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Development of fibre and follicle characteristics related to wool bulk in hoggets of genotypes used to develop GrowBulk sheep

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ABSTRACT

Wool fibre and follicle development was monitored in 40 hoggets born in 1996 comprising sex-balanced groups of Romney (R), Dorset x Romney (DR), Texel x Romney (TR) and DR x TR and TR x DR (DTR) sheep between 3 and 12 months of age. There was a significant curvilinear pattern of development for fibre curvature and follicle curvature for the DR, TR and DTR groups whereas values for the R group did not change significantly with time. Fibre diameter was not significantly different between the groups. A combination of fibre curvature and fibre diameter explained approximately 70% of the variation in core bulk within all genotypes at hogget shearing for samples taken at points in time during growth of the fleece. The combination of fibre curvature and fibre diameter is a useful predictor of adult wool bulk to assist breeders of GrowBulk sheep.

Keywords: wool bulk; development; fibre curvature; Romney; Dorset; Texel.

INTRODUCTION

Wool bulk, the ability of wool to resist compaction and fill a space, is an important characteristic associated with superior performance for many of the end-products that can be produced from Romcross type wool. The expression of wool bulk is strongly inherited and controlled by relatively few genes (Sumner *et al*., 1995; Wuliji *et al*. 1995). Consequently wool bulk is responsive to selective breeding procedures.

In an attempt to improve the bulkiness of the crossbred sector of the New Zealand clip, high wool bulk Poll Dorset and Texel rams, and high fleece weight Romney ewes were screened from within industry flocks throughout New Zealand. Subsequent crossing, in association with intense selection of the progeny, has resulted in development of the GrowBulk strain. GrowBulk sheep are a specialty breed producing high bulk wool with a minimal reduction in fleece weight.

In seeking to improve wool bulk farmers may wish to join hoggets and minimise the numbers of ram hoggets wintered, without compromising potential genetic gains for bulk. Both these practices necessitate being able to identify sheep at young ages that have the potential to produce high bulk wool as an adult. Within the Perendale breed, originally developed from crossing Cheviot and Romney sheep, many of the fibre and follicle characteristics related to bulk have been found to follow curvilinear development patterns which attain plateau values by 6 months of age (Dick and Sumner, 1996). To investigate whether fibre and follicle characteristics in the GrowBulk strain are likely to also attain plateau value by 6 months of age, each of the component genotypes used to develop the strain was evaluated separately.

This paper reports trends between 3 and 12 months of age in the development of fibre and follicle characteristics related to wool bulk for Romney, Dorset cross Romney, Texel cross Romney and (Dorset x Romney) cross (Texel x Romney) sheep.

MATERIALS AND METHODS

A total of 40 hoggets born in 1996 comprising sex balanced groups of Romney (R), Dorset x Romney (DR), Texel x Romney (TR), and interbred DR x TR (DTR) sheep were used. Of the 10 hoggets in the DTR group, five were generated from joining DR sires with TR ewes and five were generated from joining TR sires with DR ewes. The sheep were selected at random, within sire lines, from subflocks generated during development of the GrowBulk strain. Half the DTR group (DR x TR) and the TR group were born at Woodlands Research Station (near Invercargill) and moved to Whatawhata Research Centre (near Hamilton) at approximately 20 weeks of age. The other half of the DTR group (TR x DR) and the R and DR groups were born and reared at Whatawhata Research Centre. Each sex was grazed as a separate group from weaning/lamb shearing in December.

A sample of the lamb's fleece was clipped with Oster clippers and a snip skin biopsy sample taken from the midside region of both sexes of lambs at weaning (mean age of 14 weeks) immediately before they were shorn. Serial wool samples were similarly clipped and snip skin biopsy samples taken from the midside region of each lamb/hogget, adjacent to the initial sample, at mean ages of 27, 34, 40 and 48 weeks. The ewe hoggets were re-sampled at a mean age of 54 weeks. Each sex group was shorn immediately following the last sampling, individual fleeces were weighed and a midside sample of the "hogget" fleece was collected.

Wool measurements

Staple length and total number of crimps along the staple of each greasy fleece sample were measured and crimp frequency calculated. The samples were washed in water and detergent, and washing yield calculated. Core bulk (Standards Association of New Zealand, 1994), and mean fibre diameter, fibre diameter variation and mean fibre curvature (Edmunds, 1995) of cored sub-samples of the scoured fleece samples were measured.

A sub-sample of less than 2mm in length was trimmed by scissors from the base of each clipped serial wool sample and washed in water and detergent. Mean fibre diameter, fibre diameter variation and mean fibre curvature of the snippet were measured (Edmunds, 1995).

Skin measurements

The skin biopsies were fixed in 10% formalin. Longitudinal sections (2 mm) were cut from each skin sample, stained with 0.25% nile blue sulphate and graded for follicle curvature by two assessors on a scale of 1 (straight) to 7 (highly curved) (Dick and Sumner, 1995).

Statistical analysis

Individual measurements were analysed by least square regression analysis, fitting effects of sex and flock. Serial measurements were analysed for flock effects by Bayesian smoothing (Upsdell, 1994). The proportion of variation in core bulk explained by the measured characteristics was assessed by multiple regression using GENSTAT (Lawes Agricultural Trust, 1993). A straight line predicting core bulk was fitted to each characteristic individually. The one giving the least residual mean square was chosen as the initial equation. This was repeatedly modified in stepwise fashion by adding or deleting the next characteristic that resulted in the least residual mean square. The critical F-statistic for variate selection or deletion was set at F = 2.

RESULTS

As the two sexes were grazed in separate groups and shorn at different times the sex effects, while balanced, cannot be directly assessed. A sex effect was inserted into all analyses to reduce the error variance but in view of its confounding with grazing management will not be further discussed.

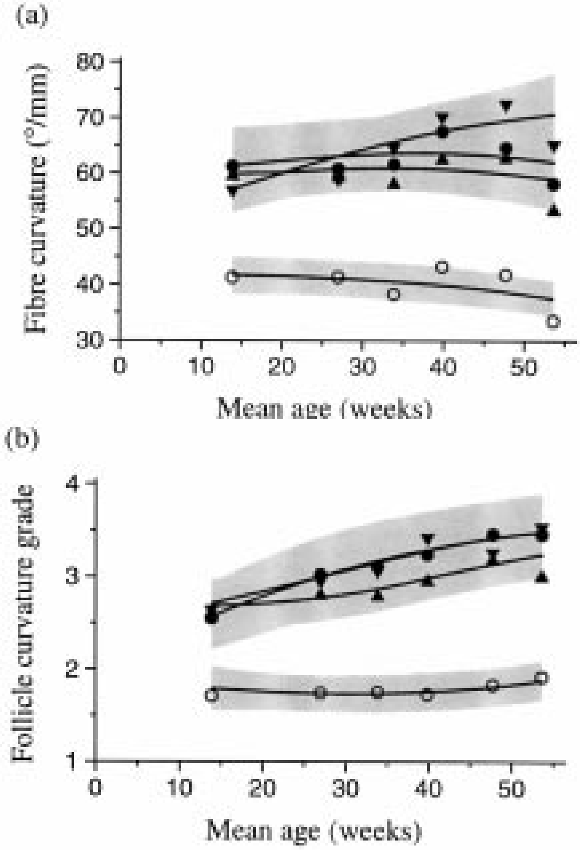
TABLE 1: Least square means of characteristics measured at hogget shearing. R = Romney; DR = Dorset x Romney; TR = Texel x Romney; DTR = DR x TR and TR x DR.

Characteristic	Breed				SED[1]	Significance
	R	DR	TR	DTR		
Number of sheep	10	10	10	10		
Clean fleece weight (kg)	2.52	1.96	2.09	1.86	0.18	***
Core bulk(cm^3/g)	23.8	30.9	31.2	30.4	0.9	***
Staple length (mm)	123	90	96	101	6	***
Staple crimp frequency (crimps/cm)	1.6	2.3	2.4	2.7	0.2	***
Mean fibre diameter (µm)	32.7	33.7	33.4	33.1	1.0	NS
SD fibre diameter (µm)	6.7	7.6	8.2	6.6	0.4	**
Fibre curvature (°/mm)	53.3	69.7	69.4	69.7	4.3	***

[1] Standard error of difference.

Least square means for the characteristics measured at hogget shearing are given in Table 1. The R fleeces were significantly heavier, less bulky, longer, had a lower crimp frequency and a lower fibre curvature than the other three breed types which were not significantly different from each other. Fibre diameter variation within the DR and TR groups was significantly greater than within the DTR and R groups. Mean fibre diameter did not differ significantly between any of the breed groups.

FIGURE 1: Mean values for (a) fibre curvature and (b) follicle curvature grade, over time. Plotted lines are significantly different at 5% level where shaded areas do not overlap. ❍ = Romney (R); ▲ = Dorset cross (DR); ▼ = Texel cross (TR); ● = DR x TR (DTR).



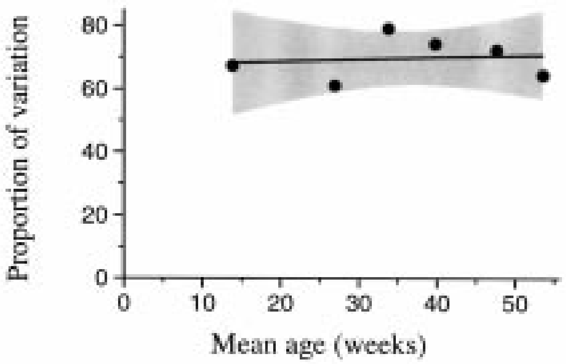
Both fibre curvature and follicle curvature showed a curvilinear pattern of development for the DR, TR and DTR groups (Figure 1) approaching a plateau value over the sampling period while the pattern for the R group did not differ significantly from linearity and the slope was not significantly different from zero. Although both mean fibre diameter and fibre diameter variation also showed a curvilinear response over the sampling period, there was no significant difference between genotypes. Both parameters decreased after December (approximately 12 weeks of age) until April (approximately 30 weeks of age), before increasing until shearing in the spring in line with seasonal trends in pasture availability and associated changes in pasture quality.

A breed effect term was included when deriving the initial estimates of the proportion of variation in core bulk explained by individual fleece characteristics. The effect was consistently not significant indicating a similar relationship for each genotype and was deleted from subsequent analyses. The relative proportion of the variation in core bulk explained by individual fleece characteristics is given, in decreasing order, in Table 2 along with the residual mean square. The proportion of variation explained by combinations of characteristics was also estimated. Most variation was explained by a combination of mean fibre curvature and mean fibre diameter (71.5%).

TABLE 2: Proportion of variation in core bulk explained by individual fibre characteristics and the combination of fibre curvature and mean fibre diameter, measured at hogget shearing. Mean residual standard deviation for core bulk remaining is included.

Characteristic	Proportion of variation explained (%)	Residual standard deviation (cm^3/g)
Crimp frequency	62.5	1.8
Fibre curvature	59.3	1.9
Staple length	39.7	2.3
SD fibre diameter	9.8	2.8
Mean fibre diameter	0.4	2.9
Fibre curvature + mean fibre diameter	71.5	1.6

FIGURE 2: Proportion of variation in core bulk at hogget shearing explained by the combination of fibre curvature and mean fibre diameter. The characteristics were measured at the base of staples clipped from the midside region at each sampling time. The shaded area covers the 95% confidence interval for the line.



To evaluate the effectiveness of fibre curvature and fibre diameter as early indicators of wool bulk, the proportion of core bulk at hogget shearing explained by a combination of the two measured characteristics was calculated at points in time during growth of the hogget fleece. Measurements of fibre curvature and fibre diameter for the serial wool samples were used. Derived estimates are plotted against the sheep's age at sampling in Figure 2. The slope of the relationship does not differ significantly from zero, with 70% of the variation of core bulk in the hogget fleece being explained by a combination of mean fibre curvature and mean fibre diameter regardless of the time of sampling.

DISCUSSION

Previous studies on the interrelationships between fibre and follicle characteristics, and wool bulk have been undertaken using sheep of one breed, the Perendale, selected for or against wool bulk (Sumner *et al*., 1993; Dick and Sumner, 1996). These trials using the Perendale were established to compare physiological differences in aspects of wool growth between groups of sheep that were genetically similar in all aspects other than wool bulk. The study reported here is the first known to the author where the development of fibre and follicle characteristics related to bulk, have been compared across different genotypes.

The results reported here are very similar to the Perendale data of Sumner *et al*., (1993) and Dick and Sumner (1996). In making these comparisions it should be borne in mind however, that the fleece structure of Cheviot, Dorset and Texel sheep, the breeds crossed with the Romney to generate the Perendale and the crosses evaluated in this study, is similar. The higher bulk wools consistently had a lighter clean fleece weight, a shorter staple length, higher crimp frequency and a higher fibre curvature with similar mean fibre diameter. Fibre diameter variation may be affected by genotype in that the DR and TR genotypes were more variable than the R and DTR groups, however the group sizes were small and may not reflect a true genotypic difference. In contrast fibre diameter standard deviation did not differ significantly between the high and low bulk Perendale lines (Dick and Sumner, 1996).

The pattern of development of fibre and follicle characteristics related to bulk was also similar between the measured genotypes and Perendales (Dick and Sumner, 1996). Development within the three genotypes (mean bulk 30.9 ± 2.0 cm^3/g) generated from sires screened for high wool bulk was similar to that in Perendales selected for increased wool bulk (31.5 ± 1.8 cm^3/g). Similarly the R genotype, a breed growing low bulk wool (23.8 ± 1.5 cm^3/g), was similar to Perendale sheep selected for decreased wool bulk (23.6 ± 0.9 cm^3/g).

Mean fibre curvature, mean fibre diameter and fibre diameter standard deviation are objective measurements that can be obtained concurrently with one pass of a sample through an OFDA more cheaply than measuring core bulk. In earlier studies (Edmunds and Sumner, 1996), the inclusion of fibre diameter variation had a marginal effect on the prediction of core bulk, whereas here it did not improve the accuracy of prediction of core bulk. In this study mean fibre curvature and mean fibre diameter consistently explained approximately 70% of the variation in core bulk of the hogget fleece, regardless of when the sample was taken from the fleece between 14 weeks and 12 months of age. The measurements of fibre diameter and curvature were not confounded by the time of lamb shearing and both measurements were carried out on the same sample. These measurements thus have the potential to be a practical indicator for the prediction of adult wool bulk for on-farm use in GrowBulk sheep. Samples can be taken as early as 4 months of age without reducing their predictive accuracy. The snippets of wool submitted for measurement should be taken close to the skin so the most recently grown wool is measured. Sumner and Dick (1997) have reported values for the correlation coefficients between core bulk at hogget shearing and subsequent shearings to gradually reduce from 0.87 at 2 years of age to 0.72 at 5 years of age. Currently there are insufficient GrowBulk sheep to monitor age effects within this genotype. Nevertheless the magnitude of the coefficients, and the similarity of the trends reported here relative to those of the Perendale, suggest that the combined measures of fibre curvature and fibre diameter in GrowBulk hogget fleeces will be a useful parameter to assist breeders of GrowBulk sheep in their selection decisions. The findings may also be applicable to other genotypes being selected for increased wool bulk.

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REFERENCES

Dick, J.L. and Sumner, R.M.W. 1995. The relationship between cortical structure and fibre diameter in primary and secondary wool fibres of yearling Perendale sheep. *Proceedings of the New Zealand Society of Animal Production* **55:** 31-43.

Dick, J.L. and Sumner, R.M.W. 1996. Development of fibre and follicle characteristics related to wool bulk in Perendale sheep over the first year of life. *Proceedings of the New Zealand Society of Animal Production* **56:** 314-318.

Edmunds, A.R. 1995. OFDA measurement of additional fibre parameters; some preliminary results. International Wool Textile Organisation Technical Committee. Report Number 19, June 1995.

Edmunds, A.R. and Sumner, R.M.W. 1996. Further data on the use of OFDA for estimating raw wool core bulk. International Wool Textile Organisation Technical Committee. Report Number 7, December 1996.

Standards Association of New Zealand 1994. Measurement of the bulk of raw wool. NZS 8716: 1994.

Sumner, R.M.W., Clarke, J.N., and Cullen, N.G. 1995. Responses to selection for and against loose wool bulk and the associated effect on clean fleece weight and objective fleece characteristics in yearling Perendale and Cheviot sheep. *Proceedings 9th International Wool Textile Research Conference*, Biella, Italy. **IV:** 3-10.

Sumner, R.M.W. and Dick, J.L. 1997. Changes in fibre and follicle characteristics related to wool bulk during the lifetime of Perendale sheep. *Proceedings of the New Zealand Society of Animal Production* **57:** 65-69.

Sumner, R.M.W., Stobart, R.H. and Johnson, D.L. 1993. Relationships between loose wool bulk and follicle and fibre characteristics in yearling Perendale sheep. *Proceedings of the New Zealand Society of Animal Production* **53:** 307-310.

Upsdell, M.P. 1994. Bayesian smoothers as an extension of nonlinear regression. *The New Zealand Statistician* **29(2):** 66-81.

Wuliji, T., Montgomery, G.M., Dodds, K.G., Andrews, R.N., Beattie, A.E., Turner, P.R. and Rogers, J. 1995. Establishing a flock for gene mapping in wool traits. *Proceedings of the New Zealand Society of Animal Production* **55:** 285-288.