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Milk Composition Traits of Hamdani Crossbreed Sheep Raised Under Extensive Management

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Abstract
This study aimed to reveal the milk composition traits of Hamdani crossbred sheep (Hcs) raised under extensive conditions. A total of 96 sheep milk samples were collected during the early lactation stage. Selected ewes did not have clinical mastitis or subclinical mastitis. Milk composition analyses were performed using milk autoanalyzer. Mean values for milk fat (%), solid non-fat (SNF) (%), protein (%), lactose (%), salt (%) and pH, conductivity (mS/cm), freezing point (◦C) and density (kg/m^3) in Hcs were determined as 7.49±0.15, 8.69±0.08, 4.13±0.04, 3.89±0.04, 0.62±0.01, 6.93±0.04, 4.05±0.07, -0.5±0.01, and 1.027.84±0.38 respectively. In correlation analysis, negative and significant correlations were detected between milk fat and protein (r=-0.368, p<0.001), milk fat and SNF (r=-0375, p<0.001) milk fat and lactose (r=-0.380, p<0.001). On the other hand, positive and significant correlations were detected between SNF and milk protein (r=0.999, p<0.001), SNF and salt (r=0.963, p<0.001), and SNF and lactose (r=0.976, p<0.001). As a result, the milk fat percentage of Hcs was higher compared to other native sheep breeds of Turkey. In addition, phenotypic variation for milk fat percentage was found to be high among individuals in the same flock. These findings may contribute to new studies to improve milk composition traits in Hamdani crossbred sheep.

Research Article

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1. Introduction

Cattle are the main farm animal species for milk production worldwide (Haenlein and Wendorff, 2006). Sheep and goats are also important for milk production. Contrary to cattle, lactation is seasonal in sheep and goats. Sheep milk offers an alternative to cow milk owing to its nutritional precision (Raynal-Ljutovac et al. 2008). Total solids, protein, lactose, and other components are higher in sheep milk compared to cow milk, and less sheep milk is required to make cheese or other milk products. Therefore, the improvement of sheep milk composition is an important subject of sheep breeding (Wendorff and Haenlein, 2017).

Turkey is an important country in sheep breeding in Europe and Asia. In addition, Turkey is the second position in the production of sheep milk after China (Mohapatra et al. 2019). According to novel data, Turkey has 46,1 million heads of sheep from different breeds (TUIK, 2022). Most of Turkey’s sheep population consists of native Akkaraman, Morkaraman, and İvesi breeds (Yilmaz et al. 2012). Hcs are mainly raised in Siirt province and its surrounding by nomadic breeders (Bakır and Mikail, 2019).

Milk composition traits are important for the quality of animal products. Milk fat, protein, and lactose are the main solid components of milk. Sheep milk products such as cheese, yogurt, and butter are one of the important sources of income for breeders (Komprej et al. 2012; Mohapatra et al. 2019). Milk composition can be influenced by breed, stage of lactation, health situation, and nutrition (Şahan et al. 2005; Kuchtík et al. 2008; Komprej et al. 2012). There are studies on milk composition traits in native sheep breeds of Turkey. These studies show that milk composition may differ between native sheep breeds of Turkey (Yılmaz et al. 2004; Şahan et al. 2005; Ocak et al. 2009; Kiper and Alkan, 2016; Koyun et al. 2021). In this study, it was aimed to detect milk composition traits of Hcs and contribute to new studies to be carried out on this subject. According to our knowledge, this is the first report revealing milk composition traits of Hcs.

2. Material and Methods

2.1. Animals and Collection of Sheep Milk Samples

In the study, a total of 96 Hamdani crossbreed ewes were selected randomly from the same flock. Selected ewes did not have clinical mastitis or subclinical mastitis. Milk samples were collected in 50 ml sterile falcon tubes and labeled. All milk samples were collected between 25-40 days of lactation before morning and evening milking. In addition to pasture, ewes were fed 0,4 kilograms of hay and 250 grams of barley daily during sample collection. All milk samples were transported to the laboratory immediately on +4ºC ice blocks for further examinations.

2.2. Milk Composition Analysis

Milk samples were analyzed following transportation. Lactoscan SA Milkanalyzer (Nova Zagora, Bulgaria) was used for milk composition analysis. A total of 10-15 ml volume milk was used for analysis. The prob was cleaned with distilled water after each measurement. Measurements were taken two times for each sample for reliable results and average values were recorded. Milk samples were analyzed for milk fat (%), SNF (%), milk protein (%), lactose (%), pH, conductivity (mS/cm), freezing point (̊C), salt (%) and density (kg/m^3).

2.3. Statistical Analysis

Descriptive statistics were computed to summarize the distribution for each parameter of milk composition separately. To report the central tendency and variation of the collected milk samples, mean±SE values were used with median (Q1-Q3). Minimum and maximum values of each measurement were also reported for better interpretation of results. Pearson's correlation analysis was performed to examine the possible correlations between milk composition traits. A critical value of $p<0.05$ was considered as a criterion of significance and all analyses were conducted by using The Statistical Package for the Social Sciences (SPSS 26.0, IBM) software package.

3. Results

3.1. Content of Milk Composition and Milk Properties

Descriptive statistics showing content of milk composition and milk properties of Hamdani crossbreed sheep were given in the Table 1. Box plots of milk components and some milk properties are given in the Figure 1. Mean values for milk fat, SNF (%), milk protein (%), lactose (%), salt (%), pH, conductivity, freezing point and density were 7.49±0.15, 8.69±0.08, 4.13±0.04, 3.89±0.04, 0.62±0.01, 6.93±0.04, 4.05±0.07, -0.5±0.01, and 1.027,84±0.38 respectively.

Table 1. Descriptive statistics showing content of milk components and milk properties

	N	Mean±SE	Median (Q_1-Q_3)	Minimum	Maximum
Fat (%)	96	7.49±0.15	7.55 (6.4-8.4)	4.12	11.44
SNF (%)	96	8.69±0.08	8.775 (8.22-9.25)	6.58	10.13
Protein (%)	96	4.13±0.04	4.17 (3.92-4.4)	3.14	4.82
Lactose (%)	96	3.89±0.04	3.925 (3.69-4.15)	2.96	4.55
Salt (%)	96	0.62±0.01	0.63 (0.58-0.67)	0.4	0.74
Density (kg/m^3)	96	1.027±0.0003	1.028.3 (1.027-1.031)	1.019	1.035
Conductivity (mS/cm)	96	4.05±0.07	4 (3.78-4.2)	3.05	9.11
pH	96	6.93±0.04	6.835 (6.73-6.95)	6.6	9.96
Freezing point (°C)	96	-0.5±0.01	-0.506 (-0.54-0.48)	-0.61	-0.371

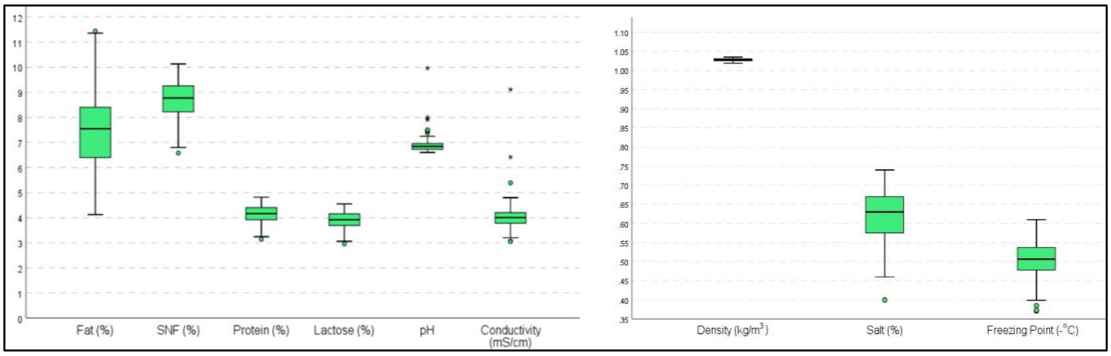

Figure 1. Box plots of milk components and some milk properties of Hamdani crossbreed sheep

3.2. Phenotypic Correlations Between Milk Characteristics

Correlation coefficients between milk components of Hamdani crossbreed sheep were given in the Table 2. Negative and significant correlation was detected between milk fat and protein (r=-0.368. p<0.001), milk fat and SNF (r=-0.375.

p<0.001) milk fat and lactose (r=-0.380. p<0.001). Positive and significant correlations were detected between SNF and milk protein and (r=0.999. p<0.001), SNF and salt (r=0.963. p<0.001) and SNF and lactose (r=0.976. p<0.001). Phenotypic correlations between milk characteristics were summarized in Table 2. Scatter-plot visualizing relationship between milk characteristics were given Figure 2.

Table 2. Phenotypic correlations between milk characteristics

		Fat	SNF	Protein	Lactose	Salt
SNF	Pearson's r	-0,375***	—			
	p-value	< .001	—			
Protein	Pearson's r	-0,368***	0,999***	—		
	p-value	< .001	< .001	—		
Lactose	Pearson's r	-0,389***	0,976***	0,977***	—	
	p-value	< .001	< .001	< .001	—	
Salt	Pearson's r	-0,481***	0,963***	0,962***	0,975***	—
	p-value	< .001	< .001	< .001	< .001	—
Density	Pearson's r	-0,631***	0,953***	0,95***	0,932***	0,955***
	p-value	< .001	< .001	< .001	< .001	< .001

Note: *** indicates p < .001

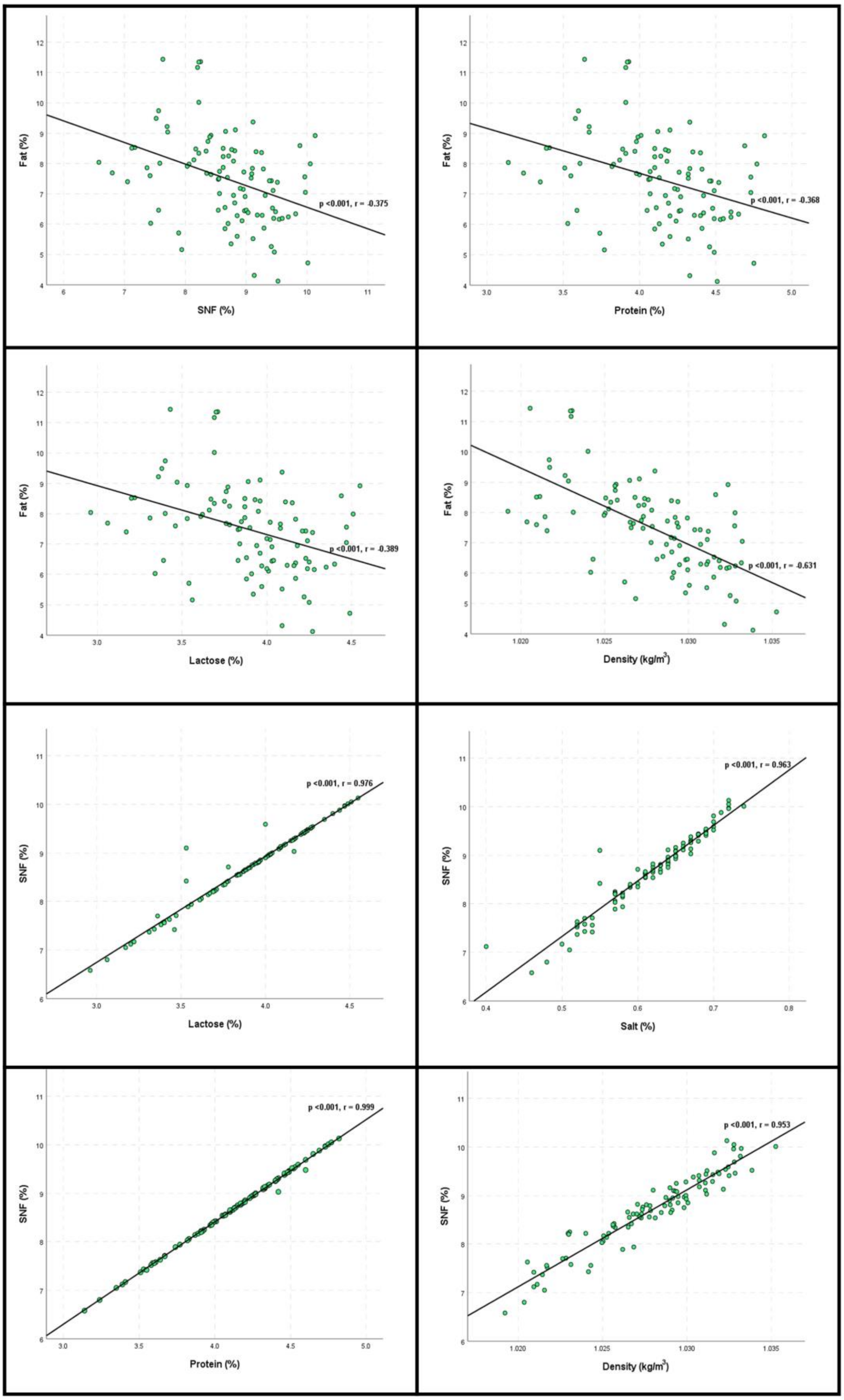

Figure 2. Scatter-plot visualizing relationship between milk characteristics

4. Discussion

In this study, we have detected that the content of milk fat, protein, lactose, SNF, and salt of Hcs were 7.49±0.15, 4.13±0.04, 3.89±0.04, 8.69±0.08, and 0.62±0.01 respectively. The composition of sheep milk was investigated in different native sheep breeds of Turkey. The percentage of milk fat, protein, and lactose during the early stage of lactation reported as 4.69±0.2, 4.76±0.07, and 5.58±0.08 in Akkaraman and 4.28±0.26, 4.75±0.09, 5.65±0.06 in Bafra sheep respectively (Kahraman and Yüceer-Özkul, 2020). The percentage of milk fat, SNF, protein, and lactose of Turkish Awassi sheep were reported as 6.61±1.33, 10.93±0.44, 5.68±0.47, and 4.34±0.27 respectively (Şahan et al. 2005). In Norduz sheep, the content of milk fat, protein, and lactose were 6.49±0.07, 6.11±0.08, and 5.07±0.17 respectively (Yılmaz et al. 2004). In Karakaş sheep, the percentage of milk fat, protein, and lactose were reported as 5.4±0.5, 6.8±0.09, and 4.6±0.01 (Koyun et al. 2021). In Morkaraman sheep, the percentage of milk fat, SNF, protein, and lactose were 7.19±0.35, 9.67±0.26, 3.18±0.09 and 5.55±0.15. In addition, in Tuj sheep, milk fat, SNF, protein and lactose reported as 7.20±0.31, 9.95±0.23, 3.29±0.08, and 5.70±0.14 respectively (Türkyılmaz et al. 2018). In Karayaka sheep, the percentage of milk fat and total solid were 7.09±0.25 and 19.75±0.66 respectively (Kiper and Alkan, 2016). These findings show that the milk fat percentage of Hcs is higher than other native sheep breeds of Turkey. Milk protein percentage was higher compared to Morkaraman and Tuj sheep while it was lower than in Norduz, Akkaraman, Bafra, Awassi, and Karakaş sheep. In addition, milk lactose percentage was lower in Hcs compared to other native breeds of Turkey. In this study, we have detected the milk pH as 6,93±0.04. The milk pH was reported as 6.50, 6.90, 6.65, and 6.72 in Norduz, Karakaş, Karayaka, and Awassi sheep respectively. (Şahan et al. 2005; Akdağ et al. 2018; Koyun et al. 2021). Therefore, the milk pH of Hcs is compatible with other native sheep breeds.

There are many factors that affect milk composition in sheep. These are stages of lactation, nutrition, breed of sheep, and health conditions. Kahraman et al. (2020) reported that daily milk yield was low at the beginning of the lactation reaches a peak level between 20-40th days and decreases thereafter in native sheep breeds. Similar lactation curves were reported in the dairy sheep breeds (Komprej et al. 2012). The effects of the stage of lactation on sheep milk composition may vary between sheep breeds. The percentage of milk fat was lowest during early stage of lactation and increases parallel to lactation length in Akkaraman sheep while it did not change in Bafra sheep until mid-term of lactation (Kahraman and Yüceer-Özkul, 2020). However, the percentage of milk fat, protein, and lactose increased from the beginning to the late stage of lactation in Slovenian dairy sheep breeds (Komprej et al. 2012). In this study, we collected milk samples during the early stage of lactation. Milk fat percentages were higher during early lactation (25-40th) compared to other native sheep breeds of Turkey. However, it would be more reliable to analyze milk samples collected during middle and late stage of lactation in Hcs in addition to early lactation stage.

In this study, the correlation coefficient between milk fat and protein, milk fat and SNF, milk fat and lactose, and milk fat and density were -0.368, -0.375, -0.380, and -0.631 respectively. Yılmaz et al. (2004) reported that there is a positive correlation (r=0.25) between milk fat and protein in Norduz sheep. Similar findings were reported in Rambouillet sheep (Ochoa-Cordero et al. 2002). In this study, however, we have detected a negative and significant correlation between milk fat and protein content (r=-0.368, p<0.001). Nutrition is an important determinant of sheep milk composition. It was emphasized that a negative energy balance by undernutrition may cause an increase in milk fat and a decrease in milk protein (Caja and Bocquier, 2000). In the southeastern region of Turkey, feeding sheep is mainly based on pasture (Taşkın and Kandemir, 2022). During the beginning to late stage of lactation, sheep are fed with a small amount of additional feeding while some flocks are fed with only pasture. This is also the fact that the Hcs raised under extensive conditions in Siirt and its surrounding. Therefore, the negative phenotypic correlation between milk fat and protein can be explained by feeding regime based on pasture in this region.

The density of the milk is an important indicator of the nutritional component of sheep milk. It is reported that sheep milk density was 1.030 kg/m3 in Morkaraman, Tuj, and Awassi sheep (Türkyılmaz et al. 2018). In this study, milk density was 1.027 kg/m3 in Hcs and was lower than other native sheep breeds. We have detected that there is a negative and significant correlation between density and milk fat percentage (r=-0.631, p<0.001). It has been shown that the density of milk fat is around 0.90 kg/m3 (Jenness et al. 1942). Therefore, lower milk density of Hcs and negative correlation between milk fat and density may be due to the high milk fat content of Hcs.

In this study, it was detected a positive and significant correlation between SNF and protein (r=0.999, p<0.001), SNF and lactose (r=0.935, p<0.001), and SNF and salt (r=0.963, p<0.001) as seen in Table 2. Because milk SNF is mainly composed of protein, lactose, and minerals, results are reasonable. Similarly, there was a positive and significant correlation between milk density and SNF percentage (r=0.953, p<0.001).

In summary, in this study, we have revealed milk composition traits of Hcs. Especially percentage of milk-fat sheep was higher compared to other native sheep breeds of Turkey. In addition, there was a wide range of variations between individuals in the same flock and environment in milk composition traits especially in milk fat percentage (Figure 1). These results show that phenotypic differences in the content of milk composition may be due to genetic variations between individuals. Therefore, in the second step of our study, we aim to focus on the detection of genetic variations related to milk composition traits in Hamdani crossbreed sheep using PCR-based methods. New studies to be carried out on this subject will contribute to the improvement of milk composition characteristics of Hcs.

Declaration of Conflicts of Interest

The authors declare that there is no conflict of interest.

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Ethical Statement

This study was approved by Siirt University Animal Experiments Local Ethics Committee (Approval no: 2023-01-10)

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