Egypt. J. Food. Sci. **Vol. 48,** No.2, pp. 389-398 (2020)

Egyptian Journal of Food Science
http://ejfs.journals.ekb.eg/

Effect of Feeding *Moringa* Tree Products on Ewe Milk Composition and on The Resultant Yoghurt Properties

CrossMark

Samy M. El-Shamy[1], Heba H. Salama[1*], Ahmed A. Aboamer[1], Mahmoud M. Shaaban[2], Hossam M. Ebeid[1], Mohamed M. M. Mostafa[2]

[1]*Dairy Sciences Department, National Research Centre, 33 Bohouth St. Dokki, Giza, Egypt*

[2]*Biological Applications Department, Nuclear Research Center, Atomic Energy Authority, Inshas, Cairo,*

MORINGA oleifer tree products are rich in various bioactive ingredients that have a good role in dairy products. This work aimed to study the effect of adding different *Moringa* tree products (oil, leave, and cake) in ewe's rations on milk composition as well as chemical, sensory and microbiological properties of the resultant yoghurt. Thirty-five lactating Barki ewes were randomly assigned into five groups. Each group was feed diet containing different ratios and type of Moringa products. The first group was control (C) The other four groups were classed as follow: Group (1): feed 2.5% Moringa seed cake: (MC_1); Group (2): feed 5% Moringa seed cake: (MC_2). Group (3): feed 1% Kg /DM Moringa oil (MO) Group (4): feed 15% of total DM Moringa leaves (ML). The chemical compositions of milk as well as the microbiological properties of the resulting yoghurt were studied fresh and during storage time. Results revealed that milk composition significantly (*P<0.05*) increased with diet fed on MC1 as compared to control. The observed pH differences between different yoghurts treatments are attributed to differences in chemical composition and high total solids of milk between groups. The diacetyl and acetaldehyde contents of yoghurt samples were higher in treatment than the control. The count of *S. thermophilus* and *L. bulgaricus* in all treated yoghurt samples was higher than in control, while no significant difference observed in the counts of *S. thermophilus* and *L. bulgaricus*, either in the control or between yoghurt treatments. The yoghurt produced from the dairy ewes' feeding on *Moringa oleifera* product had good chemical and microbiological properties. So, using it was concluded that feeding *Moringa oleifera* products is effective in the feeding of dairy ewes' and other ruminant animals.

Keywords: *Moringa* products, Ewes' milk, Yoghurt.

Introduction

Sheep milk is extensively used in several counties of the world to produce yoghurt. Ewes' milk has characteristics and advantages as it considered a potential functional food, (Balthazar et al., 2017). People who suffer from lactose intolerance can safety drink and consume that milk. The physicochemical property of ewes' milk and manufactured yoghurt significantly affected by many factors, the most important factor is ration composition (Bonczar et al., 2002).

On the other side. *Moringa oleifera* tree requests to be extensively cultured in most of the regions where climatic conditions errand its best growth like Egypt (Soltan et al., 2017).

Supplementation of *Moringa* tree products in animals' diet could help small farmers to improve milk production and milk chemical composition especially in the dry period (Salih et al., 2017 and Aboamer et al., 2020). All part of *Moringa oleifera* are full of numerous bioactive ingredients with many activities. Therefore, researchers can have wondered that *Moringa* affects the ruminant production by several mechanisms of actions; it can be used in the growth of hopeful normal

Corresponding author: E-mail: hh.salama@nrc.sci.eg
Personal E mail: hebasalama11@yahoo.com; hebasalama11@gmail.com
Orcid number: http://orcid.org/0000-0002-2978-6292
Received:17/8/2020; accepted: 25/12/2020
DOI: 10.21608/EJFS.2020.39580.1074

feeding additives for ruminants (Hansen et al., 2020 and Ebeid et al., 2020a,b). In contrast to the dietary antibiotics, residual of these bioactive components in the milk may be has a benefit for human health. Consequently, Elaidy et al. (2017) reported that using Moringa leaves by replacing up to 15% of calf starter enhanced growth of buffalos. In addition, Damor et al. (2017) decided that feeding of dried *Moringa* leaves substituting conservative concentrate mixture upgraded body weights and average daily body weight improvement without affecting feed consumption and general health of *Mehsana* goat. Moreover, Dong et al. (2019) confirmed that different supplementation levels of *Moringa oleifera* in the diet attained similar feed intake, milk production, but adding 6% of *Moringa oleifera* increased milk fat percent.

Literature review indicates many researchers studied the addition of *Moringa oleifera* tree products in different dairy products such as use its oil and dry leaves in ice milk (Salama et al., 2017), however ; EL-Sayed et al., 2017 improved the nutritional value and extending the shelf life of labneh by adding Moringa oleifera oil; while Mohamed et al., 2018 use *Moringa oleifera* leaves extract as an antioxidant and antimicrobial in cream cheese.

Therefore, this work aimed to study the effect of including different moringa tree products (cake, oil, and leaves) direct in dairy ewes' diets on milk composition as well as chemical, sensory, and microbiological properties of the resultant yoghurt.

Materials and Methods

Materials

This study was conducted within a cooperation work among *Morinaga* production unit, National Research Center; Dairy production Lab., Dairy Science Department, National Research Center and Atomic Energy Authority, Inches, Cairo, Egypt.

Morinaga trees were cultivated, and its seed oil was extracted by *Moringa* production unit.

Animals and feeding

This study was carried out at the experiments station, Atomic Energy Authority, Inshas, Cairo, Egypt in cooperation with Dairy Sciences Department, National Research Centre, Dokki, Giza, Egypt.

Thirty-five late pregnant Barki ewes were randomly classed into five groups using complete random design. The experiment lasted 75 days from the last 15 day of pregnancy to 60 days after parturition. The first, one was fed the control diet, while the second and third groups fed diets contains *Moringa* cake as a replacement for cottonseed meal at level 2.5 % (MC1) and 5% (MC2), respectively. The fourth group was fed control ration supplemented by 1% (as DM basis) Moringa seed oil and labeled MO. The fifth group was fed *Moringa* leaves as a replacement of Berseem hay at the rate of 15% (ML). Ewes were normally fed the dry matter which represented 4% of their body weight to cover the total requirements according to NRC (1975) allowances. The ration was offered (1:1; R: C ratio). The half quantity of concentrate feed mixture was offered at 09:00 and the second half at 1400. The berseem and rice straw were offered daily at 00:10.

The ingredients of rations and their chemical composition are shown in Tables 1 & 2.

TABLE 1. Ration ingredients and their levels.

Item	C	MC 1	MC2	MO	ML
Ingredients, g/kg DM					
Berseem	500	500	500	500	425
Yellow corn	177.5	177.5	177.5	177.5	177.5
Olive pulp dry	75	75	75	75	75
Cottonseed meal	115	102.5	90	115	115
Moringa cake	-	12.5	25	-	-
Moringa oil	-	-	-	10	-
Moringa leaves	-	-	-	-	75
Soybean meal	20	20	20	20	20
Wheat bran	100	100	100	100	100
Salt	5	5	5	5	5
Di-calcium phosphate	5	5	5	5	5
Mineral mixture	1.5	1.5	1.5	1.5	1.5
Vit. AD3	0.5	0.5	0.5	0.5	0.5
Bicarbonate sodium	0.5	0.5	0.5	0.5	0.5

C: control; MC_1: Group (1): feed 2.5% Moringa seed cake;MC_2: Group (2): feed 5% Moringa seed cake; MO: Group (3): feed 1% Kg / DM Moringa oil; ML: Group (4): feed 15% of total DM Moringa leave.

TABLE 2. Chemical composition of ration ingredients.

	Chemical composition, g/kg DM				
Organic matter	933.4	935.9	930.4	934.0	928.5
Crude protein	169.8	174.4	180.8	171.2	198.1
Ether extract	29.9	38.3	24.6	41.0	35.1
NDF	339.0	345.5	367.2	349.8	276.0
ADF	509.2	504.4	532.9	511.3	418.3
Ash	66.6	64.1	69.6	66.0	71.5

NDF: neutral detergent fiber;ADF: acid detergent fiber.

Bacterial strains

Streptococcus thermophilus and *Lactobacillus delbrueckii spp bulgaricus* Strains were obtained from stock cultures of Dairy Microbiology Lab., National Research Centre, Dokki-Cairo, Egypt.

Bacterial starter activation

Lactobacillus delbrueckii spp bulgaricus and *streptococcus thermophilus* were multiplied by three successive transfers in sterile 10% recovered nofat-milk powder. Followed by three successive transfers in modified MRS and M17 agar media (Harrigan and McCance, 1990).

Yield and milk composition

Milk yield was recorded for every ewe once every two weeks started from the 15th day until the 60th day of lactation. Lambs were kept away from their dams twenty-four hours before complete hand milking. Representative milk samples of about 100 g/ewe were taken and stored at –20^{o}C until analysis. Analysis of milk samples of each ewe was carried out using Ultrasonic milk analyzers (Milkotester Ltd) at Dairy lab, National Research Centre.

Preparation of yoghurt made from ewes' milk feeding on Moringa tree products

All the ewes' milk separately collected for each group was heated to 90°C/ 5 min., then cooled to 42°C. 1.0% w/v of *S. thermophiles* and *L. bulgaricus was added to each sample*. The inoculated treatments were dispensed in 100 ml cups and incubated at 42°C until complete coagula were formed. The produced yoghurt samples were analyzed when fresh, and during storage time (7, 15 and 21 days) at 4±2°C. The yoghurt manufacturing was done two times in this study.

Analytical methods

Chemical analysis

Total solids (T.S), fat, protein, ash content and titratable acidity (T.A) were determined according to AOAC, (2012). The pH values were measured using a digital laboratory Jenway 3510 pH meter, UK. Bibby Scientific LTD. Stone, Stafford shire, ST 15 OSA. Diacetyl & acetaldehyde levels of yoghurt samples were estimated according to Less and Jago, (1969).

Microbiological analysis

Twenty-five grams of yoghurt samples were homogenized with 225 ml of sterile solution (2% w/v) of buffered peptone water Total aerobic colony count (TACC) was carried out according the method of (FDA, 2002).

Enumeration of molds & yeasts were carried out using the media of acidified potato dextrose agar according to Mu96, Himedia, Mumbai by FDA, (2002). On the other hand, Coliform group was detected according to the method of Harrigan and McCance, (1996), the counts of *Streptococcus thermophilus* was enumerated on M17 agar (El-Kholy et al., 2016), however Lactobacillus bulgaricus were enumerated using modified MRS agar supplemented with 0.05% L-cysteine-HCl according to Abbas et al. (2017).

Sensory evaluation

Yoghurt treatments were sensory evaluated when fresh and after 15 days of storage by ten panelists of the staff member of Dairy Department at Food Industries and Nutrition Division, National Research Center, using the score sheet according to Badawi et al. (2008).

Statistical analysis

Data was statistically analyzed using One-Way ANOVA, (2011). The statistical model was as follows: $Y_{ij} = \mu + T_i + e_{ij}$, Where Y_{ij} = the jth observation (j = 1… 7) for ration i, μ = the overall mean, T_i = the effect of treatment i (i = 1… 5), e_{ij} = the experimental error.

Results and Discussion

Milk chemical composition

Table 3 revealed the chemical composition of ewes' milk feeding on *Moringa* tree products involved (oil, leave and cake). Protein, lactose, SNF and ash contents were significantly ($p<0.05$) increased with MC1 that feeding 2.5% *Moringa* cake and *Moringa* oil (MO) as compared to other groups especially control. However, the ML (Moringa leaves) was the higher ($p<0.05$) in fat (5.07%) than control. While the lowest group in fat (3.86%) was MO ($p<0.05$).

Previous studies illustrated that *Moringa* leaves are rich in nutrients that are essential for milk production (Newton et al., 2010; Mendieta-Araica et al., 2011). Additionally, milk composition can be improved by adding Moringa leaves as a supplement, which increases the dry matter intake and the digestibility of the fodder by livestock, and increasing the protein intake as reported by Richter et al. (2003) and Rani & Arumugam (2017).

The chemical composition of milk was affected the chemical properties of yoghurt produced as shown in Table 4. The significantly highest moisture content was at C (control) while the significantly lowest moisture noted with MC1 which feeding on 2.5% *Moringa* cake. Total solids, fat, protein, and ash also significantly increased in yoghurt made from milk produced from MC1 to record the highest values.

The chemical composition of ewe's milk highly affected the chemical composition of yoghurt produced from that milk. The feeding on different *Moringa* tree products improved the chemical composition of milk and yoghurt produced. These data were in agreement with Kholif et al. (2016) who reported that feeding *M. oleifera* diets resulted in higher milk yield, energy-corrected milk and milk contents of protein and lactose than for the control diet, and higher milk fat contents were noted in goats fed on *M. oleifera* fresh biomass and hay compared with the control diet.

Babikera et al. (2016) recorded that replacement of alfalfa with *M. oleifera* had a positive influence on milk yield and composition.

pH and acidity of yoghurt

Table 5 refers to significant variation in the pH values and acidity percent of yoghurt manufacture from ewe's milk produced from animal feed on *Moringa* products. The significant pH decrease in relationship with titratable acidity increase can be attributed to the yoghurt starter culture activity (Prasanna et al., 2013 and Dimitrellou et al., 2019). The observed pH differences between different yoghurts manufactured with ewes' milk after feeding on different *Moringa* products be attributed to differences in chemical composition and high total solids of milk between treatments (Table 3), that may be due to higher buffering capacity caused by the high protein content in ewes' milk as reported by Li and Guo, (2006), Salaun et al. (2005). Additionally, the significantly decrease on pH values observed during storage can be due to starter cultures and metabolic activities (Bonczar et al., 2002; Vianna et al., 2017). The results confirmed by Erkaya and Sengul (2012) who reported that ewes milk yoghurt presented the greatest pH and titratable acidity values. Furthermore, pH of yoghurts significantly decreased during storage; this results in agreement with Bonczar et al. (2002), Vianna, et al. (2017) who noted that during storage there is an increase on titratable acidity values and pH decrease in yoghurt made by ewes' milk and this related to metabolic activity of yoghurt starter.

The diacetyl and acetaldehyde contents of yoghurt samples made with ewe's milk feeding on different *Moringa* products were significantly higher than control treatment (Table 4). These results could be established that *Lb. bulgaricus* produces higher amounts of aroma metabolites in milk than that by *Str. thermophiles* (Beshkova et al., 1988; Georgala et al., 1995; Bonczar et al., 2002 and Salama et al., 2019). *Lb. bulgaricus* have high alcohol dehydrogenase activity which results in lower hydrolysis activity of acetaldehyde to ethanol. Therefore, the presence of either *lactobacilli* species in the starter culture can influence the cumulative content of acetaldehyde in these products (Fuller, 1989 and Bonczar et al., 2002). These results could be lelated to the numbers of the total lactic acid bacteria in MC1 were higher than those of other treatments.

The significant decrease in acetaldehyde levels during storage can be related to the hydrolysis by microbial action to form other materials, such as ethanol (Yilmaz-Ersan & Kurdal, 2014 and Akl et al., 2020). Also, this could be related with further metabolic action of the starter cultures during the storage period and evaporation from the samples and/or hydrolysis (Georgala et al., 1995; Tamime and Robinson, 1999).

TABLE 3. Chemical composition (%) of ewe's milk produced by feeding on *Moringa* tree products.

Parameters %	Treatments				
	C	MC 1	MC2	MO	ML
Fat	4.07^{c}	5.44^{a}	4.52^{bc}	3.87^{c}	5.07^{ab}
Protein	4.49^{b}	4.92^{a}	4.54^{b}	4.62^{ab}	4.55^{b}
Lactose	6.63^{b}	7.40^{a}	6.81^{b}	6.95^{ab}	6.86^{b}
SNF	12.14^{b}	13.51^{a}	12.48^{b}	12.69^{ab}	12.53^{b}
Ash	0.95^{b}	1.06^{a}	0.97^{b}	0.99^{b}	0.97^{b}

C: control; MC_1: Group (1): feed 2.5% Moringa seed cake; MC_2: Group (2): feed 5% Moringa seed cake; MO: Group (3): feed 1% Kg / DM Moringa oil; ML: Group (4): feed 15% of total DM Moringa leave. The means with the different capital (a, b, c…) superscript letters within the same column indicate significant (P≤0.05) differences between treatments.

TABLE 4. Main Chemical composition (%) of yoghurt manufactured from ewe's milk produced by feeding on *Moringa* tree products.

Treatment	T. S.	Fat	Protein	Ash
C	14.02^{D}	4.30^{CD}	5.12^{C}	1.04^{B}
MC 1	18.60^{A}	5.40^{A}	5.62^{A}	1.24^{A}
MC2	14.13^{D}	4.60^{BC}	4.99^{D}	1.09^{B}
MO	15.40^{C}	3.96^{D}	5.36^{B}	1.07^{B}
ML	16.25^{B}	5.12^{AB}	4.95^{D}	1.05^{B}

C: control; MC_1: Group (1): feed 2.5% Moringa seed cake; MC_2: Group (2): feed 5% Moringa seed cake; MO: Group (3): feed 1% Kg /DM Moringa oil; ML: Group (4): feed 15% of total DM Moringa leave. The means with the different capital (A, B, C…) superscript letters within the same column indicate significant (P≤0.05) differences between treatments.

Vagenas and Roussis (2012) indicated that ewes milk contained several methyl esters. However, Karami, (2018) mentioned that higher acetaldehyde content of ewe's milk yoghurt may be related to production of acetaldehyde from amino acids degradation, especially Threonine, by Threonine Aldolase. This degradation was mostly done by *Lb. bulgaricus*. Researches decided that high acid yoghurts have more acetaldehyde (Guler et al., 2009; Güler and Gursoy-Balci, 2011).

Microbiological examination of yoghurt

Table 5 revealed the number (log cfu/g) of the *S. thermophilus* and *L. bulgaricus* during storage at 4-8 C^{o} of samples manufactured from ewe's milk produced from animal feed on *Moringa* tree products (leaves, oil, and cake). In general, there were no significant variations (*P*>0.05), in the of *S. thermophilus* and *L. bulgaricus* counts, in the control and all yoghurt treatments. This increase in counts of lactic acid bacteria may be a result to *Moringa's* action in growth-enhancing starter (Van et al., 2011). similar results showed growth enhancing properties on *Lactobacillus* bacterial growth (Hekmat et al., 2015).

During storage time in all five groups, a slight increase (P > 0.05) was observed in the counts of microorganisms at days 15. These, significant increase in count of *S. thermophilus* and *L. bulgaricus* ware observed that refer to the possible growth enhancing effects of *Moringa* also, because in order to produce health benefits. So bacterial colony formation cannot fall below 10^{6} CFU/mL and this agree with Kechagia et al. (2013) and Vianna et al. (2017) whom found all yoghurt treatments strains characterized (a minimum of 10^{7}CFU/g) at 28 days of storage. Yoghurt could be had counts ranged between 10^{6}-10^{7}CFU/g (Codex Alimentarius, 2010). however, probiotic counts classified the fermented food as probiotic (a minimum of 106 and 10^7CFU/g) (Bedani et al., 2013). Olvieira et al. (2002) mentioned that a minimum of 10^6– 10^7 viable cfu/gm must be found in dairy products in order to reply the requirements of probiotic food to promote health benefits.

The detection of Molds, yeasts and coliforms bacteria was not observed in all treatments either fresh or during storage. This indicate that the good hygienic conditions during manufacture or storage of yoghurt, as well as, the bactericidal effect of the *Moringa* tree products in enhancing the shelf-life of the yoghurt (Van et al., 2011).

Sensory evaluation

Yoghurt treatments sensory accepted (data not presented), no significant differences between treatments and control observed. The feeding animals on Moringa products to yoghurt doesn't affect all of the sensory properties of yoghurt.

TABLE 5. Chemical properties of yoghurt manufactured from ewe's milk produced by feeding on *Moringa* tree products.

Treatments	Storage (days)	pH	T.A%	Diacetyl*	Acetaldehyde*
C	Fresh	4.88^{Aa}	0.95^{Cc}	68.6^{Ce}	29.72^{Da}
MC 1		4.08^{Da}	1.80^{Aa}	93.2^{Ad}	35.56^{Aa}
MC2		4.22^{Ca}	1.45^{Bd}	90.0^{Ae}	33.28^{Ca}
MO		4.47^{Ba}	1.00^{Cc}	77.33^{Be}	33.70^{BCa}
ML		4.19^{CDa}	1.76^{Ab}	90.0^{Ae}	34.00^{Ba}
C	3	4.64^{Aab}	1.22^{Cb}	91.2^{Ed}	22.76^{Eb}
MC 1		4.00^{Aa}	1.83^{Aa}	133.2^{Ac}	30.25^{Ab}
MC2		4.18^{Aa}	1.51^{Bc}	100.0^{Cd}	27.34^{Cb}
MO		4.18^{Ab}	1.50^{Bb}	94.0^{Dd}	25.92^{Db}
ML		4.06^{Ab}	1.80^{Aab}	101.6^{Bd}	28.08^{Bb}
C	7	4.58^{Aab}	1.29^{Cb}	95.2^{Ec}	20.74^{Ec}
MC 1		3.96^{Ba}	1.90^{Aa}	172.8^{Ab}	27.29^{Ac}
MC2		4.20^{ABa}	1.58^{Bb}	113.6^{Cc}	23.73^{Cc}
MO		4.16^{ABb}	1.58^{Bb}	101.2^{Dc}	22.85^{Dc}
ML		4.07^{Bb}	1.81^{Aab}	141.87^{Bc}	25.06^{Bc}
C	12	4.43^{Abc}	1.42^{Cab}	130.8^{Da}	14.58^{Cd}
MC 1		3.95^{Ea}	1.98^{Aa}	176.27^{Ab}	24.4^{Ad}
MC2		4.23^{Ba}	1.58^{Bb}	132.8^{Cb}	14.86^{Cd}
MO		4.14^{Cb}	1.63^{Bb}	105.33^{Eb}	14.88^{Cd}
ML		4.05^{Db}	1.90^{Aab}	154.4^{Bb}	23.68^{Bd}
C	15	4.18^{Ac}	1.60^{Aa}	128.4^{Eb}	12.54^{De}
MC1		3.95^{Ca}	2.00^{Aa}	250.0^{Aa}	15.84^{Ae}
MC2		4.17^{Aa}	1.68^{Aa}	144.0^{Da}	13.20^{Ce}
MO		4.01^{Bc}	1.95^{Aa}	151.2^{Ca}	13.72^{Be}
ML		3.99^{BCc}	2.00^{Aa}	192.4^{Ba}	14.00^{Be}

C: control; MC_1: Group (1): feed 2.5% Moringa seed cake; MC_2: Group (2): feed 5% Moringa seed cake; MO: Group (3): feed 1% Kg /DM Moringa oil; ML: Group (4): feed 15% of total DM Moringa leave.The means with the different capital (A, B, C…) superscriptletters within the same column indicate significant (P≤0.05) differences between treatments. Means with thedifferent small (a, b, c,) superscript letters within the same row are significantly (P≤0.05) different between treatment.*Diacetyl (μm/100 g); Acetaldehyde (μm/100 g).

TABLE 6. Microbiological examinationof fresh yoghurt manufactured from ewe's milk produced by feeding on *Moringa* tree products.

Storage period (days)					
zero time					
Treatments	**TACC* *Log cfu /g***	***Streptococcus thermophilus* *Log cfu /g***	***Lactobacillus bulgaricus* *Log cfu /g***	**Coliform *Log cfu /g***	**Mold & Yeast *Log cfu /g***
C	8.38^{ABb}	6.21^{Bd}	6.14^{Acd}	0.0	0.0
MC1	8.3^{Cb}	6.45^{Da}	6.56^{Ca}	0.0	0.0
MC2	8.59^{Ca}	6.39^{Cb}	6.41^{Cb}	0.0	0.0
MO	7.57^{Cd}	6.13^{Ce}	6.03^{Cd}	0.0	0.0
ML	8.03^{Dc}	6.28^{Bc}	6.28^{Cbc}	0.0	0.0
3 days					
C	8.31^{Bc}	6.17^{Bc}	6.13^{Ad}	0.0	0.0
MC1	8.37^{Cbc}	6.58^{Ca}	7.03^{Ba}	0.0	0.0
MC2	8.69^{Ba}	6.39^{Cb}	6.85^{Ba}	0.0	0.0
MO	7.73^{BCd}	6.34^{Bb}	6.39^{Bc}	0.0	0.0
ML	8.45^{Cb}	6.58^{Ba}	6.76^{Bb}	0.0	0.0
7 days					
C	8.43^{Ab}	6.28^{ABc}	6.16^{Ac}	0.0	0.0
MC1	8.80^{Ba}	6.79^{Bb}	6.96^{Bab}	0.0	0.0
MC2	8.85^{Aa}	6.75^{Bb}	6.98^{ABab}	0.0	0.0
MO	7.86^{Bc}	6.96^{ABab}	6.86^{Ab}	0.0	0.0
ML	8.72^{Ba}	7.24^{Aa}	7.03^{Aa}	0.0	0.0
15 days					
C	8.45^{Ab}	6.4^{Ac}	6.19^{Ad}	0.0	0.0
MC1	8.91^{Aa}	7.10^{Aab}	7.83^{Aa}	0.0	0.0
MC2	8.84^{Aa}	7.04^{Ab}	7.14^{Ab}	0.0	0.0
MO	8.12^{Ac}	7.29^{Aa}	6.95^{Ac}	0.0	0.0
ML	8.86^{Aa}	7.27^{Aab}	7.12^{Ab}	0.0	0.0

C: control; MC_1: Group (1): feed 2.5% Moringa seed cake; MC_2: Group (2): feed 5% Moringa seed cake; MO: Group (3): feed 1% Kg /DM Moringa oil; ML: Group (4): feed 15% of total DM Moringa leave.TACC* (total aerobic colony count). The means with the different capital (A, B, C…) superscript letters within the same column indicate significant (P≤0.05) differences between treatments. Means with the different small (a, b, c,) superscript letters within the same row are significantly (P≤0.05) different between treatment

Conclusion

Yoghurt made from the dairy ewes' feeding on *Moringa oleifera* product presented desirable chemical and microbiological properties. Feeding of dairy ewes' and other ruminant animals with different *Moringa oleifera* products was found to be useful and obtained milk had good chemical and microbiological quality.

References

Abbas, H.M., Shahein, N.M., Abd-Rabou, N.S., Fouad, M.T. and Zaky, W.M. (2017) Probiotic-fermented Milk Supplemented with Rice Bran Oil. *International Journal of Dairy Science*, **12**, 204-210. https://doi.org/10.3923/ijds.2017.204.210

Aboamer, A.A., Ebeid, H.M., Shaaban, M.M., Gawad, R.M.A., Mostafa, M.M., Abdalla, A.M.

(2020) Effect of feeding moringa seed cake as an alternative protein source in lactating ewe's rations. *International Journal of Dairy Science*, **15** (2), 80-87. doi: 10.3923/ijds.2020.80.87

Akl, E.M., Abdelhamid, S.M., Wagdy, S.M. and Salama, H.H. (2020) Manufacture of functional fat-free cream cheese fortified with probiotic bacteria and flaxseed mucilage as fat replacing agent. *Current Nutrition and Food Science*, **16**, 1-11. https://doi.org/10.2174/1573401316666200227112157

AOAC. (2012) Official Methods of Analysis, 19th ed., Association of Official Analytical Chemists, Washington.

Babikera, E.E., Juhaimia, F.A.L., Ghafoora, K., Khalid, A. and Abdoun, K.A. (2017) Comparative study on feeding value of moringa leaves as a partial replacement for alfalfa hay in ewes and goats. *Livestock Science*, **195**, 21–26. http://dx.doi.org/10.1016/j.livsci.2016.11.010

Badawi, R.M., Hamed, A.I., Kebary, K.M.K., El-Sayed, H.A. (2008) Effect of replacing milk fat with fat replacers on the quality of stirred yoghurt. *Egyptian J. Dairy Sci.* **36**, 197-206.

Balthazar, C.F., Pimentel T.C., Ferr˜ao, L.L., Almada, C.N., Santillo, A., Albenzio, M., Mollakhalili, N., Mortazavian, A.M., Nascimento, J.S., Silva, M.C., Freitas, M.Q., Sant'Ana, A.S., Granato, D. and Cruz, A.G. (2017) Ewes' Milk: Physicochemical Characteristics and Relevance for Functional Food Development. *Comprehensive Reviews in Food Science and Food Safety*, **16**, 247-262. doi:10.1111/1541-4337.12250

Bedani, R., Rossi, E.A. and Saad, S.M.I. (2013) Impact of inulin and okara on *Lactobacillus acidophilus* La-5 and *Bifidobacterium animalis* Bb-12 viability in a fermented soy product and probiotic survival under in vitro simulated gastrointestinal conditions. *Food Microbiology*, **34**, 382–389. http://dx.doi.org/10.1016/j.fm.2013.01.012.

Beshkova, D., Simova, E., Frengova, G. and Simov, Z. (1988) Production of flavour compounds by yogurt starter cultures. *Journal of Microbiology and Biotechnology*, **20**, 180–184.

Bonczar, G., Wszolek, M. and Siuta, A. (2002) The effects of certain factors on theproperties of yoghurt made from ewe's milk. *Food Chemistry*, **79**,85–91. https://doi.org/10.1016/S0308-8146(02)00182-6

Codex Alimentarius. (2010) Codex standard for fermented milk, second ed., Codex Alimentarius Comission, Brussels, Belgium.

Damor, S.V., Pawar, M.M., Ankuya, K.J., Gami, Y.M., Srivastava, A.K., Chauhan, H.D. and Chaudhary, K.R. (2017) Effect of Feeding Different Levels of Moringa (*Moringa oleifera*) Leaves on Growth Performance of Mehsana Goat Kids. *Trends in Bioscience*, **10** (18), 3190- 3193. http://trendsinbiosciencesjournal.com/upload/10-7702_(S_V__DAMOR).pdf

Dimitrellou, D., Salamoura, C., Kontogianni, A., Katsipi, D., Kandylis, P., Zakynthinos, G. and Varzakas, T. (2019) Effect of milk type on the microbiological, physicochemical and sensory characteristics of probiotic fermented milk. *Microorganisms*, **7**, 274-282. https://doi.org/10.3390/microorganisms7090274

Dong, L., Zhang, T. and Diao, Q. (2019) Effect of Dietary Supplementation of Moringa Oleifera on the Production Performance and Fecal Methanogenic Community of Lactating Dairy Cows. *Animals*, **9** (5), 262. https://doi.org/10.3390/ani9050262

Ebeid, H.M., Kholif, A.E., Chrenkova, M., Anele, U.Y. (2020a) Ruminal fermentation kinetics of Moringa oleifera leaf and seed as protein feeds in dairy cow diets: in sacco degradability and protein and fiber fractions assessed by the CNCPS method. *Agroforestry Systems*, **94**, 905-915. https://doi.org/10.1007/s10457-019-00456-7

Ebeid, H.M., Mengwei, L., Kholif, A.E., Hassan, F., Lijuan, P., Xin, L., Chengjian, Y. (2020b) Moringa oleifera oil modulates rumen microflora to mediate in vitro fermentation kinetics and methanogenesis in total mix rations. *Current Microbiology*, **77**, 1271–1282. https://doi.org/10.1007/s00284-020-01935-2

Elaidy, A.A., Abou Selim, I.A., Abou-Elenin, E.I.M., Abbas, M.S., Hassan, M. and Sobhy, H.M. (2017) Effect of feeding dry *moringa oleifera* leaves on the performance of suckling buffalo calves. *Asian Journal of Animal Sciences*, **11** (1), 32-39. https://doi.org/10.3923/ajas.2017.32.39

El-Kholy, W., Abd El-Khalek, A.B., Mohamed, S.H.S., Fouad, M.T. and Kassem, J.M. (2016) Tallaga cheese as a new functional dairy product. *American Journal of Food Technology*, **11**, 182-192. https://doi.org/10.3923/ajft.2016.182.192

EL-Sayed, S.M., El-Sayed, H.S., Salama, H.H.

and Abo El-Nor, S.A.H. (2017) Improving the nutritional value and extending shelf life of labneh by adding moringa oleifera oil. *International Journal of Dairy Science*, **12** (2), 81 – 92. https://doi.org/10.3923/ijds.2017.81.92

Erkaya, T. and Sengul, M. (2012) A comparative study on some quality properties and mineral contents of yoghurts produced from different type of milks. *kafkas üniversitesi veteriner fakültesi dergisi*, **18**, 323–329. https://doi.org/10.9775/kvfd.2011.5498

FDA. (2002) Food and Drug Administration. Bacteriological Analytical Manual. 9th ed., AOAC International, Arlington, VA, USA.

Fuller, R. (1989) Probiotics in man and animals. *Journal of Applied Microbiology*, *66*, 365–378.

Georgala, A.I.K., Tsakalidou, E., Kandarakis, I. and Kalantzopoulos, G. (1995) Flavour production in ewe's milk and ewe's milk yogurt, by single strains and combinations of *Streptococcus thermophiles* and *Lactobacillus delbrueckii* subsp. *bulgaricus*, isolated from traditional Greek yoghurt. *Dairy Science and Technology*, **75**, 271–279. https://doi.org/10.1051/lait:1995319

Güler, Z. and Gursoy-Balci, A.C. (2011). Evaluation of volatile compounds and free fatty acids in set types yogurts made of ewes', goats' milk and their mixture using two different commercial starter cultures during refrigerated storage. *Food Chemistry*, **127**, 1065-1071. https://doi.org/10.1016/j.foodchem.2011.01.090

Guler, Z., Tasdelen, A., Senol, H., Kerimoglu, N. and Temel U. (2009) The determination of volatile compounds in set type yogurts using static headspace gas chromatographic method. *Gida*, 34, 137-142. https://pdfs.semanticscholar.org/20d9/9629dafabc1f9bbec5a68716c50fc8afefb2.pdf

Hansen, H.H., Ebeid, H.M., El-Bordeny, N.E., Faiz_ ul Hassan, (2020) In-vitro evaluation of moringa seed cake as a feed ingredient to abate methane emanation in ruminants. *International Journal of Agriculture & Biology*, **23** (5), 994–1002. doi: 10.17957/IJAB/15.1380

Harrigan, W. and McCance, M. (1990) Laboratory Methods in Food and Dairy Microbiology, 8th ed, Academic Press, London, UK.

Harrigan, W.E., McCanc, M.E. (1996) Academic Laboratory Methods in Microbiology Press, London, New York, pp. 292-294.

Hekmat, S., Morgan, K., Soltani, M. and Gough, R. (2015) Consumer test of locally-grown fruit purees and inulin fibre on probiotic yogurt in Mwanza, Tanzania and the microbial analysis of probiotic yogurt fortified with moringa oleifera. *Journal of Health, Population and Nutrition*, **33** (1), 60-68. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4438649/pdf/jhpn0033-0060.pdf

Karami, M. (2018) Investigation of physicochemical, microbiological, and rheological properties and volatile compounds of ewe and cow milk yoghurt. *Journal of Agricultural Science and Technology*, **20**, 1149-1160. https://jast.modares.ac.ir/article-23-20120-en.pdf

Kechagia, M., Basoulis, D., Konstantopoulou, S., Dimitriadi, D., Gyftopoulou, K., Skarmoutsou, N. and Fakiri, E.M. (2013) Health benefits of probiotics: A review. *International Scholarly Research Notices*, 1-7. http://dx.doi.org/10.5402/2013/481651.

Kholif, A.E., Morsy, T.A., Gouda, G.A., Anele, U.Y. and Galyean, M.L. (2016) Effect of feeding diets with processed moringa oleifera meal as protein source in lactating Anglo-Nubian goats. *Animal Feed Science and Technology*, **217**, 45–55 https://doi.org/10.1016/j.anifeedsci.2016.04.012

Less, G.J. and Jago, G.R. (1969) Method for the Estimation of acetaldehyde in culture dairy products. *Australian Journal of Dairy Technology*, 24-181. http://hdl.handle.net/102.100.100/320503?index=1

Li, J.C. and Guo, M.R. (2006) Effects of polymerized whey proteins on consistency and water-holding properties of goat's milk yogurt. *Journal of Food Science*, 71, 34–38. https://doi.org/10.1111/j.1365-2621.2006.tb12385.x

Mendieta-Araica, B., Sporndly, R., Sanchez, N.R. and Sporndly, E. (2011) Moringa (*Moringa oleifera*) leaf meal as a source of protein in locally produced concentrates for dairy cows fed low protein diets in tropical areas. *Livestock Science*, **137**, 10-17. https://doi.org/10.1016/j.livsci.2010.09.021

Mohamed, F.A.E., Salama, H.H., El-Sayed, S.M., El-Sayed, H.S. and Zahran, H.A. (2018) Utilization of Natural Antimicrobial and Antioxidant of Moringa oleifera Leaves Extract in Manufacture of Cream Cheese. *Journal of Biological Science*, **18** (2), 92 – 106. https://doi.org/10.3923/jbs.2018.92.106

Newton, K.A., Bennett, R.N., Curto, R.B.L., Rosa, E.A.S., Turc, V.L., Giuffrida, A., Curto, A.L., Crea, F. and Timpo, G.M. (2010) Profiling selected phytochemicals and nutrients in different tissues of the multipurpose tree Moringa oleifera L., grown in Ghana. *Food Chemistry,* **122**, 1047-1064. https://doi.org/10.1016/j.foodchem.2010.03.073

Oliveira, M.N., Sivieri, K., Alegro, J.H.A. and Saad, S.M.I. (2002) Aspectos tecnológicos de alimentos funcionais contendo probióticos. *Revista de Farmácia e Bioquímica da Universidade de São Paulo,* **38** (1):1-21. https://doi.org/10.1590/S1516-93322002000100002

Prasanna, P.H.P., Grandison, A.S. and Charalampopoulos, D. (2013) Microbiological, chemical and rheological properties of low fat set yoghurt produced with exopolysaccharide (EPS) producing Bifidobacterium strains. *Food Research International*, **51**, 15–22. https://doi.org/10.1016/j.foodres.2012.11.016

Rani, E.A. and Arumugam, T. (2017) Moringa oleifera (Lam) – A nutritional powerhouse. *Journal of Crop and Weed*, **13** (2), 238-246. https://pdfs.semanticscholar.org/5157/6d80b08d70711c0927f51a175b53555eb6e8.pdf

Richter, N., Perumal, S. and Klaus, B. (2003) Evaluation of nutritional quality of moringa (*Moringa oleifera* Lam.) leaves as an alternative protein source for Nile tilapia (*Oreochromis Lamarck*). *Journal of the Science of Food and Agriculture*, **79**: 815-820. https://doi.org/10.1016/S0044-8486(02)00497-0

Salama, H.H., Abdelhamid, S.M. and El Dairouty, R.K. (2019) Coconut bio-yogurt phytochemical-chemical and antimicrobial-microbial activities. *Pakistan Journal of Biological Sciences*, **22**, 527-536. https://doi.org/10.3923/pjbs.2019.527.536

Salama, H.H., EL-Sayed, S.M and Abdalla, A.M. (2017). Enhancing the nutritive values of ice milk based on dry leaves and oil of moringa oleifera. *American Journal of Food Technology*, **12** (2): 86 – 95. https://doi.org/10.3923/ajft.2017.86.95

Salaun, F., Mietton, B. and Gaucheron, F. (2005) Buffering capacity of dairy products. *International Dairy Journal*, **15**, 95–109. https://doi.org/10.1016/j.idairyj.2004.06.007

Salih, S.F.A., Bushara, I. and Ahmed, M.M.M. (2017) Effect of feeding moringa on Sudanese desert ewes' performance. *American Research Journal of Agriculture*, **3**,1-5. https://www.arjonline.org/papers/arja/v3-i1/1.pdf

Soltan, Y.A., Morsyb, A.S., Hashema, N.M. and Sallama, S.M. (2017) Utilization of Moringa oleifera in ruminant nutrition (Review article). *3rd International conference "Sustainable Development of Livestock's Production Systems" (sdlps 2017)"* from 7-9 November, 2017. Department of Animal production, Faculty of Agriculture, Alexandra University, Egypt.

SPSS. (2011) IBM. "IBM corporation." Armonk, NY, USA.

Tamime, A.Y. and Robinson, R.K. (1999) Yoghurt. Science and technology. Cambridge, UK. Woodhead Publishing Limited.

Vagenas, G., Roussis, I.G. (2012) Fat derived volatiles of various products of cows', ewes', and goats' milk. *International Journal of Food Properties*, **15**, 665-682. https://doi.org/10.1080/10942912.2010.498542

Van, T.A., Hullegie, Y.M., Hummelen, R., Hemsworth, J., Changalucha, J. and Reid, G.B. (2011) Development of a locally sustainable functional food for people living with HIV in Sub-Saharan Africa: laboratory testing and sensory evaluation. *Beneficial Microbes ,* **2** (3), 193-198. https://doi.org/10.3920/BM2011.0024.

Vianna, F.S., Canto, A.C.V.C.S., Costa-Lima, B.R.C., Salim, A.P.A.A., Costa, M.P., Balthazar, C.F., Oliveiraa, B.R., Rachid, R.P., Franco, R.M., Conte-Junior, C.A., Adriana, C.O. and Silva, A.C.O. (2017) Development of new probiotic yoghurt with a mixture of cow milk: effects on physicochemical, textural and sensory analysis. *Small Ruminant Research*, **149**, 154–162. https://www.sciencedirect.com/science/article/pii/S0921448817300366

Yilmaz-Ersan, L. and Kurdal, E. (2014) The Production of Set-Type-Bio-Yoghurt with Commercial Probiotic Culture. *International Journal of Chemical Engineering and Applications*, **5** (5), 402-408. https://doi.org/10.7763/IJCEA.2014.V5.418