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Variation of fibre characteristics important in processing, over the body of Australian brushtail possum (*Trichosurus vulpecula*).

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ABSTRACT

The amounts of fur and processing properties of fur from the Australian Brushtail Possum (*Trichosurus vulpecula*) were determined. The amounts of fur per animal ranged from 18 – 94 g depending on the sizes of the animals, with 75% coming from the body, 10 - 151% from each of the belly and tail. Fur from the belly was shorter and finer than that from the body, which was shorter and finer than that from the tail (20.1 vs. 27.1 vs. 37.9 mm; 16.2 vs. 17.7 vs. 22.9 μm respectively ($P < 0.001$)). Belly fur was less curved than body or tail fur (47.2 vs. 52.8 and 55.6 $^{\circ}/\text{mm}$ respectively ($P < 0.001$)). The fibre curvature of fur from all three body sites was half to two thirds of the curvature expected for Merino wool of similar diameter. Coefficients of variation of both fibre length and fibre diameter were approximately double those normally observed in Merino wool (coefficient of variation (CV) = 32.8% (length) and 47.6% (diameter)). The number of medullated fibres was high (mean = 44.5% by weight), with most of the coarser fibres being medullated. The cuticle scale structure was smoother than Merino wool. The high degree of medullation observed contributes to the reported high insulation value of the fur as it results in a high number of fibres for the weight. The relatively low curvature and low scale profile, give the fibre a smooth, slippery surface. This makes processing difficult and causes problems for fibre retention in fabric.

Keywords: Possum fur; *Trichosurus vulpecula*; fibre length; fibre diameter; coefficient of variation; medullation; processing; wool/possum fur blends.

INTRODUCTION

The Australian Brushtail Possum (*Trichosurus vulpecula*) was first introduced into New Zealand in the mid to late 19th Century with the aim of developing a fur trade (Pracy, 1974). While trading in fur and skins occurred over the intervening years, development of wool/possum fur blend knitwear in the late 20th century provided a renewed impetus for a valuable trade in possum fur and the possum became viewed by some as a valuable resource. There appears to be little information on the fibre characteristics of possum fur important in processing and no published information on how these characteristics vary over possum's body. This paper aims to partially overcome this dearth of published information (Gore & Laing, 2002).

The characteristics of wool important in processing are:

- Fibre diameter, which determines the end products for which the wool will be suitable,
- Length (and strength), which determine the types of processing routes and processing efficiency and yarn strength,
- Colour which influences dyeing,
- Crimp (or curvature), affecting cohesion of fibres within a yarn or fabric and the "handle" of a yarn or fabric,

- Degree of medullation as this affects the evenness of dye uptake.

This report describes the fibre diameter, length, curvature and medullation characteristics of possum fibre from a small number of animals captured at two times of year mainly in the Eastern Bay of Plenty, New Zealand.

METHODOLOGY

Fur was plucked by hand soon after killing from 23 possums captured in two regions of New Zealand, Eastern Bay of Plenty ($n = 21$) and South Westland ($n = 2$), in late winter/early spring (September/October) ($n = 13$) and in summer (February) ($n = 10$). Individual fibre length was determined by the method described in IWTO (1967) on fur from four possums captured in summer and from a bulk lot of fur from several captured in winter/spring. Approximately 100 fibres were counted by each of two operators for the winter/spring fur and 150 to 250 fibres were counted for the summer fur. Samples of the fur were analysed to determine mean fibre diameter and fibre diameter variation, (IWTO, 1998) mean fibre curvature and degree of medullation using an optical fibre diameter analyser (OFDA 100) instrument (Brims & Peterson, 1994; Edmunds, 1995).

RESULTS

As there were no differences in any of measured characteristics between animals captured in Bay of Plenty or Westland nor between animals captured in late winter/spring or in summer, data from the two regions and the two seasons of capture have been combined for analysis.

Weights of fur

The weights of fur from the various parts of the possum body are given in Table 1. As no attempt was made to weigh the animals, the weights of fur could not be adjusted for body weight. The apparent differences in weight of fur between the two seasons probably reflected differences in the body weights and/or maturity of the animals captured for plucking. The amounts of fur collected ranged from 18.0 g to 94.2 g with a mean of 60.4 g. In both seasons approximately 75% of the fur was collected from the animals' bodies with the bellies and tails each providing 10 to 15%.

Table 1: Distribution of fur on possums in two seasons.

Season	Body part	Mass of fur (g)			
		Mean	%	Minimum	Maximum
Winter/Spring	Body	51.8	77.2	21.7	75.9
	Belly	7.3	10.9	3.0	12.6
	Tail	8.0	11.9	1.9	12.3
	Total	67.1		26.6	94.2
Summer	Body	37.0	71.6	11.6	56.2
	Belly	7.1	13.7	2.5	17.1
	Tail	7.6	14.7	1.8	22.0
	Total	51.7		18.0	67.1

Fibre characteristics

Possum fur is a relatively short (mean length 28.4 mm), fine (mean diameter 18.9 μm), straight (mean curvature 51.9 $^{\circ}/\text{mm}$) fibre, with high variability of both length and fibre diameter (Table 2) and high degree of medullation on both volume and weight basis. Fibre lengths and diameters (mean and coefficient of variation (CV)) were similar to those noted elsewhere (Gore & Laing, 2002; Brady & Wang, 2004).

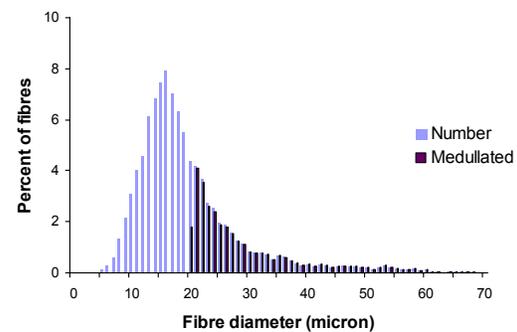
There were differences evident in all the fibre length, fibre diameter, fibre curvature and medullation measurements except from CV of length, between fur from the three different parts of the body. Tail fur was longer, coarser, more curved and more highly medullated than body fur which was in turn longer, coarser and more highly medullated than belly fur (Table 2). Fibre diameter variability of tail fur was higher than that of fur from the belly or body.

The degree of medullation measured in the OFDA instrument was very high for all fur (Table 2) and most fibres of diameter greater than about 21 μm were medullated (Figure 1).

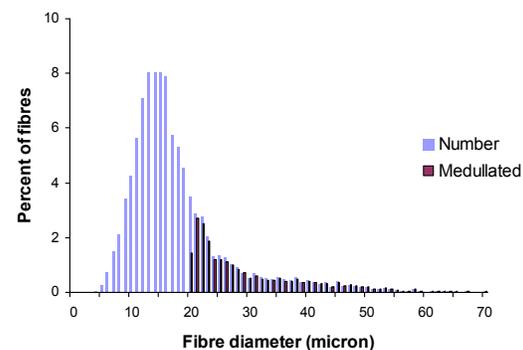
The distributions of fibre diameter differed for the three body parts sampled. All were typical of a dual coat with a number of fibres with a coarse fibre diameter. This is most evident in the tail fibres (Figure 1c) where the coefficient of variation of fibre diameter was greater than 50%, and over 55% of fibres were of greater diameter than the mean (22.9 μm).

Figure 1: Typical fibre diameter and medullation distributions for possum fur at the (a) body, (b) belly and (c) tail sites.

a) body



b) belly



c) tail

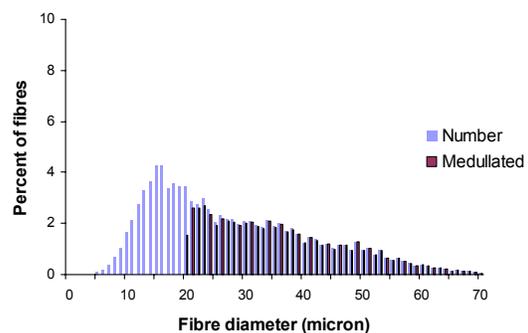


Table 2: Mean and coefficient of variation (CV) of fibre length and fibre diameter, and mean curvature and medullation of possum fur collected in two seasons. SED = Standard error of difference. Means within columns with differing superscripts differ significantly ($P < 0.01$).

Body part	Fibre length		Fibre diameter		Fibre curvature	Medullation (%)	
	Mean (mm)	CV (%)	Mean (μm)	CV (%)	Mean ($^{\circ}/\text{mm}$)	by volume	by weight
Body	27.1 ^b	29.7	17.7 ^b	44.9 ^a	52.8 ^b	51.3 ^a	37.7 ^a
Belly	20.1 ^a	32.1	16.2 ^a	44.6 ^a	47.2 ^a	45.4 ^b	32.2 ^b
Tail	37.9 ^c	36.8	22.9 ^c	53.2 ^b	55.6 ^c	76.2 ^c	65.0 ^c
SED	3.10	5.21	0.62	1.28	2.73	2.58	2.69
Significance	***	ns	***	***	**	***	***

DISCUSSION

Three types of hair have been described in possum fur; fine underhairs, guard hairs and long coarse overhairs. These types of fibre differed in length, curvature and average diameter (Woods, J.L.; Vernon, J.A.; Harland, D.P.; Krsinic, G.L. unpublished observations). The underhairs were shortest and showed a degree of crimp, while the overhairs were longest and straightest. There was little apparent difference in properties within each hair type in the belly, body and tail fur. However, overhairs were not found in the belly fur, were uncommon in the body fur and common in tail fur. Thus the differences in mean fibre length and diameter, and variations of both, reflect the different proportions of these three hair types found on the different parts of the possum body.

No seasonal differences were observed here in the fibre characteristics measured between possums captured in late winter/spring or those captured in summer. Other authors have observed low rates of pelage replacement in the possum (Nixon, 1990), and found no effect on the fur quality of dosing with melatonin (Pearson *et al.*, 1990). Those authors concluded that marked seasonal changes in coat structure, similar to those observed in northern hemisphere fur-bearers, would be unlikely.

As unprocessed possum fibre is expensive to buy for processing at around \$75 to \$100/kg, and because it is difficult to process, it is typically blended with wool before processing. Most blends contain up to 30% possum fur with synthetic fibre often added to improve the wearability of the end-product. The wool used is generally of similar diameter to the possum fur, to ensure the finished product has good performance.

The average tested length (as distinct from the individual fibre length) of wool of fibre diameter 18-19 μm is 78 mm (Tectra, 2004), or nearly three times the mean fibre length reported here. This restricts the processing routes suitable for wool/possum blends. Yarn making by the worsted process includes a combing step which removes, among other things, the short fibre. With

wool/possum fibre blends this includes most of the possum fibres in the blend. Semi-worsted processing, although lacking the combing step, requires long, strong fibres. For these reasons blends of possum and wool are normally processed by the woollen route, which is relatively tolerant of the presence of short fibres. Yarn made by this method tends to have a low linear density (or count) and is hairy in appearance compared with worsted yarn. Wool/possum fur blends are also suitable for processing by non-woven routes where the performance is less dependant than yarn making processing routes on the fibre characteristics measured here. The data presented here from a limited number of possums mainly from one geographic location, suggest that fur from all three parts of the possum body would be equally suitable for processing either by the woollen route or by non-woven methods.

Wool of similar average fibre diameter to this fur has a curvature of around 100 $^{\circ}/\text{mm}$ (Edmunds & Sumner, 1996; Tectra, 2004) – nearly twice that observed here with possum fur. In contrast, the fibre curvature observed for Perendale wool of diameter 31.3 μm was reported as 64 ± 10 (\pm standard deviation) $^{\circ}/\text{mm}$ (Sumner *et al.*, 2007). Thus, the curvature of possum fur is at the lower end of the range observed for wool with a diameter over 60% greater. This relative straightness and shortness combined with the low scale height (Gore & Laing, 2002) means that possum fur is a “slippery” fibre, which is difficult to process. It tends to fall out of the blend during carding and is easily shed from the yarn or garment in use. This limits its use and has been one of the main problems with the processing and performance of wool/possum fur blends.

Generally, wool fibres of similar mean diameter to possum fur are very low in medullation (Scobie, *et al.*, 1993). Over 90% of possum fur fibres with diameter 21 μm or greater were measured by the OFDA as being medullated. Further studies (Woods, J.L.; Vernon, J.A.; Harland, D.P.; Krsinic, G.L. unpublished observations) have indicated that many finer fibres are also medullated. These will not be detected in the OFDA technology.

The OFDA instrument estimates degree of medullation as a function of fibre opacity. Fibre opacity is in turn affected by the optical lens effect of the fibre cross section and the effect of a keratin/air interface within the fibre (Brims & Peterson, 1994). It is thus unlikely to detect medulla of small diameter in fine fibres. In addition, the opacity of fibres is influenced by their colour (Baxter, 1998). Many of the possum fibres are coloured black or brown for at least some of their length and this will affect identification any medulla they may contain. Thus the data on medullation presented in this paper should be considered an estimate only of the true level of medullation present in possum fibres. The differences observed may well reflect differences in fibre diameter of the different fibre types rather than an inherent difference in medullation between the three body sites examined. Other studies (Woods, J.L.; Vernon, J.A.; Harland, D.P.; Krsinic, G.L. unpublished observations) suggest that the true levels of medullation are considerably higher than those described here.

The extent of medullation makes the possum fibres light for their diameter in that they are more like hollow pipes than rods. Consequently there are more fibres in a given weight of fur than would be the case for wool. This contributes to a high insulating value for a given weight of fur. Hence wool/possum blend fabric has a good reputation for warmth without weight.

Possum fibre has become a very popular fibre to include in blends with fine wool to make new ranges of high quality fabrics and garments produced from yarn spun on the woollen system. At \$75 to 100 /kg it is too expensive to use on its own and the processing properties identified in this report make it very difficult to process on its own by any conventional processing route. The fur is fine (average diameter 18.9 μm) and because of this it is very soft. In spite of the high proportion of fibres of greater than 30 μm (11, 9 and 40% for body, belly and tail fur respectively) the fur shows little sign of prickly – a factor associated, in wool, with the proportion of fibres greater than 30 μm in diameter. With their smooth outer surface and relative straightness and shortness possum fibres do not bind well with each other or with other fibres during processing. Blending with fine wool at 20 - 30% retains a high proportion of the valuable qualities such as soft feel, lightness and warmth, while minimising the difficulties of processing.

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