Low canola seeds (5%), HCS: High canola seeds (10%), LSFS: Low sunflower seeds (7%) and HSFS: High sunflower seeds (14%)

Table 3: Goaty flavor compounds (as % of TVFA) in raw milk produced from goats fed rations supplemented with oil seeds (canola seeds or sunflower seeds)

		Goat's milk					
Goaty flavor compounds	Cow's milk	Control	LCS milk	HCS milk	LSFS milk	HSFS milk	±SE
Hexanoic acid	4.73^{e}	8.94^{a}	8.12^{b}	8.74^{a}	7.53^{c}	5.31^{d}	0.380
4-methyl octanoic acid	-	1.23^{a}	0.81^{b}	1.11^{a}	0.56^{c}	0.37^{d}	0.023
4-ethyl octanoic acid	-	0.83^{a}	0.62^{b}	0.84^{a}	0.39^{c}	0.21^{e}	0.018
Decanoic acid	41.74^{e}	49.32^{a}	47.12^{b}	48.05^{a}	42.11^{c}	40.13^{d}	0.820
Nonanoic acid	1.05^{e}	2.41^{a}	2.08^{b}	2.28^{a}	2.02^{b}	1.84^{c}	0.029
3-methylbutanoic acid	0.65^{d}	1.21^{a}	0.73^{c}	0.89^{b}	0.68^{d}	0.59^{e}	0.015

Means within the same row having different superscripts are significantly different (p<0.05), LCS: Low canola seeds (5%), HCS: High canola seeds (10%), LSFS: Low sunflower seeds (7%) and HSFS: High sunflower seeds (14%)

Table 4: Effect of treatments on yield and weight loss% of Edam-like cheese during ripening period

	Treatments										
	Control (%)		LCS cheese (%)		HCS cheese (%)		LSFS cheese (%)		HSFS cheese (%)		
Ripening period (weeks)	Yield	Weight loss	Yield	Weight loss	Yield	Weight loss	Yield	Weight loss	Yield	Weight loss	±SE
Fresh	12.81^{d}	-	14.23^{b}	-	12.93^{d}	-	13.51^{c}	-	14.73^{a}	-	0.048
3	11.87^{d}	7.34	13.25^{b}	6.88	11.98^{d}	7.34	12.79^{c}	5.33	13.97^{a}	5.15	0.043
6	11.60^{d}	9.44	12.98^{b}	8.78	11.71^{d}	9.43	12.38^{c}	8.36	13.75^{a}	6.65	0.041
9	11.41^{d}	10.92	12.71^{b}	10.68	11.52^{d}	10.90	12.15^{c}	10.06	13.41^{a}	8.96	0.037
12	11.11^{e}	13.27	12.68^{b}	10.89	11.38^{d}	11.98	11.99^{c}	11.25	13.20^{a}	10.38	0.031
15	10.75^{d}	16.10	12.43^{b}	12.65	11.22^{c}	13.22	11.82^{c}	12.50	12.98^{a}	11.88	0.027

Means within the same row having different superscripts are significantly different (p<0.05)

milk recorded the highest level of these compounds. Cow's milk was the lowermost than all treatments and the control; it was free of 4-methyl octanoic acid and 4-ethyl octanoic acid but was slightly higher decanoic acid and 3-methylbutanoic acid than HSFS.

Supplementation of goats' rations with oil seeds changed the ruminal fermentations thus these compounds decreased; this was confirmed by chemical analysis of ruminal fermentation products, milk and fatty acid profile of milk fat (Abou Ayana and El-Shabrawy, 2015). El-Zawahry (2003) claimed that he could reduce the level of goaty flavour compounds by heat treatments of goats' milk before manufacturing Edam cheese.

Yield and weight loss%: It was necessary to estimate the yield and weight loss % of Edam- like cheese during ripening period because it was very important for the economic standpoint. Data listed in Table 4, indicated that HSFS milk significantly (p<0.05) produced the greatest yield of Edam-like cheese followed by LCS, LSFS and HCS then control. Cheese yield is affected by many factors including milk composition, amount and genetic variants of casein, milk quality, somatic cell count in milk, milk pasteurization, coagulant type, vat design, curd firmness at cutting and manufacturing parameters. Thus, the improvements of cheese yield due to some previous factors such as milk composition particularly the increment of fat and protein, total solids, milk quality, lowing of somatic cell count that caused by the oil seeds in goats rations (Abou Ayana and El-Shabrawy, 2015) who also obtained similar results for Labneh made from the same treatments. Cheese yield increases with the increment of fat and protein of milk (Guo *et al*., 2004). Interestingly, the weight loss% of stored Edam-like cheese took a completely opposite direction, weight loss % of HSFS cheese was the lowest and it reached 11.8% after 15 weeks in ripening room, this ratio increased to 12.5, 12.65, 13.22 and 16.10% for LSFS, LCS and HCS then control of Edam-like cheese, respectively. Simply, these results indicated that the previous treatments increased the fresh or ripened cheese yield and declined weight loss%, this certainly have a significant degree of economic benefit.

Microbiological quality: To evaluate the microbial quality of Edam-like cheese, total viable, proteolytic, lipolytic bacterial counts and molds and yeasts viable counts were determined. These microbial counts are ripening indices during storage, availability of hygiene conditions during the manufacturing and storage lead to expectation the taste quality and consumer scalability of cheese. Significantly (p<0.05), HSFS cheese has the lowest counts of all previous microbial parameters followed by LSFS cheese, LCS cheese, HCS cheese then the control sample that contained the greatest counts of those microorganisms (Table 5). This confirms the increment of microbial quality of these treatments compared to the control sample. During analyses, it was noted that the pressurization of Edam-like cheese at 150 lb in-2 inch did not affect the total, proteolytic and lipolytic bacterial count. Yet, during its ripening, the numbers of bacteria were observed to decrease distinctly, i.e., after 15 weeks of ripening bacterial

Table 5: Some microbial quality parameters of Edam-like cheese made from treated goats milk

Microbiological properties	Storage period (w)	Treatments					±SE
		Control	LCS cheese	HCS cheese	LSFS cheese	HSFS cheese	
Total viable bacterial count ($\times 10^6$ CFU g^{-1})	0	205	168	175	155	147	0.005
	9	96	62	66	51	36	
	15	57	25	27	19	13	
	Means	119.3^a	85^c	89.3^b	75^d	65.3^e	0.002
Proteolytic bacterial count ($\times 10^4$ CFU g^{-1})	0	91	81	85	76	71	0.005
	9	43	44	46	41	33	
	15	18	17	18	15	11	
	Means	50.6^a	47.3^c	49.6^b	44^d	38.3^e	0.002
Lipolytic bacterial count ($\times 10^3$ CFU g^{-1})	0	97	91	95	88	86	0.005
	9	50	45	47	43	41	
	15	23	17	18	14	12	
	Means	56.6^a	51^c	53.3^b	48.3^d	46.3^e	0.001
Molds and yeasts viable count ($\times 10$ CFU g^{-1})	0	--	--	--	--	--	0.002
	9	1.9	1.5	1.6	1.4	1.3	
	15	2.3	1.8	1.9	1.7	1.6	
	Means	1.40^a	1.10^c	1.16^b	1.03^d	0.96^e	0.001

Means within the same row within each category having different superscripts are significantly different at ($p<0.05$), Data after 3, 6 and 12 weeks not shown, LCS: Low canola seeds, HCS: High canola seeds, LSFS: Low sunflower seeds and HSFS: High sunflower seeds

counts reached 13×10^6, 11×10^4 and 12×10^3 from 147×10^6, 71×10^4 and 86×10^3 for total, proteolytic and lipolytic bacterial count in HSFS cheese, respectively. These results are confirmed by the findings of Kuzmicka *et al.* (2007). The presence of pathogenic bacteria such as *Salmonella, L. monocytogenes* and *Staphylococcus aureus* in milk or dairy products as cheese is likely to pose a risk to consumer health. Literature data indicate the possibility of a substantial reduction in the number of *L. monocytogenes* in cheese as a result of pressurization. Szczawinski *et al.* (1997) confirmed that the pressure treatment of cheese at 500 MPa for 15 min decreased the number of bacteria by six orders of magnitude. There are very rare data on the effect of pressure on pathogenic bacteria. Salmonella, *L. monocytogenes* and *Staphylococcus aureus* were not detected in Edam-like cheese so data not shown.

The growth of undesirable microflora may lead to numerous defects in cheese, the most common of which is the so-called "early blowing of cheeses". This defect is due to the growth of coli group bacteria (Wuytack *et al.*, 2002). In contrast, the so-called "late blowing of cheese" is probably caused by the growth of saccharolytic bacilli of the genus *Clostridium* (Su and Ingham, 2000). All analyzed samples were free of coliform group. The spore-forming bacteria are likely to occur in dairy and pressurized products due to the considerable resistance of resting spores to high pressures. The samples contained a negligible (no more than 10 CFU g^{-1}) amount of spore-forming bacteria, there was not significantly ($p<0.05$) differences among all treatments and control in experimental Edam-like cheese.

Chemical properties: As given in Table 6 significantly ($p<0.05$) there was significant differences among all treatments in mean moisture of experimental Edam-like cheese but the significant difference disappeared between HSFS and LSFS treatments. The control recoded the lowest level of average moisture (43.89%) whilst HSFS attained 46.98%. The HSFS cheese contained the greatest moisture along ripening period contrary to control. From the same table, it was observed that all treatments recorded higher slightly fat/DM values than the control. The difference between two groups (canola and sunflower seeds) was statistically. As for the protein content of empirical Edam-like cheese, there was no significant difference among HSFS, LSFS and LCS cheese but it evinced between the treatments and control which contained the lowest protein (20% in average). To be sure, this is due to the increment of protein % in the milk treatments, these increases may be because oilseeds given to lactating goats, oil seeds changed the ruminal fermentation which increased urea, albumen and globulin blood (Abou Ayana and El-Shabrawy, 2015). With regard to salt/DM%, dry matter is the main factor in the change of ratio salt/DM because salt% nearly similar in all samples. The control was the highest salt/DM%, this ratio decreased to reach 4.18, 4.33, 4.39 and 4.49% (as average) in HSFS, LSFS, LCS and HCS cheese, respectively. Furthermore, all samples had pH higher than control and the difference in pH (as average) among all treatments was statistically significant. The HSFS recorded the highest pH-value followed by LSFS, LCS and HCS then control cheese along ripening period. These results were

Table 6: Some chemical properties of Edam-like cheese made from treated goats milk

		Treatments					
Ripening indices	Ripening period (W)	Control	LCS	HCS	LSFS	HSFS	±SE
Moisture (%)	0	49.11	50.88	50.72	51.82	52.71	
	9	41.91	44.55	44.35	44.58	44.65	
	15	40.66	43.61	42.88	43.70	43.57	
	Mean	43.89^{d}	46.34^{b}	45.98^{c}	46.70^{a}	46.98^{a}	0.50
Fat/DM (%)	0	47.22	48.75	48.28	49.89	49.25	
	9	48.25	50.19	50.18	50.38	50.99	
	15	50.26	51.16	51.22	51.57	52.22	
	Mean	48.58^{c}	50.03^{b}	49.89^{b}	50.65^{a}	50.82^{a}	0.61
Protein (%)	0	17.55	18.22	18.25	18.24	18.13	
	9	19.27	20.84	20.93	21.15	21.25	
	15	23.19	24.11	24.35	24.85	25.12	
	Mean	20.00^{c}	21.56^{a}	21.17^{b}	21.41^{a}	21.50^{a}	0.79
Salt/DM (%)	0	3.35	3.22	3.30	3.21	3.08	
	9	4.82	4.65	4.71	4.55	4.35	
	15	5.54	5.31	5.46	5.23	5.12	
	Mean	4.57^{a}	4.39^{c}	4.49^{b}	4.33^{d}	4.18^{e}	0.023
pH	0	4.91	5.10	5.08	5.16	5.18	
	9	4.62	4.80	4.79	4.88	4.91	
	15	4.43	4.68	4.63	4.75	4.82	
	Mean	4.65^{e}	4.86^{c}	4.83^{d}	4.93^{b}	4.97^{a}	0.025

Means within the same row within each category having different superscripts are significantly different at ($p<0.05$). Data after 3, 6 and 12 weeks not shown LCS: Low canola seeds, HCS: High canola seeds, LSFS: Low sunflower seeds and HSFS: High sunflower seeds

related to the level of moisture in cheeses as well as the concentration of substances affecting the acidity of cheeses.

It was important to determine ripening indices of Edam-like cheese, results listed in Table 7 indicated that the differences in SN/TN, NPN/TN, AAN/TN, soluble tyrosin, soluble treptophane and TVFA (mL N/NaOH/10 g) for Edam- like cheese among all treatments and control were statistically significant. Generally, HSFS cheese had the greatest levels of ripening indices followed by LSFS, LCS and HCS then control. All previously mentioned ripening indices clearly increased along storage period. These findings were happened despite decline the population of microbes associated with the ripening process, may be due to high activity of these microorganism such as lipolytic and proteolytic bacteria beside increase of moisture that activated the ripening microorganisms. These results are in agreement with these obtained by El-Zawahry (2003). From these results we conclude that feeding lactating goats on sunflower or canola seeds (previous levels) improved the milk composition and profile of fatty acids so this helped perfection the ripening of goats Edam cheese. It was important to accelerate the ripening period. This improves the cheese quality and economic returns.

Goaty Flavor Compounds (GFC) in cheese: During ripening period, it was necessary determine the of the major branched chain fatty acids which are considered to be responsible for goaty or irritating flavor. From data in Table 8 appeared that these compounds were twice determined in fresh Edam-like cheese then at the end of storage period. Interestingly, fresh Edam-like cheeses recorded higher levels of GFC compared to goats milk then went down at the end of storage period. Hexanoic acid, 4-methyl octanoic acid, 4-ethyl octanoic acid, nonanoic acid and 3-methylbutanoic acid sharply decreased after 15 weeks in all treatments and control to reach 0 -5.11, 0- 6.07, 0.55- 6.33, 0.63- 8.11 and 0.79-9.27 (as % of TVFA), respectively. Decanoic acid took an opposite trend; it increased during ripening in all cheeses. Experimentally proved that GFC were low in the treated goats milk before manufacturing compared to of control milk. Significantly ($p<0.05$), HSFS cheese had the lowest level of these compounds, 5.11, 0.15, 0.21, 52.27, zero and 0.53 for hexanoic acid, 4- methyl octanoic acid, 4-ethyl octanoic acid, decanoic acid, nonanoic acid and 3-methylbutanoic acid after 15 weeks, respectively followed by LSFS, LCS and HCS then control cheese. These findings indicate that the initial levels of GFC in fresh milk effected on their levels in the cheese. El-Zawahry (2003) confirmed that he could reduce the level of GFC in Edam like cheese by heat treatments of goats milk before manuf acturing. Poveda *et al.* (2008) detected hexanoic acid, 4- methyl octanoic acid, 4-ethyl octanoic acid, decanoic acid, nonanoic acid and 3-methylbutanoic acid at levels 0.62-6.84, tre-0.07, tre-0.01, 6.14-58.40, 0.31-0.81 and 0.00-0.87, respectively in goat cheeses.

Table 7: Some ripening indices of Edam-like cheese made from treated goats milk

		Treatments					
Ripening indices	Ripening period (Week)	Control	LCS	HCS	LSFS	HSFS	±SE
SN/TN	0	7.86	8.21	8.12	8.62	9.17	
	9	15.35	17.22	16.88	18.41	20.11	
	15	17.95	19.00	18.51	20.62	22.32	
	Mean	13.72^{e}	14.81^{c}	14.5^{d}	15.88^{b}	17.2^{a}	0.09
NPN/TN	0	3.00	3.56	3.13	3.98	4.87	
	9	10.05	10.64	10.25	11.12	11.81	
	15	9.87	11.37	10.66	12.55	13.95	
	Mean	7.64^{d}	8.52^{c}	8.01^{d}	9.22^{b}	10.21^{a}	0.07
AAN/TN	0	1.72	2.00	1.88	2.22	2.41	
	9	6.15	7.11	6..75	8.32	8.94	
	15	8.91	9.75	9.13	10.11	10.81	
	Mean	5.59^{e}	6.29^{c}	5.92^{d}	6.88^{b}	7.38^{a}	0.05
Soluble tyrosin	0	6.23	7.11	6.55	7.78	8.11	
	9	66.81	84.73	73.14	92.32	99.15	
	15	131.57	149.25	139.69	154.13	168.24	
	Mean	68.20^{e}	80.36^{c}	73.13^{d}	84.74^{b}	91.83^{a}	0.93
Soluble treptophane	0	1.72	2.19	1.99	2.34	2.73	
	9	46.55	58.39	52.61	62.21	64.35	
	15	75.16	88.52	83.46	91.48	95.14	
	Mean	41.14^{e}	49.70^{c}	46.02^{d}	52.01^{b}	54.07^{a}	0.79
TVFA (mL N/NaOH/100 g)	0	10.16	13.21	11.52	14.68	15.31	
	9	33.29	35.16	32.18	37.14	38.27	
	15	39.27	42.51	38.91	45.71	46.65	
	Mean	27.57^{c}	30.29^{b}	27.53^{c}	32.51^{a}	33.41^{a}	0.57

Means within the same row within each category having different superscripts are significantly different at (p<0.05). Data after 3, 6 and 12 weeks not shown, LCS: Low canola seeds, HCS: High canola seeds, LSFS: Low sunflower seeds, HSFS: High sunflower seeds, SN: Soluble nitrogen, TN: Total nitrogen content, AAN: Amino acid nitrogen and TVFA: Total valatile fatty acids

Table 8: Goaty flavor compounds (as % of TVFA) in Edam-ike cheese made from treated goats milk

	Treatments										
	Control		LCS milk		HCS milk		LSFS milk		HSFS milk		
Goaty flavor compounds	Fresh	+15 weeks	Fresh	+15 weeks	Fresh	+15 weeks	Fresh	+15 weeks	Fresh	+15 weeks	±SE
Hexanoic acid	11.13	9.27^{a}	8.54	6.33^{c}	9.02	8.11^{b}	7.96	6.07^{c}	7.31	5.11^{d}	0.037
4-methyl octanoic acid	1.78	1.31^{a}	1.22	0.69^{c}	1.41	0.78^{b}	0.46	0.19^{d}	0.27	0.15^{e}	0.014
4-ethyl octanoic acid	1.05	0.79^{a}	0.74	0.55^{b}	0.91	0.77^{a}	0.39	0.25^{c}	0.31	0.21^{d}	0.012
Decanoic acid	66.03	68.22^{a}	57.85	54.14^{c}	58.17	60.12^{b}	49.11	53.19^{d}	49.13	52.27^{e}	0.149
Nonanoic acid	1.41	1.11^{a}	0.71	0.55^{c}	0.81	0.63^{b}	0.45	---	0.35	---	0.014
3-methylbutanoic acid	1.26	1.29^{a}	0.81	0.79^{c}	0.93	0.88^{b}	0.71	0.66^{d}	0.55	0.53^{e}	0.014

Means within the same row within each category having different superscripts are significantly different at (p<0.05), +15 weeks means after 15 weeks, LCS: Low canola seeds, HSFS: High canola seeds, LSFS: Low sunflower seeds and HSFS: High sunflower seeds

The pattern and concentration of individual free fatty acids (as % of total) of Edam-like cheese made from goats milk as affected improvement of milk composition by feeding goats on supplemented rations with oil seeds were shown in Table 9 it could be observed that all experimental cheese contained high level of Volatile Fatty Acids (VFA) against control. In general, VFA increased clearly after 15 weeks of ripening stage to reach 14.57, 12.22, 3.79, 2.58 and 2.56% of the total fatty acids for HSFS, LSFS, LCS and HCS Edam-like cheese then control, respectively. This shows the low level of lipolysis in cheese samples with somewhat lower liberation of fatty acids. With respect to non-volatile fatty acids, all treatments were higher than the control despite the apparent disparity among them, tested VFA increased during ripening period, after 15 weeks LCS had the highest VFA 100.75, HSFS 95.41, HCS 94.05 and LSFS 93.64 then 85.9.

The rheological attributes of hard and semi hard cheese usually are followed by determining of the cheese hardness (expressed as mm penetration). There is a close relationship relevant between moisture and the hardness of Edam cheese through ripening stage. Hardness of Edam-like cheese made from lactating goats that were fed supplemented rations with

Table 9: Free fatty acids (as% of total) of Edam-like cheese made from goats milk were fed on supplemented rations with oil seeds

		Treatments									
		Control		LCS cheese		HCS cheese		LSFS cheese		HSFS cheese	
Fatty acids	Carbon (C)	Fresh	+15 weeks	Fresh	+15 weeks	Fresh	+15 weeks	Fresh	+15 weeks	Fresh	+15 weeks
Volatile fatty acids	6+4	1.03	0.91	1.33	1.71	1.04	0.95	2.06	1.25	2.21	2.51
	8	0.51	0.62	0.62	0.95	0.49	0.61	2.16	2.41	2.74	2.95
	10	0.06	1.03	0.09	1.13	0.07	1.02	7.23	8.56	7.14	9.11
	Toatl	1.60	2.56	2.04	3.79	1.60	2.58	11.45	12.22	12.09	14.57
	12	2.38	2.11	3.65	3.11	3.22	2.98	3.35	3.12	3.34	3.11
	Iso 14			0.02	-			0.03	-	0.03	-
	14	7.55	8.12	8.11	8.37	7.65	7.98	8.55	8.76	8.37	8.88
	14:1	0.35	0.31	0.37	0.35	.0.45	0.38	0.71	0.60	0.73	0.62
	14:2	-	-	-	-	-	-	0.25	0.12	0.35	0.17
	15	0.31	0.11	0.27	0.23	0.25	0.22	0.71	0.59	0.79	0.63
	Iso 16	-	0.27	0.51	0.41	0.53	0.43	0.61	0.60	0.81	0.75
Non volatile fatty acids	16	28.21	30.21	31.20	33.00	32.02	33.51	33.72	34.11	32.95	33.78
	16:1	0.51	0.98	0.68	1.11	0.65	1.15	0.71	1.23	0.76	1.27
	17	0.35	0.33	0.37	0.35	0.38	0.35	0.42	0.36	0.45	0.41
	18:1	32.41	22.35	35.22	32.51	36.66	24.11	41.21	30.00	42.86	31.54
	18	5.32	21.11	5.81	21.31	5.60	22.61	6.55	13.71	7.22	13.69
	18:2	-	-	-	-	0.28	0.33	0.34	0.44	0.35	0.56
	Total	77.39	85.90	86.21	100.75	87.78	94.05	97.16	93.64	99.01	95.41

Means within the same row within each category having different superscripts are significantly different at ($p<0.05$), Data after 3, 6 and 12 weeks not shown, LCS: Low canola seeds, HCS: High canola seeds, LSFS: Low sunflower seeds and HSFS: High sunflower seeds

Table 10: Hardness of Edam-like cheese made from goats milk were fed on supplemented rations with oil seeds

	Hardness					
	Treatments					
Storage period (weeks)	Control	LCS cheese	HCS cheese	LSFS cheese	HSFS cheese	Means±SE
0	13.62	13.94	13.72	14.31	14.81	
3	12.15	12.21	12.03	13.56	13.49	
6	11.03	11.36	11.12	11.72	12.65	
9	9.61	9.92	9.63	10.22	10.75	
12	9.13	9.55	9.29	9.61	9.73	
15	8.38	8.97	8.75	9.15	9.34	
Means	10.65^{c}	10.99^{b}	10.76^{c}	11.43^{a}	11.80^{a}	0.145

Means within the same row within each category having different superscripts are significantly different at ($p<0.05$), LCS: Low canola seeds, HCS: High canola seeds, LSFS: Low sunflower seeds and HSFS: High sunflower seeds

oil seeds was presented in Table 10. Results showed that the hardness in all cheese samples gradually increased along ripening stage. It could be noticed that cheese made all treatments had lower hardness than control. The HSFS and LSFS cheese had hardness lower than HCS and LCS cheese. Significantly ($p<0.05$), HSFS cheese was the lower hardness followed by LSFS, LCS and HCS cheese then the control that was the highest hardness. This could be related to the increment of moisture, because of the increase of protein and lactose in cheese goats milk of these samples, as well as increment of fat that decrease the hardness of experimental cheese compared to the control. It could avoid hardness defect of Edam cheese by those treatments.

Firstly, the intended of flavor here is the clean and desirable flavor of cheese. Organoleptic tests of Edam-like cheese during the stage of ripening showed that flavour gradually decreased along the ripening stage, this means that the cheese samples had a clean flavor at fresh and the first period of the stage of ripening. Goaty or pungent flavour increased with increment of ripening stage thus the score of flavor declined to reach its lowest level after 15 weeks. Otherwise, at the same time body and texture and appearance gradually increased. Significantly ($p<0.05$), HSFS Edam-like cheese gained the greatest of total score means (92.62) followed by LSFS Edam-like cheese (88.7), LCS Edam-like cheese (85.42), HCS Edam- like cheese (77.97) then the control

Table 11: Organoleptic evaluation of experimental Edam-like cheese made from treated goats milk

		Organoleptic properties						
Treatments	Ripening period (w)	Flavor (50)	Body and texture (35)	Appearance (15)	Total score (100)	Notes	Total score means	±SE
Control	Fresh	41.2	27.5	12.1	80.8	*	76.3[d]	2.731
	3	38.2	28.7	12.5	79.4	**		
	6	36.0	29.0	12.7	77.7	**+		
	9	33.4	29.3	13.0	75.7			
	12	30.5	29.0	13.2	72.7	++		
	15	28.4	29.8	13.3	71.5			
LCS Edam-like cheese	Fresh	44.1	28.0	13.1	85.2	*	85.42[c]	
	3	42.5	29.5	13.2	85.2	**		
	6	42.0	29.8	13.5	85.3	***		
	9	41.6	30.2	13.5	85.4			
	12	39.7	32.0	13.9	85.6	#		
	15	38.1	33.5	14.2	85.8			
HCS Edam-like cheese	Fresh	43.0	27.5	12.1	82.6	*	77.97[d]	
	3	39.1	28.8	12.6	80.5	**		
	6	36.8	29.1	12.6	78.4	**+		
	9	35.0	29.5	13.1	77.6			
	12	31.7	29.7	13.3	74.7	++		
	15	30.5	30.0	13.5	74.0			
LSFS Edam-like cheese	Fresh	45.5	28.2	13.3	87.0	*	88.7[b]	
	3	44.6	29.7	13.5	87.8	**		
	6	44.2	30.3	13.7	88.2	***		
	9	43.8	31.2	13.9	88.9			
	12	43.0	32.4	14.2	89.6	#		
	15	42.3	33.9	14.5	90.7			
HSFS Edam-like cheese	Fresh	47.1	28.4	13.2	88.7	*	92.62[a]	
	3	46.2	31.0	13.5	90.7	**		
	6	45.6	32.3	13.8	91.7	***		
	9	44.9	33.1	14.2	92.2			
	12	44.3	33.8	14.4	92.5	#		
	15	43.8	34.2	14.6	92.9			

Means within the same row within each category having different superscripts are significantly different at ($p<0.05$) * Fresh curdy, clean after taste, **Freshly acid and curdy, very little aroma, ***: Beginning cheese flavour, pure taste, **+beginning pungent flavor or "goaty", #: More pronounced aroma than taste, bitter after taste, ++: More pungent flavor or "goaty"

sample (67.3). Noteworthy, total score for HCS Edam- like cheese and the control at fresh were 82.6 and 80.8, respectively, these values gradually decreased until the end of ripening period to reach 74.0 and 71.5, respectively (Table 11). On the other side, total score for LCS, LSFS and HSFS Edam-like cheese at fresh were 85.2, 87.0 and 88.7, gradually increased to become 85.8, 90.7 and 92.9, respectively. Important notes were recorded by panelists; all fresh samples were fresh curdy and clean after taste, after 3 weeks they were freshly acid and curdy, very little aroma. Beginning pungent flavor or "goaty" in the sixth week for control and HCS cheese samples and continued till the ninth week, after that until the end of storage period, this flavor was more and the acceptability decreased but the samples not rejected. Regarding LCS, LSFS and HSFS Edam-like cheese samples during sixth and ninth weeks, the cheese flavor began with pure taste after that, during 12th and 15th weeks the samples had more pronounced aroma than taste and slight bitter after taste.

CONCLUSION

On the light of the above mentioned results, it could be concluded that supplementation of goat rations with 14 and 7% of sunflower seeds or 5% of canola seeds increased the yield, enhanced the quality of milk or Edam-like cheese, it was clearer in reduction of the goaty flavor compounds whether in milk and Edam-like cheese during ripening period. Interestingly, organoleptic properties of Edam-like cheese won appreciation and acceptance and its ripening process accelerated.

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