
VOLUME 62 2002

The assessment of natural means of controlling loose wool feltability and yarn shrinkage

P.R. KENYON, G.A. WICKHAM AND H.T. BLAIR

Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Palmerston North, New Zealand.

ABSTRACT

Midside wool samples from Romney and 3/4Romney 1/4Merino cross (1/4M) hoggets were tested for loose wool feltability. Romney samples were also hand spun and yarn shrinkage measured. Sire progeny groups accounted for 6.5% of the variation among samples in loose wool felting ($P<0.10$) and 12% in yarn shrinkage ($P<0.05$). Fibre traits most highly correlated with feltball diameter were loose wool bulk ($r = 0.65$ for Romneys and 0.73 for 1/4M), crimp frequency ($r= 0.53$ and 0.41 respectively) and lustre (-0.30 and -0.40 respectively). Loose wool bulk ($r= -0.25$) and greasy fleece weight ($r=-0.40$) were most correlated to yarn shrinkage. These results suggest that low-shrinkage wools could be produced by selecting rams on shrinkage of yarn. Loose wool feltability might also be changed by direct or indirect selection.

Keywords: Wool; felting; yarn shrinkage; wool characteristics; sheep selection.

INTRODUCTION

Consumer surveys indicate that many clothing buyers are turned away from wool-based articles by the perception that they need special care in laundering if garment shrinkage is to be avoided. Chemical shrink-proofing techniques have been developed but these have adverse side effects on the properties of wool. Shrinkage is generally undesirable in the textile industry. It is mainly a consequence of felting, a process which is shown to a greater extent by wool than other fibres (including most other animal fibres). Felting is not always undesirable. The process is used on loose wool and woven fabrics to induce the formation of a dense, more compact and often warmer structure. The aim of this study was to determine if a natural means of controlling loose wool felting and yarn shrinkage could be found.

MATERIALS AND METHODS

Sample source

Mid-side samples were available from the fleece of each of 87 Romney hoggets. These hoggets came from eight sire groups, four each within fleece weight selected and control sub-flocks (Blair *et al.*,1985). Samples from 100 1/4 Merino 3/4 Romney (1/4M) hoggets, progeny of two sires were also available. The Romney and the 1/4M data were analysed separately

Wool assessment

Greasy fleece weight (GFW) was recorded at shearing. Midside samples were assessed for total number of crimps, crimp frequency, staple length, colour (Y-Z), loose wool bulk and fibre diameter. Lustre and cotting were assessed on a scale of 1 to 9 (Sumner 1969). The production of feltballs from loose wool is the accepted method for measuring loose wool feltability (Chaudri and Whiteley 1970a; 1970b). Diameters of three feltballs, produced using a tumble-drier technique (Kenyon and Wickham 1998) were measured for each sheep. A low feltball diameter is indicative of high loose wool feltability. Hand-spun yarns were produced from each of 67 Romney samples (chosen randomly from the original 87 samples) and their shrinkage in a tumble dryer assessed. This involved placing a short length of wet yarn inside a 75ml plastic container, with one end of the yarn being attached to the container. The containers (ten per run) were then placed inside the tumble drier for twenty minutes. Percentage of yarn shrinkage was calculated (Kenyon *et al.*, 1998). A mean shrinkage for each wool sample was determined from three sub-samples.

RESULTS

Feltball diameters

The Romney wool produced feltballs with a mean diameter of 25.33mm and a standard deviation of 0.85mm. The sample (sheep) effect was highly significant ($P=0.001$). Over the three sub-samples 80% of variance in feltball diameter was due to between sample (sheep) differences. The differences between the progeny of the different rams within this flock contributed 6.5% of the variance ($P=0.09$) but the sub-flocks did not differ. The 1/4M feltballs had a mean diameter of 24.84mm and a standard deviation of 1.04mm. The associations between feltball diameter and wool traits for both Romney and 1/4M samples is shown in table I.

Yarn shrinkage of Romney wool

Average length shrinkage of the yarns was 26.8% with a standard deviation 9.4%. Individual sheep showed highly significant differences in shrinkage ($P=0.001$), accounting for 71% of the variance in yarn shrinkage. The sire effect was found to be significant ($P=0.04$) after the data was adjusted for spinner effects and accounted for 12% of the overall variance. Yarn shrinkage was found to be significantly negatively correlated to feltball diameter ($P<0.01$).

The associations between yarn shrinkage and wool traits for Romney wool samples is shown in table I.

TABLE I: Correlations between feltball diameters, yarn shrinkage and fibre characteristics

Character	Feltball diameter Romney	Feltball diameter 1/4M	Shrinkage Romney
Feltball diameter	———	———	-0.65 **
Bulk	0.65 **	0.73 **	-0.25 *
Micron	- 0.09	0.20 *	-0.17
Lustre	- 0.30 **	-0.40 **	-0.03
Cotting	0.08	0.16	0.16
Staple length	- 0.21 *	- 0.41 **	-0.08
Total no of Crimps	0.52 **	0.25 *	-0.26 *
Crimp frequency	0.53 **	0.41 **	-0.16
Greasy fleece weight	0.06	0.10	-0.40 **
Y-Z	- 0.10	0.20 *	0.15

Sample sizes; Romney 87, 1/4M 100., Yarn shrinkage 67.
* $P < 0.05$; ** $P < 0.01$.

DISCUSSION

The overall variance accounted for by sample variance for feltball diameter and yarn shrinkage (80 and 71% respectively) included between-sheep genetic effects and effects of some environmental differences. Between-sire effects account for only one quarter of the between-sheep genetic differences. Sheep numbers were not sufficient to allow an accurate measure of the genetic effect, but these results indicate, that genetically controlled differences in the wool play a role in yarn shrinkage and loose wool feltability. The between-sire component of variance suggests a medium heritability of yarn shrinkage.

If direct selection was to be used to decrease yarn shrinkage, it should be based on ram hogget data to minimise the generation interval and to maximise the genetic gain. Assuming that yarn shrinkage has a heritability of 0.4 then selection based on the top 1% of ram hoggets with a generation interval of three years, could result in a 50% reduction in the level of yarn shrinkage within 9 years. It is however unlikely, that a sheep breeder would select animals solely on this trait. A more acceptable strategy may be for a breeder to select the top 20% of sires based on other traits first and then from these select the top 2% on yarn shrinkage data. This method while not as effective as sole selection, could result in a 50% reduction in yarn shrinkage within 25 years (assuming there are no genetic correlation's with other traits used in selection). Selection for high loose wool bulk or total number of crimps might decrease yarn shrinkage but progress is likely to be far slower. The phenotypic correlation's of these two fibre traits with yarn shrinkage while significant are in the low to medium range, the genetic correlation's are unknown.

Feltball diameter is an inverse measure of loose wool feltability. The sire effect on feltball diameter is not as significant (P=0.09) as in yarn shrinkage. Loose wool bulk, total crimp number and crimp frequency were the fibre traits found to be most highly correlated (positively) with feltball diameter for both genotypes. This is in agreement with previous authors (Chaudri and Whiteley 1970a; 1970b). These fibre traits are the space occupying properties of wool. High bulk causes fibres to be further apart in a random assembly reducing contact and fibre inter-lockage and therefore loose wool felting. Lustre was negatively correlated with feltball diameter, in agreement with Short (1958). Lustrous fibres tend to be straighter making it easier for a single fibre to move through a fibre assembly. Staple length was negatively correlated with feltball diameter, which is in agreement with Snooke *et al.,* (1950), however Chaudri and Whiteley (1970a) found no relationship. Fibre diameter was found to be significant in feltball diameter for the 1/4Ms but not for the Romney samples. Snooke *et al.,* (1950) and Chaudri and Whiteley (1970a) also found contradicting results. If the genetic correlation's are in line with the phenotypic correlation's found, then selection for either loose wool bulk, total crimp, crimp frequency or lustre, or a combination of these could result in a change in loose wool feltability. The heritabilities of loose wool bulk, total crimp number, crimp frequency and lustre are 0.5, 0.5, 0.4 and 0.3 respectively (Newman 1988, Sumner *et al.,* 1989).

Greasy fleece weight was significantly negatively correlated to yarn shrinkage. Since there was no difference between samples from the fleece weight selection sub-flock and the controls, the correlation with greasy fleece weight is thought to be environmental in origin. The loss in degree of significance for loose wool bulk, total number of crimps and crimp frequency in relation to yarn shrinkage when compared to loose wool feltability is most likely due to wool losing it's ability to occupy space during spinning. Indirect selection based on either loose wool bulk or total number of crimps could be affected by this occurrence.

CONCLUSION

The significant sire effects found for yarn shrinkage indicate that direct selection would induce changes within a flock. If genetic correlation's are similar to the phenotypic correlations, then indirect selection could be used as a means of reducing yarn shrinkage and changing loose wool feltability. It is likely that indirect selection is far less effective than direct selection. It is possible that loose wool feltability could be changed by direct selection. The associated costs of testing samples for direct or indirect selection may outweigh any financial benefit incurred. The current trend in the wool industry of reducing fibre diameter and lustre while increasing loose wool bulk should result in a reduction in the level of yarn shrinkage.

ACKNOWLEDGEMENTS

The authors are indebted to Wools of New Zealand for financial assistance and to the Wool Research Organisation of New Zealand (WRONZ). They also wish to thank Julie Everett-Hincks for her measurement of loose wool characteristics and both Tracy White and Maria Michael for hand spinning.

REFERENCES

Blair, H.T.; Garrick, D.J.; Rae, A.L.; Wickham, G.A., 1985. Selection response in New Zealand Romney sheep 2. Selection for yearling greasy fleece weight. *New Zealand journal of agricultural research* **28:** 257-264.

Chaudri, M.A.; Whiteley, K.J.; 1970a. The influences of natural variations in fibre properties on the felting characteristics of loose wool, *Textile research journal* **40:** 297-303.

Chaudri, M.A.; Whiteley, K.J., 1970b. The relationship between loose wool felting and bulk compressional properties, *Textile research journal* **40:** 775-779,

Kenyon, P.R.; Wickham, G.A. 1998a. A new technique for measuring loose wool feltability. *Journal of the textile institute* (in press).

Kenyon, P.R.; Wickham, G.A.; Blair, H.T. 1998. Natural variation in felting and yarn shrinkage in wool from Romney and Romney cross sheep. *Journal of the textile institute* (in press).

Newman, S. A. 1988. Genetic and environmental variation and genotype x environment interactions in New Zealand Romney sheep. PhD. thesis, Massey University, New Zealand.

Short, B. F. 1958. A dominant felting lustre mutant fleece type in Australian merino sheep, *Nature* **181:** 1414-1415.

Snooke, A.; Bogaty, H.; Harris, M. 1950. Some felting properties of wools of different geographical origin, *Textile research journal* **20:** 637-642.

Sumner, R. M. W. 1969. A comparative study of the effects of two stocking levels on wool follicle development and wool production of the New Zealand Romney sheep, M.Agr.Sc. thesis, Massey University, New Zealand.

Sumner, R. M. W.; Clarke, J. N.; Johnson, D. L. 1989. Inheritance of loose wool bulk, *Proceedings of the New Zealand society of animal production* **49:** 297 - 301.