Research Journal of Dairy Sciences 7 (1): 6-10, 2013
ISSN: 1993-5277
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Factors Affecting Milk Composition of Algerian Ewe Reared in Central Steppe Area

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Abstract: The aim of this study was to assess changes in composition of individual raw ewe's milk reared in Algerian area steppe. In total 167 milk samples from 2 local breeds, Ouled Djellal (75 samples) and Rumbi (92) were taken. For each ewe, researchers recorded the number of lactation (primiparous vs. multiparous), lactation stage (beginning, middle or end) and age. Milk samples were taken twice time from lactating period during Winter and Spring season. Rumbi ewe milk exhibited the highest ($p \leq 0.001$) protein, lactose, solid-non-fat and density than Ouled Djellal ewe milk. Conversely, Ouled Djellal manifested significantly higher ($p \leq 0.001$) fat concentration and freezing point in milk than the Rumbi. The pH value was not significantly affected by breed. The stage of lactation had significant effect on fat contents ($p \leq 0.05$) and freezing point ($p \leq 0.01$) while other parameters studied were not significantly influenced by lactation stage. The season had a significant effect on all parameters tested except total solids. Lactose and freezing point were not significantly affected by the age of ewe. On the contrary, there was an important effect of age for other parameters. Regarding the lactation number, no significant effects were found.

Key words: Milk composition, Ouled Djellal sheep, Rumbi sheep, variation, lactation stage, Algeria

INTRODUCTION

In Algerian area steppe, the ruminant livestock are mostly represented by sheep. Sheep are operated mainly for meat production and secondarily for milk and wool. Ouled Djellal and Rumbi are the most common breed with low production but well adapted to the different natural regions (Benyoucef *et al*., 1995) and represents approximately 75% of the total number (Boucif *et al*., 2007). In this environment, sheep milk is generally used for breast lambs in the first place then it is consumed by the farmers, as well as or transformed traditionally.

Milk is undoubtedly the first food consumed by mammals. The composition of the raw milk specifies both its nutritional quality and also its ability to technological transformation and quality of resulting products (Pirisi *et al*., 2001; Bencini, 2002). This composition is not stable and is subject to multiple variations. Several factors affecting the composition of sheep's milk have been reported in the literature. Some of these factors are related to the animal breed (Haenlein, 2002; Tsiplakou *et al*., 2006; Mierlita *et al*., 2011), lactation stage (Sahan *et al*., 2005; Kuchtik *et al*., 2008; Hejtmankova *et al*., 2012), parity (Gonzalo *et al*., 1994; Piras *et al*., 2007), lactation number (Kremer *et al*., 1996; Oravcova *et al*., 2007), age of the animal (Kremer *et al*., 1996; Berger *et al*., 2004; Abd Allah *et al*., 2011) udder health (Bianchi *et al*., 2004; Raynal-Ljutovac *et al*., 2007), other are related to diet (Pirisi *et al*., 2001; Bocquier and Caja, 2001; Bovera *et al*., 2011), milking practices (Nudda *et al*., 2002; Rassu *et al*., 2007; Sinapsis, 2007), season (Thomson *et al*., 1982; Bocquier *et al*., 1997; Abd Allah *et al*., 2011) and other factors (Sevi *et al*., 2003; Morand-Fehr *et al*., 2007). Thus, this investigation constitute the first and preliminary study carried out concerning the factors affecting milk composition of Algerian ewe reared in central steppe area.

MATERIALS AND METHODS

Sampling: Individual milk samples were collected from 2 local sheep breed, Ouled Djellal (OD) (n = 75) and Rumbi (R) (n = 92) conducted in the same herd with similar

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conditions regarding housing and feeding. Ewes were allowed to graze on natural pasture and feed with hay, pasture ensilage and barley when necessary. All were housed under semi-intensive mode. For each ewe, researchers recorded the number of lactation (primiparous vs. multiparous), lactation stage (beginning, middle or end) and age. Milk samples were taken from each ewe twice time from lactating period during Winter and Spring season. Milk samples were collected at the afternoon hand milking and analyzed within 24 h with refrigeration overnight in terms of milk composition.

Analytical procedure: The pH values were measured using a pH-meter (Hanna H211, Hanna Instrument, Portugal previously calibrated. Density was performed by using Quevenne lactometer, according the method described by AOAC (1998) and milk freezing point by using a cryoscope (model 403, advanced Instruments, Norwood, NA). Total Solids (TS) content was determined according to the method of AOAC (1998) by drying at 103±2°C. Fat, protein and lactose were determined by infrared analysis using a Milkoscan apparatus (FT 120, FossElectric, Hilleroed, Denmark). Solid-Non-Fat (SNF) was calculated as the difference between the total solids and fat content.

Statistical analysis: Statistical analysis was carried out using Statistica program. The significant differences between means were calculated by one-way Analysis of Variance (ANOVA) using Turkey range test and probability level was either 95 or 99%.

RESULTS AND DISCUSSION

Average composition: Table 1 report the mean and standard deviations of chemical composition of individual milk samples collected. These contents are not constant and vary depending on breed, stage of lactation, age and season. The average composition of the 167 samples of ewe's milk used in this study was 5.10±1.21% protein, 6.02±3.48% fat and 4.76±0.72% lactose. These values were found lower than those reported by several researchers for sheep milk in various countries: Baltadjieva *et al.* (1982) in Bulgaria and Greece, Pavic *et al.* (2002) in Croatia, Sahan *et al.* (2005) in Turkey and Rouissi *et al.* (2006) in Tunisia except for lactose who seems to be higher. The content of TS (16.91±3.55%) and SNF (10.90±1.44%) were also lower than those reported previously. The physico-chemical characteristics, expressed by the freezing point, density and pH shows the following averages -0.58, 1036.78 and 6.76°C, respectively. These data are somewhat similar to those mentioned by many researchers (Pavic *et al.*, 2002; Park *et al.*, 2007; Kuchtik *et al.*, 2008; Hilali *et al.*, 2011).

Factors of variation

Effect of breed: The results in Table 1 confirm the hypothesis put forward by several researchers on the effect of breed on the composition of sheep milk. Rumbi ewe milk exhibited the highest ($p \leq 0.001$) protein (5.41 vs. 4.71%), lactose (4.93 vs. 4.54%) and solid-non-fat (10.24 vs. 11.43%) than Ouled Djellal ewe milk. Conversely, OD manifested significantly higher ($p \leq 0.001$) fat concentration in milk (6.83 vs. 5.35%) than the R. On the other hand, OD ewes yielded more milk than R ewes.

Table 1: Factors affecting milk composition

Factor of variation	Means±SD								
	Effective	Protein (%)	Fat (%)	Lactose (%)	TS (%)	SNF (%)	Freezing point (°C)	Density	pH
Overall mean	167	5.10±1.21	6.02±3.48	4.76±0.72	16.91±3.55	10.90±1.44	-0.58±0.07	1036.78±8.16	6.76±0.20
Breed of ewe	-	***	***	***	NS	***	***	***	NS
Rumbi	92	5.41±1.26	5.35±3.67	4.93±0.71	16.78±3.75	11.43±1.52	-0.60±0.06	1039.26±9.43	6.77±0.21
Ouled-Djellal	75	4.71±1.04	6.83±3.07	4.54±0.67	17.07±3.32	10.24±1.31	-0.55±0.07	1033.73±4.82	6.74±0.19
Parity	-	NS	NS	NS	NS	NS	NS	NS	NS
Primiparous	14	5.07±1.19	5.91±3.88	4.52±0.69	16.47±3.60	10.56±1.25	-0.57±0.07	1035.27±5.56	6.67±0.16
Multiparous	153	5.10±1.22	6.03±3.46	4.78±0.72	16.95±3.56	10.93±1.57	-0.59±0.07	1036.92±8.37	6.77±0.20
Stage of lactation	-	NS	*	NS	NS	NS	**	NS	NS
Beginning	97	5.19±1.30^{a}	5.42±3.49^{a}	4.82±0.74	16.48±3.76	11.06±1.66	-0.60±0.06^{a}	1037.95±9.58	6.77±0.02
Middle	49	5.11±1.10^{ab}	6.59±3.05^{b}	4.63±0.77	17.39±3.18	10.80±1.36	-0.55±0.07^{b}	1035.65±5.13	6.75±0.20
End	21	4.60±0.98^{b}	7.42±3.90^{b}	4.73±0.46	17.78±3.22	10.36±1.27	-0.65±0.02^{a}	1033.99±5.69	6.76±0.17
Age (years)	-	*	**	NS	**	**	NS	*	***
≤2	35	4.74±1.05^{a}	6.08±2.87^{a}	4.53±0.52^{a}	16.31±2.81^{a}	10.23±1.03^{a}	-0.55±0.06^{a}	1034.10±4.11^{a}	6.68±0.13^{a}
≤3 and >2	44	5.21±1.08^{ab}	4.16±2.65^{b}	5.04±0.83^{b}	15.49±2.87^{ac}	11.34±1.43^{bc}	-0.59±0.05^{bc}	1038.87±5.33^{bc}	6.82±0.19^{bc}
≤4 and >3	42	4.99±1.23^{a}	7.01±3.94^{a}	4.66±0.67^{a}	17.70±3.93^{bad}	10.69±1.54^{a}	-0.57±0.09^{abc}	1035.14±5.95^{a}	6.74±0.19^{ad}
≤5 and >4	15	4.65±0.99^{a}	6.83±2.92^{a}	4.65±0.36^{ab}	17.15±2.48^{ae}	10.32±1.06^{a}	-0.58±0.04^{abd}	1034.06±4.40^{ad}	6.71±0.15^{ae}
>6	31	5.70±1.44^{b}	6.84±3.89^{a}	4.80±0.83^{ab}	18.42±4.30^{be}	11.58±1.94^{c}	-0.61±0.08^{cd}	1040.37±14.71^{dc}	6.81±0.27^{cde}
Season	-	***	**	***	NS	***	-	***	***
Winter	73	6.30±0.75	5.19±3.14	4.47±0.63	17.07±3.48	11.89±1.44	-0.58±0.07	1040.69±9.88	6.82±0.22
Spring	94	4.16±0.44	6.66±3.62	4.98±0.71	16.78±3.63	10.12±1.13	-	1033.74±4.71	6.71±0.17

NS = Not Significant; *, **, ***$p<0.05$, $p<0.01$ and $p<0.001$, respectively; $^{a-c}p<0.05$

This variation includes negative correlation between milk yield and composition (Haenlein, 2002). Many researchers have shown the effect of breed on milk composition, although reports are somewhat contradicting and disparate. Abd Allah *et al.* (2011) found that breed had a significant effect only on fat and SNF when comparing Rahmani and Chios Egyptian ewes. Jaramillo *et al.* (2008) observed a significant difference in the concentration of fat and lactose from 2 Spanish ewe breeds (Guirra and Manchega). However, Mierlita *et al.* (2011) reported that breed of ewe had no significant effect on protein, fat and TS contents for Spanca and Turcana Romanian ewes. Also, Tsiplakou *et al.* (2008) did not found any effect of breed on fat, protein and lactose concentration of the 4 sheep breeds (Awassi, Lacaune, Friesland and Chios) kept under the same management in Greece. If it is recognized that fat and protein concentration in milk show a positive correlation with cheese yield (Barron *et al.*, 2001), breeds selected for dairy production tend to have a lower concentration of milk components (Flamant and Morand-Fehr, 1982; Berger *et al.*, 2004). Then Bencini (2001) concluded that with high milk production, the total amount of cheese produced from the milk can be higher but the relative yield of cheese from each liter of milk will be lower. So, the East Friesian which is considered one of the best milking sheep in the world, it has however, one of the lowest fat and protein contents (5.5-6.5 and 5%, respectively; Berger, 2004).

Regarding the physical characteristics of milk, R had significantly ($p \leq 0.001$) higher milk density (1039.26) than the OD (1033.73) and weak freezing point (-0.60 vs. -0.55°C). The pH value was not significantly affected by breed. The same finding was observed with density (Rouissi *et al.*, 2006), pH (Rouissi *et al.*, 2006; Abd Allah *et al.*, 2011). A contrary, Martini and Caroli (2003) reported that breed of ewe had a significant ($p<0.001$) effect on pH value. According to Mathieu, the pH of milk depends on its richness in certain constituents, particularly phosphates, citrates and casein.

Effect of stage of lactation: Changes in physico-chemical characteristics of ewe's milk during the stage of lactation are shown in Table1. Fat percentage increase significantly ($p \leq 0.05$) as lactation progressed. Similar observations had been made by Pavic *et al.* (2002), Bianchi *et al.* (2004) and Kuchtik *et al.* (2008). This increase was 36.8% between beginning and end lactation period which is in agreement with percentage (37.6%) reported by Gonzalo *et al.* (1994) between d 45 and 150 postpartum. Also, the stage of lactation had significant effect on freezing point ($p \leq 0.01$). Its value at the end of lactation period was significantly lower with regard to the mid lactation. Pavic *et al.* (2002) showed the same trend but with lower values. Other parameters studied were not significantly influenced by lactation stage. This observation is in agreement or in disagreement, regards the parameter considered with various previous findings. Thus, Sahan *et al.* (2005) report significant lactational effects on the contents of dry matter ($p<0.01$), pH and density ($p<0.05$) not on protein, lactose and non-fat dry matter of Awassi ewe's milk. However, Bianchi *et al.* (2004) showed significant effect of lactation stage on lactose, protein but not on pH. While Gonzalo *et al.* (1994), Pavic *et al.* (2002) and Kuchtik *et al.* (2008) found that the stage of lactation had a significant influence on all analyzed parameters. On the other hand, Hejtmankova *et al.* (2012) report that the contents of total protein as well as acid whey proteins in ovine milk were dependent on the period of lactation.

Effect of age and parity: The composition of milk depending on age and parity of ewes is summarized in Table 1. Lactose and freezing point were not significantly affected by the age of ewe. On the contrary, there was an important effect of age for all of the other parameters. Fat and SNF were the most affected. The highest values were recorded at the age of 4 years for fat and >6 years for SNF. The lowest ones were observed, respectively at the age of 3 and 2 years old. Among other things, the older ewes (>6 years) produce milk which is richer in term of protein, TS, density and less acid than milk produced by maiden ewes (<3 years). The result contrast with the results reported by Abd Allah *et al.* (2011) who found no significant effect of ewe's age on the chemical components (TS, SNF, protein and pH) analyzed except fat% where the fat percentage is lower in older ewes compared with that of younger ewes. By contrast, Corbett in Bencini (2001) reported that the concentration of fat is higher in older than younger ewes. Similarly, Hassan (1995) found no significant effect of age of ewe on TS and SNF but also on fat. Lateif *et al.* (1989) reported the significant effect of the age of ewe on protein percent which agrees with our finding. According to Kremer *et al.* (1996), only fat content was affected by age not protein, lactose and SNF contents.

Regarding the lactation number, no significant effects were found for all parameters studied which corresponds with the results reported by Piras *et al.* (2007) and contrast with the results reported by Gonzalo *et al.* (1994) for which parity had a significant effect on the fat content but not on the protein content. Also, the concentration of TS increases with parity (Berger *et al.*, 2004). Bencini (2001) report that there are contrasting literature reports on the effect of parity on milk composition and it is not possible to distinguish between age and parity of ewe. As

documented, it seems that the results and those found in the literature are disparate and sometimes contradictory.

Effect of season: Results in Table 1 show the influence of the season on the variables studied. Protein, lactose, SNF, density and pH have been found to increase in Winter while fat was reduced significantly. Reduction of fat can be explained by reduction of milk C4-16 fatty acids (Haenlein, 2002). The effect of season on milk composition may be direct by length of day (Bocquier *et al*., 1997) not by high temperature (Thomson *et al*., 1982) or indirect by its effect on food for sheep fed primarily pasture (Pulina *et al*., 1993). The effect of season on pH, protein, SNF contents recorded in this study were supported by Abd Allah *et al*. (2011) but were not for fat and TS percentage.

CONCLUSION

This study showed that all parameters were affected by breed (except pH), season (except TS) and age of ewe (except lactose and freezing point). However, no significant effect was observed of lactation number while the stage of lactation had significant effect only on fat contents and freezing point. On the other hand, the results and those found in the literature are disparate and sometimes contradictory.

ACKNOWLEDGEMENT

This study was supported by Algerian Ministry of higher education and scientific research (research project of CNEPRU, code: F02820100030).

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