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Bulk and fibre diameter affect leather and woolskin quality of lamb skins

D.R. SCOBIE, S.M. COOPER[1], A. PASSMAN[1] AND S.R. YOUNG

AgResearch, PO Box 60. Lincoln, 8152, New Zealand.

ABSTRACT

Poll Dorset x Romney lambs were chosen from a group of 300 on the basis of measured diameter and bulk. The selected lambs made up four groups of twenty, that had the four possible combinations of low (LD) or high diameter (HD) (29 or 32 µm), and low (LB) or high bulk (HB) (22 or 26 cm^3/g). Pelts were recovered at slaughter, assessed for woolskin tanning, processed to dyed crust leather and scored for the grain surface defect known as pinhole (1 to 5, best to worst). Suitability for woolskins was greatest for the high bulk groups (LDHB, 20; HDHB, 18), and least for the HDLB group (5), with the LDLB group intermediate (13). More pelts were found to exhibit pinhole in the high bulk groups (HDHB, 16; LDHB, 16 vs HDLB, 8; LDLB,10) and mean pinhole scores were higher ($p < 0.001$) for these groups (HDHB, 2.5; LDHB, 2.4, vs LDLB, 1.7; HDLB, 1.5). Woolskins are a more appropriate product for finer and bulkier wool types, whereas less bulky wools of high diameter lend themselves to leather production, because they are unsuitable for woolskins and less prone to pinhole.

Keywords: pinhole; wool-on tanning; pelt; crust leather; terminal sire.

INTRODUCTION

Historical and current literature all promote New Zealand sheep as being a dual purpose breed that produces meat and wool. The pelt is a valuable part of the lamb, yet it receives little in the way of recognition. The authors believe that this "by-product mentality" has actually led to the unfortunate circumstances outlined below.

The average value of an 18 kg lamb in February 1997 was $36.49 (New Zealand Farmer magazine, 13/2/97). In the same magazine, the value of the woolly pelt from that lamb was $7.17 and only a two dollars less if shorn. Shorn lambswool was worth about $3.90 per clean kilogram, so lamb producers perceive a price incentive to shear their lambs. Given that shearing cuts are the most common defect which down grades New Zealand lamb pelts (Cooper, 1994), this incentive is misplaced. Price signals and feedback on pelts are a current area of interest in the industry, and a more complicated problem is investigated below.

The general hypothesis tested in the following experiment, was that wool characteristics affect the suitability of lamb skins for certain end-products. In this study, fibre diameter and loose wool bulk were the two characteristics under consideration. Fibre diameter was chosen because it is the primary determinant of wool value. Loose wool bulk was chosen because it is important for certain textile uses of wool, and it has therefore been of prominent interest to Wools of New Zealand (formerly the New Zealand Wool Board) and indeed ourselves and other research providers.

There are two main uses for lamb skins. They can be tanned with the wool on to make, among other things, rugs, car seat covers, clothing and footwear. In New Zealand, lamb skins are more commonly fellmongered to remove the wool, and processed to nappa leather for garment manufacture.

There is a small amount of scientific literature which explores the traits that constitute a good lambskin for the purposes of leather and woolskin manufacture. The cause of shearing scars in the example above is obvious. The solution is difficult for many environments in which lambs are raised, but not impossible in all. However, there are no known methods to deal with the fault called "pinhole". Pinhole consists of small holes in the grain surface of the dewooled pelt, said to be caused by the breakdown of the walls of adjacent follicles Caughley (1950).

Passman and Dalton (1982) found that 60% of Perendale, 10% of Coopworth and 0% of Romney lamb pelts in their study were affected by pinhole. In another study, Perendale, Coopworth and Romney lamb pelts were 60, 40 and 38% affected by pinhole respectively (Passman and Sumner, 1987). In 18 month old Cheviot, Drysdale and Romney wethers, 69, 50 and 31% of pelts exhibited pinhole respectively (Passman and Sumner, 1983). In order of decreasing percentage of pelts affected by pinhole, these breeds would grossly rank: Cheviot, Perendale, Drysdale, Coopworth and Romney.

Passman and Dalton (1982) suggested that the fine wool of the Perendales could have been the cause of the pinhole defect. In contrast to this suggestion though, the Cheviots had the greatest fibre diameter and were most affected by pinhole (Passman and Sumner, 1983). It was notable that in both sets of data presented by Passman and Sumner (1983, 1987), the breeds which were most affected by pinhole also ranked highest for loose wool bulk.

On the other hand, 50 % of Perendale lamb skins (Passman and Dalton, 1982) and 65% of Cheviot wether skins (Passman and Sumner, 1983), were assessed as suitable for woolskin processing. The Romney, Coopworth and Drysdale pelts were completely unsuitable (Passman

[1] NZ Leather and Shoe Research Association, Private Bag, Palmerston North, New Zealand.

and Dalton, 1982; Passman and Sumner, 1983). Passman and Sumner (1987) found that shearing at 10 weeks of age, could make Romney and Coopworth lambskins suitable for woolskins at 20 or 30 weeks of age, but Perendale lamb skins were universally more suitable for woolskins at these ages. They also graded the skins as suitable for rugs or clothing, and found that those with the highest loose wool bulk were most suitable for clothing, while those with moderate loose wool bulk were regarded as suitable for rugs. The lowest bulk corresponded with pelts regarded as suitable for fellmongering only.

Although terminal sires are used to produce around 15% of the lambs slaughtered in New Zealand, little is known about the suitability of the skins of their progeny for leather or woolskins. Since most of the terminal sire breeds have very bulky fleeces, there is the potential that the amount of pinhole in the crossbred lambs will increase relative to the purebreds discussed above. The shorter and bulkier wool may lend itself to woolskin tanning. The following experiment examined both these possibilities.

MATERIALS AND METHODS

Poll Dorset sired lambs (n = 300) from Romney dams were purchased at weaning and run together. A midside sample of wool (50 g) was harvested from all the animals when their average liveweight reached 34 kilograms. Mean fibre diameter was measured on each sample using the optically-based fibre diameter analyser (OFDA). Loose wool bulk was measured according to the method of Bigham *et al.* (1984).

When the lambs reached a mean liveweight of 37 kg, all were inspected by an experienced assessor of woolskins (Assessment A). They were graded for their suitability for tanning as babycare rugs.

Lambs were chosen from the original 300, to make up four groups of 20 based on measured fibre diameter and loose wool bulk. The groups consisted of the four possible combinations of low or high fibre diameter and low or high wool bulk (actual values are presented in Table 1).

The eighty lambs were slaughtered in random order and the pelts recovered and tagged for identification. A small punch sample was collected from each pelt for the determination of follicle density using the method of Nixon (1993). A second punch sample was collected to estimate follicle curvature using the method of Maddocks and Jackson (1988). The pelts were stack-salted before being transported to the Leather and Shoe Research Association, where they were assessed for wool-on tanning for general use (Assessment B). This assessment took into account wool fineness, cover and colour.

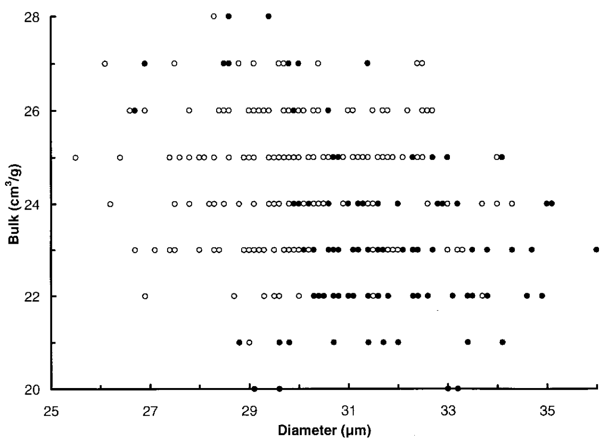
All of the pelts were then fellmongered and tanned to dyed crust leather, a chromium-tanned product at the stage immediately preceding finishing, which can be evaluated for suitability for all end uses. A panel of assessors evaluated the pelts for a number of traits. Only the results for pinhole will be discussed here. The extent of pinhole was scored from 1 to 5, where five indicates the worst affected class.

Analysis of variance was used to compare all traits with discrete or continuous variation. A chi squared analysis was used to compare woolskin suitability because this information was binomial. To produce comparable binomial data, pinhole score was also transformed by counting the total number of skins affected in each group (a score of 2 and greater), and a similar chi squared analysis was conducted.

RESULTS

The influence of fibre diameter and bulk on the suitability of the 300 Poll Dorset x Romney lambs for woolskin production (Assessment A) is shown in Figure 1. A sub-population of skins regarded as unsuitable by an experienced appraiser is evident in the low bulk and high diameter sector of the graph. The average bulk of those suitable for woolskins was 24.5 (± 1.3) cm^3/g and diameter 30.3 (± 1.8) µm. The skins regarded as unsuitable for woolskins were less bulky by 1 unit (23.3 ± 1.9 cm^3/g) and had 1.3 µm greater average fibre diameter (31.6 ± 1.9 µm). This is a simplification of the data, because the decision to reject a skin for woolskin tanning can be based on yellow discolouration of the wool, or the staple length of the wool (too long or too short, assessed visually and not measured or recorded). A less easily defined trait of the wool was "webby-fibre", where the fleece did not lay in clearly defined staples, which apparently leads to matting of the wool during tanning. For one of these reasons, 12 skins which had relatively high bulk, were considered to be unsuitable for woolskin tanning. This would have biased the average bulk of the unsuitable skins upwards.

FIGURE 1: Average fibre diameter and loose wool bulk of Poll Dorset x Romney lambs considered suitable (open circles) or unsuitable (closed circles) for tanning into woolskins.



Woolskin suitability of 61 of the 80 pelts sent to LASRA (Assessment B) were identical to the decisions made by the industry assessor on the live animal (Assessment A). Of the skins with conflicting decisions, 5 were unsuitable and 14 suitable according to Assessment B. The number of suitable skins according to each assessment is

TABLE 1: Fibre diameter, loose wool bulk, the number (out of 20) suitable for woolskin tanning, the number (out of 20) affected by pinhole, average pinhole score, average follicle density and average follicle curvature score (curvature score) of four groups of Poll Dorset x Romney lamb skins.

	Low diameter Low bulk	High diameter Low bulk	Low diameter High bulk	High diameter High bulk	LSD 5%
Diameter (μm)	29.2	32.5	29.0	32.5	0.45
Bulk (cm^3/g)	22.3	21.6	26.5	25.6	0.55
Woolskin suitability					
Assessment A[1]	14	2	16	15	-
Assessment B[2]	13	5	20	18	-
Pinhole					
Number affected	10	8	16	16	-
Mean score (1 to 5)	1.7	1.5	2.4	2.5	0.54
Follicle density ($\#/mm^2$)	27.0	22.2	24.3	21.8	2.29
Curvature score (1 to 7)	2.1	2.1	2.9	2.5	0.29

[1] An experienced assessor from G L Bowron and Co Ltd.
[2] An experienced assessor from the Leather and Shoe Research Association.

presented in Table 1. These results are very similar given the number of criteria that are all visually assessed and the fact that the two assessors had different products in mind.

Pelts from the high diameter low bulk group of lambs were the least suitable for woolskin tanning. Most of the pelts of the two high bulk groups were acceptable according to either assessor. A chi squared analysis revealed a significant effect of both bulk ($P < 0.001$) and diameter ($P < 0.01$), and a significant interaction ($P < 0.05$) between these two characteristics on the choice of pelts for woolskins by the assessor from G.L. Bowron (Assessment A). Pelts with high wool bulk ($P < 0.05$) and low diameter ($P < 0.001$) were also preferentially chosen in Assessment B, yet there was not a significant interaction in preference during this assessment. The low bulk groups were significantly less affected by pinhole ($P < 0.001$) but diameter had no effect on the incidence of pinhole and there was no interaction. So the group least suitable for woolskin production were least affected by pinhole.

Table 1 shows the mean diameter, loose wool bulk and the average pinhole score of the four groups of 20 lambs. Quite clearly there was little effect of diameter, but there was a significantly higher average pinhole score in the high bulk groups ($p < 0.001$). Follicle density estimates were greatest in the group with low bulk and low diameter ($p < 0.001$), and mean follicle curvature score was highest in the high bulk groups ($p < 0.001$).

DISCUSSION

This experiment shows that skins from lambs with bulkier wool tend to exhibit pinhole more frequently. This confirms the association between bulk and pinhole that was evident in the data presented by Passman and Dalton (1982) and Passman and Sumner (1983, 1987). Although there was a 3 μm difference in fibre diameter between high and low, it had no effect on pinhole in this crossbred. In work using other breeds and crossbreds, similar relationships have been found with a greater range of fibre diameter (D.R. Scobie, unpublished).

While the exact cause of pinhole is unknown, these data suggest a link between the curvature and entanglement of follicles within the skin. Follicle curvature is greater in down breeds (Maddocks and Jackson, 1988) and Perendales selected for loose wool bulk, than in coarse crossbreds and Perendales selected for decreased bulk (Sumner *et al.*, 1993). Although the average scores estimated for follicle curvature were significantly different, the follicles of the high bulk groups were not much more curved on average than the low bulk groups (2.7 vs 2.1 on a scale from 1 to 7). We propose that individual follicles with extreme curvature and entanglement, pull some of the collagen matrix out of the skin when the wool is removed at the fellmongery. In comparison, the relatively straight follicles associated with the less bulky wool type, could be removed from the skin much more easily.

Campbell *et al.* (1996) observed a large variation in pinhole scores of progeny within terminal sire breeds, and suggested that selection against pinhole could be possible. The information presented here suggests that loose wool bulk would be a suitable selection criterion. It is ironic that terminal sire breeds tend to have bulky wool, and perhaps there is an underlying genetic association between wool bulk and meat production which will defeat attempts to reduce pinhole by breeding.

In contrast to pinhole, the suitability of raw skins for woolskin tanning actually improves with bulk. This concurs with the results of Passman and Dalton (1982) and Passman and Sumner (1983, 1987). Diameter, and characteristics associated with diameter, also impact on the choice of raw skins for woolskin tanning because selection tends to be largely based on the Bradford Quality Number system. Although it has largely been replaced within the wool-trade, the Bradford Quality Number system was originally developed as a subjective indicator of fibre diameter, based on a positive association between crimp and diameter. High bulk wools are highly crimped, and tend to be assessed as finer than their measured diameter. Finer wools tend to be softer, and are generally associated with a higher density of follicles in the skin which impart softness and resilience to woolskins. Other traits which are also desirable for woolskin tanning, such as wool colour and length, can be adjusted by bleaching, dyeing and clipping during processing.

In practice, experienced woolskin assessors select raw skins for a combination of several wool characteristics. In the future we intend to expand this work to quantify the association between woolskin quality and objectively measured characteristics. However, it is unlikely that objective measurement will be able to replace the skilled observer in time taken, cost, or the need to produce skins that are not damaged by sampling.

CONCLUSIONS

A leather with pinhole is worth around 50 to 60% of that of a leather with no defect, whereas a good quality woolskin has an equivalent value to that of a good quality leather. Since increased bulk is associated with increased incidence of pinhole, it would make greater economic sense to tan the skins with bulky wool into woolskins, and fellmonger the remainder. A pre-slaughter decision support system to segregate the skin types would optimise the quality of both products. In the longer term, it should be possible to formulate breeding strategies which will produce lambs with pelts that are likely to produce better woolskins or better nappa leather.

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