Variation in fleece characterisitics over the body of alpacas

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ABSTRACT

Variation in fleece characteristics over the body of alpacas was examined in order to determine the optimum sampling site to provide an estimate of overall fleece properties. Fibre samples were taken from the neck, shoulder, midside, mid-back and rump positions on 35 mature female alpacas.

Yield was significantly ($P<0.0001$) lower on the neck and back and higher on the rump than on the shoulder and midside sites, 91.1, 91.0, 94.4, 94.0, 93.2 % (se 0.3) respectively. Staple length varied significantly ($P<0.001$) between all sites. Fibres on the neck were considerably shorter than at other sites, with staple length at the neck only 56.7 mm compared to the other sites where length was between 80 and 100 mm. Staple length increased from rump (81.9 mm) to shoulder (99.6 mm) and from the back (86.4 mm) down the midside (92.8). Fibre diameter did not vary over the fleece (mean 33.3 ± 0.4 μm), except for the back site where fibre was 2.7 μm finer ($P<0.001$). The average proportion of medullated fibres was 80%, but this varied significantly ($P<0.01$) between sites from 68 to 86 %. There were no differences ($P>0.05$) in the proportion of partially medullated fibres between sites but levels of kemp (3.7 - 8.9 ± 1.0 %) and fully medullated fibres (26.4 - 45.1 ± 2.3 %) varied significantly ($P<0.01$).

Correlations between individual sites and the overall fleece mean were high for most characteristics, 0.74 to 0.97, with the exception of the proportion of partially medullated fibres, where correlations were 0.48 to 0.75. The midside site is recommended as the best site for representative sampling for all fleece measurements.

Keywords: Alpaca; camelid; fleece; fibre, body site.

INTRODUCTION

Alpacas (Lama pacos) are economically the most important member of the South American camelids, which also includes llamas, guanacos and vicunas. In their native lands alpacas are farmed mainly for fibre and meat production. In the llama, guanaco and vicuna the fleece is characteristically double-coated, with a relatively fine undercoat or down and a coarser coat of guard hair, similar to primitive breeds of sheep and the cashmere goat. The alpaca fleece is closer to a single-coat, as found in improved breeds of sheep and the Angora goat, where all fibres are essentially similar in their physical characteristics, although in normal alpaca fleeces some very coarse fibres similar to the guard hair of a double-coat may be found.

Accurate assessment of fleece characteristics is required to determine rankings of animals for breeding programmes. Information on variation in fleece characteristics over the body is sought as a prelude to determining the best sampling sites. If there is a regular pattern, sampling procedures can be simplified by the use of a fixed site or sites (Turner,1956). Earlier studies on variation in fleece characteristics over the body in sheep were reviewed by Turner (1956), with some more recent work (Beattie and Chapman, 1956; Sumner and Revfeim, 1973; Thornberry and Atkins, 1984). Few studies on the variation in fleece characteristics over the body of Angora goats have been published (Bigham, 1988; Gifford, 1989; Ulmek *et al.*, 1992). There is limited published work on the variation in fleece characteristics both between alpacas and, in particular, over the body of alpacas. Villarroel (1959) examined fibre length and diameter at six sites and Leyva (1979) studied variation in fibre diameter. The objectives of this study were to examine the variation in fleece characteristics over the body of alpacas and to determine an optimum sampling site for ranking animals on these characteristics.

MATERIALS AND METHODS

The 35 mature female alpacas sampled were part of a group imported from Chile to Flock House Agricultural Centre (40°14'S, 175°16'E, altitude 9m), Bulls, New Zealand in 1990. At Flock House average annual rainfall is 874 mm, with variation of 607 to 1067 mm/year; mean temperature is 17.4°C in mid-summer and 8.0°C in mid-winter. Alpacas were predominantly grazed on perennial ryegrass (Lolium spp.) and white clover (Trifolium repens) pasture, with some supplementation with hay in winter. Cria were born in either November/December or February/March and, because of an 11 month gestation period, females were generally at some stage of pregnancy over the entire year. At the annual shearing in October 1991, the 35 alpacas had an average liveweight of 65.3 ± 2.2 kg and clipped 1.91 ± 0.08 kg of fibre.

Prior to shearing, fibre samples approximately 10 cm x 10 cm were removed with Oster small animal clippers from the neck, shoulder, midside, mid-back and rump positions on each animal. Each sample was subsequently tested for yield, staple length, fibre diameter and proportions of medullated fibres. Yield of samples was determined by washing in a four bowl laboratory wool scour with samples conditioned to 65% humidity and 20°C

before weighing. Staple length was determined as the average length of 10 randomly measured staples. Fibre diameter and proportions of fibre types were measured on 400 fibres by projection microscope (ASTM, 1961). Fibres were classified as non-medullated, partially medullated, fully medullated or kemp fibres and the proportion of each type as a percentage of the total fibre number calculated (ASTM,1992). An overall mean for each animal was calculated as the average of the measurements at each site (Villarroel, 1959; Sumner and Revfeim, 1973; Bigham, 1988).

Data were analyzed using generalised least squares (SAS, 1987). The effects of individual site and animal effects were examined. Correlations between each site and the overall fleece mean were calculated. For each characteristic, Bartlett's test was used to test for homogeneity of variances between sampling sites (Snedecor and Cochran, 1980). The only trait for which variances were not homogeneous was kemp, where the variances were lower at the back and neck sites.

RESULTS AND DISCUSSION

Fibre characteristics at each site and the overall fleece mean are presented in Table 1. Table 2 gives the correlations between each site and the overall fleece mean.

Yield

Yield was significantly lower on the neck and back than at other sites and higher at the rump than midside position. However, yield at all sites was over 90% and variation is likely to be of little practical importance in processing. In sheep (Beattie and Chapman, 1956; Thornberry and Atkins, 1984) and in Angora goats (Gifford, 1989), yield declined from the neck to rump positions. Information on dorsal-ventral trends in wool yields are conflicting (Beattie and Chapman, 1956; Thornberry and Atkins, 1984).

Correlations between the yield at each site and the overall fleece mean were high for all sites, with the shoulder and midside positions having the highest correlations. Thornberry and Atkins (1984) also obtained high correlations (0.65 - 0.87) for 9 sites in Merino sheep.

TABLE 2: Correlations between each site and the overall mean for fibre characteristics on mature female alpacas.

Fibre characteristic	Body Site				
	Neck	Shoulder	Midside	Back	Rump
Yield	0.86	0.91	0.89	0.74	0.86
Staple length	0.76	0.91	0.93	0.92	0.85
Fibre diameter	0.91	0.95	0.96	0.95	0.89
Std dev. FD	0.66	0.90	0.92	0.84	0.91
Proportion of fibre types					
Non-medullated	0.90	0.97	0.95	0.90	0.93
Partially medullated	0.48	0.77	0.75	0.52	0.54
Fully medullated	0.77	0.83	0.92	0.78	0.80
Kemp	0.47	0.94	0.90	0.88	0.89

All r values significant for P<0.01 and n=35.

Staple length

Staple length varied significantly between all sites. Fibre on the neck (56 mm) was considerably shorter than at other sites (80 - 100 mm). Staple length increased from rump to shoulder and from back to midside. Villarroel (1959) found considerable variation in fibre length in staples taken at six sites in alpacas, but was unable to draw any useful conclusions about possible trends. Gecele and Glade (1985) found the longest fibres were on the shoulder and shortest fibres on the haunches for fibre traits from 9 vicunas. Similar posterior - anterior trends have been reported in sheep (Turner, 1956) and Angora goats (Gifford, 1989). Turner (1956) also noted some higher values on the midside line when considering dorsal - ventral changes but the pattern was not consistent.

As fibres become shorter than 75 - 100 mm adverse effects tend to arise in processing, yarns become weaker and more irregular and fibres are more likely to be shed from the yarn, causing pilling in clothing (Hunter, 1980). Separation of the neck fibre from the rest of the fleece would remove the shortest fibre, reduce variability in staple length and improve processing performance.

Correlation estimates between staple length at individual sites and the overall fleece mean were highest for the midside and almost as high for the shoulder and back positions. Villarroel (1959) reported all sites were well correlated with the average staple length, although one site, similar to the rump in this study, was less representative.

TABLE 1: Fibre characteristics at five sites and the overall mean on mature female alpacas.

Fibre characteristic	Body Site					Mean	Std error
	Neck	Shoulder	Midside	Back	Rump		
Yield (%)	91.1^{a}	94.0^{bc}	93.2^{b}	91.0^{a}	94.4^{c}	92.7	0.3
Staple length (mm)	56.7^{a}	99.6^{b}	92.8^{c}	86.4^{d}	81.9^{e}	83.5	1.1
Fibre diameter (μm)	33.7^{a}	34.1^{a}	33.5^{a}	31.1^{b}	34.1^{a}	33.3	0.4
Std dev. FD (μm)	6.3^{a}	8.4^{b}	7.7^{c}	6.5^{a}	8.1^{bc}	7.4	0.2
Proportion of fibre types (%)							
Non-medullated	16.8^{ac}	20.7^{a}	18.3^{a}	32.0^{b}	14.0^{c}	20.3	1.4
Partially medullated	35.9	34.0	34.4	37.6	32.0	34.8	2.3
Fully medullated	43.7^{a}	36.6^{b}	39.3^{ab}	26.4^{c}	45.1^{a}	38.2	2.3
Kemp	3.7^{a}	8.7^{b}	8.0^{b}	4.1^{a}	8.9^{b}	6.7	1.0

where a-e indicate significant differences between sites (P<0.05).

Fibre diameter

Fibre diameter was finest on the back and did not vary significantly between other sampling sites. Variability in fibre diameter (standard deviation) was significantly higher at the midside and rump than neck and back sites. The distribution of fibre diameter is of importance in determining wool quality, both for the appearance and comfort of the finished garment and for its performance during processing (Mayo *et al.*, 1994).

Von Bergen (1963) reported variation in fibre diameter over the body of alpacas to be small, with finer fibres generally grown on the back and sides of the animal and coarser fibres on the belly and britch. Leyva (1979) found little variation in fibre diameter from shoulder to rump but there was a dorsal - ventral trend with mean fibre diameter increasing from the back down the sides of huacayo and suri type alpacas. The midside area was finer than shoulder and rump areas, with neck and legs 7 - 10 microns coarser than midside areas.

The variation in fibre diameter over the body in alpacas differs to that over the body of sheep. With the exception of Indian sheep breeds, wool on the rump or thigh has been found to be coarser than on the shoulder (Turner, 1956). Sumner and Revfeim (1973) found posterior - anterior and ventral - dorsal trends in both fibre diameter and standard error of fibre diameter in New Zealand Romney sheep, with the midline coarsest and having the highest standard error. In Merinos, Olivier *et al.* (1993) found fibre diameter and fibre diameter variance increased from the anterior to the posterior position of the fleece, while fibre diameter of belly and midrib samples were generally lower than those of back samples and variance of fibre diameter decreased dorsoventrally. In Angora goats, Gifford (1989) found mean fibre diameter declined significantly from neck to breech positions, however Ulmek *et al.* (1992) found no differences between shoulder, mid-side and britch positions in Angora and crossbred goats.

In this study correlations between fibre diameter at each site and the overall fleece mean were high for all sites, with the midside site the most highly correlated. Villarroel (1950) also found high correlations between diameter at individual sites and the average. Sumner and Revfeim (1973) found correlation estimates between fibre diameter at each site and the overall fleece mean were highest at the shoulder and midside positions in sheep. In Angora goats (Bigham, 1988), correlations between individual sites and the overall fleece mean were high, 0.90 and greater, with the exception of the midbelly site.

Correlations for standard deviation of fibre diameter at each site to the overall fleece mean varied more than for fibre diameter, 0.66 for neck to 0.92 for midside.

Proportion of fibre types

The proportion of non-medullated fibres, as a percentage of total fibre number, averaged 20%. This varied between regions with the rump having significantly fewer and the back significantly more non-medullated fibres. There were no differences in the proportion of partially medullated fibres between the regions.

The back position had significantly lower proportions of fully medullated fibres and coarser, hairy fibres or kemp than other sites. The neck position had a high proportion of fully medullated fibres but few kemp fibres, while the rump position had a high proportion of fully medullated and kemp fibres.

Similar to results outlined in this paper, Gifford (1989) found no difference in Australian Angora goats between neck, midside and thigh with regard to proportions of mohair, partially medullated and continuously medullated fibres. However the neck contained significantly fewer kemp fibres than the other two positions. New Zealand Angora buck kids had higher medullation at the rump and britch point, while kemp was highest at the midback site (Bigham, 1988).

Von Bergen (1963) reported that the distribution of kemp over the body of alpaca seemed to be the principal cause of variation in fibre diameter. Villarroel (1959) found higher fibre diameter at the britch and kemp levels were also higher at this position. Russel (1994) reported a strong positive correlation ($r=0.81$) between the proportion of medullated fibres and mean fibre diameter in llamas. In this study fibre diameter was the finer at the back sampling site, which also had lower proportions of kemp and fully medullated fibres than other sites. The correlation between proportion of medullated fibres and mean fibre diameter in this study was also high ($r=0.73$).

Correlation of the proportion of non-medullated fibres between each site and the overall fleece mean was high. However for medullated fibres correlations between each site and the overall fleece mean were lower. Correlations between the midside site and overall fleece mean were high for all proportion of fibre type traits. In Angora goats, medullation at the rump and britch point sites were most highly correlated to overall fleece mean, while the midside and britch point sites were most highly correlated to the overall fleece mean for kemp (Bigham, 1988).

CONCLUSIONS

Variation between sites in yield was statistically significant, but yield at all sites was over 90%, so variation would be of little practical importance.

Fibres on the neck were considerably shorter than at other sites and below the desirable length required for processing in other fibre types. Separation of the neck fibre at shearing to decrease variation may be desirable.

Fibre diameter varied very little between sites, with the exception of the back site which was finer, indicating that uniformity of fibre diameter over the body is greater in alpacas than in sheep and goats. However there is considerable variation between alpacas in fibre diameter, with the overall fleece mean in this study ranging from 23.6 to 42.5 microns. Fibre diameter is generally accepted as the most important fibre characteristic in manufacturing and this is reflected in prices achieved by most fibres. If the heritability of fibre diameter is as high in alpacas as in sheep or goats then there is considerable scope for selection.

The shoulder and midside sites were well correlated to the overall fleece mean for all fibre characteristics. The accuracy of identification and ease of sampling of the midside site makes it the most suitable for routine sampling, as is the case in sheep and Angora goats.

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