MILi< COMPONENT ANALYSIS IN AWASS/EWES THROUGHOUT LACTATION

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Abstract

This study intends to describe progressive changes of lactation on milk components and to analyze the correlations among milk components and traits with ·body fat mobilization. Data were collected from eight lactating Awassi ewes housed indoors at the Lebanese Agricultural Research Institute - Terbol research station, under conventional feeding regimen. Milk composition and production parameters including ewe body condition score (BCS) and weight (BW), toil circumference (FTC) were recorded during lactation period from February till August 2017 on days (D) 0, 10, 20, 30, 40, 70, 100, 120, and 130 after lambing. Milk fat, protein, total solids (TS), lactose, solids non fat (SnF), acidity, density and freezing point (FP) were measured using infrared spectrometry (Milkoscon, FT 120, Foss Electric). Preliminary results showed positive correlation between BCS and BW, as well as between BCS and FTC (r = 0.77 and 0.80 respectively). Moreover, milk acidity, TS, SnF and milk protein followed the some pattern where they were highest by DO (l5.77±0.66°SH, 20.43±0.84%, 11.92±0.34%, 6.61 ±0.20% respectively), decreased by Dl O and then recovered to lower levels than the first milk by Dl30 showing significant differences (P<0.05). However, lactose followed on opposite pattern where it was lowest in the first milk DO (3.85±0.2%) and then increased at Dl O (4.83±0.22%), decreased significantly *(P<0.05)* and steadily till Dl30. Fat stayed high until 020 (7.30±0.58%) and then dropped significantly by 030 (4.71 ±0.58%), recovering gradually until 0130 to lower levels than the first milk. On the other hand, milk density and FP showed steady variations. The findings indicate that lactation stages contribute to the variation in milk composition during lactation.

l<eywords:

Milk components, lactation stages, Awossi ewes.

Introduction

The Awassi fat-tailed breed of sheep is the most widespread breed in the regions of Lebanon and the desert areas of the Middle East (Abi Saab *et al.*, 2011). The Lebanese sheep census has around 450,000 heads (FAO, 2016). The major concentration of sheep is in the Bekaa Valley (800 - l 000 m above sea level, 528 mm rainfall), where seasonal postures contribute to animal diet (70%) and stubble, crop residues and fallows supplement the remaining 30%, composed of concentrate supplement of forage for feeding during the winter when the accessibility for grazing diminish (Abi Saab and Sleiman, 1995; Khazaal, 2005). Local Awassi sheep produce milk and meat where milk represents 7.2% of the total quantity of milk produced in Lebanon in 2009 (MoA, 2009), and the milk production of Awassi ewes was recorded in the Lebanese Agricultural Research Institute at Terbol station as 167 liters per 180 days of lactation (LARI, 2009).

Information on sheep milk composition and its physico-chemical characteristics is essential for the improvement of ovine industry (Pork *et al.*, 2007) whereas demand on animal products, especially cheese, is growing and leading to the intensification of the production system (Hilali *et al.*, 2011 a; Haile *et al.*, 2017). Milk production and its physico-chemical characteristics fluctuate depending on several factors such as physiological (age, lambing, stage and number of lactation), genetic (breed, genotype), management (feeding system) and methods of milking (Bencini and Pulina, 1997). These factors will lead to variability in milk yield and quality throughout lactation periods and thus affecting the cheese quality. Further researches are needed to assess the relationship between milk yield and composition across Awassi sheep breed, especially in the early lactation, so they become able to stand up competition with other breeds for a better milk quality. Various questions arise concerning the improvement of the sector: Do negative energy balance at the onset of lactation affects ewe's fat reserves? Do Awassi ewes produce milk with high physico-chemical variability at different stages of lactation?

The objective of this paper is to characterize the physico-chemical propreties of Awassi sheep milk under Terbol research station conditions throughout lactation period.

2. Materials and Methods

2.1. Animals and diet

The study was carried out at the Lebanese Agricultural Research Institute (LARI) - Terbol station, Lebanon (33°48'40.7"N, 35°59'24.3"E). Eight multiparous lactating Awassi ewes were used and enrolled in the experiment from the day of lambing. All animals were housed indoors under the same feeding practice based on 30 % alfalfa hay and 70% commercial concentrate diet available in the local Lebanese market. The concentrate consisted of barley, wheat, maize, wheat bran, soybean meal (44%), cotton seeds, calcium phosphate, salt, mineral and vitamins premix. The used feed diet was analyzed for fat, crude protein and dry matter content according to AOAC (2000).

2.2. Production parameters

The following production parameters were collected during the experimental period: ewes' body condition score (BCS), body weight (BW), and fat tail circumference (FTC) at its widest point (Abi Saab et *al.,* 1999), were monitored throughout lactation every 10 days from DO to D 40, then every 30 days afterwards, from February till August 2017 to cover all the period of lactation. Milk yield (ml/d) was recorded each 15 days once the lambs were weaned after 2 months and a half of lambing.

2.3. MilR composition

On the dote of sampling, ewes were hand milked twice a day, at 08:30 and 16:30, and samples were stored in 50 ml tubes for later analysis. Milk composition (%) in fat, protein, total solids (TS), solids non fat (SnF) and lactose, in addition to its physico-chemical properties as the total acidity (°SH), density (specific gravity SG*lOOO) and freezing point (FP, °C) were analyzed by an infrared spectroscopy instrument (MilkoScan FTl 20, Foss Electric).

2.4. Statistical analysis

The mixed procedure of SAS was adopted in order to analyze the repeated measured variables. The statistical model included week of lactation as source of variation and animal as the random effect. LSM stands for least squares means were calculated considering all milk compositions. Proc CORR was used to estimate the Pearson's correlations between the production parameters.

3. Results

3.1. Production parameters

Descriptive statistics and standard errors for production parameters of Awassi ewes during lactation period are shown in Table I. Lactation weeks had a highly significant effect on production parameters: body condition score, body weight and toil circumference (P<0.0001). Ewe's body weight showed a drop at D10 of 11 .55% then remained steady until the end of lactation (P<0.05). However, fat tail circumference was stable until D100 where an increase of 13. 23% was observed; whereas, body condition score showed higher stability along with the advance of lactation (table 1).

Table 1 | Production parameters of Awassi ewes' milk during the whole lactation period

Days in Milk	Production parameters (x ± SEM)					
	BW (Kg)		BCS		FTC (in)	
DO	57.38	2.49±^{0}	2.28	0.3] ±^{cb}	18.19	I .36±$^{'b}$
D10	50.75	2.49±^{c}	1.91	0.31 ±'	17.06	I .36±'d
D20	51.63	2.49±'	2.06	0.31 ±$^{'b}$	16.44	I .36±'d
D30	51.19	2.49±'	2.25	0.31 ±$^{'b}$	15.31	I.36±^{d}
D40	51.81	2.49±'b	2.31	0.31 ±'b	15.31	I.36±^{d}
D70	54.38	2.49±abc	2.63	0.31±^{cb}	17.19	I .36±^{cd}
DI00	53.75	2.49±^{abc}	2.94	0.31 ±^{0}	19.81	I.36±^{ab}
D120	55.75	2.49±^{ab}	3.03	0.31 ±^{0}	20.44	I.36±^{a}b
D130	55.75	2.49±^{ab}	2.98	0.31 ±^{0}	21.81	1.36±^{0}
P value	<0.0001		<0.0001		<0.0001	

$^{o, b, ç, d}$ = *means in the row with no common superscript letters differ (P<O. 05)*

[1]BCS = *Body Condition Score; FTC=Fot Tail Circumference; BW=Body Weight*

Milk yield (ml/d) showed a decline after weaning as shown in figure 1 and the correlations between the productive parameters of the study throughout lactation are shown in Table 2. Milk production showed a negative correlation with fat tail circumference and body condition score; however it showed o positive correlation with the body weight. On the other hand, body weight and condition score revealed high and positive correlation _(P<0.001).

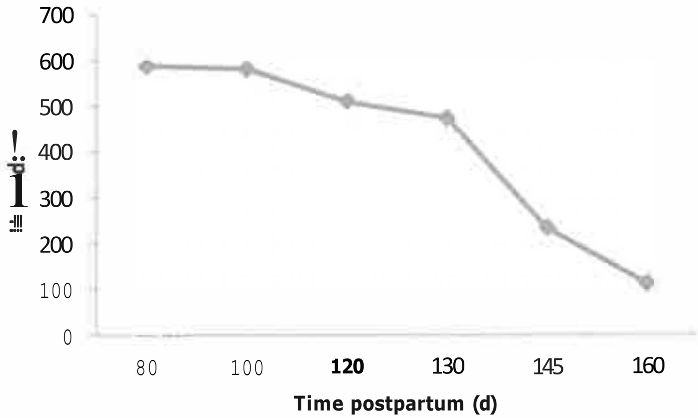

Figure 1 I Milk yield {ml/d) throughout lactation

Table 2 I Correlations between productive parameters of the study

Parameter[1]	BCS	FTC	BW
Milk	-0.13557	-0.18123	0.08098
BCS		0.80267***	0.77617***
FTC			0.71812***

*** P<0.001

[1] *BCS= Body Condition Score; FTC=Fat Tail Circumference; BW=Body Weight*

3.2. Chemical composition

Descriptive statistics and standard errors for chemical composition of milk during lactation period in Awassi ewes are shown in **Table 3.** Milk fat content showed the highest percentage at the onset of lactation (DO) followed by a drop of 43.5% to the lowest percentage at D30 with significant difference (P<0.05) then showed an increase of 30.0% until the late lactation but to lower levels comparing to the first milk **(table 3).** Total solids showed the some pattern as milk fat where it showed the highest value at DO then showed a decline of 24.1% with a significant difference (P<0.05) toward the lowest value at D30, followed by an increment of 11 .6% toward the end of the lactation.

Table 3 I Chemical composition of Awossi ewes' milk during the whole lactation period

Days in Milk	Milk components (x ± SEM in %)[1]									
	Fat		TS		Protein		Lactose		Snf	
DO	8.34	±0.64°	20.43	±0.84°	6.61	±0.20°	3.85	±0.24d	11.92	±0.34°
D10	7.01	±0.58°b	17.47	±QJ7bc	4.4	±0.18°	4.83	±0.22°b	10.48	±0.3lb
D20	7.3	±0.58°h	17.94	±0.77abc	4.65	±0.18cde	4.75	±o.22ab	10.67	±0.3l h
D30	4.71	±0.58<	15.5	±0.77<	4.59	±0.1 Sd	5.01	±0.22°	10.85	±0.31 ab
D40	5.7	±0.58bc	16.65	±QJ7bc	4.83	±0.1 Sbcde	4.88	±Q.22ob	10.98	±0.31 ab
D70	6.64	±Q,58obC	18.05	±Q,7?ab	5.49	±0.18b	4.61	±Q,22obc	11.42	±0.3ab
D100	6.29	±D.58obc	17.11	±0.77bc	5.25	±0.1 Sbcd	4.22	±0.22bcd	10.77	±0.3b
D120	6.93	±0.58°b	17.58	±0.7?bc	5.32	±0.18bc	3.95	±0.22cd	10.57	±0.31b
D130	6.73	±0.61 ObC	17.53	±0.80bc	5.41	±0.19b	4.02	±0.23,d	I0.73	±0.32b
P value	<0.0001		<0.0001		0.0001		0.0001		0.0012	

a, *b,* **c,** *d,* **e** *= means in the row with no common superscript letters differ (P < 0. 05)*
[1] *TS= Total solids; SnF = Solids non Fat*

In contrast, lactation started with the highest protein percentage at DO then showed a drop of 33.3% to the lowest value at DI O followed by an increase of 18.7% until the late lactation showing lower values comparing to the first milk with significant difference (P<0.05). However, lactose content and solids non fat showed an increase of 20.3% and a decrease of 12.1 % respectively from DO and DI O then remained steady throughout the lactation (table 3).

3.3. Physico-chemical properties

Descriptive statistics and standard errors for physico-chemical properties of Awassi ewes' milk during lactation period are shown in Tobie 4.

Table 4 | Physico-chemical **propreties of Awassi ewes'** milk during the **whole** lactation period

Days in Milk	Physico-chemical Properties (x ± SEM)					
	Total Acidity (°SH)		Density (SG*IOOO)		Freezimg Point (C)	
DO	15.77	±Q.66 a	1033.12	± 1.24•bc	0.69	±O,Q3a
D10	9.49	±0.59 d	1032.88	± 1.12abc	0.62	±O.Q2•b
D20	11.05	±0.59«1	I 033.25	± I. I 2abc	0.62	±O.Q2•b
D30	11.02	±0.59,d	1036.81	±1.12•	0.62	±O.Q2•b
D40	11.64	±0.59bcd	1035.63	± I .12ab	0.64	±0.02°0
D70	13.75	±0.59ab	1035.44	±I.]2ab	0.66	±0.02ab
D100	12.71	±0.59bc	1033.25	± I .12•bc	0.61	±0.02°
D120	13.02	±0.59bc	1031.38	±I. 12'	0.6	±0.02°
D130	13.35	±0.62•b	1032.22	±1.17b,	0.6	±0.03°

° b,' = *means* in *the row with no* common *superscript* letters *differ (P<0.05)*

Milk acidity showed the highest value (15.77 ± 0.66°SH) at the onset of lactation (DO) then declined to the lowest value (9.49 ± 0.59°SH) with significant difference (P<0.05) followed by an ascending phase till the end of lactation (table 4). However, milk density and freezing point was showing a steady phase throughout the lactation with the highest value 1036.81 ± 1.12 SG*I 000 and 0.69 ± 0.03°C at D30 and DO respectively, then the lowest values at late lactation (DI 20) with significant difference (P<0.05).

4. Discussion

The relationship between body weight and condition score was studied by many authors (Ada *et al.*, 2004; Arik et *al.,* 1997) and was highly and positively correlated (r=0.78, P<0.0001) in this study. Sezenler *et al.* (2011) concluded in their study that body condition score is a good estimator for body weight modifications. The some positive and high correlation was found in this study between fat tail circumference, body weight and condition score (r = 0.80, r = 0.78 respectively; P<0.0001). These findings ore in accordance with the results reported by Abi Saab et a/. (1999). However, milk production showed negative correlation with fat toil circumference and body condition score (r = - 0.18 and r = - 0.14, respectively), as previously reported by Connas (2002) especially at early lactation where ewes, in negative energy balance, mobilize body fat reserves in order to cope with milk production, or more specifically the fat tail in Awassi breed.

Milk production in Awassi ewes reached its peak yield in improved Awassi breed at 27 days as mentioned by Gootwine and Pollett (2000) or at the third week of lactation as reported by Tolafha and Ababneh (2011) after which it began to decline. Komprej et al. (2012) stated that the curves of protein and fat content showed an opposite trend to that of milk yield as explained by the increased daily milk yield in this period (Hasson, 1995). These conclusions were in accordance with this study, where fat content curve showed high variation during lactation from 4.71 % to 8.34% characterized by a descending phase in the early lactation until day D30, due to peak milk production dilution of fat, followed by on ascending phase till the period of late lactation. Findings in this study correspond with those of Jelinek *et al.* (1990) for Tsigai and Tsigai/East Friesian ewes where they reported that fat content decreased up to the 34th day of lactation then increased. The overage fat content of Awassi ewes' milk during the whole lactation was 6.63%, similar to the findings of other studies conducted in the area (Srour *et* al., 2006; Hilali et *al.,* 2011 b) on the same breed in which average percent of milk fat was reported as 6.9% and 6.59% respectively, or in Spain and Turkey, where average mii k fat was reported as 6.52% (Milan *et al.,* 2006) and 6.61 % (ohon *et a/.*, 2005) respectively. Total solids in milk showed the same pattern as milk fat content with an average of 17.58% during lactation which is in accordance with the results of ahan *et al.* (2005) and Hilali *et al.* (2011 b) on Awossi ewes where total solids averaged at 17.54% and 17.66% respectively.

Furthermore, milk protein content curve was more stable throughout the lactation showing a variation from 4.40% to 6.61 % characterized by a drop at day DI O followed by a smooth increase till the end of lactation. This decline was earlier comparing with the study conducted by Jelinek *et al.,* (1990), where they found a drop of protein content on the 34th day of lactation then increased. Oravcov6 et *al.* (2007) reported the stability of protein content on three breeds of sheep Lacoune, Tsigai and improved Valachian, and explained that this is most likely reflecting the stability of protein content during the period of lactation. Quite an opposite trend of protein content was described by Pavic *et al.* (2002), who reported on ascending phase of protein content from the beginning till the ending of lactation. These differences might be explained by the modeling of the experiments where lactation curves starts two weeks (Fuertes *et al.,* 1998) after lambing thus skipping the descending phase at the beginning of the lactation. In the other hand, lactose and solids non fat were the most stable between all the milk components with an average of 4.46% and I 0. 93% respectively. These findings were in accordance with those reported by ahan et *al.* (2005) where lactose marked an average of 4.34% and solids non fat an average of 10. 93%.

According to the physical properties of Awassi ewes' milk, total acidity values and freezing point were higher at the start of lactation period (15.77 ± 0.66 °SH and 0.69 ± 0.03 °C, respectively) than dropped rapidly at day D I 0 to be followed by a smooth increase till the end of lactation whereas freezing point showed another decline at day D70 ($P < 0.05$). Pavic *et al.* (2002) reported that the high variability of acidity observed during lactation period is probably associated to the poor hygiene while milking. However, density showed an ascending phase in the beginning of lactation until day D30 where it reached its peak (1036.81 ± 1.12 SG'" I OOO) and declined afterward till the end of lactation. These results were in accordance with those reported by ahan *et al.* (2005) on Awassi ew s.

5. Conclusion

Milk composition varied greatly with the stage of lactation in Awassi ewes. In fact, Awassi ewes produce milk with a quite steady protein and solids non fat contents throughout lactation, whereas significant recovered content of total solids and fat was observed at mid and late lactation stages. Consequently, these observations promote the continual use of Awassi sheep milk in the production of manufactured dairy products at different stages of lactation.

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