DETERMINANTS OF HANDLE IN WHITE HUACAYA ALPACA FIBRE

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SUMMARY
A study was made of the fibre-based determinants of handle in samples derived from white Huacaya alpacas (n=136). Fibre diameter and fibre curvature provided the greatest discriminantory power between handle scores, the correlation between these traits and handle score being 0.72 and –0.30 respectively. However, the influence of fibre curvature was non-linear, with both extremes of handle having the lowest degree of curvature. Additional traits relating to evenness of the fibre surface were also implicated, but warrant further investigation.
Keywords: Alpaca, handle, fibre diameter, fibre curvature, crimp

INTRODUCTION
The Australian alpaca industry currently consists of at least 15,000 animals, with a pre-dominance of the Huacaya type (crimped staple) over the Suri type (ringlet staple) (Ponzoni *et al.* 1997). One of the most commonly promoted strengths of alpaca fibre is softness, an attribute that has become a high priority with consumers in relation to garment performance. The interaction between fibre diameter and fibre crimp has been shown to be the major determinant of the overall tactile response, or handle, associated with raw wool fibre (Stevens 1994). At the same diameter, low crimp wools ranked softer than high crimp wools, and at the same level of fibre crimp, low diameter wools ranked softer than those of high diameter. These raw wool traits were shown to translate into discernible and measurable differences in the performance of the fabric derived from these wools (Stevens 1994). In terms of genetic correlations, breeding for either reduced fibre diameter or crimp frequency is predicted to enhance the softness of the Merino fleece (Swan *et al.* 1997).

The commercial future of the Australian alpaca industry will require development of formalised breeding programs emphasising the fibre attributes most capable of meeting consumer demands. Recent surveys of Australian alpaca fibre (McGregor *et al.* 1997; Stapleton and Holt 1993) have shown a wide range in fibre diameter (<20 to >39 μm) and varying levels of crimp (crinkle) frequency and definition. A wide range in medullation (ranging from 0 % to >90 %) and high coefficient of variation of fibre diameter (ranging from 18 % to 39 %) in midside samples have also been reported. The objective of the present study was to examine the fibre-based determinants of handle in Huacaya alpaca fibre, given the emphasis on softness and the growing interest in crimp within the industry (Safley 1997).

MATERIALS AND METHODS
Fibre samples. Samples derived from white Huacaya alpacas only were used in this study. Some samples (n=39) were collected and submitted by breeders throughout Queensland, NSW and Victoria

while other samples (n=96) were collected directly from animals on properties throughout NSW and south west Queensland. All samples were at least 30g.

Handle assessment. Samples were assessed for handle in their original condition, ie. no washing or carding of samples or removal of vegetable matter prior to assessment. Assessment was based on a 5-point scoring system ranging from 1 (extremely soft) to 5 (extremely harsh), with inclusion of half scores. A single assessor was used in the study, this person being a lecturer in Sheep and Wool Production, and Alpaca Production, with the NSW Institute of Technical and Further Education. A set of reference samples was defined. Assessments of handle score were then conducted using a curtain to screen the samples from view, removing any influence of visual indicators of softness. All samples were assessed on two separate occasions, from which an estimate of 0.74 was derived for the repeatability of handle score. The distribution of handle scores arising from the second round of assessment was: score 1 (11), 1.5 (8), 2 (16), 2.5 (30), 3 (39), 3.5 (15) and 4^+ (16).

Fibre measurements. Each sample was mini-cored to produce 2mm fibre snippets. Snippets were cleaned using a hot detergent wash, dried and conditioned to 65 % RH and 20°C. An OFDA machine was then used to obtain all fibre measurements available with version 2.09 (Baxter 1998), based on 2,000 snippets. These were mean (MFD) and standard deviation (SDFD) of fibre diameter, mean (MFC) and standard deviation (SDFC) of fibre curvature, % of medullated fibres by number (MED %), volume (VOL %) and weight (WT %), mean (MEDDIAM) and standard deviation (SDMED) of medullated fibre diameter. The ratio of MEDDIAM to MFD (RATIO) and the difference between the two diameters (DIFF) were calculated. All along-snippet measurements were recorded, including the so-called "blob factors".

Statistical analysis. The STEPDISC procedure in SAS (1990) was used in a stepwise manner to obtain a subset of the fibre measurements best capable of discriminating between handle scores. Entry and removal of variables in the model was determined on the basis of significance of the F statistic and Wilks' lambda associated with each variable. Based on this subset of variables (Model 1), the DISCRIM procedure was then used to obtain the canonical variables summarising between-class variation as well as an evaluation of the performance of the discriminant functions based on error rates in classification. A model based only on MFD and MFC was also examined (Model 2).

RESULTS AND DISCUSSION

Table 1 summarises the descriptive statistics for handle score and some of the fibre measurements identified in Model 1. This model showed MFD and MFC as providing the greatest level of discrimination between handle scores ($P<0.001$), fibre diameter having the larger influence. The phenotypic correlations with handle score were 0.72 for MFD and –0.30 for MFC (Table 1). Additional traits identified related to the size and variability of blob factors ($P<0.007$), SDFC ($P<0.02$) and RATIO ($P<0.05$). Although the correlations between handle score and each of MED % and RATIO were moderately large (0.59 and –0.46 respectively), the influence of these medullation traits on handle score was markedly reduced after accounting for the effects of MFD.

For Model 1, the first canonical variable (CAN1) accounted for 73 % of between-class variation. This was strongly influenced by MFD (0.77), with negative loadings on all blob factors (small blob was largest, at -0.57) and RATIO (-0.36). The second canonical variable (CAN2) accounted for 15 % of between-class variation, being influenced mainly by MFC (0.59) and SDFC (0.53), a negative loading for MFD (-0.37) and moderate positive loadings on some blob factors (0.30-0.35). The third canonical variable (CAN3) accounted for 5 % of the between-class variation, with moderate negative loadings for blob factors (-0.27 to –0.51). Figure 1 summarises the mean canonical variables for each handle score. It indicates clear separation of scores 1 and 4 on the basis of CAN1 but not on CAN2, separation between scores 1.5 and 2 on the basis of CAN3, and great difficulty in separating scores 2.5, 3 and 3.5. The classification error rates were: score 1 (18 %), 1.5 (50 %), 2 (44 %), 2.5 (60 %), 3 (51 %), 3.5 (80 %) and 4 (19 %). For Model 2, CAN1 accounted for 89 % of between-class variation, reflecting a strong positive influence of MFD (0.95) and a negative influence of MFC (-0.34). For CAN2, the loadings were essentially reversed. The classification error rates were: score 1 (27 %), 1.5 (100 %), 2 (75 %), 2.5 (63 %), 3 (28 %), 3.5 (100 %) and 4 (24 %).

Table 1. Descriptive statistics for handle score and some of the fibre measurements identified in Model 1 (n=136), as well as MED%. Correlations with handle score (corr.) are also given

Trait	Mean	St. dev.	Minimum	Maximum	Corr.
Handle	2.70	0.84	1.0	4.5	-
MFD (μm)	26.9	5.5	17.2	41.9	0.72
MFC (deg. mm^{-1})	37.3	9.5	14.3	62.6	-0.30
RATIO	1.27	0.19	0.99	2.26	-0.46
MED%	24.7	21.2	0.8	91.8	0.59

If fibre curvature is assumed to be a measure of fibre crimp frequency in alpaca as appears to be the case for wool (Edmonds 1997), then these results indicate that fibre diameter and crimp do influence the handle of alpaca fibre. The softest samples were generally the finest samples (mean MFD=21.2 μm) while the harshest samples had the highest average diameter (mean MFD=35.8 μm). However, both extremes were characterised by low curvature (27-34 deg/mm), with the intermediate handle scores (and intermediate diameters) having the highest level of curvature (35-43 deg/mm). This suggests that the influence of curvature or crimp on alpaca handle may depend on fibre diameter, with finer diameters requiring less curvature and coarser diameters, more curvature, to improve overall handle. Thus the trends observed for wool handle may not be directly applicable to alpacas.

It is worth noting that the model based on diameter and curvature only was not as efficient in discriminating between scores compared to the model including along-snippet diameter variation and blob factors. While the validity of these parameters has not been documented, Baxter (1998) showed they increased the potential for discriminating between wool and mohair. It was postulated that the along-fibre variation component of the model might reflect differences in cuticle scale geometry between the two animal species. While the relationship between blob factors, scale height and fibre softness warrants further investigation, the influence of these traits is likely to be small relative to fibre diameter and fibre curvature.

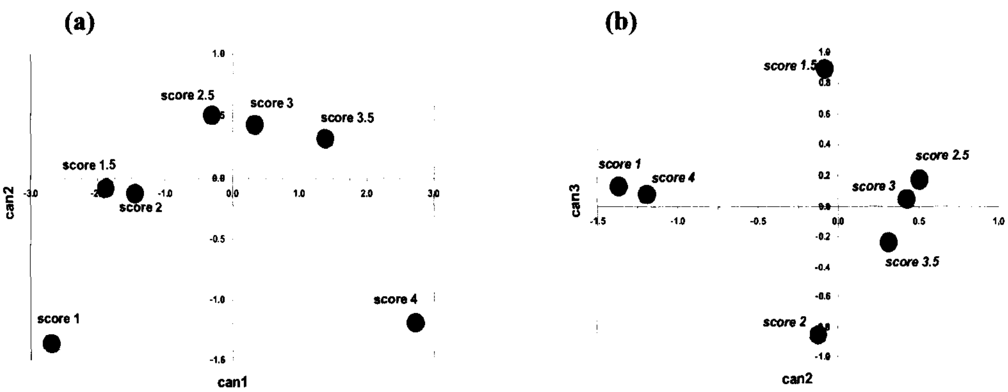

Figure 1. Means for canonical variables 1 (CAN1), 2 (CAN2) and 3 (CAN3) for each handle score, obtained under model 1. Figure 1(a) shows CAN1 vs CAN2, and figure 1(b) shows CAN2 vs CAN3.

These results indicate that at the phenotypic level, handle in raw alpaca fibre is partially a function of easily-measured fibre based traits, these being fibre diameter and fibre curvature. The genetic associations between handle and these traits should therefore be investigated to ensure that softness is accommodated within the breeding program. The one aspect that requires particular attention is the potential non-linear influence of curvature on handle, dependent on fibre diameter.

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