Pakistan Veterinary Journal

ISSN: 0253-8318 (PRINT), 2074-7764 (ONLINE)
Accessible at: www.pvj.com.pk

RESEARCH ARTICLE

Physical-Chemical Composition of Milk and Fiber Quality in Hair Goats and the Phenotypic Correlations between Milk Composition and Fiber Traits

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ARTICLE HISTORY (16-050)

Received:	February 27, 2016
Revised:	September 01, 2016
Accepted:	September 08, 2016
Published online:	October 01, 2016

Key words:
Hair goat
Hair quality
Milk composition
Phenotypic correlation

ABSTRACT

The objective of this study was to investigate physical-chemical composition of milk and fiber quality in Hair goats and to evaluate the phenotypic correlations between milk composition and fiber traits. The mean values of milk fat, protein, lactose, non-fat solid, total solids, lactic acid and pH in Hair goats' milk were 4.09, 3.53, 5.15, 9.36, 13.45, 0.22% and 6.61, respectively. The mean values of fiber length, fiber diameter, breaking strength, fiber elasticity and clean hair yield were 9.13cm, 80.93µm, 13.67g, 35.89% and 91.61%, respectively. The effect of lactation stage on physical-chemical parameters of milk was significant ($P<0.05$). Fat content of milk was highly and positively ($P<0.01$) correlated (0.71) with total solids. Protein was highly and positively ($P<0.01$) correlated with lactose (0.99), non-fat solid (0.98) and total solids (0.68) contents. There were not significant correlations between all fiber parameters. The phenotypic correlation between fiber diameter and protein content of milk was -0.54 and between fiber diameter and total solids was -0.36 and between fiber diameter and lactose was -0.51. In conclusion, fat content of milk was the lowest in the early lactation stage. Protein, lactose, non-fat solid and total solids contents were the highest in the mid lactation stage. pH was the highest in the late lactation stage. The diameter of the fibers of hair obtained from Hair goats was high. Also, results indicate that there was highly and positively correlation between fat and total solids, protein and lactose, protein and non-fat solid, protein and total solids contents. However, there was significant negatively correlation between fiber diameter and protein content of milk, fiber diameter and lactose, fiber diameter and total solids.

To Cite This Article: Cak B, Yilmaz O and Ocak E, 2017. Physical-chemical composition of milk and fiber quality in hair goats and the phenotypic correlations between milk composition and fiber traits. Pak Vet J, 37(1): 35-38.

INTRODUCTION

In Turkey, the Socio-economic and geographical structure make small ruminant production an important profession; it is also a significant source of income in rural regions (Ocak *et al.,* 2010). In rural regions, farmers keep goats for meat, milk, hair and mohair. The goat population in Turkey is estimated at 10.4 million head and approximately 98% of total goat population is Hair goat. Hair goats, generally a combined productive breed for production of meat, milk and hair, have long pendulous ears, long and coarse hairs, predominantly black colour to brown, grey and white colours (Toplu and Altinel, 2008). The length of the hair can be short or long. Milk production for Hair goat varies from 80.5 to 226.8kg. Lactation period in Hair goat ranges from 143.7-206d (Atac and Burcu, 2014).

Contents such as fat and protein of milk are important in the dairy industry and nutrition. Addas *et al.* (2013) reported that composition of goat milk is affected by breed, stage of lactation, season and parity. Hair produced by Hair goats is utilized for carpet, blanket, tent productions and clothing, etc. Fiber diameter is one the most important fiber characteristics. Helal (2010) reported that hair production and characteristics changed significantly with seasons. Mirmahmoudi *et al.* (2011) noted that no seasonal differences were observed in fiber diameter. The objective of this study was to investigate physical-chemical composition of milk and fiber quality in Hair goats and to evaluate the phenotypic correlations between milk composition and fiber traits.

MATERIALS AND METHODS

Animals and management: The study was conducted on 30 lactating Hair goat at 3-year-old at Research Farm of Yuzuncu Yil University in Van province, Turkey. Animals were kept under semi-intensive housing conditions. During study, all goats were reared in one group under identical conditions and without any principal differences in nutrition and management. All goats were in good body condition and healthy. Goats were grazed during daytime and were also fed 600g of concentrate mixture (16% crude protein and 2500 kcal metabolizable energy per kg dry matter) per animal per day.

Milk samples: Physical-chemical parameters of milk were detected in the early (1st month), mid (3rd month) and late (5th month) lactation stages. The first milk samples were taken in March 2014. A sample of approximately 200ml from each goat was collected once at 1st, 3rd and 5th months of lactation. Milk samples were taken immediately to the laboratory for analysis in ice box. Milk samples were analyzed on the basis of the following methods; fat content (Gerber method), total protein content (measurement of total nitrogen using the Kjeldahl method and multiplying by 6.38), lactose content (Fotometric method), total solids (Gravimetric method) and lactic acidity (Titration method) according to Kurt *et al.* (2003). pH was determined by a pH meter (Hanna Instrument pH 211; Microprocessor pH meter, Germany) equipped with an electrode (H1 1131, Germany) (Kosikowski, 1982).

Hair samples: Shearings were done in June 2014, of which were third shearing. Greasy hair weights were recorded. Hair samples (50g) were taken from each goats for hair analysis. Hair samples were collected from midrib area of the body of the individual Hair goats processed for the quality parameters (Taddeo *et al.*, 2000). Analyses were carried out at Lalahan Livestock Research Institute (Ankara, Turkey) according to ASTM and IWTO standards for determining fiber characteristics; fiber diameter was measured using an optical-based fiber diameter analyzer (USTER OFDA 100) (Anonymous, 1993a), fiber length was analyzed by the USTER FL 100 equipment. The barbe method was used to determine the mean fiber length in this study (Anonymous, 1993b), breaking strength and fiber elasticity were analysed by the FAFEGRAPH HR+ME equipment (Anonymous, 1993c).

Statistical analysis: Physical-chemical parameters of milk were analyzed by using Duncan multiple comparison test in one-way ANOVA method. Descriptive statistics forfiber traits were calculated by the Frequencies procedure of SPSS. Also, correlations among different variables were calculated (SPSS, 2002).

RESULTS

The physical-chemical composition of milk: The physical-chemical composition of the milk; fat, protein, lactose, non-fat solid, total solids pH and lactic acid are presented in Table 1. The mean values of fat, protein, lactose, non-fat solid, total solids, pH and lactic acid were 4.09%, 3.53%, 5.15%, 9.36%, 13.45%, 6.61 and 0.22%, respectively. The effect of lactation stage on the physical-chemical composition of the milk was significant ($P<0.05$). Fat content of milk was the lowest ($P<0.05$) in the early lactation stage. Protein, lactose, non-fat solid and total solids contents were the highest ($P<0.05$) in the mid lactation stage. pH was the highest ($P<0.05$) in the late lactation stage.

Fiber quality: The mean values of fiber length, fiber diameter, breaking strength, fiber elasticity and clean hair yield are 9.13±3.27cm, 80.93±2.49µm, 13.67±0.58g, 35.89±0.59% and 91.61±0.78%, respectively.

Phenotypic correlations: Pearson phenotypic correlations among different variables are presented in Table 2. Fat content of milk was highly and positively ($P<0.01$) correlated with total solids (0.71) content. Protein was highly and positively ($P<0.01$) correlated with lactose (0.99), non-fat solid (0.98) and total solids (0.68) contents. Lactose was highly and positively ($P<0.01$) correlated with total solids (0.65) and non-fat solid (0.98) contents. pH was negatively ($P<0.01$) correlated with lactic acid (-0.56).

There were not significant correlations between all fiber parameters in the present study.

Correlations between fiber and milk parameters: Fiber diameter was negatively ($P<0.05$; $P<0.01$) correlated with protein (-0.54), non-fat solid (-0.50), total solids (-0.36) and lactose (-0.51) contents of milk; breaking strength was negatively ($P<0.05$) correlated with lactic acid (-0.39), was positively ($P<0.05$) correlated with pH (0.37).

Table 1: Physical-chemical composition of milk

Parameter	1st month (early)	3rd month (mid)	5th month (late)
Fat (%)	3.93±0.11^{b}	3.99±0.09^{a}	4.33±0.04^{a}
Protein (%)	3.45±0.03^{b}	3.71±0.04^{a}	3.43±0.04^{b}
Lactose (%)	4.99±0.04^{b}	5.45±0.05^{a}	4.99±0.06^{b}
Non-fat solid (%)	9.13±0.07^{b}	9.85±0.08^{a}	9.11±0.11^{b}
Total solids (%)	13.07±0.12^{c}	13.84±0.13^{a}	13.45±0.13^{b}
pH	6.57±0.02^{b}	6.59±0.02^{b}	6.66±0.01^{a}
Lactic acid (%)	0.22±0.00^{b}	0.24±0.00^{a}	0.22±0.00^{b}

Values (mean±SE) bearing different alphabets in a row differ significantly ($P<0.05$).

DISCUSSION

The physical-chemical composition of milk: The milk industry buyers pay a premium for milk fat and milk protein percentages because milk quality is greatly determined by its chemical composition, especially protein, lactose and fat contents (Raynal-Ljutovac *et al.*, 2005). Milk fat and protein obtained for Hair goats in this study was 4.09% and 3.53%, respectively. Ciappesoni *et al.* (2004) found lower percentages of fat (3.72%) and protein (2.84%) in the Czech White Shorthaired goats.

Milk fat and protein contents obtained from Hair goats in this study were lower than findings reported for

Boer goats by Mestawet *et al.* (2012) who reported 4.70 milk fat and 4.05 protein. Kanwal *et al.* (2004) found higher milk fat (4.73%) and lower protein (2.38%) for goats of Rawalpindi/Islamabad Region in Pakistan. Guler *et al.* (2007) found similar to percentages of milk fat (4.02%) in Damascus goats. Aplocina *et al.* (2014) reported that goat milk composition is strongly influenced by goat nutrition, especially in highly productive Alps goat. The highest protein content (2.84%) in goat milk was observed when Alps goats received a diet containing wheat grain. Also, the highest milk fat content (4.56%) was obtained goats who received pasture grass with wheat grain.

Guler *et al.* (2007) noted that the highest fat percentages were obtained during the last month of lactation in Damascus goats, which was similar to the findings of the current study. This may have been due to largely to the decrease in daily milk yield. Guler *et al.* (2007) obtained the highest total solids contents during the last month of lactation. However, in our study, total solids content was the highest in the mid of lactation stage. Addass *et al.* (2013) found that the effect of lactation stage on total solids in the milk was not significant.

The lactose content in the present study was similar in the early and late lactation stages. Conversely, Mestawet *et al.* (2012) and Prasad *et al.* (2005) reported that the lactose content was the highest in the early lactation stage and was at its lowest in the late lactation stage. Lactose content in our study is higher more the finding (4.66%) reported by Kanwal and Mirza (2004). Total solids content in the current study was the lowest in the early lactation stage. Conversely, Mestawet *et al*. (2012) reported that total solids content in milk of dairy goats was the highest in the early lactation. Addass *et al.* (2013) reported that the pH content could not be affected by lactation stage season. The effect of lactation stage on pH was statistically significant ($P<0.05$) in the present study and pH was detected the highest in the last lactation stage.

Fiber quality: Fiber length of Hair goats in this study was 9.1cm. The mean value of fiber length determined in this study was lower than the results (13.63, 11.8 and 12.2cm) reported for Hair goats raised in Turkey by Deger *et al*. (2008), Dellal *et al*. (2014) and Soylemezoglu *et al.* (2002). However, our finding is higher than the finding (5.5cm) reported for Hair goat raised in Iran by Negahdari and Salehi (2012). The differences among the studies in terms of fiber length could be related to management, shearing method, shearing time and analysis methods. Helal and Hekal (2014) found that fiber length of Shami goat's hair was 9.91cm. This value is consistent with the finding of this study.

The fiber diameter is a very important economical trait in textile and carpet industry. Therefore, the fiber diameter is an important selection criterion. The mean value of fiber diameter in this study was determined as 80.9µm. Dellal *et al.* (2014) reported that the diameter of Hair goat fibers was between 64-93µm. The mean value of fiber diameter in this study was at between values reported by Dellal *et al.* (2014). Salehi *et al.* (2013) reported that fiber diameter in hair goats was 82.6µm. This value is similar to the result of the present study. Furthermore, Deger *et al.* (2008) reported that fiber diameter of Hair goats was determined as 76.70µm. Soylemezoglu *et al.* (2002) reported that fiber diameter of Hair goats was 96.1µm. The mean value of fiber diameter in our study was higher than the result reported by Deger *et al.* (2008), was lower than the result of Soylemezoglu *et al.* (2002). Also, fiber diameter in the current study was lower than the value (101 µm) reported for Baladi goats by Helal *et al.* (2010). An average value of 18 µm for fiber diameter in Raeini cashmere goats has been reported. Furthermore, the mean fiber diameter was affected by district, staple length and age of goat. Staple length was affected by district, mean fiber diameter, gender, age of goat (Shamsaddini-Bafti *et al.*, 2012).

The mean value of breaking strength in this study was determined as 13.67g. This value was higher than value (7.6g) reported for Lori goats by Salehi *et al*. (2013). The differences between the studies in terms of hair diameter could be related with management, feeding, region's climatic conditions, shearing method, shearing time and analysis methods.

Phenotypic correlations: The existence of strong correlations between analyzed variables significantly reduces their individual importance and emphasizes the existence information redundancy Addas *et al.* (2013) and Yilmaz *et al.* (2011) reported that milk fat was positively correlated with milk protein. Yilmaz *et al*. (2011) reported that the correlation between protein and total solids contents of milk was highly and positively. The results of the above literatures are consistent with the results of this study. Conversely, Addas *et al.* (2013) found that the correlation between protein and total solids was negatively.

Table 2: Pearson phenotypic correlations among different variables

	Fat	Protein	Non-fat solid	Total solids	Lactose	pH	Lactic acid	Fiber length	Fiber diameter	Breaking strength	Fiber elasticity
Protein	-0.02										
Non-fat solid	-0.09	0.98**									
Total solids	0.71**	0.68**	0.65**								
Lactose	-0.07	0.99**	0.98**	0.65**							
pH	0.31	-0.09	-0.08	0.18	-0.08						
Lactic acid	-0.22	0.33	0.32	0.06	0.33	-0.56**					
Fiber length	0.27	-0.03	-0.04	0.18	-0.04	0.16	-0.19				
Fiber diameter	-0.01	-0.54**	-0.50**	-0.36*	-0.51**	0.32	-0.22	0.07			
Breaking strength	0.27	-0.17	-0.20	0.07	-0.19	0.37*	-0.39*	0.13	0.31		
Fiber elasticity	0.01	0.12	0.11	0.08	0.14	-0.06	0.12	-0.02	-0.31	0.12	
Clean hair yield	0.06	-0.21	-0.22	-0.11	-0.19	0.24	-0.33	0.27	0.07	0.23	0.11

*:P<0.05;**:P<0.01.

Fiber diameter was positively (P>0.05) correlated with fiber length (0.07). Conversely, Salehi *et al.* (2013) reported that the correlation between fiber diameter and fiber length was negatively. Negahdari and Salehi (2012) reported that the correlations between fiber length and fiber elasticity, fiber length and breaking strength, fiber elasticity and breaking strength were highly and positively. These results reported by Negahdari and Salehi (2012) are in agreement with results our study. In the present study, the correlation between fiber diameter and fiber length was 0.07. Conversely, Kosimov et al. (2013) reported that the correlation between fiber diameter and fiber length of Angora goats was 0.78.

In this study, fiber diameter was negatively (P>0.05) correlated (-0.01) with fat content of milk. Similarly, Afolayan *et al.* (2009) reported that fiber diameter of ewes' fleece was negatively correlated (-0.06) with fat content of milk. Also, in the present study, fiber diameter was highly and negatively (P<0.01) correlated (-0.54) with protein content of milk. Conversely, Afolayan *et al.* (2009) reported that fiber diameter was quite low positively correlated (0.02) with protein content of milk. This difference may have been due to different species.

Conclusions: Fat content of milk was the lowest in the early lactation stage. Protein, lactose, non-fat solid and total solids contents were the highest in the mid lactation stage. pH was the highest in the late lactation stage. The diameter of the fibers of hair obtained from Hair goats was high. Also, results indicate that there was highly and positively correlation between fat and total solids, protein and lactose, protein and non-fat solid, protein and total solids contents. However, there was significant negatively correlation between fiber diameter and protein content of milk, fiber diameter and lactose, fiber diameter and total solids.

Acknowledgements: This research was supported financially by Yuzuncu Yil University Scientific Research Project Commission, Project No:2014-VF-B080. This study was approved by Yuzuncu Yil University Animal Researches Local Ethic Committee in the session held on 27/02/ 2014 (decision number 2014/03).

Author's contribution: BC and OY conceived of the study, participated in its design and coordination, verification of data and helped draft the manuscript. EO participated in the verification of the data and helped draft the manuscript. All authors read and approved the final manuscript.

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