

## The Survey on Quantity and Quality of Hair Produced by Goats Under Fars Province Conditions

Research Article

S. Negahdari<sup>1</sup> and M. Salehi<sup>2\*</sup>

<sup>1</sup> Department of Animal Science, Karai Branch, Islamic Azad University, Karai, Iran

<sup>2</sup> Animal Science Research Institute, Karaj, Iran

Received on: 19 Jan 2011

Revised on: 11 Jun 2011

Accepted on: 14 Jul 2011

Online Published on: Mar 2012

\*Correspondence E-mail: [m\\_salehi@asri.ir](mailto:m_salehi@asri.ir)

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### ABSTRACT

This study was conducted to investigate the hair production and fleece characteristics of hair goats in Fars province. The material of the study included a total data of 84 hair goats, which were between kids and adult in male and female goats, respectively. The overall average for fleece weight, fiber length, staple lengths, washing yield, hair fiber diameter, of fiber diameter, breaking force, tenacity and elongation were  $293.3 \pm 20.5$  g,  $5.5 \pm 0.3$  cm,  $8.0 \pm 0.5$  cm,  $73.8 \pm 0.5\%$ ,  $81.0 \pm 1.9$   $\mu\text{m}$ ,  $20.3 \pm 0.5\%$ ,  $7.8 \pm 0.4$  kg f,  $9.5 \pm 0.4$  gf/tex and  $3.5 \pm 0.2\%$ , respectively. It was found that the effect of sex on the hair traits except fleece weight was not statistically significant ( $P > 0.01$ ), whereas the difference between males and females on the fleece weight was significant. Fleece weights in males and females were  $331.7 \pm 29.8$  and  $237.4 \pm 25.7$  g, respectively. However, significant difference ( $P < 0.01$ ) was found in fleece weight, hair length, hair diameter and tenacity between two age groups except for washing yield, coefficient of variation CV of hair diameter and hair elongation. Adult goats had more fleece weight, fiber diameter, fiber lengths, staple length, breaking force and breaking tenacity than those of kids.

**KEY WORDS** fleece weight, goat, hair traits, sex.

### INTRODUCTION

Hair production depends up on genetic and environmental factors including raising method, living place, temperature, altitude from sea level, age, sex, etc., in such a way that goats of tropical areas are hairy because of the adaptation with the climate conditions (Millar, 1985). Hair production throughout the world, especially in Asia, Africa, and the southern America is in various colors and express goat by product. Common goat hair for textile use comes from some Asiatic countries that supply cashmere, namely China, outer Mangolia, Pakistan, India and Turkey. Local application of fibers has been reported in weaving carpet, blanket, black tent, clothing, rope felt and fabricate paint-brush (Iñiguez, 2005). These fabrics have little or no felting

property. However, generally are smoother and straighter than wool, thus resulting into difficulties while processing (Nagal, 2006). Largest amount of common goat hair is used in the manufacture of cheap felts and carpets for automobile industry and very small quantity is used for interlinings. Although, man made fibres have replaced much of the goat hair for that purpose but still in rural areas, it is one of the major source of earnings (Nagal, 2006). The mean diameter of commercial goat fiber is 30-150  $\mu\text{m}$  and it has been reported as 25-68  $\mu\text{m}$  for Iranian goats. The goat fiber length is 1-10 cm and Iranian goats have an average of 6-9 cm. The clean fiber yield is 90%; the rest is dirt, plant remains, and soil including less than 0.3% grease (Pordel, 1999). The objective of the present study was to evaluate fiber characteristics of goat hair reared in Fars province condi-

tion. Effect of some of the environmental factors on the characteristics of fibers was also determined.

## MATERIALS AND METHODS

### Animals and fiber measurements

To determine the effect of sex and age on annual growing fiber characteristics, 46 female and 38 male kids and adult goats rising on range forage from rural flocks in Fars province, south of Iran, were shorn. Fiber samples were taken randomly overall fleeces of each goat. Three or four locks were randomly chosen from area throughout each sample. The staple and stretch fiber lengths were measured by ruler from 3 locks and 30 fibers, respectively. Usually staple length is an estimate of the distance between the fibre ends without a tension to remove the crimp is applied. Washing yield in four scouring bowls was determined.

Each sample were individually washed with hot (45 °C) water and a non-ionic detergent<sup>1</sup> rinsed in hot water, and then air-dried overnight. Small amounts of fiber samples were separated as sub samples for hair fineness analyses and other sub samples for measuring the breaking force and tenacity. The first sub sample was prepared for measurement with the projection microscope technique in accordance with ASTM D2130 (2001) short-section procedure to determine hair fiber diameter. Each sample was compressed and fibers were cut at mid-staple with a heavy – duty cross-section device to provide snippets 200-300  $\mu\text{m}$  in length.

Over one hundred fibers from each sample were measured. Mean fiber diameter and standard deviation were obtained for each sample and the CV was calculated. Visual subjective test was used to separate the various fiber types, including down and guard hairs if it was observed a few cashmere in the samples. The sub sample was paralleled so that, an aligned specimen of 15 to 25 mg was available for testing. The paralleled fibers were combed; the protruding end was combed by comb to remove loose fibers and foreign material and to secure partial parallelization of the fibers. The tuft was reversed and combing on the other end was repeated. The clamped tuft was placed in the grips of tensile testing machine (Instron<sup>2</sup>) 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 calculated using Equation 1 (ASTM, 2005).

Breaking tenacity,  $\text{gf}/\text{Tex} = (b/M) \times 2.54 \times 10^{-5}$  (Equation 1)  
Where  $b$ = Bundle breaking load in gf, and  $M$ = Bundle mass (g).

### Statistical analysis

Analysis of variance was performed using a general linear model (GLM) of SAS package (SAS, 2000). The statistical model (Equation 2) used for Fars goats of different sex and age group was as follows:

$$\gamma_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \quad (\text{Equation 2})$$

Where  $\gamma_{ijk}$ : is individual records;  $\mu$ : is the population mean;  $\alpha_i$ : is the effect of  $i^{\text{th}}$  sex;  $\beta_j$ : is the effect of  $j^{\text{th}}$  age;  $(\alpha\beta)_{ij}$ : is the interaction between  $i^{\text{th}}$  sex and  $j^{\text{th}}$  age and  $\varepsilon_{ijk}$ : is the residual effect.

## RESULTS AND DISCUSSION

### Fleece weight (FW)

Mean fleece weight of hair goats bred under traditional management condition of Fars province was  $293.3 \pm 20.5$  g with a wide range of 65-1345 g (Table 1).

**Table 1** The expected means and their range for hair performances

Traits	Mean $\pm$ SE	CV	Min	Max
Fleece weight (g)	293.3 $\pm$ 20.5	68.7	65	1345
Fiber length (cm)	5.5 $\pm$ 0.3	50.3	2.4	16.3
Staple lengths (cm)	8.0 $\pm$ 0.5	53.5	3.3	26.7
Washing yield (%)	73.8 $\pm$ 0.5	6.5	61.3	85.7
Hair fiber diameter ( $\mu\text{m}$ )	81.0 $\pm$ 1.9	21.9	56.1	170.9
CV of fiber diameter (%)	20.3 $\pm$ 0.5	21.1	12.6	31.9
Breaking force (kgf)	7.8 $\pm$ 0.4	27.1	3.5	11.0
Breaking tenacity (gf/tex)	9.5 $\pm$ 0.4	23.6	3.6	13.6
Elongation (%)	3.5 $\pm$ 0.2	33.9	1.7	6.6

SE: standard error.

CV: coefficient of variation.

The fleece weight of males was higher than that of female goats and the difference between two age groups (kids and adult) was statistically significant ( $P < 0.005$ ; Table 1).

### Fiber length (FL) and staple length (SL)

The expected mean values of fiber length and staple lengths were  $5.5 \pm 0.3$  cm and  $8.0 \pm 0.5$  cm respectively. There was a wide range of fiber and staple lengths as 2.4-16.3 cm and 3.3-26.7 cm, respectively, with a high variation more than 50% (Table 1). It was determined that the effects of age on fiber and staple lengths were statistically significant ( $P < 0.001$ ). The adults have longer length than kids (Table 2).

### Washing yield (WY)

Our results revealed that this characteristic is about 73.8%

1- Serdax NCA 2 G Elementis Specialties Netherlands B.V. P.O. Box 1, 7490 AA Delden Langestraat 167, 7491 AE Delden The Netherlands

2- Instron 4501-Instron LTD Corporation Road High Wycombe Buckinghamshire HP12 3SY England

with a range of 61.3-85.7%, which indicates suitable washing shrinkage in fibers (Table 1), but no significant differences were found between different sex and age groups (Table 2).

### Hair diameter (HD) and coefficient of variation of mean hair diameter (CVHD)

As shown in Table 1, the expected mean of hair diameter in the goat's fleece is in the range of 56-171  $\mu\text{m}$  with an average of 81  $\mu\text{m}$ . We found low coefficient of variation of mean fiber diameter (20.3%).

There were no significant differences in the mean hair diameter and CV of hair diameter of male and female hair goats (Table 3).

Mean hair diameter and CV of hair diameter of male and female hair goats were as  $82.6 \pm 2.8$  and  $77.5 \pm 2.6$   $\mu\text{m}$ ;  $20.2 \pm 0.7$  and  $20.1 \pm 0.7\%$ , respectively. Effect of age on mean hair diameter was significant ( $P < 0.05$ ).

### Mechanical properties

Wide variation of breaking tenacity (BT) and elongation (EL) observed between individual hair goats ranging from a minimum of 3.6 gf/Text and 1.7% to a maximum value of 13.6 gf/Text and 6.6%, respectively (Table 1). Mechanical properties revealed that hairs had high breaking force (BRF) and tenacity but with very low elongation percentage.

There were no significant differences in mean breaking force, breaking tenacity and elongation between male and female hair goats (Table 3).

Significant differences in mean breaking force and breaking tenacity were found between goats of different age groups and the adult goats had more hair breaking tenacity compared to the kids. Average breaking force and breaking tenacity of kids and adult groups of hair goats were as  $6.4 \pm 0.5$  and  $8.8 \pm 0.4$  kgf and  $8.2 \pm 0.6$  and  $10.4 \pm 0.5$  gf/Text, respectively (Table 3).

### Down fiber percent

The result revealed very low percentage of down in these goats.

### Correlations between traits

The phenotypic correlations were strong between FL, SL, and EL with fleece weight (0.63, 0.67 and 0.49 respectively), while those for both FL and SL with hair diameter and EL were negative but negligible, apart from that for HD with EL (-0.24). The BT had a moderate correlation with fleece weights (0.25). Mechanical properties (BRF, BT) showed very high positive correlations with fiber and staple lengths but a moderate correlation with EL (Table 4). A high correlation was found between BRF and BT (0.83), while they exhibited nearly perfect correlation with EL (0.49 and 0.51, respectively).

**Table 2** Least square means and their standard errors of fixed effects (sex and age groups) for fleece weight, hair fiber diameter, fiber length, staple length, fiber yield and fiber shrinkage upon hair goats

Characteristics	Fleece weight (g)	Fiber length (cm)	Staple length (cm)	Washing yield (%)	Fiber shrinkage (%)
Sex	*	NS	NS	NS	NS
Male	$331.7 \pm 29.8$	$7.8 \pm 0.6$	$5.3 \pm 0.4$	$73.6 \pm 0.8$	$26.4 \pm 0.8$
Female	$237.4 \pm 25.7$	$7.5 \pm 0.6$	$5.2 \pm 0.4$	$74.4 \pm 0.7$	$25.6 \pm 0.7$
Age group	***	****	****	NS	NS
Kids	$207.6 \pm 30.6$	$5.5 \pm 0.7$	$4.0 \pm 0.4$	$74.9 \pm 0.8$	$25.1 \pm 0.8$
Adults	$361.5 \pm 25.1$	$9.6 \pm 0.5$	$6.5 \pm 0.4$	$73.1 \pm 0.7$	$26.9 \pm 0.7$

\*  $P < 0.05$ ; \*\*\*  $P < 0.005$ ; \*\*\*\*  $P < 0.001$  and NS: non significant.

**Table 3** Least square means and standard errors of fixed effects for hair fiber diameter, CV of hair diameter, breaking tenacity and fiber elongation

Characteristics	Hair fiber diameter ( $\mu\text{m}$ )	CV of hair diameter (%)	Breaking force (kgf)	Breaking tenacity (gf/Text)	Fiber elongation (%)
Sex	NS	NS	NS	NS	NS
Male	$82.6 \pm 2.8$	$20.2 \pm 0.7$	$7.9 \pm 0.5$	$9.7 \pm 0.6$	$3.9 \pm 0.3$
Female	$77.5 \pm 2.6$	$20.1 \pm 0.7$	$7.3 \pm 0.4$	$8.9 \pm 0.5$	$3.2 \pm 0.3$
Age group	*	NS	**	**	NS
Kids	$75.0 \pm 3.0$	$19.5 \pm 0.7$	$6.4 \pm 0.5$	$8.2 \pm 0.6$	$3.3 \pm 0.3$
Adults	$85.1 \pm 2.4$	$20.8 \pm 0.6$	$8.8 \pm 0.4$	$10.4 \pm 0.5$	$3.8 \pm 0.3$

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

CV: coefficient of variation.

**Table 4** The Pearson correlation between FW (fleece weight, g); HD (hair fiber diameter,  $\mu\text{m}$ ); CVHD (coefficient of variation of hair fiber diameter, %); WY (washing yield, %); FL (fiber length, cm); SL (staple length, cm); BRF (breaking force, kgf); BT (breaking tenacity, gf/Tex) and EL (fiber elongation, %) of goats

	HD	CVHD	WY	FL	SL	BRF	BT	EL
FW	-0.09	-0.03	-0.01	0.63***	0.67***	0.19	0.25*	0.49**
HD	-	0.15	-0.19	-0.02	-0.04	0.11	0.15	-0.24*
CVHD	-	-	-0.07	0.02	0.11	0.07	0.02	0.09
WY	-	-	-	-0.03	-0.06	-0.32**	-0.26*	-0.15
FL	-	-	-	-	0.86***	0.67***	0.78***	0.39**
SL	-	-	-	-	-	0.62***	0.65***	0.31*
BRF	-	-	-	-	-	-	0.83***	0.49**
BT	-	-	-	-	-	-	-	0.51***

\* P<0.05; \*\* P<0.01; \*\*\* P<0.001.

### Fleece weight

Generally, a wide range of goat fleece weight has been reported. Millar (1985) has reported the fleece weight of different goats in the range of 75-1639 g. Hair production of Anatolian Black goat was determined as 381.0 g in the study of Deger Oral Toply *et al.* (2008). Pokharana *et al.* (1999) revealed that the annual fibre yield of domestic breeds in western Rajasthan ranged between 400-600 g. Some researchers have reported the fleece mean weight of Iranian cashmere and hair goats in the range of 100 to 1000 g and 222 to 400 g, respectively (Salehi *et al.* 2000; Ebrahimi *et al.* 2002; Pordel, 1999). The mean of fleece weight determined in this study are lower than those of Deger Oral Toply *et al.* (2008); Pokharana *et al.* (1999), but the range of fleece weight is similar to that in common goats (Millar, 1985; Pordel, 1999).

However, the fleece weight is more in adult goats compared to the young ones which it may be due to the high nutrient requirements for growth by young animals or the variance between the body tissues and fiber growth (Corbett, 1979). In our study the fleece weight of adult goats and males were significantly higher than that of kids and female goats. Various researchers have found that the effect of sex and age on the fleece weight of the downy goats was significant (Salehi *et al.* 2000; Taherpour-dari *et al.* 2004; Saghi *et al.* 2004). The yield of goat hair produced in Jordan varies according to age, sex, and the nutritional status of animal (ACSAD, 1983). Another research showed that sex and age had significant effects on the goat hair production (Hezareh Moghadam *et al.* 2009; Isazadeh *et al.* 2009; Deger Oral Toply *et al.* 2008; Mittal, 1988).

### Fiber length and staple length

Fleece characteristic is an important yardstick to determine the quality and price of animal hair. We found that the length of a single fiber was in the range of 2.45-16.3 cm with an average of 5.5 cm. There are three classes of hair based on its marketing; very lengthy fibers having 5.8-9.0 cm length with minimum 10% short fibers. Fibers with 3.5-5.8 cm length and maximum 25% short fibers are referred

as lengthy fibers while the fibers with 5 cm or less length are classified as short fibers (Devendra *et al.* 1970). Generally, the lengths of the hair fibers in goats have been recorded as 12.6-23.5 cm (Millar, 1985). Based on the Iran standard, the hair fiber length should be 2.5-18 cm (ISIRI, 2001). The length of hair is 15-22 cm, in Jordan hair goats (ACSAD, 1983). Therefore, the hair of goats in our study can be classified as medium to lengthy hair fiber.

It is evident from Table 1 that the staple length of goat hair varied with a range 3.3-26.7 cm with a higher variation (53%). The measurement of staple length of natural fibre is a task, which is not easy because of the fact that variation exists not only between different types of same stock, but also within (Booth, 1983). Nagal (2006) indicated that the staple length of goat hair varied with a range 3.5-15 cm with a higher standard deviation (29.71). Isazadeh *et al.* (2009); Hezareh-Moghadam *et al.* (2009) found that length of a staple hair fiber was in the range of 3.2-18.6 and 1.2-26 cm, respectively.

There were significant differences in fiber and staple length with increasing age (Table 2). Deger Oral Toply *et al.* (2008) found that the staple of fibers in different age groups was significant and fibers of younger goats had shorter length, which is well match with the present research.

### Hair diameter and CV of mean fiber diameter

One of the important components of fibre quality is mean fibre fineness, which influences yarn quality, spinability and fabric texture, hand and feel. The variability of fibre diameter increases proportionately with the thickness of the fibre.

Table 1 depicts the fineness of goat hairs that shows, the hair diameter in the goats (81  $\mu\text{m}$ ) is suitable for hair marketing. The low CV of fiber diameter (20%) shown that Fars goat hair contained a uniform diameter. The hair diameter in Iranian goats has been reported as 25-68 and 60-68  $\mu\text{m}$  by Pordel (1999); Syeed Moumen *et al.* (2004), respectively. The hair diameter of Jordan goats reported as 40-55  $\mu\text{m}$  (ACSAD, 1983).

We found that the age had significant effect on the hair diameter (Table 3). In another research carried out on the characteristics of the Lorestan hair goats showed that the older goats had significant coarser fibers compared with the youngs in this regard (Isazadeh *et al.* 2008). Contrary to Deger Oral Toply *et al.* (2008) who demonstrated that fibre diameter significantly increased with age, Van Niekerk *et al.* (2004) reported that there was no significant difference in this regard. However, the hair diameter especially in adult goats in the present study had high quality for hair marketing compared to other Iranian goats reported by Pordel (1999) and Syeed Moumen *et al.* (2004).

### Mechanical properties

Few studies have been carried out on the mechanical properties of hair fibers and so forth goat hair fibers. As shown in Table 3, effect of sex factor on breaking force with an average of  $7.8 \pm 0.4$  kgf and hair breaking tenacity ( $9.5 \pm 0.4$  gf/Tex) was not significant, but the effect of age groups was significant and the adult goats had more hair breaking tenacity compared to the kids. These amounts are more than the down breaking tenacity of the cashmere goats ( $0.31-5.62$  gf/Tex) (Syeed-Moumen *et al.* 2004; Shamsaddini *et al.* 2010). In the recent studies, breaking tenacity of the down fibers was negligible in different age and sex groups. In our study, the elongation of hair was very low that it is very less than the other animal fibers especially for wool of sheep (Bas, 1994; Oznacer, 1973).

### Down fiber percent

The goat fleece grows in two principle coats, the outer coarser coat and inner down hair. The percentage of fine hair varies considerably depending on the animal species, breed and climatic conditions. Generally, there was observed no effect of down on the hair value (Devendra *et al.* 1970). The low percentage of down in the goats of our study, indicates that fleece of goats are in good class (Table 1). Down mean percentage of domestic goats species in different areas was from 0 in Spanish goats up to more than 75 in cashmere Chinese goats (Millar, 1985). The standard of Iran for goat hair specification places the consignments having 5.2-10% down in the hair fleece class (ISIRI, 2001). In the present study, only one sample had 31% down and mean diameter of  $17.4 \mu\text{m}$  but the other samples had no down fiber. This would have an impact to classify the fleece of these goats as good hair fleece.

### Correlations between traits

From the results of this study, it is evident that there are substantial correlations between fiber traits (Table 4). The correlation between fiber diameter variability (CVFD) with

staple strength (0.11) was opposite that recorded (-0.44) and (-0.26) by Yamin *et al.* (1999); Salehi and Kamalpoor (2007) in wool fibers, respectively. However, does match the moderate to high correlation between mechanical traits in our observations within the breed of sheep (Hawker and Littlejohn, 1989).

## CONCLUSION

It was found that the Fars goats fleece had a few percent of down fibers with perfect fibers. Their length was long and had strong tensile. Therefore, the fibers of this goat can be considered as a valuable hair fiber based on the standard of goat hair.

## ACKNOWLEDGEMENT

This study was summarized from MS thesis of the first author. Financial support for this study by the research fund of the Animal Science Research Institute of Iran is gratefully acknowledged (Investigations Fund of ASRI in inclusion of the project with the number of 2-13-13-88034).

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