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RESEARCH ARTICLE

Effects of Lactation Stage, Age, Birth Type and Body Weight on Chemical Composotion of Red Karaman Sheep Milk

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Summary

The present study was undertaken to assess the influences of lactation stage, age, birth type and body weight of ewes on chemical properties of milk of Red Karaman sheep reared under extensive conditions. Average milk fat, protein, total solid, lactose and ash percentages of Red Karaman sheep milk were 6.31, 6.23, 17.35, 5.12 and 0.91%, respectively. Effects of lactation stage, age and body weight of ewes were significant (P<0.001; P<0.01) on milk fat and protein contents. The effect of only lactation stage was significant (P<0.01) on total solid. Milk fat and protein contents were lowest (6.20% and 5.72%) at the beginning and highest (6.44% and 6.80%) at the end of lactation stage. Significant positive phenotypic correlations were established between total solids and milk fat (0.87) and between total solids and protein (0.41). Significant negative phenotypic correlations were established between lactose and milk fat (-0.58), between lactose and protein (-0.40) and between lactose and total solid (-0.50). The results of the present study suggest that increase in milk fat was accompanied by a increase in milk protein and total solid toward the end of lactation. The younger and lighter ewes produced more milk fat and protein. Chemical compositions of milk of ewes rearing single lambs were similar to that of ewes rearing twins.

Keywords: *Red Karaman, Lactation stage, Body weight, Sheep milk, Chemical composition*

Morkaraman Koyun Sütünün Kimyasal Bileşimine Laktasyon Evresi, Yaş, Doğum Tipi ve Beden Ağırlığının Etkisi

Özet

Bu araştırma ekstansif koşullarda yetiştirilen Morkaraman koyunların sütünün kimyasal bileşimine laktasyon evresi, yaş, doğum tipi ve beden ağırlığının etkisini incelemek amacıyla yapılmıştır. Araştırmada, Morkaraman koyun sütünde yağ, protein, kuru madde, laktoz ve kül oranları sırasıyla %6.31, 6.23, 17.35, 5.12 ve 0.91 olarak tespit edilmiştir. Süt yağı ve protein üzerine laktasyon evresinin (P<0.001), yaşın (P<0.001; P<0.01) ve beden ağırlığının etkisi önemli (P<0.01) olmuştur. Kuru madde üzerine ise sadece laktasyon evresinin etkisi önemli (P<0.01) olmuştur. Sütte, süt yağı ve protein oranları en düşük laktasyonun başlangıcında (%6.20 ve %5.72), en yüksek laktasyonun sonunda (%6.44 ve %6.80) tespit edilmiştir. Toplam kuru madde ile süt yağı arasında (0.87), toplam kuru madde ile protein arasında (0.41) düzeyinde önemli pozitif fenotipik korelasyon, ancak laktoz ile süt yağı arasında (-0.58), laktoz ile protein arasında (-0.40) ve laktoz ile toplam kuru madde arasında (-0.50) düzeyinde önemli negatif fenotipik korelasyon tespit edilmiştir. Sonuç olarak, laktasyonun sonuna doğru sütte yağ, protein ve toplam kuru madde miktarının arttığı, daha genç ve daha hafif koyunların daha fazla süt yağı ve protein ürettiği, tek ve ikiz kuzu büyüten koyunların sütünün kimyasal bileşimlerinin ise benzer olduğu belirlenmiştir.

Anahtar sözcükler: *Morkaraman, Laktasyon evresi, Beden ağırlığı, Koyun sütü, Kimyasal kompozisyon*

INTRODUCTION

Extensive breeding of sheep and goats in most of the Mediterranean areas is characterized by grazing during daytime and housing during night-time, with possible integration of concentrate feed, and of straw or hay. In extensive production systems, animals are free to move within a habitat that allows them to best perform their physiological and behavioural functions. However, grazing can also adversely affect animal well-being, due to seasonal fluctuations of herbage amount and quality; consequently, grazing animals are usually subjected to a

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temporary nutritional stres [1].

The quality of sheep milk is paramount in controlling the quality of dairy products made from it. The factors affecting the quality of the milk of sheep milked commercially for dairy production, such as the genotype of the sheep, are difficult to control, but others are environmental factors, such as the nutrition and management of the milking flock, and can be manipulated by the farmer to produce high quality milk. To obtain high quality milk, the ewes should be healthy and receive adequate diets. Physiologically the ewes must be in an appropriate stage of lactation because at the very beginning and at the end of lactation the milk is of poor manufacturing quality, even though it has high fat and protein content. These factors and their influence on milk quality for the processing of milk into dairy products, especially cheese, are described and critically examined [2].

The present study was undertaken to assess effects of lactation stage, age, birth type and body weight of ewes on chemical properties of milk of Red Karaman sheep reared under extensive conditions.

MATERIAL and METHODS

The experiment was carried out on 82 lactating Red Karaman ewes in a traditional private farm in Van province of Turkey. All ewes were identified by ear tag. Ewes were lambed during March. Age, body weights and birth type of ewes at the beginning of lactation were recorded. Litter size was limited to one or two lambs. Management of ewes was similar. At 20 d postpartum, ewes had free access to barley (250 g per ewe per day) in addition to *ad libitum* alfalfa hay. Then, ewes were grazed on pasture during daytime when weather conditions permitted. However, alfalfa hay was fed to ewes during the cold days. Ewes were housed in a sheep fold at nights. Pasture consisted of mainly grass and some legumes and very few weeds. Individual samples of milk for chemical analyses were taken from Red Karaman ewes twice a month during lactation period. The ewes were hand-milked two times daily both morning and evening. Milk samples were taken after the morning and evening milkings. The morning and evening milk samples were mixed. A mixture of morning and evening milk samples refrigerated at +4ºC until the time of analyses. The total solid was analysed by Gravimetric method. Milk fat was analysed by Gerber method. Protein content was analysed by Kjeldahl method. Lactose content was determined according to lactose (%) =100-(water% + fat% + protein% + ash%) [3]. Milk samples were analized at Faculty of Veterinary Medicine University of Yüzüncü Yıl. It was assumed that there was no significant interaction among factors affecting chemical composition of milk. Effects of factors such as lactation stage, age, birth type and body weight on fat, protein, total solid, lactose and ash of Red Karaman sheep milk were examined using the LSM procedure of SAS statistic package programme. For fat, protein, total solid, lactose and ash of Red Karaman sheep milk, $Y_{ijklm}= \mu + a_i + b_j + c_k + d_l + e_{ijklm}$ model was developed. Y_{ijklm}: individual value, μ: expected mean, a_i: effect of lactation stage, b_j: effect of age, c_k: effect of birth type, d_l: effect of body weight, e_{ijklm}: error term. Analysis of correlation among all of the variables was performed [4].

RESULTS

Least square means of milk fat, protein, total solids, lactose and ash content of Red Karaman sheep milk are presented in *Table 1*. Milk samples of Red Karaman sheep contained on average 6.31% fat, 6.23% protein, 17.35% total solids, 5.12% lactose and 0.91% ash. Milk fat was significantly affected by lactation stage, age and body weight. Milk fat content was decreased with increased of age. At the begining of lactation the content of milk fat and total solids were significantly lower ($P<0.001$; $P<0.01$) with regard to the mid and end of lactation stage. Protein content was lowest (5.72%) at the beginning and highest (6.80%) at the end of lactation stage. Lactose content was highest (5.40%) at the beginning of lactation stage. However, the effect of lactation stage was not significant on lactose. Effect of birth type did not produce any significant effect on milk fat, protein, total solids, lactose and ash contents. Milk fat and protein were increased with decreased of body weight.

Coefficients of phenotypic correlation between milk components were given in *Table 2*. When correlations coefficients were evaluated, significant correlations ($P<0.001$; $P<0.01$) were established between total solid and fat content (0.87) and between total solid and protein (0.41). The correlation (0.56) between milk fat and protein content was also significant ($P<0.01$). Significant negative correlations ($P<0.01$; $P<0.05$) were established between the content of lactose and milk fat (-0.58), between lactose and protein (-0.40), between lactose and total solid (-0.50) and between lactose and ash (-0.23).

DISCUSSION

In the eastern part of Turkey, extensive breeding system is the most common breeding system within the private farms with native sheep breeds. Sheep milk production and composotion of milk are changed due to genotype and breeding systems. That is why, the present study was undertaken to assess the influences of lactation stage, age, birth type and body weight of ewes on chemical properties of milk of Red Karaman sheep reared under extensive conditions.

Milk samples of Red Karaman ewes contained on average 6.31% fat, 6.23% protein, 17.35% total solids, 5.12% lactose and 0.91% ash. These values in agreement with the values reported for Norduz ewes, but total solids were

Table 1. *Least squares means for the chemical composition of Red Karaman sheep milk (%)*
Tablo 1. *Morkaraman koyun sütünün kimyasal bileşimine ait en küçük kareler ortalamaları (%)*

Factors	Fat		Protein		Total Solid		Lactose		Ash	
	Mean ± S_x		Mean ± S_x		Mean ± S_x		Mean ± S_x		Mean ± S_x	
General	6.31	0.10	6.23	0.11	17.35	0.23	5.12	0.14	0.91	0.03
Lactation Stage	***		***		**		-		-	
1. Month	6.20^{b}	0.08	5.72^{b}	0.09	16.98^{b}	0.32	5.40	0.16	0.86	0.02
2. Month	6.11^{b}	0.11	5.92^{b}	0.10	17.40^{a}	0.43	5.25	0.15	0.77	0.01
3. Month	6.40^{a}	0.07	6.49^{a}	0.14	17.39^{a}	0.41	5.29	0.13	0.93	0.02
4. Month	6.40^{a}	0.10	6.22^{ab}	0.13	17.54^{a}	0.38	4.76	0.11	1.02	0.03
5. Month	6.44^{a}	0.14	6.80^{a}	0.16	17.44^{a}	0.47	4.90	0.10	0.97	0.03
Age (Year)	***		**		-		-		-	
2	6.53^{a}	0.13	6.31^{a}	0.14	17.48	0.40	5.09	0.29	0.97	0.02
3	6.49^{a}	0.10	6.28^{a}	0.16	17.39	0.41	5.11	0.21	0.92	0.02
4	6.27^{ab}	0.08	6.30^{a}	0.12	17.36	0.38	5.13	0.30	0.88	0.03
5	5.95^{b}	0.14	6.03^{b}	0.15	17.17	0.44	5.15	0.27	0.87	0.03
Birth Type	-		-		-		-		-	
Single	6.39	0.11	6.34	0.10	17.41	0.30	5.23	0.18	0.96	0.02
Twin	6.23	0.10	6.12	0.12	17.29	0.32	5.01	0.27	0.86	0.03
Body Weight (kg)	**		**		-		-		-	
36-40	6.45^{a}	0.13	6.31^{a}	0.17	17.42	0.42	5.17	0.19	0.90	0.03
40.1-44	6.49^{a}	0.14	6.32^{a}	0.14	17.49	0.37	5.15	0.24	0.92	0.02
44.1-48	6.29^{ab}	0.11	6.17^{ab}	0.11	17.36	0.38	5.11	0.25	0.91	0.04
≥ 50	6.01^{b}	0.12	6.12^{b}	0.18	17.13	0.33	5.05	0.19	0.91	0.04

^{a,b} Means within the same columns followed by different letters significantly differ
*-: P>0.05, ** P<0.01, *** P<0.001*

Table 2. *Phenotypic correlation coefficients among milk componenets*
Tablo 2. *Süt bileşenleri arasındaki fenotipik korrelasyon katsayıları*

Parameter	Fat	Protein	Total Solid	Lactose
Protein	0.56**			
Total solid	0.87***	0.41**		
Lactose	-0.58**	-0.40**	-0.50**	
Ash	0.15^{-}	0.47**	0.11^{-}	-0.23*

-: P>0.05, *P<0.05, **P<0.01, ***P<0.001

higher than the value (16.29%) reported for Norduz ewes by Yılmaz et al.[5]. Milk fat obtained in the present study was higher than the value (5.86%) reported for Akkaraman ewes by Yardımcı and Özbeyaz [6], however, this value was lower than the values reported for Hamdani (7.45%) [7] and Karakas-Akkaraman (6.60%) [8]. Lipids are the most important components of milk in terms of cost, nutrition, physical and sensory characteristics that they impart to dairy products [9]. Pavić et al.[10] found that the stage of lactation had a significant influence on milk fat, protein, total solids and lactose parameters, which correspond with the results of this study. At the begining of lactation the content of milk fat, protein and total solids were significantly lower with regard to the mid and end of lactation stage. These results are in agreement with the results reported for Travnik sheep by Pavić et al.[10].

Nutrition can be regarded as one of the most important sources of variation in composition of milk [5]. High fat, protein and total solids concentration in the milk are associated with high yields in the resulting dairy products [1,11]. Protein contents vary widely within species, and are influenced by breed, stage of lactation, feeding, climate, parity, season, and udder health status [9]. Protein content was lowest at the beginning and highest at the end of lactation stage. Pavić et al.[10] and Manfredini et al.[12] also reported that sheep milk contains a significantly lower protein content at the beginning than at the end of the lactation (5.38 and 7.11%; 5.47 and 6.46%, respectively).

Lactose is the major carbohydrate in milk. Lactose is a valuable nutrient, because it favors intestinal absorption of calcium, magnesium and phosphorus, and the utilization of Vitamin D [9]. In this study, lactose content was highest at the beginning of lactation stage. Lactose in sheep milk as in other ruminants is lower at the beginning of lactation in colostrum and towards the end of lactation, contrary to the behavior of fat and protein contents in milk [13]. Dario et al.[14] reported a higher lactose content at the beginning (5.32%) in relation to the end (4.93%) of lactation period for milk taken from Leccese sheep. Pavić et al.[10] also reported a

higher lactose content at the beginning (4.97%) in relation to the end (4.09%) of lactation period for milk taken from Travnik sheep. In this study, milk fat content was decreased with increased of age, and this result is in agreement with literatures [5,15]. However, it was found that age of ewes is not having significant influence on total solids, lactose and ash contents, which correspond with the information provided by Yılmaz et al.[5].

Effect of birth type did not produce any significant effect on milk fat, protein, total solids, lactose and ash contents. This observation is supported by Yılmaz et al.[5]. In contrast, in a earlier study, Gardner and Hogue [16] reported that Hampshire and Corriedale ewes that gave birth to single lambs produced milk with a higher concentration of fat and protein. Bencini and Pulina [2] noted that the negative relationship between yield and quality of milk may explain why twin-bearing ewes who produce more milk have lower concentrations of fat and protein in the milk.

In the study, the younger and lighter ewes produced more milk fat and protein. There are few reports on the effect of liveweight on the quality of sheep milk. Yılmaz et al.[5] were found that the body weight of Norduz ewes had a significant effect on the concentration of milk fat, which correspond with the information provided by this study. In the study, the effect of body weight was significant on milk protein, however, this finding was not similar to the finding reported for Norduz sheep by Yılmaz et al.[5]. This difference was probably due to genotype. Pulina et al.[17] found positive phenotypic correlations (from 0.26 to 0.56) between the liveweight of Sarda ewes and the concentration of fat and protein in their milk for the first 10 weeks of lactation.

In the present study, the correlation between fat and protein content was also significant, which was also reported by Yılmaz et al.[5], Pavić et al.[10], Gut et al.[18] and Ubertalle et al.[19]. Significant negative correlations were established between the content of lactose and fat, between lactose and protein and between lactose and total solid. These results are in agreement with the results obtained by Yılmaz et al.[5], Pavić et al.[10], Gut et al.[18] and Bufano et al.[20].

The results of the present study suggest that the increase in milk fat was accompanied by a increase in protein and total solid towards the end of the lactation. The younger and lighter ewes produced more milk fat and protein. Chemical compositions of milk of ewes rearing single lambs were similar to that of ewes rearing twins.

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