

## Quality attributes of commercial cashmere

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### Abstract

Recent investigations into objectively measured attributes of commercial cashmere have differentiated cashmere produced in different regions of the world on the basis of cashmere fibre attributes. By plotting any two of mean fibre diameter, fibre curvature and resistance to compression, cashmere from different producing regions was segregated into distinct groupings. Australian cashmere had lower fibre curvature ( $P < 0.05$ ) probably as a consequence of being longer. Improved feeding of cashmere goats produced longer and slightly coarser cashmere but with significantly lower fibre curvature ( $P < 0.05$ ). The low resistance to compression of cashmere from new origins, mainly Australia, indicates that this cashmere is more compressible, ie is softer to handle, than cashmere from traditional sources. The composition of typical raw commercial Australian cashmere was determined as: guard hair 44.3%, cashmere 28.5%, moisture 17%, suint 4.2%, grease 3.0%, soil 2%, vegetable matter 0.9%, other impurities  $< 0.1\%$ . The use of fibre curvature in the commercial trading of cashmere is discussed.

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**Keywords:** Fibre curvature, softness, fibre diameter, impurities, nutrition, cashmere length

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### Introduction

Cashmere, the downy fibre grown by secondary skin follicles in some breeds of goats is expensive to purchase and process into textiles (McGregor, 2000a). For such an expensive textile raw material, surprisingly little objective information has been published on measurable attributes of commercially traded cashmere in either the raw or semi-processed form used by spinners. Many of the fundamental attributes of raw cashmere that are important in wool processing have not been measured and therefore are not understood. For a commercial industry to develop in Australia, cashmere producers and commercial trading partners need to understand all the quality attributes of the raw and processed product. This paper reports recent investigations into objectively measured attributes of commercial cashmere collected from traditional and new regions of cashmere production with a focus on Australian cashmere.

### Materials and Methods

Samples of commercially dehaired cashmere from a range of manufacturers and countries of origin, samples of raw cashmere from Australia and China and cashmere from nutrition studies in Australia were tested. Bales of core samples were tested in accordance with IWTO-19-95 (1995) and IWTO-33-88 (1988) to determine wool base, vegetable matter content, VM base and VM type and ash content. Mean fibre diameter (MFD) and an objective measure of the fibre crimp, the fibre curvature of cashmere (FC, degree/mm, Swan, 1994) were determined by mini coring cashmere and testing with the OFDA100 following aqueous scouring and using Interwool Lab calibrations (IWTO-47-95 1995, IWTO-57-96 1996). Resistance to compression (Rc) was determined on dehaired cashmere (AS 3535 – 1988). Raw cashmere fibre length was measured to the nearest mm. Further details are provided elsewhere (McGregor, 1988; 2000b; McGregor, 2003a; b).

Mean fibre diameter, Rc and FC of dehaired cashmere were modelled as a function of geographical origin and processor using multiple regression with factors (Genstat, 2000). The initial geographical origins could be sensibly grouped into broader regions without losing any explanatory power of the model. The final Origins were: West Asia (Iran, Turkey, Afghanistan), Eastern Asia (China including Inner Mongolia but excluding Xinjiang Autonomous Region), Central Asia (Western Mongolia, Xinjiang Autonomous Region of China) and New (Australia, representing 85% of New samples, New Zealand, USA). For fibre curvature, Iran was a separate Origin. There was no evidence of interaction between origin and processor. Scatter plots between MFD, FC and Rc were created with the data adjusted for processor. The processor adjustment was an equal (as distinct from proportional) adjustment, with processor effects estimated from the full fitted model. There was no adjustment of processors used for the dehaired samples from Central Asia, since these processors were completely distinct from those used in other regions. Conservative least significant intervals

(LSI) were calculated using a new technique (M. Hannah, unpublished data). This approach guarantees that if the LSI for two means do not overlap then the two means are definitely significantly different at the 5% level, in a pair-wise comparison.

Samples of cashmere from a replicated factorial experiment designed to assess the effect of nutrition on fibre quality and production of Australian cashmere goats (McGregor, 1988a), were measured for cashmere FC, fibre length and Rc. The main treatment groups were: <M; goats were fed less than maintenance energy requirements resulting in loss of live weight; M; goats were fed to maintain live weight; >M; goats were fed above maintenance energy requirements resulting in gain in live weight. Nested within M were three treatments to assess the effect of additional protein. Nested within >M were three treatments to assess the effect of level of energy intake above maintenance (1.25 M, 1.5 M and *ad libitum*, representing 25% greater, 50% greater and approximately twice the energy intake of the M treatment respectively). As there was no affect on nutrition within either M or >M, results presented are the main treatments including the nested treatments. The standard error of difference between means (s.e.d.) and the probability of significant difference between means (P) are given.

## Results

Commercial bales of Australian cashmere have relatively low levels of naturally occurring extraneous matter with an average wool base of 80% and low levels of vegetable matter and soil (Table 1).

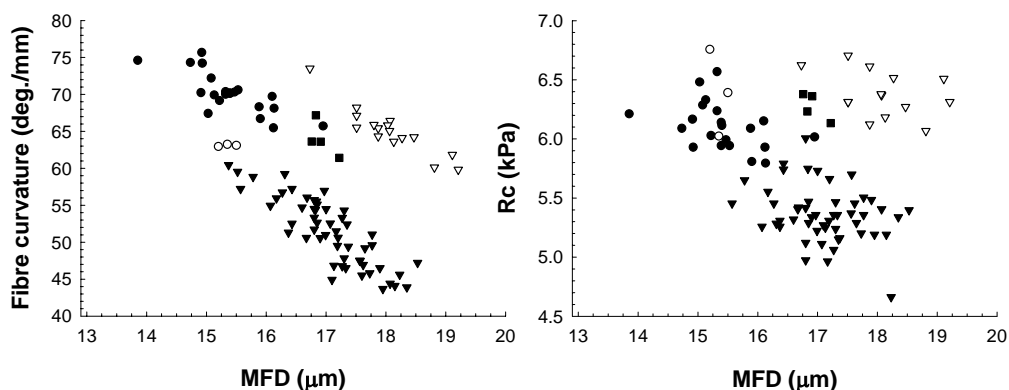
**Table 1** Mean and s.d. of clean washing yield, mean fibre diameter (MFD), fibre curvature (FC), resistance to compression (Rc), vegetable matter (VM), VM and wool base, ash, cashmere yield and incidence of wax and suint of commercial bales of Australian cashmere (adapted from McGregor, 2003b)

Trait	Washing yield (%)	MFD ( $\mu\text{m}$ )	FC (deg./mm)	Rc (kPa)	VM (%)	VM base (%)	Wool base (%)	Ash (%)	Cashmere yield (% w/w)	Wax (%)	Suint (%)
Mean	96.4	17.0	51	5.8	0.8	0.7	80.4	1.9	33.3	3.0	4.2
s.d.	0.8	0.8	4	0.3	0.4	0.3	0.9	0.3	1.8	0.7	0.6

Mean fibre diameter of dehaired cashmere samples ranged from 13.6 to 19.2  $\mu\text{m}$  (Figure 1). Chinese samples were finer than those from other origins ( $P < 0.05$ ). Cashmere from Australia was finer than that from Iran. The mean FC (SD) of dehaired cashmere was 60.7 (9.1) deg./mm ranging from 44 to 76 deg./mm. Cashmere from new origins of production (Australia, New Zealand and USA) had lower FC than that from Iran, East and Western Asia ( $P < 0.05$ ). Resistance to compression (Rc) of dehaired cashmere overlapped substantially between origin. Iranian cashmere showed the highest median value and the largest variation. Cashmere from new origins of production had the lowest Rc ( $P < 0.05$ ).

In Australian goats, cashmere FC was dependent on nutrition. Goats fed to lose weight grew less cashmere that was shorter and finer with significantly increased FC compared with goats fed to gain weight (Table 2, McGregor, 1988; 2003a). In raw Chinese Liaoning cashmere, there was a significant difference between each age and sex group in FC (bucks 52; does 65; kid bucks 78 deg./mm;  $P < 0.001$ ). Increasing Liaoning cashmere staple crimp frequency by 1 crimp per cm was correlated with an increase in FC of 6.5 deg./mm ( $r^2 = 0.61$ ). In raw and dehaired Australian and Liaoning cashmere, increasing MFD and cashmere fibre length was associated with decreasing FC (for each 3  $\mu\text{m}$  increase in MFD, FC declined 10 to 41 deg./mm; for each 10 mm increase in cashmere fibre length FC declined 3 to 13 deg./mm). In Australian and Liaoning cashmere, the direction of response in FC to changes in MFD and fibre length was similar.

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**Figure 1** The mean fibre diameter (MFD), fibre curvature and resistance to compression (Rc) of dehaired cashmere from traditional and new origins of production. Legend: closed circle, East Asia, China; open circles, Central Asia; open triangle, Iran; closed triangle, Australia and other new origins; closed square, West Asia. (Adapted from McGregor, 2000b)

**Table 2** The effect of nutrition treatment on live weight change, cashmere production, cashmere mean fibre diameter (MFD), cashmere fibre length (FL), cashmere fibre curvature (FC) and dehaired cashmere resistance to compression (Rc). Values after adjustment for covariates. (Adapted from McGregor, 1988, 2003a)

Treatment group <sup>1</sup>	Live weight change (g/d) <sup>2</sup>	Cashmere weight (g)	MFD (µm)	FL (mm)	FC (°/mm)	Rc (kPa)
< M	-28	146	16.67	87.7	61.3	5.80
M	+2	192	16.93	99.9	53.2	5.64
> M	+38	221	17.69	102.2	47.5	5.53
sed <sub>&lt;M-other</sub> ;		28.1;	0.38;	8.5	4.7;	0.18
P - value		0.05	0.05	NS	0.05	NS
sed <sub>M-&gt;M</sub> ;		19.9;	0.27;	6.0	3.3;	0.13
P - value		NS	0.05	NS	NS	NS

<sup>1</sup>Nutrition feeding treatment: < M, live weight loss; M, maintenance of live weight; > M, live weight gain

<sup>2</sup>Fleece-free live weight change during main period of cashmere growth from mid December to mid April

## Discussion

The composition of typical raw commercial Australian cashmere can be summarised as: guard hair 44.3%, cashmere 28.5%, moisture 17%, suint 4.2%, grease 3.0%, soil 2%, vegetable matter 0.9%, other impurities < 0.1%. The measurements of VM, ash and wax content of commercial Australian cashmere are much lower than data for cashmere from the seven main producing regions of Inner Mongolia (Ze, 1989). Ze reported the wax content of Chinese cashmere ranged from 3.1 to 6.8%; VM content ranged from 0.3 to 1.2%; soil content ranged from 0.7 to 10.6%; and skin debris ranged from 3.1 to 20.5. The commercial significance of VM in greasy wool ranks just after MFD and washing yield as a physical attribute affecting processing of greasy raw wools. VM amount and type affects scouring, top making, yarn and cloth attributes (Smith, 1988).

The low Rc of cashmere from new origins, mainly Australia, indicates that this cashmere is more compressible, ie is softer to handle, than cashmere from traditional sources. This work has differentiated cashmere produced in different regions of the world on the basis of cashmere fibre attributes. It was possible to segregate cashmere from different producing regions by plotting any two of MFD, FC and Rc (Figure 1). This method can also segregate other fibres such as cashgora from cashmere (McGregor, 2000b).

The likely explanation as to why cashmere from new origins such as Australia is softer (i.e. has lower Rc) than traditional cashmere is provided in Figure 1, Table 2 and McGregor (2003a). It is likely that improved feeding of Australian cashmere goats compared with the nutrition of cashmere goats in traditional

origins of supply, leads to longer and slightly coarser cashmere with significantly reduced FC. The results suggest that for Australian cashmere, only a certain number of fibre crimps are produced. As such, crimp frequency in Australian cashmere is time dependent and not length dependent (McGregor, 2003a). This indicates that cashmere producers can manipulate the FC attributes of their cashmere by altering cashmere fibre length and fibre diameter via nutrition management. While age of goat, and physiological state are likely to be correlated with cashmere FC, cashmere producers could also manipulate cashmere FC directly by genetic selection (McGregor, 1997).

Currently FC is not included in international definitions of cashmere. The use of FC in greasy cashmere evaluation, specification, selling and classification systems needs to be clarified.

## Conclusions

Dehaired cashmere shows commercially important variations in fibre attributes based on origin of cashmere. Commercial lots of Australian cashmere had low levels of impurities and vegetable matter and lower cashmere fibre curvature compared with traditional sources of cashmere. Cashmere with low fibre curvature has a lower resistance to compression and is likely to have a softer handle. Producers can manipulate cashmere fibre curvature by altering fibre length via nutrition. The use of fibre curvature in the commercial trading of cashmere has not been clarified.

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