

## Properties of goat fibres from selected Albanian regions

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### Abstract

The focus of this paper is to study the quality of goat fibres /hair from various Albanian regions for possible use in the textile industry. In Albania there are several regions where the collection of these fibres is possible but interest to employ them is lacking. This dearth of interest could be due to the paucity of information regarding the quality of such fibres. In the not-so-distant past Albania had a tradition of using these fibres for various handmade textile products, especially for products where strength, durability and dimensional stability are required.

In this investigation the physical mechanical and thermal properties of this material are studied. Also, given that wool fibres are the main attraction as a component in high performance thermal protection applications to provide protection from fire, high limitation oxygen index (LOI) tests are performed. Samples are taken from five regions and from the obtained results the finesses of the fibres are at very high values, approximately 78 $\mu$ ; however, the values of LOI are rather promising, 41%, and comparable values concerning the special fibres used for fire protection.

### 1. Introduction

Throughout the last 20 years, although some farmers in Albania have expressed interest to increase the number of the goats [1] to be used for meat and milk, the same level of enthusiasm has not been shown for using their fibres in textile products. This lack of interest could be because there is a dearth of information regarding the quality of fibres; there are no published papers or studies regarding such an issue. Although there are several papers and studies providing information about the quality of wool fibres from local sheep herds in Albania, surprisingly not much is known about the quality of goat hair.

In addition, in the recent past Albania had a tradition [2] in using these fibres for several textile products, especially for products where strength, durability and dimensional stability were required. It should be mentioned here that “*m'taf*”, a kind of rug produced by 100% from goat fibres, usually covered the carpeted area of a guest's room, which used to be the largest room in the house; “*duq*” a kind of satchel used to transport goods in the villages, “*norta*”, amongst numerous other handmade items, were also made of this material. Several such traditional products could be enumerated here, which these days rarely can be seen or used. Thus, this paper can be used like an “emergency call” ***to assist in the passing down of the tradition so that it does not die out!*** The objective of this paper is to investigate the properties of goat fibres to increase awareness and draw attention to matters concerning the possibility to improve the industrial interest for utilizing such fibres, and indirectly to create sustainable business opportunities for local farmers. When it comes to the definition of the quality of the fibres, it is not as simple as just characterising the strands. As Khan *et al* [3] explains there are



several factors that influence their properties, including environmental, genetic, physiological state, hormones, parasite and diseases, amongst others.

Regarding these factors, conducting research, in particular concerning evaluating the quality of the goat fibres in Albania is reasonable, especially considering that in recent years there has been a gap concerning information about the race of goats and conditions for properly treating them. Physical and mechanical properties are the classical properties to define in order to assess the quality of fibres, but it might be of interest to also study: Limitation Oxygen Index (LOI), Thermogravimetric Analyses (TGA) and Microscale Combustion Calorimeter (MCC) of local goat fibres as rather important parameters, especially concerning floor covering textiles. Wool is regarded as a naturally flame-resistant fibre, and thus wool fabrics were the traditional materials for flame and heat protection [4, 5]. These fibres have been found to yield high performance thermal protection, i.e. to provide protection from fire. In general wool is known to have a high ignition temperature, high LOI and a low heat release from the combustion, but it varies depending on the type of wool as well as the region of the collected samples [6].

## 2. Materials and Methods

Fibre samples; samples are randomly selected from five different regions in Albania. The chosen areas include Hasi, Tropoja, Zagore, Vorfë (Shkodër) and Përmeti. Per each region, 500g of hair were considered for analyses. The hair samples were sheared directly from the goats, specifically from the midrib area of the body, to be processed for the quality parameters. Sample preparation for this test was according to ISO 1130:1975 Textile fibres -- Some methods of sampling for testing [7].

Physical and Mechanical tests were carried out at the accredited laboratory at the Department of Textiles and Fashion (Polytechnic University of Tirana, Albania) according to the ISO standards for determining fibre characteristics. The fibre length was calculated according to ISO 6989:1981 Textile fibres - Determination of length and length distribution of staple fibres (by measurement of single fibres) [8]. Breaking strength and fibre elasticity were performed according to ISO 5079:1995 Textile fibres -- Determination of breaking force and elongation at break of individual fibres [9].

LOI, MCC and TGA tests were performed at the Textile Department Laboratory in Zagreb Croatia. The burning behaviour of the fibre was determined with Limiting Oxygen Index (LOI) in a LOI chamber (Dynisco), according to the ISO 4589:1996– *Plastics – Determination of Burning behaviour by Oxygen Index* [10].

Fabric was able to be produced from goat fibres (figure 1) taken from the Hasi region. The structure of the textile that was consisted of 100% goat fibres, plain weave; the density of warp and weft yarns are respectively 23y/10cm and 34y/10cm.



**Figure 1.** Picture of 100% of goat fabric from the Has region in Albania.

Thermogravimetric analyses (TGA) was performed on TGA Pyris 1 (PerkinElmer). The mass of the sample was 5 mg of goat fibres.

Microscale Combustion Calorimeter (MCC) tests were performed according to ASTM D 7309 *Standard Test Method for Determining Flammability Characteristics of Plastics and Other Solid Materials Using Microscale Combustion Calorimetry* [11], on MCC-2, Govmark, USA. The 5 mg of test sample (three samples per each system) were placed within the sample cup and the test was performed under the following conditions: pyrolysis operating temperature range of min. 25°C to 600°C at a heating rate of 1 K/s in an inert gas stream (nitrogen, 80 ml/min), with a detection sensitivity limit of min. 5 mW, repeatability of  $\pm 2\%$ .

For samples taken from the Hasi region, the fibre diameter was measured by using SEM. SEM pictures were made on FE-SEM MIRA/LMU (Field Emission Scanning Electron Microscope).

### 3. Results and discussion

In table 1 the mean length, fibre diameter, fibre elasticity and elongation per each sample taken from five different regions in Albania are presented.

**Table 1.** Values of mechanical properties of goat fibre samples.

Sample	Length[mm]	Diameter [ $\mu\text{m}$ ]	Elongation [%]	Max Force [cN]
Tropoj	118.6 $\pm$ 13.5	78.79	68.4	106.03
Hasi	95.5 $\pm$ 7.93	77.62	69.4	95.28
Zagore	134 $\pm$ 17.8	82.79	56.38	149.87
Vorfë	103 $\pm$ 8.73	84.91	47.51	103.28
Përmet	109.1 $\pm$ 14.01	74.73	63.6	78.58

From the obtained results, regarding the length, the samples taken from Zagora area show the highest value (134mm), followed by Tropoja and Përmeti. Samples taken from two other regions have almost the same value. The differences in the samples could be related to several factors, which should be considered: not much is known about the race of the goats, in that different regions have different races; in addition to this genetic influence, the environment itself could serve as a strong indication. These values, however, are almost the same as those reported by other studies conducted in Turkey; Deger *et al.* (2008) [12] the mean length value was 136.3mm, Della *et al.* 2014 [13] and Soylezmezoglu *et al.* (2002) [14], where the mean value lengths were 118mm and 122mm, respectively.

Regarding the values concerning the diameter of the tested samples, the situation is completely different from the length of the fibres; all the samples have nearly the same value, approximately 78 $\mu\text{m}$ . These values are comparable with studies conducted by Dellal *et al* which reported that the diameter of the goat hair was between 64-93 $\mu\text{m}$  [13]. Only samples from Përmet have the lowest value 74.73 $\mu\text{m}$ , almost at the same value as those reported by Deger *et al* (2008), where the mean value was 76.70 $\mu\text{m}$  [12].

Similar to the length of the fibres, the diameter is very much influenced by the conditions where the goats are treated [3].

Regarding the evaluation of the fibres in term of industrial use, the length and diameter are rather important parameters. The length does show comparable values with the wool fibres from sheep, but the diameter is far away from the values of the angora goats (approximately 17.2 $\mu\text{m}$ ).

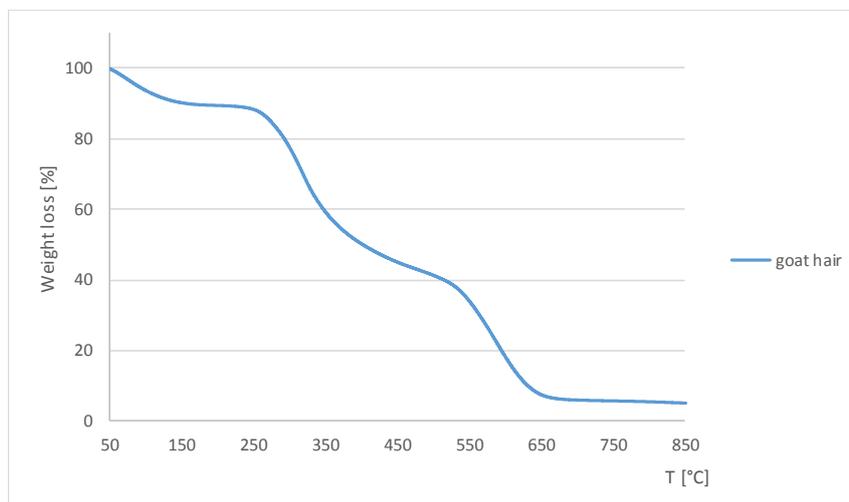
The burning behaviour of the textiles of 100% of goat fabric was performed through a LOI test according to the ISO 4589 standard. The results are presented in table 2. According to the results, it can be seen that the textile burns was a presence of 41%. The same results were found for three repetitions. Compared with other studies [6, 15], the values of LOI for wool was 25% ; the results

seem to be promising (41%) and yield comparable values with the special synthetic fibres used for fire protection after special treatment [16].

**Table 2.** LOI values of 100% goat fabric.

Sample	LOI	t <sub>100 mm</sub> [s]	t <sub>glow</sub> [s]
Goat fabric	41	113	120
	41	118	105
	41	115	111

By performing the TGA, the evaluation of the thermal stability of the textile was possible. In figure 2 and table 3, the curve and the values for the thermal degradation of goat fabric, which takes place at 300–400 °C through two competitive processes, namely depolymerisation and dehydration, are presented. The goat fabric started the degradation process at 92 °C (Tonset5%), where the maximum temperature of first weight loss (Tmax1) is 247 °C and the maximum temperature of the second weight loss (Tmax2) is 526 °C. The residue at the end of TGA measurement is 4.9%.



**Figure 2.** TGA curve of goat fabric in the air, heating rate 10 °C/min.

**Table 3.** Thermogravimetric data of goat fabric measured in the air condition.

Sample	T <sub>onset 5%</sub> [°C]	T <sub>max1</sub> [°C]	T <sub>max2</sub> [°C]	Residue at 800 °C [%]
Goat hair	92	247	526	4,9

For samples taken from the Hasi region, it has been performed the measurement of MCC, as shown in figure 3 and table 4. The results of the micro combustion calorimeter (MCC) analyses show that goat fabric has a rather low Heat Rate (80,9 W/g), evidence that these samples exhibit good thermal properties. A yield of pyrolysis residue at the end of the measurements is 24%. For the samples taken from the Hasi region it was possible to realize some measurements of the fibre diameter by using SEM. (see figure 4). The SEM pictures were made on FE–SEM MIRA/LMU (Field Emission Scanning Electron Microscope). It can be seen some impurities.

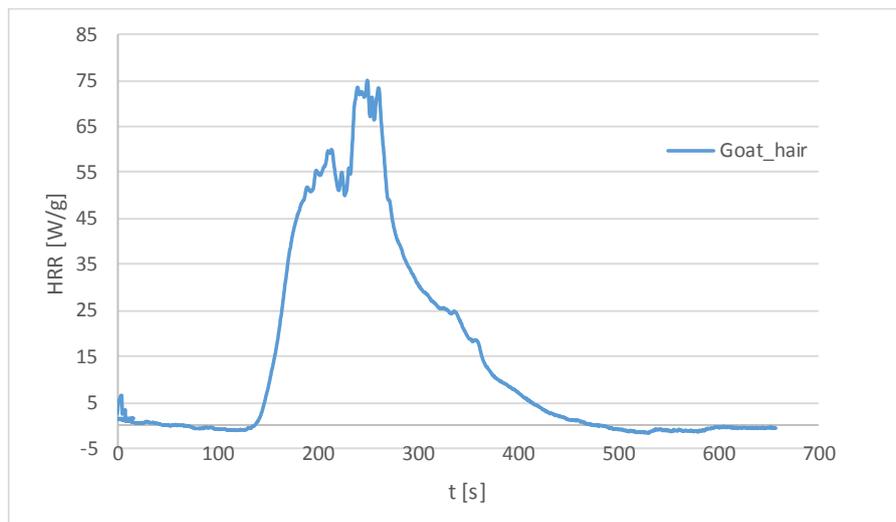


Figure 3.MCC curve of goat’s fabric.

Table 4.MCC data of goat hair.

Sample	Heat release temperature $T_{max1}$ (°C)	Maximum specific heat release $Q_{max1}$ (W/g)	Specific Heat release $hc$ (kJ/g)	Heat release capacity $c$ (J/g-K)	Yield of pyrolysis residue $Y_p$ (g/g)	Spec. heat of fuel gases combustion $hc.gas$ (kJ/g)
Goat hair	351,1	80,9	9,6	92	0,24	12,7

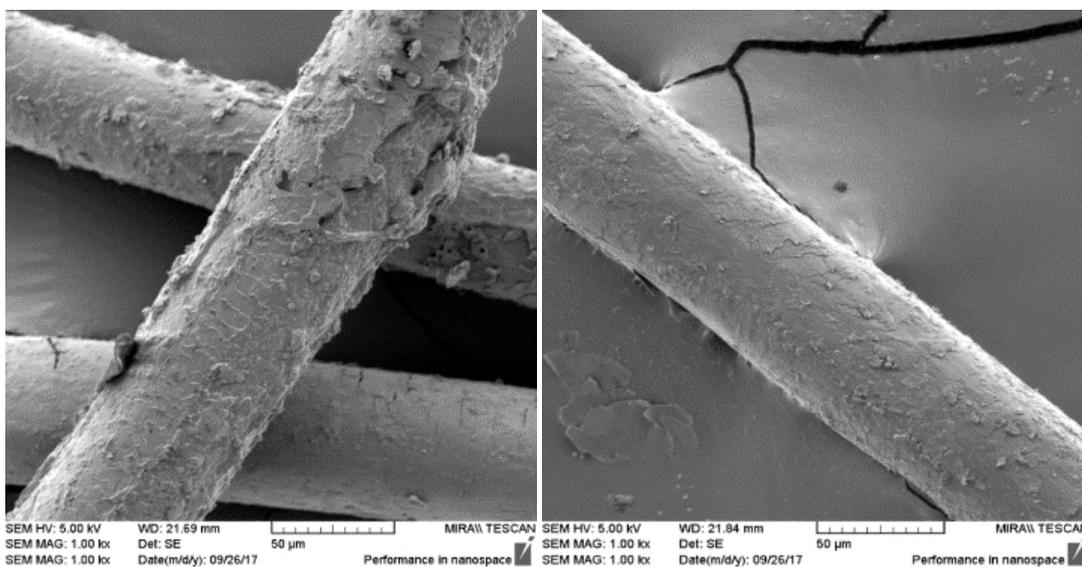


Figure 4. SEM images of goat fabric.

#### 4. Conclusion

This paper includes information describing the physical and mechanical properties of goat fibres. The values of length vary from 95.5 to 134 mm, and the diameter varies from 74.7 to 84.91µm. The values differ depending on the region, thus suggesting that the race and environment have a strong influence on the goat hair properties.

Regarding thermal properties, such as the LOI, TGA and MCC, the goat fabric from the Hasi region is rather promising; the LOI was 41 %, comparable values with the special fibres used for fire protection. The MCC shows that goat fabric has rather low Heat Rate (80, 9 W/g), evidence that these samples exhibit good thermal properties. The goat fabric started the degradation at 92 °C ( $T_{\text{onset}5\%}$ ); the maximum temperature of the first weight loss ( $T_{\text{max}1}$ ) is 247 °C and the maximum temperature of second weight loss ( $T_{\text{max}2}$ ) is 526 °C.

In terms of industrial processing of goat fibres from Albanian regions, although a part of the work has been completed; more samples are needed to be tested, which is the next stage of the research.

## References

- [1] Source of information: Ministry of Agriculture and Rural Development, available at <http://www.instat.gov.al/al/temat/bujq%C3%ABsia-dhe-peshkimi/blegtoria/#tab2>, accessed on 2018, 08.10.
- [2] Gjergji A., *Ligjerata per Etnologjine Shqiptare*, ISBN 99927-36-25-92001
- [3] Khan M., Abbas A., Ayaz M., Naeem M., Akhter M. and Soomro M., *Factors affecting wool quality and quantity in sheep. African journal of Biotechnology* Vol. **11** (73), pp. 13761-66, 2012.
- [4] Guxho G., Shehi Y., Shehi E., *Shkenca dhe teknologjia e materialeve tekstile*, ISBN: 978-99943-49-99-9; 2011.
- [5] N. A. G. Johnsons, I. Russell, *Advances in Wool Technology*, Woodhead Publishin, ISBN 978-1-84569-5469-0 (e-book).
- [6] IWTO Fact Sheet: Wool and Flame resistance international wool Textile Organization aisbl.2018.
- [7] ISO 1130:1975 Textile fibres -- Some methods of sampling for testing.
- [8] ISO 6989:1981 Textile fibres - Determination of length and length distribution of staple fibres (by measurement of single fibres).
- [9] ISO 5079:1995 Textile fibres - Determination of breaking force and elongation at break of individual fibres.
- [10] ISO 4589:1996– Plastics – Determination of Burning behaviour by Oxygen Index.
- [11] ASTM D7309- Standard Test Method for Determining Flammability Characteristics of Plastics and Other Solid Materials Using Microscale Combustion Calorimetry.
- [12] Deger H, Toplu O and Altinel A, 2008. Some production traits of indigenous Hair goats bred under extensive conditions in Turkey. 1st communication: reproduction, milk yield and hair production traits of does. *Arch Tierz* **51**:498-506.
- [13] Dellal G, Soylemezoglu F, Erdogan Z, et al., 2014. Present situation and future of animal fiber production in Turkey: A Review. *J Life Sci* **8**: 192-200.
- [14] Soylemezoglu F, Erdogan Z, Dellal G and Tatar AM, 2002. The Relationships between colourfulness and physical traits of down and coarse fibers obtained from goats raised in Turkey. *Turk J Vet Anim Sci* **26**:1395-1400.
- [15] Edited by N.A.G. Jahnson and I.M.Russell, Woodhead Publishing 2009, Isbn 978-1-84569-546-0-e-book.
- [16] Horrocks A. and Anand S., *Handbook of Technical Textiles*, Woodhead Publishing ISBN 1 85573 385 4.