Genetic and Non-genetic Effects on Colostrum and Milk Constituents of ewes

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Abstract: The objective of this work was to study the effect of breed, lamb sex, parity and stage of lactation on colostrum and milk constituents in Ossimi, Rahmani and Suffolk ewes. Twenty four ewes (12 Ossimi, 8 Rahmani and 4 Suffolk), aged 2.5-6 years and weighed 35-45 kg. were used. The lamb was separated over night from his mother and the ewe was hand-milked in the morning. Colostrum and milk samples were collected in the first day, 7th day then every two weeks until the 13th week post-partum. Fat (F), protein (P), lactose (L) and ash (A) contents were determined in colostrum and milk samples. The overall percentage means of F, P, L and A were 6.24, 5.39, 5.17 and 0.98 respectively. Breed had effected on F ($P<0.001$) and P ($P<0.05$) but insignificantly effect on L and A. Fat averaged 5.76, 6.41 and 6.95 and P averaged 5.44, 5.42 and 5.23 in Ossimi, Rahmani and Suffolk ewes milk respectively. Sex of lamb had no effect on F, L or A but P was slightly affected ($P \leq 0.05$). Protein in milk of ewes lambed males was 5.45 higher than that 5.33 of ewes lambed females. Fat percentages were 5.56, 7.08, 6.77, 6.24, 6.24 and 6.52 in the 1st, 2nd, 3rd, 4th, 5th and 6th lactations. Stage of lactation had significant ($P \leq 0.0001$) effect on F, P and L but insignificantly affected A. Fat, P, L and A percentages of colostrum averaged 8.38, 6.49, 5.48 and 1.04 respectively, which differ markedly than that of normal milk in F, P and L. Fat and P tend to increased but L and A tend to decrease with the advancement of lactation period. Milk constituents determined in this experiment may be used as indicator to make suitable ewe milk replacer.

Keywords: ewes, lamb sex, breed, parity, stage of lactation, colostrum, milk constituents.

INTRODUCTION

Sheep milk is widely used in the Mediterranean regions for making hard and soft cheese, yoghurt and other dairy products. Accordingly, milk composition is very important because it affects the quality and determines the ratio processed product/milk and therefore the cost. On the other hand, milk constituents are important to the growth of the suckling offspring and in respect to the consequences of lactation to the ewe. Determination milk constituents are very important as indicator to make a suitable milk replacer. Milk composition varies according to several factors, such as breed, nutrition, environment (Raynal-Ljutovac *et al.*, 2008) parity, year and number of lambs (Carnicelle *et al.*, 2008). An example is given in Table (1).

The colostrum of the twin-producing animals (goat and cow) contained significantly more dry matter, total protein, true protein, whey protein, true whey protein and immunoglobulin-G than that of mothers with single progeny. The sex or progeny of twin-calving cows had no influence on the composition of colostrum (Csapó *et al.*, 1994). Findings of several researchers on the effect of parity on yield and quality of ewe milk are not consistent. A progressive increase of milk protein and fat contents with increasing number of lactations has been reported by Casoli *et al.* (1989) and Dell'Aquila *et al.* (1993) but the opposite trend has been observed by Ubertalle (1989). Wohlt *et al.* (1981) did not find any influence of parity on ewe milk constituents.

There is very little information relating to milk composition of ewes under Egyptian conditions.

Therefore, the present work was to study effect of breed, lamb sex, parity and stage of lactation on the milk constituents of ewes.

MATERIALS AND METHODS

Twenty four ewes (12 Ossimi, 8 Rahmani, 4 Suffolk), aged 2.5-6 years and weighing 35-45 kg. were used in this experiment. The ewes (12 having male and 12 having female lambs) were housed and managed at the experimental farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. The ewes were fed according to NRC (1985) on concentrated feed mixture and rice straw. Concentrate feed mixture consisted of 30% wheat bran, 27.5% cotton seed meal, 30% Yellow corn, 1% limestone, 1% minerals & vitamins and 0.5% salt. Part of the ration was substituted with clover (*Trifolium alexandrinum*) through winter season. Rice straw was offered to the animals *ad libitum* and fresh water was available all the time. The date of mating was recorded; all ewes lambed single lamb throughout winter season (28 days on December). All ewes were under the same environmental conditions.

Milk sample collection:

The sampling period began at the first day after birth (colostrum), then at the 7th day post-partum then biweekly until the 13th week post-partum. The lamb was separated over night from his mother and the ewe was hand-milked in the morning. Samples were kept at -20 °C till the analysis.

Table (1): Average composition of sheep milk (Paccard and Lagriffoul, 2006).

Number of data	Total solids (%) (*n* = 36)	Fat (%) (*n* = 68)	Proteins (%) (*n* = 67)	Caseins (%) (*n* = 18)	Lactose (%) (*n* = 30)
Mean	18.1	6.82	5.59	4.23	4.88
Minimum	14.4	3.60	4.75	3.72	4.11
Maximum	20.7	9.97	7.20	5.01	5.51

Analysis of milk:

Fat, protein and ash contents were determined according to the methods described in AOAC (1990). Lactose content was determined by Lawrance method (1968). The lactose content of the sample was calculated from a standard curve of pure lactose solution ranging from 10-100 μg/ml.

Statistical analysis:

General Linear Model (GLM) procedure of Statistical Analysis Software (SAS Institute Inc., 1998), was used for statistical analysis of the data while Duncan's multiple range test (Duncan, 1955) was applied to distinguish significant differences between means. The statistical linear mathematical model for the analysis comprised the effects of breed, parity, lamb sex, and stage of lactation as fixed effects.

RESULTS AND DISCUSSION

Milk constituents:

Sheep and goat milk products can provide a profitable alternative to cow milk products owing to their specific taste, texture, typicity and their natural and healthy image. Nevertheless, consumers are requesting more and more information concerning the hygienic quality and nutritional composition of these products. All these characteristics can be influenced by several factors, such as breed, physiology, feed, environment and technology (Raynal-Ljutovac *et al.,* 2008). Milk composition is in constant evolution with production becoming more intensified, but this is also in relation to the quality criteria of milk payment.

Fat Content (F%):

Fat is the more quantitatively and qualitatively variable component of milk, depending on lactation stage, season, breed and feeding (Raynal-Ljutovac *et al.,* 2008). The averages of milk constituents as affected by breed, lamb sex, parity and stage of lactation are shown in Tables 2 and 3. Similar values of F % were found in Chiapas in Mexico (Verdalet *et al.,* 1993), Egyptian strains (Hassan, 1995), Chios (Plouni *et al.,* 1998) and Rambouillet ewes (Ochoa-Cordera, *et al.,* 2002). However, Wohlt *et al.* (1981) found higher values (12.6) from Dorset ewes in the first 56 days of lactation.

Table (2): Means ± SE of milk constituents as affected by breed, lamb sex and parity

Factors	milk samples (No.)	Milk Constituents			
		Fat %	Protein %	Lactose %	Ash %
Overall mean	122	6.24 ± 0.14	5.39 ± 0.10	5.19 ± 0.07	0.98 ± 0.02
Breed		***	*	NS	NS
- Ossimi	55	5.76^c ± 0.20	5.44 ± 0.16	5.34 ± 0.12	0.95 ± 0.03
- Rahmani	39	6.41^b ± 0.23	5.42 ± 0.15	4.99 ± 0.13	1.00 ± 0.04
- Suffolk	28	6.95^a ± 0.23	5.23 ± 0.22	5.15 ± 0.12	0.99 ± 0.05
Lamb Sex		NS	*	NS	NS
- Male	62	6.19 ± 0.20	5.45 ± 0.14	5.16 ± 0.10	1.00 ± 0.03
- Female	60	6.30 ± 0.18	5.33 ± 0.14	5.21 ± 0.11	0.95 ± 0.03
Parity		NS	NS	NS	NS
- 1^{st} lactation (P1)	33	5.56^b ± 0.22	5.25 ± 0.17	5.19 ± 0.14	0.97 ± 0.04
- 2^{nd}lactation (P2)	8	7.08^a ± 0.50	5.34 ± 0.46	5.31 ± 0.16	0.95 ± 0.10
- 3^{rd} lactation (P3)	20	6.77^a ± 0.36	5.34 ± 0.25	5.22 ± 0.18	0.98 ± 0.05
- 4^{th} lactation (P4)	19	6.24^{ab} ± 0.31	5.40 ± 0.26	5.14 ± 0.21	1.00 ± 0.06
- 5^{th} lactation (P5)	23	6.24^{ab} ± 0.32	5.54 ± 0.25	5.06 ± 0.18	0.96 ± 0.03
- 6^{th} lactation (P6)	19	6.52^{ab} ± 0.35	5.52 ± 0.28	5.28 ± 0.17	0.95 ± 0.05

* (P≤0.05), *** (P≤0.001) and NS not significant

^{ab} Values in the same column with different superscript differ significantly (P≤0.05)

Table (3): Means ± SE of milk constituents as affected by stage of lactation.

Week of Lactation	milk samples (No.)*	Fat %	Protein %	Lactose %	Ash %
	Significance	***	***	***	ns
Colostrum	24	8.38^a ± 0.19	6.49^a ± 0.20	5.48^a ± 0.13	1.04^{ab} ± 0.04
1^{st} Week	22	5.56^e ± 0.17	5.03^d ± 0.11	5.68^a ± 0.11	1.00^{ab} ± 0.04
3^{rd} Week	22	4.72^f ± 0.14	3.99^e ± 0.14	5.15^{ab} ± 0.17	0.90^b ± 0.05
5^{th} Week	13	5.61^e ± 0.25	4.85^d ± 0.08	5.43^a ± 0.30	0.99^{ab} ± 0.08
7^{th} Week	11	5.66^e ± 0.23	5.35^{cd} ± 0.11	5.14^{ab} ± 0.29	1.10^a ± 0.07
9^{th} Week	10	6.05^d ± 0.24	5.71^{bc} ± 0.15	4.67^{bc} ± 0.10	0.92^{ab} ± 0.07
11^{th} Week	10	6.59^c ± 0.30	5.93^b ± 0.23	4.49^c ± 0.14	0.89^b ± 0.06
13^{th} Week	10	7.24^b ± 0.29	6.48^a ± 0.11	4.41^c ± 0.20	0.94^{ab} ± 0.05

* the different number due to the mortality of some lambs

*** P≤0.05: NS not significant

^{Abcdef} Values in the same column with different superscript differ significantly (P≤0.001).

Fat contents were varied significantly (P<0.001) between Ossimi, Rahmani and Suffolk ewes. Fat contents averaged 5.76, 6.41 and 6.95 in the milk of the previous breeds respectively. These results are in agreement with Flamant and Morand-Fehr, (1982). Gardner and Hogue (1966) were reported that F % was differed significantly between Hampshier and Corriedale ewes. Non-significant differences among breeds were reported by Sakul and Boylan, (1992) and Hassan, (1995). Peeters *et al.* (1992) found that F% was not significantly influenced by breed of ewe during the first 45 days of lactation in Flemish, Suffolk and Texel ewes and their crosses.

Lamb sex had no significant effect on F%. Wohlt, *et al.* (1981) reported that volumes and composition of milk produced by ewes having either male or female lambs were similar. In cow sex of progeny or twin calving did not influence composition of colostrum (Csapó, *et al.*, 1994).

Parity did not affect F% significantly. The first parity had the lowest value of F% and P2&P3 had the highest value then decreased in P4&P5 and increased again in P6. These results are in agreement with Wohlt *et al.* (1981), Hassan, (1995) and Plouni *et al.* (1998) who reported that age of ewe had no significant effect on F%. Sevi *et al.* (2000) worked on ewes in parities 1, 2 and 3 and reported that the P3 ewes had significantly higher milk fat contents compared to the P1 and P2 ewes. Also, significant effect of parity on F% was reported by Casoli, *et al.* (1989) and Dell"Aquila, *et al.* (1993).

Fat content was highly significant (P<0.001) affected by stage of lactation. Most of studies (wohlt, *et al.*, 1981, Plouni *et al.*, 1998, Ochoa-Cordero *et al.*, 2002) were reported significant effect of stage of lactation on fat milk constituents. Fat of colostrum was significantly higher than F% in milk. These results are agreed with (Csapó, *et al.*, 1994 and Hadjipanayiotou, 1995). On the other hand, the fat content of colostrum was less than that of milk (Wohlt, *et al.*, 1981). Fat content tended to increase with stag of lactation. The gradual increase in fat content during lactation has also been shown in other studies with different sheep breeds (Fadel *et al.*, 1989, Gonzalo *et al.*, 1994 and Plouni *et al.*, 1998). This may be due to the negative relationship between milk production and F %.

Protein Content (P%):

Total protein is one of the main quality criteria applied to sheep milk payment in many countries (Pirisi *et al.*, 2007). The overall mean of P% is 5.39 ± 0.10 (Table 2). Similar values of P% were found in Dorset (Wohlt, *et al.*, 1981), Chios (Hadjipanayiotou, 1995, Plouni *et al.*, 1998), Rambouillet (Ochoa-Cordero, *et al.*, 2002) and Awassi ewes (Kridli, *et al.*, 2007).

Breed of ewe had significant (P ≤ 0.05) effect on P. Protein contents averaged 5.44, 5.42 and 5.23 in Ossimi, Rahmani and Suffolk ewes respectively. No significant differences were reported by Peeters *et al.* (1992) and Kridli, *et al.* (2007). However, Flamant and Morand-Fehr, (1982) found significant effect of genotype on milk composition.

Lamb sex had significant effect (P ≤ 0.05) on P% (Table 2). Protein content in milk produced by ewes having male was higher (5.45) than that (5.33) in ewes having female lambs. Wohlt, *et al.* (1981) found that nutrient composition of Dorset ewe milk did not affected by lamb sex. The sex of progeny or twin calving cows had no influence on the composition of colostrum (Csapó, *et al.*, 1994).

Protein content did not affected by parity (Table 2). Protein values increased slightly with parities, this may be due to decrease milk production. This result is agreed with Wohlt, *et al.* (1981). Significant effect of parity on protein content reported by Plouni *et al.* (1998) and Sevi *et al.* (2000).

Stage of lactation had significantly effect on protein content. As the same, wohlt, *et al.* (1981), Plouni *et al.* (1998), Ochoa-Cordero, *et al.* (2002) and Kridli, *et al.* (2007) were found that milk constituents were affected significantly by stage of lactation. Protein content of colostrum was markedly higher than normal milk. Similar results were reported by Csapó, *et al.* (1994) and Hadjipanayiotou, (1995). Protein content were decreased in the 3rd and the 5th weeks and then increased gradually to the 13th weeks of lactation. Milk protein content fluctuated during week 1, 3, 6 and 8 (Ochoa-Cordero, *et al.* 2002). The clearest example of the fluctuating milk protein content is with Epirus Mountain ewes during 30 weeks of lactation (Simos *et al.*, 1996). Similarly, other researchers reported the percentage of protein to increase as lactation progresses with peak values being recorded at the end of lactation (Sevi *et al.*, 2004). The higher protein percentage may be due to the decrease in milk production (Kridli, *et al.*, 2007).

Lactose content (L%):

Lactose is the most stable milk component and as such, the milk volume varies in response to the lactose concentration. Lactose is the most abundant soluble element found in milk, and its osmotic activity is the highest of all the components. The lactose content is also inversely proportional to fat, protein and ach (Ochoa-Cordero, *et al.*, 2002).

The overall means of L% (5.19) and the averages of L% are shown in Tables 2 and 3. Similar values were found in Dorset (wohlt, *et al.*, 1981), Flemish milk sheep, Suffolk and Texel (Peeters *et al.*, 1992), Chios (Plouni *et al.*, 1998), Comisana (Sevi *et al.*, 2000), Rambouillet ewes (Ochoa-Cordero, *et al.*, 2002).

Lactose content did not affected by breed. Lactose contents were (5.34) in Ossimi, (5.15) in Suffolk and (4.99) in Rahmani. Also (Peeters *et al.* (1992) found that breed had no significant effect on L%. On the other hand, Flamant and Morand-Fehr, (1982) concluded that the genotype determines milk composition.

Lactose content did not affected significantly by lamb sex (Table 2). This result is supported by wohlt, *et al.* (1981) and Csapó, *et al.* (1994). Also, Thomson and Thomson, (1958) reported that sex of lamb had no effect on body weight gain. Early postnatal growth of lambs was dependent ($p < 0.05$) on genotype of lamb, birth weight and number of lambs suckled (Peeters *et al.* (1992).

Parity did not affect L% significantly. This result is in agreement with wohlt, *et al.* (1981), Peeters *et al.* (1992). Lactose content tended to increased to the 2nd lactation and then decreased to the 6th lactation. Plouni *et al.* (1998) found that percentage of lactose increased to the 3rd lactation and declined in later lactation. However, the lactose content of milk decreased with increasing number of lactations and was significantly higher ($p < 0.05$) in the P1 than in the P3 (Sevi *et al.*, 2000).

Lactose content was affected highly significant ($P<0.001$) by stage of lactation. Similar results were reported by wohlt, *et al.* (1981), Hadjipanayiotou, (1995), Plouni *et al.* (1998) and Ochoa-Cordero, *et al.* (2002). Lactose content gradually decreased from the beginning of lactation, attaining maximum in week 1 (5.68) and minimum in week 13 (4.41). Ochoa-Cordero, *et al.* (2002) reported that L% were higher during weeks 1, 3, 6 and 8 ($P > 0.05$) and lower ($p < 0.05$) during week 12. The changes of lactose content in milk during the lactation were opposite to those observed for protein and fat contents, with the lowest lactose contents recorded during the 11th and 13th of lactation. The lactose content of colostrum was less than that of milk. Similar result was concluded by wohlt, *et al.* (1981) and Ochoa-Cordero, *et al.* (2002). Lactose content was low in the first day of lactation, increased sharply in the third day and continued to increase slightly to the 11th day of lactation Hadjipanayiotou, (1995) and Simos *et al.* (1996) did not find differences during weeks 7-35 of lactation.

Ash content (A%):

Ash contents (means ± SE) are shown in Tables 2 and 3. Similar ash values were concluded in Dorset (wohlt, *et al.*, 1981), Chios (Hadjipanayiotou, 1995), Rambouillet (Ochoa-Cordero, *et al.*, 2002) and Awassi ewes (Kridli, *et al.*, 2007).

Breed had no significant effect on A%. This result is supported by wohlt, *et al.* (1981). However, Kridli, *et al.* (2007) was reported that ash content was affected by breed-type.

Lamb sex did not affect A% significantly, it is in agreement with wohlt, *et al.* (1981). Lamb growth and milk production by ewes were positively correlated during early lactation. Milk compositions were not significantly related to growth (Thomson and Thomson, 1958, Butterworth *et al.*, 1969 and wohlt, *et al.*, 1981).

Parity did not affect A% significantly. Also, age of ewe had no effect on nutrient composition of Dorset milk ewe (wohlt, *et al.*, 1981). Ash values increased slightly to P4 and decreased to the P6.

Ash content is the only component which did not affected by stage of lactation. This is agreement with wohlt, *et al.* (1981) and Ochoa-Cordero, *et al.* (2002). A% tended to decreased gradually from the first week to the 13th weeks. Hadjipanayiotou, (1995) concluded that ash content remained relatively constant from day 3 to day 11 of lactation. Ash gradually decreased from the beginning of lactation, attaining maximum in week 1 ($p < 0.05$) and minimum in week 12 (Ochoa-Cordero, *et al.*, 2002). We did not find significant differences between colostrum and normal milk in A%. Higher ash was in colostrum than whole milk (wohlt, *et al.*, 1981). Colostrum constituents did not affect by breed, lamb sex and parity.

CONCLUSIONS

Breed had significant effect on F and P but did affect L and A. Lamb sex had no significant effected on F, L and A but significantly effected on P. Parity did not effected on F, P, L and A, but stage of lactation was significantly effected of them. Milk constituents determined in this experiment may be used as indicator to make suitable ewe milk replacer.

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التأثيرات الوراثية وغير الوراثية علي تركيب سرسوب و لبن النعاج

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يهدف هذا العمل إلي دراسة تاثير نوع الحيوان، جنس المولود، عدد مرات الولادة وفترة الحليب علي تركيب سرسوب ولبن النعاج الأوسيمي و الرحماني والسفولك. اشتملت هذه الدراسة علي ٢٤ نعجة (١٢ أوسيمي و ٨ رحماني و٤ سفولك) عمرها تراوح بين ٢,٥-٦ سنوات ووزنها من ٣٥-٤٥ كجم. تم فصل الحملان عن أمهاتها ليلا ثم حلبت النعاج يدويا في الصباح. عينات السرسوب واللبن أخذت يوم الولادة، اليوم السابع ثم كل أسبوعين حني الأسبوع الثالث عشر بعد الولاة. تم تقدير محتوي البن من الدهن والبروتين واللاكتوز والرماد في عينات السرسوب واللبن ٠ المتوسط العام للنسبة المنوية للدهن والبروتين واللاكتوز والرماد في اللبن كان ٦,٢٤، ٥,٣٩، ٥,١٧ و٠,٩٨، على الترتيب. تأثير النوع معنوي (مستوي معنوية أقل من ٠,٠٠١) على نسبة الدهن وكذلك على نسبة البروتين (مستوي معنوية أقل من ٠,٠٥)٠ متوسطات نسبة الدهن كانت ٥,٧٦، ٦,٤١و٦,٩٥ ونسبة البروتين كانت ٥,٤٤، ٥,٤٢ و٥,٢٣ في النعاج الأوسيمي والرحماني والسفولك على الترتيب. جنس المولود لم يؤثر معنويا على كل من نسبة الدهن واللاكتوز والرماد ولكن أثر في نسبة البروتين (مستوي معنوية < ٠,٠٥)٠ محتوي البروتين في لبن الأمهات التي أنجبت ذكور كان (٥,٤٥) أعلي معنويا عن (٥,٣٣) في لبن الأمهات التي أنجبت إناث٠ متوسطات نسبة الدهن في مواسم الحليب المختلفة كانت ٥,٥٦، ٧,٠٨، ٦,٧٧، ٦,٢٤، ٦,٢٤ و٦,٥٢ لكلا من الموسم الأول والثاني والثالث والرابع والخامس والسادس على الترتيب٠ فترة الحليب أثرت معنويا (مستوي معنوية أقل من ٠,٠٠١) على كلا من الدهن والبروتين واللاكتوز ولكن لم تؤثر على نسبة الرماد ٠ محتوي السرسوب من الدهن والبروتين واللاكتوز والرماد كان ٨,٣٨، ٦,٤٩، ٥,٤٨ و ١,٠٤ على الترتيب، وكان هناك فروق واضحة فى نسبة الدهن والبروتين واللاكتوز عن تلك في اللبن الطبيعي٠ محتوي اللبن من الدهن والبروتين يميل إلي الزيادة بينما محتوي اللبن من اللاكتوز والرماد يميل إلي النقص مع تقدم موسم الحليب. مكونات اللبن المقدرة في هذه التجربة من الممكن أن تستخدم كدليل عند صناعة بديل للبن النعاج لاستخدامه في تغذية الحملان.