THE FIBRE, YARN AND FABRIC PROPERTIES OF SOUTH AFRICAN INDIGENOUS GOAT HAIR

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Summary

South Africa has over 4 million indigenous goats (Boer, Savannah and Nguni/Mbusi breeds), many of which have two coats of fibre, namely a cashmere like fine down and a coarse guard hair. These goats are primarily kept for their meat, milk and skin products and for other traditional purposes, including controlling bush encroachment. A programme was launched 10 years ago aimed at establishing and improving the cashmere fibre production and associated value addition potential of these indigenous goats. Against this background, this paper discusses the joint project between the CSIR and the Eastern Cape Department of Agriculture aimed at the utilization and promotion of fine down (cashmere) fibre production from indigenous goats. This paper reports on studies undertaken to determine the ability of South African indigenous goats to produce cashmere-like fibres and presents some of the results obtained on fleece samples tested during the past 10 years. Reference is made to the fibre quality, yield and profile of the down component of the samples and to the properties of yarn and fabric produced from the fine down fibres.

Introduction

The traditional cashmere producing countries of Asia account for the bulk of cashmere produced in the world (6000 tonnes/year), with China the main producer. Outside Asia, the combined Australian and New Zealand production is less than 20 tonnes/year and the estimated production in Scotland for 1996 was 1 tonne (Phan & Wortmann, 1996). South Africa does not produce cashmere commercially, and present there is no local cashmere industry. In South Africa, the bulk (± 6.4 million, see Table 1) of indigenous goats, such as the Boer, Savannah and other traditional goats (Nguni/Mbusi type) owned by small farmers is primarily kept for their meat, milk and skin products and for other traditional purposes, as well as for controlling bush encroachment. There is considerable potential for further value-addition by utilising the fine down fibres present in certain of the breeds. Most South African indigenous breeds possess two distinct coats, cashmere (i.e. a fine down finer than 18,5 µm) and guard hair (see Table 2). It was felt that if the yield of the highly priced cashmere type of down fibre could be increased and exploited, this could lead to the possibility of creating a viable cashmere industry in South Africa, thereby adding value to the indigenous goats. Because many of the indigenous goats are found in the Eastern Cape Province (Table 1), the Eastern Cape Department of Agriculture and the Council for Scientific and Industrial Research (CSIR) initiated a programme to establish and improve the fine down fibre (cashmere) production potential of indigenous goats with two fibre coats.

In 2006, the Eastern Cape Provincial Government identified goat production as one of its strategies to address the socio-economic development of the rural areas. It is within this context that the production of high value fibres, such as cashmere, has received favourable attention from provincial government officials. As a result of this, a joint project between the Eastern Cape Department of Agriculture's (ECDA) and the CSIR Materials Science and Manufacturing Operating Unit’s Fibres and Textiles Competence area, based in Port Elizabeth, has been created to drive the cashmere initiative. The ECDA responsibility includes the breeding trials, collecting the cashmere fibre and to increase the cashmere production within the EC. The CSIR has the responsibility to analyse and evaluate the quality and processing of the fibres so produced.

Table 1 :

Distribution of goats in South Africa (Trends in the Agriculture Sector, 2006)

Province	Goat numbers
Gauteng	42 542
Mpumalanga	97 666
Western Cape	234 602
Free State	263 430
Northern Cape	576 702
North West	782 860
Limpopo	1 062 814
Eastern Cape	2 483 811
KwaZula Natal	855 426
Total	**6 399 853**

Table 2:

Down fibre quality and yield for South African double-coated and Gorno Altai goat breeds (Braun and Roux, 2005)

	Boer goats	Savannah goats	Traditional goats	Gorno Altai goats
Fibre diameter (µm)*	16.0 – 18.5	16.0 – 18.5	14.0 – 16.5	18.5 – 19.0
Fibre length (mm)	20-31	20-31	15 – 30	28 – 45
Fibre crimp	Good	good	Good	Poor
Fibre style	Good	good	Good	Poor
Fibre weight per goat (g)	10 - 50	10 - 50	5 – 15	100 – 500
Fibre yield (%)* (Combed fleeces)	50 - 70	50 - 70	40 – 60	50 – 70
Fibre colour	white and white/colour	white	white and White/colour	Brown
Other comments	-	-	-	silky handle, very matted, intermediate fibres

*-Measured by means of an OFDA instrument (IWTO 1995a and Hermann and Wortmann, 1995, 1996, 1997).

Although some results of the properties of the down fibres have been published, no results have been published on the properties of yarns and fabrics produced from the fine down of South African indigenous goats. This paper reports such results.

Materials and Methods

The fibres (mostly white) used in these trials were collected over the years from indigenous goats and were dehaired in the UK, the CSIR only recently having acquired a dehairing machine (Dawson type). These samples were tested for fibre diameter and other attributes using the OFDA (IWTO 1995a and Hermann and Wortmann, 1995, 1996, 1997) and the results of the fibres used in the present study are shown in Table 3a. Lambswool, in the form of broken top (Table 3a), was blended with the cashmere fibre in a 60% Cashmere/ 40% lambswool blend and then mule spun into a single yarn of 83.5 tex (1/12 Nm). The yarn was spun and waxed by La Lionne Textiles in KwaZulu Natal (South Africa).

A 4.5ktex carded sliver of a 50/50 cashmere/cotton blend was produced on a Trützschler TC03, followed by two passages on a TD03 draw frame to produce a draw frame sliver which was spun at the CSIR on a Schlafhorst Autocoro 312 open-end rotor spinning machine (open roller type D174DN) fitted with automatic piecing, to create another set of experimental yarns, namely 20 tex (1/50Nm), 28 tex (1/35.7Nm) and 35 tex (1/28.5Nm), respectively. These yarns were also plied to produce two-ply yarns and waxed. The cotton characteristics were measured with an Uster AFIS and are shown in Table 3b.

The evenness properties of both the single and two-ply yarns were measured on an Uster Tester 3 and the tensile properties on an Instron according to EN ISO 2062 (500mm/min). The properties of the various yarns are given in Table 4. The yarns were knitted into a single jersey structure on a 10 gauge flat-bed knitting machine (Flying Tiger), with a constant stitch length according to the Woolmark knitting test method for washing performance of wool textiles (WM K1 (Aug. 2000. The physical properties of the different sets of fabrics are given in Table 5.

Both the yarn and fabrics properties were measured under standard atmospheric conditions (20˚C and 65 per cent RH) allowing sufficient time for the samples to reach equilibrium (at least 24 hours).

Table 3a :

Properties of the cashmere and lambswool fibres
used to produce the 60 cashmere/40 lambswool blend yarns

	Down Fibre					Guard Hair		Percentage Of Fibres In Specific Diameter Classes				
	Fibre length (mm)	**MFD (µm)**	**CV_D (%)**	**Curvature (deg/mm)**	**Yield (%)**	**MFD (µm)**	**CV_D (%)**	**1-20µm**	**21-25µm**	**26-30µm**	**31-60µm**	**61-300µm**
Indigenous goats (Cashmere)	30-40	15.9	20.7	62.6	69.3	70.2	38.4	85.9	9.4	1.2	1.7	1.7
Lambswool (broken top)	40-42	17.5	-	-	-	-	-				-	

MFD – Mean fibre diameter; CV_D – Coefficient of variation of diameter

Table 3b :

Properties of the cotton fibre used to produce the 50cashmere/50 cotton blend yarns

MFD (µm))	**CV_D (%)**	**L(w) (mm)**	**L (w) (%CV)**	**SFC (n) (%)**	**Trash (count/g)**	**VFM (%)**	**Neps (count/g)**
14.5	0.8	26.5	29.8	20.6	16	0.52	91

MFD- Mean fibre diameter, CV_D-Coefficient of variation of diameter, L (w) – Mean Length by weight, SFC (n) – Short fibre content by number, VFM – visible foreign matter by weight

Results and Discussion

The grease content of SA cashmere was found to be between 2.0 to 3.0 %, McGregor (2001) having reported that the grease content for Australian cashmere varied from 0.14% to 8% compared to that of Chinese cashmere, namely 2.0% to 7.2%.

McGregor (2001) showed that curvature is a good method for identifying cashmere. The relationship between the MFD and curvature for South African cashmere is shown in Figure 1, curvature decreasing as MFD increases, which is similar to the findings of McGregor (2001). The average curvature values for the SA cashmere (Table 3a) were very similar to those of the Australian cashmere given by McGregor (2001) (see Figure 2), although the range was wider. The Chinese cashmere had a higher average curvature value (McGregor (2001)) and a lower curvature range than the SA cashmere.

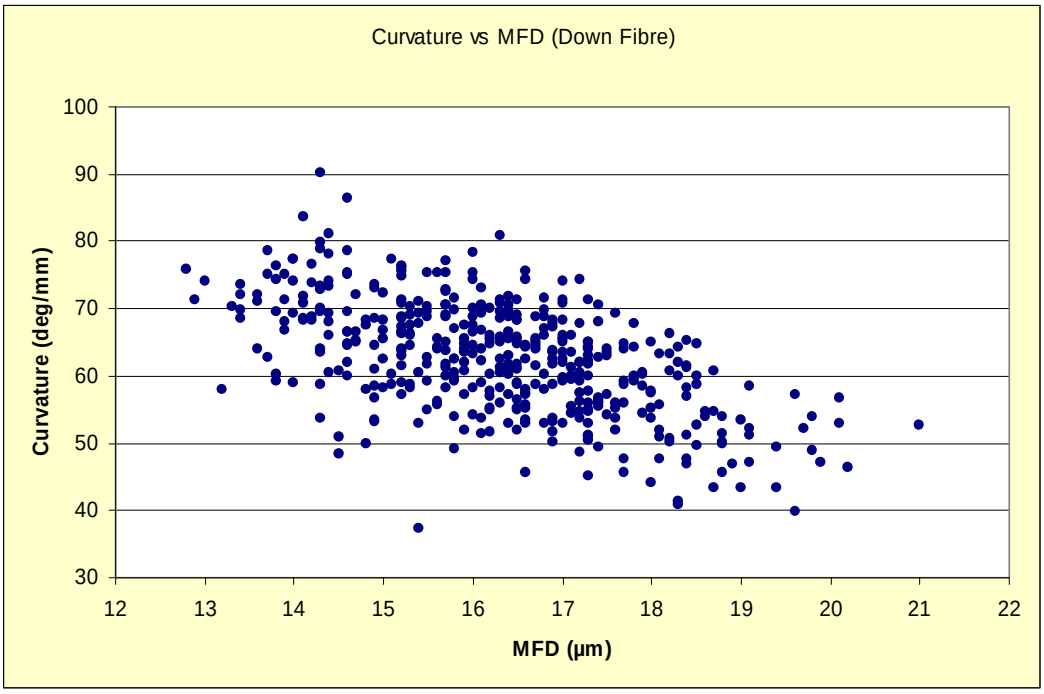

Figure 1 : Curvature as a function of MFD for the down cashmere type fibre of Indigenous goats

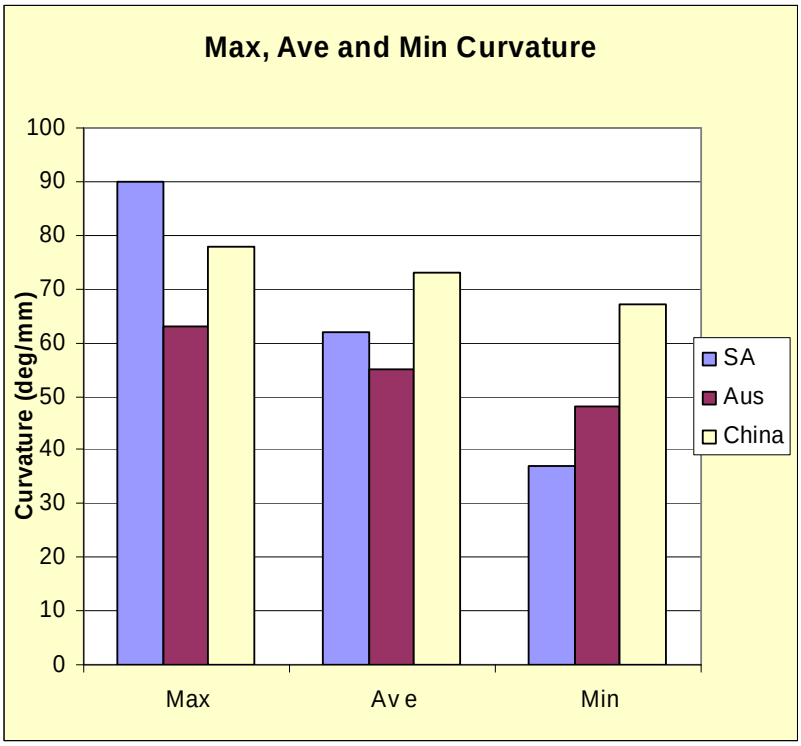

Figure 2: Curvature values for dehaired cashmere from different origins

From Table 4 it can be seen that, as expected, the evenness properties and strength of the cashmere/cotton blend yarns improved with increasing linear yarn density (single and two-ply, respectively), and also with plying. Spinning of the cashmere/cotton blends did not create any undue problems, except for the 20 tex single yarn which was difficult to spin.

Table 4 :

Yarn properties of different types of yarn blends

	Mule spun	**Rotorspun**					
	60/40 Cashmere /Lambswool	**50/50 Cashmere/Cotton**					
Yarn linear density	83.5tex	20tex	28tex	35tex	R40tex/2	R56tex/2	R70tex/2
Twist (turns/m)	400	1195	1009	907	-	-	-
Irregularity (CVm %)	11.9	16.5	14.5	13.4	11.4	10.6	10.3
Thin Places (-50%)/km	2	115	11	5	1	0	0
Thick Places (+50%)/km	4	126	41	21	4	1	1
Neps (+200%)/km	13	498	112	52	12	7	2
Neps (+280%)/km	3	45	9	3	0	1	0
Hairiness (hairs/m)	12.4	5.5	6.1	6.5	6.7	7.3	7.7
Tenacity (cN/tex)	3.8	6.6	6.5	6.6	6.9	6.9	8.0
Extension (%)	18.4	5.2	6.5	7.5	7.2	6.6	7.1

Table 5 :

Knitted fabric properties

	60/40 Cashmere /Lambswool		50/50 Cashmere/Cotton					
Yarn linear density	83.5 tex		R40tex/2		R56tex/2		R70tex/2	
Mass per unit area (g/m^2)#	246		109		158		203	
Dimensional Change (%)*	Length	Width	Length	Width	Length	Width	Length	Width
	-32.8	-16	-18.8	9.6	-18.2	2.8	-15.8	-4.4
Pilling (Rating)* **	1		1		1		1	
Spirality (mm)** **	64		14		19.5		97	

\# - AS 2001.2.13 (1987)

* - Woolworths P1A (2003) with a negative sign indicating shrinkage

*** - IWS Test Method 152 (ICI Pillbox method) (1996b)

**** - Woolworths P1B (2003)

From Table 5 it is clear that all the knitted fabrics had a very poor pill rating and appearance after the pilling test, with loose pills/debris being left behind in the drum after testing. A number of factors could be responsible for the pilling, with the low cover factor and twist factor used and the relatively short fibre length, probably playing a major role. Ways of improving pilling performance need to be investigated. The length and width shrinkage values (dimensional change) differed significantly, indicating that much of the observed shrinkage can be attributed to relaxation shrinkage resulting from loop (fabric) distortion introduced on the knitting machine. The 60/40 Cashmere/lambswool exhibited the highest shrinkage in both directions, the appearance indicating that felting occurred. This can largely be explained by the fact that the lambswool was not shrink resist treated.

Conclusion

Results obtained during a joint project between the CSIR and the Eastern Cape Department of Agriculture, aimed at the utilisation and promotion of the fine down (cashmere) fibre production from indigenous goats, are presented. It was found that the properties of the cashmere from the South African indigenous goats compared favourable with those of the Chinese and Australian cashmere fibre and that acceptable yarns could be spun from the dehaired cashmere when blended with lambswool or cotton, using either mule spinning or rotor spinning. Pilling and washing shrinkage of the knitted products are currently not of an acceptable standard and further work to improve these properties needs to be carried out.

The study indicated that the potential exists to establish a cashmere industry in South Africa. Apart from rearing goats for just meat production, the fine down component of the goat can be used to produce high quality knitted products. This value addition opportunity could have a major impact on the rural communities and the textile and clothing industries in general.

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