

Fleece Traits and Important Physical Properties of Hair Fibers in Lori Goats

Research Article

M. Salehi¹, A. Lavvaf^{2*} and T. Farahvash³

¹ Department of Animal by Product, Animal Science Research Institute, Karaj, Iran

² Department of Animal Science, Karaj Branch, Islamic Azad University, Karaj, Iran

³ Department of Animal Science, Shabestar Branch, Islamic Azad University, Shabestar, Iran

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*Correspondence E-mail: abolghasem.lavvaf@kiau.ac.ir

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ABSTRACT

This study was conducted to investigate the hair production and fleece characteristics of hairy goats according to the sex and age of animals. The material of the study consisted one total data of 73 hair goats, which were between more than one year-old and one year-old Lori goats from both sexes (26 males and 47 females). The overall fleece weight, fiber length, lock length, washing yield, hair fiber diameter, coefficient of variation f diameter, breaking load, tenacity and elongation were 429 ± 23.7 g, 6.2 ± 0.3 cm, 8.9 ± 0.4 cm, $73.9 \pm 0.6\%$, 82.6 ± 1.8 micron, $24.3 \pm 0.8\%$, 7.6 ± 0.3 kgf, 10.2 ± 0.4 gf/Tex and $14.0 \pm 1.0\%$, respectively. It was found that age and sex had a significant effect on fleece weight and lock length. Furthermore, fiber length, fiber diameter and coefficient of variation of fiber diameter were affected by age of Lori goats. Adults showed a tendency to present higher fiber tenacity (10.3 ± 0.6 gf/tex) and lower fiber elongation ($12.4 \pm 1.4\%$).

KEY WORDS age, fleece, goat, hair fiber, sex.

INTRODUCTION

Hair production is mostly dependent on genetic and environmental factors (Devendra and Burns, 1970). Common goat hair is used in textile trend. It usually comes from some Asiatic countries as China, Mongolia, Pakistan, India, Iran and Turkey. The major part of goat hair is used in the manufacture of cheap felts and carpets for the automobile industry and very small quantity is used for interlinings. Although synthetic fibers have approximately replaced goat hair, still in rural areas it is one of the major incomes for farmers (Nagal, 2006). Iranian hair goats produce coarse and long hair. The most common coat colors are black or brown and mixed colors have the lowest frequencies in hair goats (Salehi, 2010). There is a scarcity of information in the scientific literature on the characteristics of goat hair. Efforts need to be done to define the fleece performance of

goat hair, without such information it is difficult to develop systems of management for fiber production. Therefore, the objective of the present study was to evaluate fiber characteristics of goat hair reared in moderate weather in the west of Iran as well as the effects of age and sex on these characteristics.

MATERIALS AND METHODS

Selection of animals

In order to determine the effect of sex and age on goat fiber characteristics, 47 female and 26 male kids and adult goats from 30 rural flocks were shorn at late spring in Lorestan province, Iran. Lorestan is located in the west of Iran ($33^{\circ} 29' N$, $48^{\circ} 21' E$) on Zagros Mountains. The local climate is generally sub-humid continental with winter precipitation. These goats were grazing at different regions

during spring, summer and autumn and in winter they received a limited amount of supplementary forage and grain.

Sample collection and measurements

The lock and fiber length were measured by ruler from 3 locks and 30 fibers of the greasy samples, respectively (ISIRI, 2001). Samples were washed in four scouring bowls and the washing yield was determined (ISIRI, 2001). Over one hundred fibers from each sample were measured with the projection microscope in accordance to (ASTM D2130, 2001). Mean fiber diameter and standard deviation were calculated for each sample and the coefficient of variation (CV) of samples was determined. In order to separate down and guard hairs a visual subjective test was used (ISIRI, 2001). The protruding end of sub-samples was combed to remove loose fibers and foreign material in order to secure partial parallelization of the fibers. The tuft was reversed and combing at the other end was repeated. The clamped tuft was placed in the grips of tensile testing machine (Instron) and used 100 kg capacity load cell with the pulling clamps moved at 25 cm/min. After recording the breaking load, the broken fibers were weighed to the nearest 0.01 g and breaking tenacity was calculated using Eq1 (ASTM D1294, 2005).

$$\text{Breaking tenacity (gf/tex)} = (b/M) \times 2.54 \times 10^{-5} \quad [1]$$

Where:

b: bundle breaking load in gf.

M: bundle mass (g).

Statistical analysis

A general linear model (GLM) of the SAS package (SAS, 2000) was used to analyze data. The statistical model (Eq2) used for different sex and age groups were, as follows:

$$\gamma_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ijk} \quad [2]$$

Where:

γ_{ijk} : is individual record.

μ : is population mean.

α_i : is effect of i^{th} sex.

β_j : is effect of j^{th} age.

$(\alpha\beta)_{ij}$: is interaction between sex and age.

e_{ijk} : is residual effects.

As the interaction was not significant, they did not present. Pearson correlation test was used to assess the significance of the correlation between fiber traits.

RESULTS AND DISCUSSION

Fleece weight

Hair production in the present study was 429 ± 23.7 g with a range going from 115 to 1325 g (Table 1). Generally, a wide range of goat fleece weight has been reported by authors. Millar (1985) has showed the fleece weight of different goats is oscillating in the range of 75 to 1639 g. Hair production of Anatolian black goat was determined as 381.0 g in the study of Deger-Oral-Toply and Altinel (2008). Some studies revealed that the annual fiber yield of domestic breeds in western Rajasthan ranged between 400 to 600 g. Some researchers have also highlighted that the fleece mean weight of Iranian cashmere and hair goats is fluctuating in the range of 100 to 1000 g and 222 to 400 g, respectively (Pordel, 2000; Salehi, 2010). The mean of fleece weight determined in this study was lower than those of but the range of fleece weight was similar to that in common goats (Millar, 1985; Pordel, 2000; Deger-Oral-Toply and Altinel, 2008). Values of hair production could be likely because of differences between breed type, shearing, location and management conditions.

Fleece weight was higher in males than in female goats and the differences between the two age groups (kids and adults) were statistically significant (Table 1).

However, fleece weight was higher in adult goats compared to the young ones, which it may be due to the high nutrient requirements for growth on young animals or the variance between the body tissues and fiber growth (Corbett, 1979).

Several researchers (Chekini *et al.* 2006; Saghi *et al.* 2007; Salehi, 2010) have found that the effect of sex and age on the fleece weight of the Lori and downy goats was significant. The yield of goat hair produced in Jordan varies according to age, sex and the nutritional status of the animal (ACSAD, 1983). Van-Niekerk *et al.* (2004) suggested that there were no significant differences between the fleece weight and fiber diameter depending on animal's age but these traits were higher in old than in young goats. Nevertheless, other researchers (Deger-Oral-Toply and Altinel, 2008; Hezareh-Moghadam and Salehi, 2009) have showed that sex and age had a significant effect on goat hair production.

Fiber length and lock length

Fleece characteristic is an important index to determine the quality and price of animal hair. The fiber length was ranging from 2.7 to 13 cm, with an average value of 6.2 ± 0.3 cm (Table 1). There are three classes of hair in its marketing, very long fibers having 5.8 to 9.0 cm of length with a minimum value of 10% of short fibers. Fibers ranging from

Table 1 Least-squares means of fleece weight, lock length, fiber length, guard, down hair and yield for kid and adult Lori goats grouped by age and sex

Effects	N	Fleece weight (g)	Fiber length (cm)	Lock length (cm)	Guard hair (%)	Down hair (%)	Yield (%)
Age							
Significant		***	**	***	NS	NS	NS
Kid	31	364.5±33.4	5.3±0.4	7.2±0.7	99.7±0.3	0.3±0.3	72.9±1.0
Adult	42	507.9±29.2	6.9±0.4	10.2±0.5	99.7±0.2	0.2±0.2	74.6±0.5
Sex							
Significant		****	NS	*	NS	NS	NS
Male	26	528.0±34.3	6.6±0.4	9.6±0.7	99.7±0.3	0.3±0.3	73.8±1.0
Female	47	344.4±28.4	5.6±0.4	7.8±0.6	99.7±0.2	0.2±0.2	73.8±0.3
Overall mean	73	429±23.7	6.2±0.3	8.9±0.4	99.7±0.2	0.26±0.2	73.9±0.6
CV		54.5	39.4	42.5	1.6	1.6	7.0
Min-max		115-1325	2.7-13	3.2-19	90-100	0-10	62-92

**** P<0.0001; *** P<0.001; ** P<0.01; * P<0.05 and NS: non significant.

3.5 to 5.8 cm of length and showing a maximum value of 25% short fibers are referred as long fibers while the fibers with 5 cm or less length are classified as short fibers (Devendra and Burns, 1970). Generally, the length of the hair fibers in goats has been recorded to range from 12.6 to 23.5 cm (Millar, 1985). Based on the Iranian standard for goat fibers, the hair fiber length should be oscillating between 2.5 to 18 cm (ISIRI, 2001). The length of hair is normally going from 15 to 22 cm, in Jordan hair goats (ACSAD, 1983). Therefore, the hair of goats in this study can be classified as medium to long hair fiber.

Table 1 represents that the lock length of Lori goats varied considerably ranging from 3.2 to 19 cm, with a high variability (42.5%). Our results are line with those presented by Nagal (2006). This last author indicated that the lock length of goat's hair varied highly ranging from 3.5 to 15 cm, with a standard deviation value of 29.71%. Hezareh-Moghadam and Salehi (2009) found that the length of a lock and hair fiber was fluctuating from 3.2 to 18.6 and 1.2 to 26 cm, respectively.

There were significant differences in fiber and lock length as the age increased (Table 1). Chekini *et al.* (2009) and Deger-Oral-Topy and Altinel (2008) showed that the lock of fibers in different age groups was significant and younger goats had shorter fibers, which is in line with the results presented in our study. Average fiber and lock length of females were 5.6 ± 0.4 and 7.8 ± 0.6 cm, respectively. Accordingly to Zhou *et al.* (2003), sex had a significant effect on the weight, diameter and length of fiber produced by Mongolia cashmere goats.

Down fiber percentage

Average down hair percentage reported for native goats, differed from zero percent in Spanish goats to 75% in Chinese goats (Millar, 1985). Von-Bergen (1968) reported that the amount of down fibers or true cashmere percent of commercial samples could vary in a wide range going from 15 to 90%, depending on coat types and the sorting method

done. Lori goats had low cashmere percentage (0.3%). In the present study, only two samples had 9% down fibers but the other samples had no down fibers. This would have an impact in the classification of the fleece from these goats as good hair fleeces.

The results of our experiment showed non-significant effects of age and sex on guard and down hair yield (Table 1). Zhou *et al.* (2003) also reported no significant effect of age in Boer goats. This is in contrast to the reports of Van-Niekerk *et al.* (2004), which highlighted a reduced cashmere amount but an increased guard hair production with age.

Washing yield

Our results revealed that washing yield is about $73.9 \pm 0.6\%$ with a range value going from 62 to 92% and low variation, which indicates suitable washing shrinkage in fibers, but no significant differences were found between sex and ages (Table 1). Impurities and washing yield reported in Chinese, Mongolian, Iran and India goats were ranging from 68 to 82, 72 to 84, 75 to 85 and 66 to 78%, respectively (Von-Bergen, 1968). All these data are perfectly comparable to those obtained in the current study.

Hair diameter and CV of diameter

Table 2 shows that the hair diameter (82.6 ± 1.8 μm) is suitable for hair marketing. The low CV of fiber diameter (24%) in these goats contained a uniform diameter. The hair diameter in Iranian goats has been reported to range from 25 to 68 and from 60 to 68 microns according to Por-del (2000). Moreover, the hair diameter of Jordan goats was reported to oscillate from 40 to 55 microns (ACSAD, 1983).

The age had a significant effect on the hair diameter (Table 2). Van-Niekerk *et al.* (2004) reported that age had an effect on the fiber diameter and their results were in agreement with our study but some other researchers did not report a significant effect of age.

Table 2 Least-squares means (\pm SE) of Fiber diameter, coefficient of variation of fiber diameter, breaking load, tenacity and elongation (%) for kid and adult Lori goats grouped by age and sex

Effects	N	Fiber diameter (μ m)	CV of fiber diameter (%)	Breaking load (kg)	Tenacity (kgf/tex)	Elongation (%)
Age						
Significant		**	*	NS	NS	NS
Kid	31	76.6 \pm 2.6	21.9 \pm 1.2	7.1 \pm 0.5	9.1 \pm 0.6	16.0 \pm 1.5
Adult	42	86.3 \pm 2.3	25.3 \pm 1.1	7.9 \pm 0.5	10.3 \pm 0.6	12.4 \pm 1.4
Sex						
Significant		NS	NS	NS	NS	NS
Male	26	81.2 \pm 6.8	23.0 \pm 1.3	7.3 \pm 0.6	10.0 \pm 0.7	13.3 \pm 1.6
Female	47	81.4 \pm 2.2	14.2 \pm 1.0	7.8 \pm 0.5	10.3 \pm 0.5	15.1 \pm 1.3
Overall mean	73	82.6 \pm 1.8	24.3 \pm 0.8	7.6 \pm 0.3	10.2 \pm 0.4	14.0 \pm 1.0
CV	-	18.3	28.8	24.8	21.4	33.96
Min-max	-	52-119	13.6-60	4.3-11.2	5.4-13.4	7-24.3

** P<0.01; * P<0.05 and NS: non significant.

Contrary to Deger-Oral-Toply and Altinel (2008) who demonstrated that fiber diameter significantly increased with age, Van-Niekerk *et al.* (2004) reported that there was no significant difference in this regard. However, in the present study the hair diameter especially in adult goats had higher quality of hair marketing in comparison to other Iranian goats reported by Pordel (2000). Corbett (1979) suggested, in the case of high nutrient requirements for growth in young animals, total fiber, guard hair and guard hair diameter and cashmere production slightly increase as the animal is getting older.

There was no difference between the sexes in hair fiber diameter. Sumner and Bigham (1993) demonstrated that male goats tend to make growing more fiber than females and fiber diameter was slightly greater in males than in females with the difference between both sexes increasing with age.

Although, in other research (McGregor and Butler, 2008) carried out on the characteristics of down hairs of goats, it was reported that the sex of the goats had only a minor effect on the fiber diameter. A significant effect of sex and age was found by Ansari-Ranani *et al.* (2012) on cashmere goats. However, one year old males and females had finer fibers than older goats (Ansari-Ranani *et al.* 2012). The contradiction between the present results and those of other goat's results may be because of differences in the breeds or the place of origin at which these studies were carried out.

Mechanical properties

Wide variation of breaking tenacity and elongation existed between individual hair goats ranging from a minimum value of 5.4 gf/tex and 7% to a maximum value of 13.4 gf/tex and 24.3%, respectively (Table 2). Mechanical properties revealed that hairs had high breaking load and tenacity but very low elongation percentage. Compared to cashmere that has relatively low tenacity that is usually ranging from 0.8 to 16 gf/tex and elongation at break is normally

going from 25 to 40%. Under standard conditions, the hair of goats was shown to be higher breaking load and considerably stronger. Elongation at break was invariably lower for goat hair compared to cashmere so, maybe it is considered different due to the structure and chemical composition of goat fibers.

There was no significant difference in mean breaking force, breaking tenacity and elongation between male, female and different age groups (Table 2). There are only few studies about the effect of different factors affecting mechanical traits of hair. However, the age showed no significant influence on the physical properties of cashmere in the article of Mekic (1998) but differences were found between ages of Baluchi ewes by Salehi (2008). Turkish Angora goats had fiber resistance and elasticity values ranging from 8.69 to 11.21 g and 36.30 to 41.45%, respectively. Nevertheless, the effect of age was significant on these traits (Bilgen *et al.* 2008).

Correlation between hair and fiber characteristics

The correlations between fleece weight with hair length, lock length, fiber tenacity and elongation were positive. Fleece weight was not significantly correlated with fiber diameter and CV of fiber diameter. There was low to medium negative correlation between mean fiber diameter with hair length, lock length and mechanical traits. The values of 0.9 and 0.3 were found for the correlation between breaking load with fiber tenacity and the percentage of elongation, respectively.

CONCLUSION

The results of this study showed a variation in quantitative and qualitative characteristics of hair fibers in Lori goats. It was found that the goat fleece had a few percent of down fibers. Length fibers were long and were strongly tensed. Therefore, the fibers of these goats could be considered as a

valuable hair fiber based on the standard of goat hair. Also, to achieve a better quality of goat products, attention should be paid to differences in hair quality of different sexes and ages.

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REFERENCES

- ACSAD. (1983). Natural and Human Resources. Livestock in the Alhamad of Jordon. Damascus. Syria.
- ASTM D2130. (2001). American Society for Testing Materials, Diameter of Cashmere and other Animal Fibers by Microprojection. West Conshohocken. USA.
- ASTM D1294. (2005). American Society for Testing Materials, Standard test Method for Tensile Strength and Breaking Tenacity of Cashmere Fiber Bundles 1-in. (25.4 mm) Gage Length. West Conshohocken. USA.
- Ansari-Ranani H.R., Mueller J.P., Rischkowsky B., Seyed-Momen S.M., Alipour O., Ehsani M. and Moradi S. (2012). Cashmere quality of Raeini goats kept by nomads in Iran. *Small Rumin. Res.* **104**, 10-16.
- Bilgen A., Akman N., Erol H., Ankarali B. and Aytac M. (2008). Some mohair characteristics and live weights after shearing of Angora goats reared at Lalahan livestock research institute. *J. Lalahan Live. Res. Inst.* **48(1)**, 38-43.
- Chekini E., Ansari-Renani H.R., Taherpour-Dari N. and Yarahmadi B. (2006). The survey Lalahaner characteristics in different ages of Lori goats. Report of Project. Animal Science Research, Institute. Iran
- Corbett J.L. (1979). Variation in wool growth with physiological state. Physiological and Environmental Limitations to Wool Growth. J.L. Black and P.J. Reis Eds. Pp. 405-410 in New England Publishing Unit.
- Deger Oral Toply H. and Altinel A. (2008). Some production traits of indigenous hair goats bred under extensive conditions in Turkey. Pp. 498-506 in Proc. 1st Comm., Repro. Arch. Tierz. Dummerstorf.
- Devendra C. and Burns M. (1970). Goat production in the tropics. common wealth. *Agric. Bur.* **183**, 120-122.
- Hezarh-Moghadam R. and Salehi M. (2009). Evaluation of coating fiber performances of Sistan and Baluchestan native goats. Animal Science Research Institute. Iran.
- ISIRI. (2001). Goat Hair Fibers Specification and Test Method. No. 4487. Institution of Standards and Industrial Research of Iran. Ministry of Industry.
- McGregor B. and Butler K.L. (2008). Cashmere production and fleece attributes associated with farm of origin, age and sex of goat in Australia. *Australian J. Exper. Agric.* **48(8)**, 1090-1098.
- Mekic C., Skalicki Z., Grubic G., Petrovic M.P., Zujovic M. and Stojkovic M. (1998). The influence of age on important physical properties of cashmere fiber in Ile-de-France sheep. *Savremena Poljoprivreda.* **1**, 102-106.
- Millar P. (1985). The performance of cashmere goats. *Anim. Breed. Abs.* **61**, 67-80.
- Nagal K. (2006). Assessment of physical properties of camel and goat hair. MS thesis. Univ. Agric. Sci. Dharwad.
- Pordel A. (2000). Hair fibers review on iranian native goats and some boundary countries with respect to marketing and processing. Deputy for Livestock Affairs. Ministry of Agricultural Jihad, Iran.
- Saghi D.A., Shiri S.A. and Nikbakhti M. (2007). Study on cashmere quality and hair percentage of black goat of Southern Khorasan for stable development of agriculture. *Pakistan J. Nutr.* **6(4)**, 397-398.
- Salehi M. (2008). Seasonal cashmere growth and lock strength of Baluchi sheep breed. Pp. 186-187 in Proc. Annu. Conf. Brit. Soci. Anim. Sci. England.
- Salehi M. (2010). Specially hair fibers. Pp. 285-286 in Iranian Mega Guided Project of Animal Skin and Fibers. M. Ansari-Ranani, M. Salehi and N. Taherpour-Dary, Eds. Anim. Sci. Res. Inst. Iran.
- SAS Institution. (2002). SAS[®]/STAT Software, Release 9.0. SAS Institute, Inc., Cary, NC.
- Sumner R.M.W. and Bigham M.L. (1993). Biology of fiber growth and possible genetic and non-genetic means of influencing fiber growth in sheep and goats: a review. *Livest. Prod. Sci.* **33(1)**, 1-29.
- Van-Niekerk W.A., Keva S., Roets M. and Cortez R.J. (2004). The influence of age and reproductive status on the quality and quantity of cashmere produced by Boer goats under South African conditions. *South African J. Anim. Sci.* **34**, 145-146.
- Von-Bergen W. (1968). Cashmere handbook. *Intersci. Publ.* **1**, 139-569.
- Zhou H.M., Allain D., Li J.Q., Zhang W.G. and Yu X.C. (2003). Effects of non-genetic factors on production traits of Inner Mongolia cashmere goats in China. *Small Rumin. Res.* **47(1)**, 85-89.