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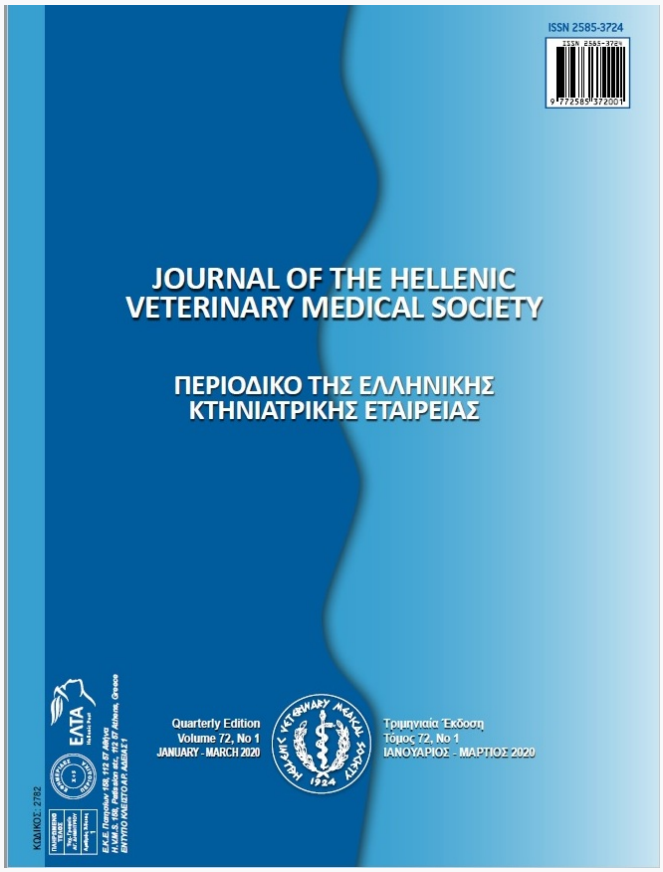

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AA AKBAŞ, F TAŞÇI, Ö ELMAZ, M SAATCI

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Research article
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Evaluation of Milk Yield and Milk Composition of Honamlı Goats

A.A. Akbaş[1]*, F. Taşçı[2], Ö. Elmaz[1], M. Saatcı[3]

[1]*Department of Animal Science, Faculty of Veterinary Medicine, Burdur Mehmet Akif Ersoy University, Burdur, Turkey*

[2]*Department of Food Hygiene and Technology, Faculty of Veterinary Medicine, Burdur Mehmet Akif Ersoy University, Burdur, Turkey*

[3]*Department of Animal Science Fethiye Faculty of Agriculture, Muğla Sıtkı Koçman University Muğla, Turkey*

ABSTRACT: The aim of this study was to determine the milk yield and milk composition (total solids, fat, protein and lactose), freezing point depressionand somatic cell counts of Honamlı goat during second lactationin Turkey. The animal material of the study consisted of a total of 30 goat. Total milk yield was detected by using Fleischmann's method. Milk composition was analyzed by Bentley 150, and somatic cells were counted by Bentley Somacount FC. One-way ANOVA was used to determine the effect of lactation stages on milk yield and milk composition. In the study, mean lactation period and lactation milk yield of Honamlı goat were detected as 202.4 days, and 92.6 kg, respectively. The percentages of fat, protein, lactose, total solid, freezing point depression, and somatic cell counts /mL of milk were 2.4%, 4.2%, 5.1%, 12.7%, -0.57 °C, 82.8 and 2.9%, 4.2%, 4.7%, 12.7%, -0.59 °C, 483 on the 60th and 120thlactation day respectively. Total solids, fat, and protein values significantly increased especially towards the end of lactation ($P < 0.05$). Lactose value decreased slowly from the beginning to the end of lactation. The somatic cell counts increased in milk particularly at the end of lactation ($P < 0.05$). The freezing point depression remained stable throughout lactation. It was thought that results of study were important representing the second lactation milk production of Honamlı goats that is one of the native goat breeds of Turkey.

Keywords: Honamlı goat, milk composition, second lactation

Corresponding Authors:
Aykut asım Akbas, Department of Animal Science, Faculty of Veterinary Medicine, Burdur Mehmet Akif Ersoy University, 15030, Istiklal Campus, Burdur, Turkey
E-mail address: icould_akbas@hotmail.com

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INTRODUCTION

Milk is one of the most important food including protein, fatty acid, vitamins, and minerals and also it is contained all the necessary energy and nutrients for growth and development (Pereira, 2014). The biological value of milk is determined by the content of bioactive components that offer health benefits (Reklewska et al. 2005, Wong et al. 2006). Its high nutritive value can be attributed to also its unique chemical composition which supports optimal digestion and absorption (Miciński et al., 2013). Like it's composition, the somatic cells count (SCC)determined in milk is of high importance for milk products of hygienic, sanitary, dietetic, nutritious, and gastronomic quality in the dairy industries (Jiménez-Granado et al., 2014; Karagiannis et al., 2018).

The freezing point depression (FPD) is one of the most important indicator of the quality of milk, which is influenced by the composition of cow and goat milk (Genčurová et al., 2008; Kędzierska-Matysek et al., 2011). All components of milk is affected by a number of factors such as breed, parity and lactation stage, milk yield, milking time, feed quality and amount, occurrence of subclinical mastitis, nutritional deficiencies, thermal stress, seasonal influences, and presence of CO_2 in milk (Janštová et al., 2007).

There has been an obvious increase in the demand for goat milk and products in developed and developing countries due to its nutritive and dietetic value (Bernecka, 2011; Akbas et al., 2019).*Caprine* milk contains averagely 12.2% total solids, which is composed of 3.5% protein, 3.8% fat, 4.1% lactose, and 0.8% ash (Park, 2016). While fat content of goat milk across breeds ranges from 2.45 to 7.76% (Jenness, 1980;Haenlein andCaccese, 1984); one of the important components of milk, Lactose make up 44% of the total carbohydrates in goat milk and between 4.1% and 4.8% of the weight of the whole milk (Park et al., 2007; Raynal-Ljutovac et al., 2008). In addition, the unique composition of goat milk, combined with its nutritional value, is related to the release of protein fragments which are more digestible than bovine milk, during digestion or technological processing, which are able to perform specific biological activities (Park et al., 2007; Ceballos et al., 2009). The quality and composition of goat milk is affected several factors that contains genetic factors, environmental conditions, goat farming practices, age, period of lactation, milking type, frequency and period of milking, feeding practices, and udder health situation (Raynal-Ljutovac et al., 2008; Bolacalı and Küçük, 2012; Park, 2016).

Honamlı goats which are named after the Honamlı nomads are generally reared on the Taurus Mountains considered as one of a native goat breed in Mediterranean region in Turkey. Honamlı goat is a multipurpose breed, but usually mentioned for its big body and meat production. Milk production and reproduction traits have also significant meaning in very limited flocks (Saatcı and Elmaz, 2017). They are officially registered as an orginal goat breed in the year of 2015 (Official Gazette of Turkish Republic, 2015).The more in-depth knowledge about Honamlı goat milk composition and properties is needed.

Although there are many studies on changes of major components in goat milk during lactation, only little is known about milk yield, composition, freezing point depression and somatic cell count of Honamlı goat milk.

The aim of this study was to determine milk yield, milk composition (total solids, fat, protein, and lactose content), freezing point depressionandsomatic cell count of Turkish local breed Honamlı goats during the second lactation.The results of the present study are expected to help characterizing the Honamlı goat breed.

MATERIALS AND METHODS

Sampling and Analytical Procedures

In this study were used 30 Honamlı goats in second lactation at the Research and Training Farm of the Faculty of Veterinary Medicine of Burdur Mehmet Akif Ersoy University in Turkey.

The goats were grazed on highland pasture and maquis area including mostly kermes oak (Quercus coccifera) in formations from cultures of green olive tree (Phillyrea latifolia), black pine (Pinus nigra), Calabrian pine (Pinus brutia), and cedar (Cedrus) during spring and summer and they kept out for minimum 8 hours in a day from early in the morning till noon. In addition to grazing and browsing, goats were kept in a barn during winter and fed with 200 g/day concentrate feed (16% crude protein and 2500 kcal metabolisable energy per kg dry matter). Kids continued to suck their mothers until 5 months of age.

Milk samples were provided during the morning and evening milking once a month. Honamlı goats were milked by hand on 30th, 60th, 90th, 120th, 150th,

180th and 210th day of lactation. The California Mastitis Test was applied to the goats milk. However, it was not determined mastitis cases during this study.

Measuring of the quantity of milk was determined using a graduated cylinder. Total milk yield (TMYL) is estimated by the centring date method, also known as Fleischmann's method (Maria and Gabina, 1992; Ruiz et al., 2000), which is currently used by the selection program. The general expression of the Fleischmann's method is:

$$TMYL = y_1 t_1 + \sum_{i=2}^{k} (y_i + y_{i+1})/2(t_{i+1} - t_i) + y_{k+1} * 15$$

Where TMY is total milk yield; y1 is yield at first milk record, tl is interval between lambing and first recording; yi is yield of the record i and ti is interval between the record i and the record (i+1), (i = 1, … k), and 15 = assumed number of days between the last recording and the dry-off.

Milk samples were transported to laboratories by using cool boxes without preservatives at temperatures not exceeding 6°C. All milk samples were analysed using the Bentley 150 (Bentley Analytical Instruments, USA) to determine the milk composition, and FPD. The SCC in goat milk samples were counted by Bentley Somacount FC (Bentley Analytical Instruments, USA).

This study was approved by Burdur Mehmet Akif University, Local Ethics Commission of Experimental Animals (6.9.2012, meeting number:1, resolution number:6).

Statistical Analysis

All statistical analysis were carried out using Minitab 16.1 statistical package (Minitab, 2011). An intense descriptive statistical analysis was applied to the data. Student-t test was employed for the differences between morning and evening milk yields. In addition, One-way ANOVA was used to determine the effect of lactation stages on milk yield and milk composition (total solids, fat, protein, and lactose content), FPD, and SCC. Tukey analysis was used to control for the significance of differences between subgroups.

RESULTS

Table 1 shows the mean lactation milk yield (kg), lactation time (days), and daily milk yield (kg) of milk samples for Honamlı goats. Table 2 shows mean milk yield (g) in different lactation stage. Mean lactation period of Honamlı goats was 202.4 days. In this study, the mean lactation milk yield of Honamlı goats was 92.6 kg. The daily milk yield of Honamlı goats was 0.453 kg (Table 1). While the highest peak of total milk yield was 610 g, and 678 g on 60th and 90th days, respectively; the mean milk yield was decreased towards ends of the lactation (Table 2).It was found to be statistically significant differences among the measurement days of lactation stages ($P < 0.05$).

Figure 1. A Honamlı goat and kids from the research flock

Figure 2. Does of the Honamlı goat, the research flock

Table 1. Mean lactation milk yield of the Honamlı goats

Parameters	n	Mean ± SE
LactationMilkYield (kg)	30	92.6±7.23
Lactation time (days)	30	202.4 ±3.12
Daily milkyield (kg)	30	0.453 ± 0.03

n: Number of theHonamlı goats; SE: Standard Error

Table 2. Mean milk yield (g) in different lactation stage (30 - 210thdays) of Honamlı goats $(\bar{x} \pm S_{\bar{x}})$

MilkingPeriod	n	30th day	n	60th day	n	90th day	n	120th day	n	150th day	n	180th day	n	210thday	P
Morning	30	$238.3^{c} \pm 17.4$	30	$375.0^{a} \pm 26.6$	30	$326.7^{b} \pm 27.9$	30	$324.7^{b} \pm 33.1$	30	$184.7^{c} \pm 16.6$	24	$145.8^{d} \pm 18.0$	7	$257.1^{c} \pm 77.5$	*
Evening	30	$190.0^{b} \pm 14.1$	30	$235.0^{b} \pm 18.3$	30	$351.7^{a} \pm 25.7$	30	$144.0^{c} \pm 19.5$	30	$68.3^{d} \pm 8.21$	24	$275.0^{b} \pm 36.7$	7	$142.9^{c} \pm 40.0$	*
Total	30	$428.3^{b} \pm 30.7$	30	$610.0^{a} \pm 41.6$	30	$678.3^{a} \pm 47.2$	30	$468.0^{b} \pm 47.3$	30	$253.0^{c} \pm 20.8$	24	$420.8^{b} \pm 51.3$	7	$400.0^{b} \pm 115$	*
P		*		*		-		*		*		*		*	

P values at the end of the each row indicate the statistical differences according to measurement days.
P values at end of the each columns how the statistical differences between morning and evening milk in each measurement days.
[a,b,c,d]: Mean with different superscripts (only for rows) are statistically different. *:P<0.05

Table 3a. Milk composition, FPD, and SSC in different lactation stage (30 - 120thdays) of Honamlı goats $(\bar{x} \pm S_{\bar{x}})$

Parameters	n	30th day			60th day			90th day			120th day			
		Morning	Evening	Mean	Morning	Evening	Mean	Morning	Evening	Mean	Morning	Evening	Mean	P
Fat (%)	30	2.2 ± 0.30	3.8 ± 0.28	$3.0^{a} \pm 0.27$	1.5 ± 0.17	3.2 ± 0.19	$2.4^{b} \pm 0.17$	1.8 ± 0.12	1.5 ± 0.10	$1.7^{b} \pm 0.10$	2.4 ± 0.26	3.4 ± 0.16	$2.9^{a} \pm 0.19$	*
Protein (%)	30	4.6 ± 0.09	4.5 ± 0.09	$4.6^{a} \pm 0.09$	4.2 ± 0.06	4.2 ± 0.05	$4.2^{b} \pm 0.05$	4.2 ± 0.06	4.1 ± 0.06	$4.1^{b} \pm 0.06$	4.3 ± 0.06	4.1 ± 0.06	$4.2^{b} \pm 0.06$	*
Lactose (%)	30	5.1 ± 0.03	4.9 ± 0.03	5.0 ± 0.03	5.2 ± 0.03	5.0 ± 0.02	5.1 ± 0.02	5.0 ± 0.03	5.0 ± 0.02	5.0 ± 0.02	4.8 ± 0.02	4.6 ± 0.03	4.7 ± 0.02	-
Total Solids (%)	30	12.0 ± 0.37	14.1 ± 0.34	$13.4^{a} \pm 0.34$	11.9 ± 0.21	13.5 ± 0.22	$12.7^{a} \pm 0.21$	11.9 ± 0.15	11.5 ± 0.15	$11.7^{b} \pm 0.15$	12.5 ± 0.31	12.9 ± 0.22	$12.7^{a} \pm 0.25$	*
FPD (-°C)	30	0.58 ± 0.01	0.57 ± 0.01	0.57 ± 0.01	0.57 ± 0.01	0.56 ± 0.01	0.57 ± 0.01	0.58 ± 0.01	0.57 ± 0.01	0.57 ± 0.01	0.59 ± 0.01	0.59 ± 0.01	0.59 ± 0.01	-
SCC ($x10^3$cell/ml)	30	115.7 ± 32.20	175.7 ± 66.00	$145.7^{b} \pm 41.20$	53.8 ± 16.00	111.8 ± 25.30	$82.8^{c} \pm 19.50$	92.3 ± 47.90	138.8 ± 75.40	$113.1^{b} \pm 61.40$	331.0 ± 105	634.0 ± 155	$483.0^{a} \pm 124$	*

FPD:Freezing point depression, SCC: Somatic cell count, [a,b,c]: Mean with different superscripts (only for rows) are statistically different.
*:P<0.05 -:Non-significant (P>0.05)

Table 3b. Milkcomposition, FDP, and SSC in differentlactationstage (150 - 210thdays) of Honamlıgoats $(\bar{x} \pm S_{\bar{x}})$

Parameters	n	150th day			180th day			210th day			
		Morning	Evening	Mean	Morning	Evening	Mean	Morning	Evening	Mean	P
Fat (%)	30	3.0 ± 0.21	3.3 ± 0.17	$3.2^{b} \pm 0.17$	4.4 ± 0.26	3.6 ± 0.21	$4.0^{b} \pm 0.22$	5.9 ± 0.85	8.1 ± 0.84	$6.6^{a} \pm 0.71$	*
Protein (%)	30	4.2 ± 0.06	3.9 ± 0.08	$4.0^{c} \pm 0.07$	5.4 ± 0.16	5.2 ± 0.13	$5.3^{b} \pm 0.12$	9.0 ± 0.51	8.7 ± 0.57	$8.8^{a} \pm 0.43$	*
Lactose (%)	30	4.7 ± 0.02	4.7 ± 0.02	$4.7^{a} \pm 0.02$	4.4 ± 0.15	4.5 ± 0.03	$4.4^{a} \pm 0.07$	3.0 ± 0.36	3.4 ± 0.31	$3.2^{b} \pm 0.25$	*
Total Solids (%)	30	12.9 ± 0.26	12.7 ± 0.25	$12.8^{c} \pm 0.23$	14.9 ± 0.35	14.2 ± 0.31	$14.6^{b} \pm 0.31$	16.9 ± 1.02	20.3 ± 0.106	$18.6^{a} \pm 0.90$	*
FPD (-°C)	30	0.59 ± 0.01	0.59 ± 0.01	0.59 ± 0.01	0.60 ± 0.01	0.59 ± 0.01	0.59 ± 0.01	0.61 ± 0.01	0.62 ± 0.01	0.61 ± 0.01	-
SCC ($x10^3$ cell/ml)	30	337.0 ± 125.0	527.0 ± 119.0	$432.0^{b} \pm 118.0$	939.0 ± 232.0	728.0 ± 160.0	$834.0^{a} \pm 176.0$	816.0 ± 315.0	977.0 ± 417.0	$896.0^{a} \pm 339.0$	*

FPD:Freezing point depression, SCC: Somatic cell count, [a,b,c]: Mean with different superscripts (only for rows) are statistically different
*:P<0.05 -:Non-significant (P>0.05)

Table 3a and Table 3bpresent the milk composition (total solids, fat, protein, lactose), FPD, and SCC in different periods of lactation in this study. As seen from tables, the mean total solids percentage of lactation was 13.4%, 12.7%, 11.7%, 12.7%, 12.8%, 14.6%, and 18.6% on 30th, 60th, 90th, 120th, 150th, 180th, and 210th days, respectively. In the present study, it was found to be statistically significant differences among lactation stages (P <0.05).

The mean fat percentage of lactation was 3.0%, 2.4%, 1.7%, 2.9%, 3.2%, 4.0% and 6.6% on 30th, 60th, 90th, 120th, 150th, 180th and 210th days, respectively (Table 3a and 3b). The fat content decreased during the first three months, and then it started to rise on the 150th day and reached the peak on 210th day.

The mean protein percentages of lactation were 4.6%, 4.2%, 4.1%,4.2%; 4.0%, 5.3%, and 8.8% on 30th, 60th, 90th, 120th, 150th, 180th, and 210th days, respectively according to Tables 3a and 3b. Additionaly, it was found to be statistically significant differences among lactation stages (P <0.05).

In the present study, the mean lactose percentage of lactation was 5.0%, 5.1%, 5.0%, 4.7%, 4.7%,

4.4%, and 3.2% on 30th, 60th, 90th, 120th, 150th, 180th, and 210th days, respectively (Table 3a and 3b). Although the lactose value was high between the 30th and the 90th days, it started to decrease on the 120th day, and remained at the rate of 3.2% on the 210th day of lactation.

The calculated average values of freezing points of raw goat milk ranged from -0.570°C to -0.610°C in the course of lactation (Table 3a and 3b). In this study, it was not found to be statistically significantdifferences between lactation stages (P >0.05).

In the present study, it was determined that SCC was 145.7 x 10^3 cell/ml, 82.8 x 10^3 cell/ml, 113.1 x 10^3 cell/ml, 483.0 x 10^3 cell/ml, 432.0 x 10^3 cell/ml, 834.0 x 10^3 cell/ml, and 896.0 x 10^3 cell/ml on 30th, 60th, 90th, 120th, 150th, 180th, and 210th days, respectively (Table 3a and 3b). In this study, it was found to be significantly different among lactation stages (P <0.05).

DISCUSSION

In the present study, mean lactation period of Honamlı goats was detected as 202.4 days. Whilethis value was lower than the mean lactation periodobserved for goats by Bolacalı and Küçük (2012), and Králíčková et al. (2013); but higher than the mean lactation perioddetermined for goats by some researchers (Tuncel and Okuyan, 1985; Forik, 1995; Sengonca et al., 2003; Simşek et al., 2006; Ata, 2007; El-Tarabany et al., 2016). When compared with values in the literature, lactation period ofHonamlı goats may have been associated with genotype and environmental factors such as manegement and feeding regime.

The mean lactation milk yield of Honamlı goats was 92.6 kg. In Turkey, the lactation milk yield of Turkish Hair goats, which is one of the native breeds reared under the same conditions with Honamlı goat, was reported to between 50-90 kg by some researchers (Tuncel and Okuyan, 1985; Cengiz and Yener, 1993; Forik, 1995; Sengonca et al., 2003; Simsek et al., 2006; Ata, 2007). While, the low milk yield might be associated with effecting by the deteriorating quality of the pastures; it was also seen that lactation milk yields of Honamlı show similaritywith native goat breeds of Turkey because of same management procedures of goats.

In the present study, the daily milk yield of Honamlı goats was 0.453 kg and it was decreased towards ends the lactation (P<0.05). While this value was compatible with the other studies (Sengonca et al; 2003; Ata, 2007) related to native goats breeds of Turkey; Simsek et al. (2006) found higher values(0.900 kg.) than the present study.Additionally, there were variability of daily milk yield reports for different goat breeds for numerous authors (Mestawet et al., 2012; Králíčková et al., 2013; El-Tarabany et al. 2016; Idamokoro et al., 2017). The milk yield value of Honamlı goat might be associated with genotype and especially inadequacy of nutritional imbalance because of extensive rearing system. Similarly, Soryal et al. (2004) reported significant pasture quality effects for milk production.

In the present study, the mean total solids percentage increased slowly from 90th day of lactation to 210th day of lactation. Due to this fact, it is believed that it was affected by the decreasing daily milk yield as a negative correlation between these traits. Similarly, Králíčková et al. (2013) and El-Tarabany et al. (2016) reported increasing of total solids value at the end of lactation. However, Mestawet et al. (2012) found that total solids were significantly higher at the beginning and the end of lactation.

In this study, while the fat content which was the most variable compared to the other parameters decreased during the first three months and then it started to rise, statistically significant differences (P<0.05) were found for fat contents among lactation stages. Similary to this, Brendehaug and Abrahamsen (1986) reported that fat content decreased over the first 4 months of lactation and increased during the pasture period. Contrary to this, Šlyžius et al. (2017) and Idamokore et al. (2017) reported that the highest milk fat content was determined during the early stages of lactation. On the other hand, there were some reports related to variations of fat content (Pridalová et al., 2008; Strzałkowska et al., 2010; Králíčková et al., 2013; Klir et al., 2015). When the results of this study were compared with previous studies, it can be said that they were lower than the values reported by some researchers (Klir et al., 2015; Kučević et al., 2016; Idamokoro et al., 2017). Fat composition of Honamlı goat milk may be associated with feeding regime, because it's a fact that fat and protein content of milk is influenced mostly by feeding (Toledo-Alonzo, 2003; Goetsch et al., 2011). Additonally, İt was reported that factors such as breed, parity, stage of lactation, and flock had an effect on quantity of goat milk fat (Šlyžius et al., 2017).

In the present study, although protein content changed over the whole period of lactation, an increase in this value was recorded only at the end

of lactation.Similarytothis,Králíčková et al. (2013) reported an increase in protein content value only during last periods of lactation. Kuchtík et al. (2015) detected that total protein was relatively high during early lactation (2.9%), decreased as lactation peaked (2.7%), and increased towards end of lactation (3.7%). Contrary to present study, El-Tarabany et al. (2016) reported non-significant differences for protein percentages (3.6%) at different stages of lactation. In the present study, the protein content of milk was also higher than most of the reported results by other researchers (Kuchtík et al., 2015; El-Tarabany et al., 2016). Additionall, Raynal-Ljutovac et al.(2008) reported that goat milk contains higher levels of protein ranging from 2.6 g/l to 4.1 g/l. The higher content of the milk components along with high protein content is an indication for the presence of higher potential for cheese production (Guo et al., 2001; Soryal et al., 2004;Fekadu et al., 2005). Because of the higher protein content, Honamlı goat milk is more advantageous for making types of cheese.

In this study, it was not found to be statistically significant differences ($P > 0.05$) among lactation stages for the period between the 30th and the 90th days for lactose value of Honamlı goats.The lactose content of Honamlı goats were similar to the results reported by Olechnowicz and Sobek (2008), Pridalová et al. (2008), Strzałkowska et al. (2010), and El-Tarabany et al. (2016). Contrary to this, Ibnelbachyr et al. (2015) mentioned that lactose content was the lowest in the early lactation stage (4.62%) and highest in the middle lactation (5.70%). Kuchtík et al. (2015)determined that the lactose content increased from 3.83 to 4.58%during lactation.In the present study, decreasing lactose concentration might be associated with a decreased freezing point in the present study.

While the calculated average values of freezing points of raw goat milk ranged from -0.570°C to -0.610°C in the present study. Janštová et al., 2007 reported compatible findings with the present study. While Park et al. (2007) reported that the freezing point for goat milk ranged between -0.540 and -0.570°C; Strzałkowska et al. (2009) determined that freezing point for the goat milk ranged between -0.609°C, -0.596°C and -0.625°C for three subsequent lactation stages, respectively. In the present study, there were not statistically significant differences between measuring periods ($P >0.05$).Contrary to this, Sousa et al. (1993) determined that there was a significant difference ($P < 0.05$) between the freezing points of goat milk collected in the morning and evening.Milk with the lowest freezing point in the study, was also characterised by the highest concentrations of protein and fat and therefore had the largest total solids content.

The SCC of Honamlı goats which is considered in quality and hygiene standards of milk was changeable in the measurement periods. While SCC of Honamlı goat milk on the 60th and 90th lactation days was $82.8x10^3$ cell/ml and $113.1x10^3$ cell/ml, respectively, daily milk yield of Honamlı goat on the 60th and 90th lactation days was 610 g and 678.3 g, respectively. While SCC was lower compared to milk of other goat breeds (Pizarro Borges et al., 2004;Pridalová et al., 2009;Martini et al., 2010; Králíčková et al., 2013); Paape et al. (2007) reported that the SCC mean in milk of healthy goats ranged from 270 x 10^3 to 2.000 x 10^3 cell/ml.In the present study, together with the increase of SCC, a decrease occurredin the daily milk yield. High SCCs in goat milk appear to be natural, particularly in the later stages of lactation. As lactation progresses, SCC increases and milk production decreases (Zeng and Escobar, 1995). In the European Union, the legal limit for cows is 400.0 x 10^3 cells/ml, but there is no legal limit for goat or sheep milk (EC, 1992). In the regulation issued by the Republic of Turkey on this subject, there is no legal limit for SCC in goats and also for SCC variation in Honamlı goats in Turkey (TFC, 2011). High SCCs in Honamlı goat milk appear to be natural, particularly at the end of theof lactation.

CONCLUSION

Milk yield of Honamlı goats was determined to be similar to that of other native goat breeds of Turkey. It was thought that the results of the present study would contribute to determination of the SCC of goat milk in the legal regulations and acceptable goat milk FPD standards in Turkey. Additionally, the findings would provide an important database for future studies in order to encourage goat farming and the consumption of dairy products from goat's milk in Turkey.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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