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FELTBALL DIAMETER MEASUREMENT LACKS REPEATABILITY OVER THE LIFESPAN OF A MERINO EWE

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SUMMARY
Felting is the action of permanent shrinkage in fabrics and is a problem for the wool industry. Feltball diameter (FBD) is a measurement that offers the potential of selecting sheep on the basis of their felting shrinkage potential. This study examines repeatability of measuring feltball diameter throughout the lifespan of breeding Merino ewes. Feltball diameters were determined on wool of ewes at hogget age and then at the age of 2, 3 or 4 years. The correlation between adult FBD and hogget FBD is weak (r_p=0.14) indicating that the measurement is probably not repeatable over the lifespan of a ewe. Fibre curvature and diameter are the two significant characteristics in explaining FBD at adult age. The best linear regression of these parameters explains only 20% of variation in FBD at adult age.
Keywords: wool, Merino, repeatability, feltball diameter

INTRODUCTION
Felting is the action of permanent shrinkage in fabrics and is a major issue for the wool industry as wool is prone to felt when wet and agitated. The wool industry currently addresses this problem by using chemical treatments to 'shrink-proof' wool fabrics. As the wool industry is being pressured to reduce production and environmental costs to remain viable, alternative options to 'shrink-proof' wool are being explored. One option is to breed sheep that grow wool that is naturally resistant to felting shrinkage.

Feltball diameter (FBD) is a measurement performed on loose wool to determine the degree of felting (Kenyon and Wickham 1999). Past studies have examined the genetic variation within flocks for FBD and the heritability of the trait. Greeff and Schlink (2002) determined that FBD at hogget age was a heritable trait in Merino sheep, indicating that genetic differences exist between animals, hence it would be possible to select for reduced felting using FBD.

However, repeatability of the FBD measurement across ages has not been examined. Thus, it is not known if there is value in taking only one measurement at hogget age or if several measurements are required over the lifespan of a sheep. Hence, this study examines how repeatable the FBD measurement is throughout the lifespan of a breeding Merino ewe.

MATERIALS AND METHODS
This study was carried out on the Merino Resource flocks of the Department of Agriculture of Western Australia at Katanning. Ewes born in the years 1999, 2000, and 2001 were used in the study. All ewes were reared under normal commercial conditions. The ewes were shorn soon after weaning and again at 15 months of age with 12 months wool growth, and then annually. Mid-side wool samples were collected at hogget age and from the 2003 shearing when ewes were either 2, 3 or 4 years of age. All standard fleece measurements including fibre diameter, coefficient of variation of fibre diameter (CV of

fibre diameter), clean fleece weight, staple strength, staple length and fibre curvature were carried out on the samples, as well as FBD measurements (Kenyon and Wickham 1999).

GenStat (Payne *et al.* 2003) was used to calculate phenotypic correlations of the FBD measurement at hogget age with each age group of adult ewe. An overall phenotypic correlation was calculated by adjusting for age effects in the model. Linear regressions on these groups were also performed to determine basic traits at hogget age that contributed to expression of adult FBD at ages 2-4 years. The linear regression was performed using an All Subsets Linear Regression allowing all combinations of traits and variances explained to be examined.

RESULTS

The phenotypic correlation between hogget FBD and FBD at 2, 3 and 4 years of age varied from 0.15 to 0.45 (Table 1). When all age groups are combined the overall phenotypic correlation is weak but significant (r=0.14). Fibre curvature has moderate phenotypic correlations with adult FBD ranging from 0.31 to 0.48 and overall the all aged phenotypic correlation was 0.37. Fibre diameter correlated poorly with FBD and ranged from 0.08 to 0.24, with an overall weak but significant phenotypic correlation of 0.15 across group of all ages.

Table 1 Phenotypic correlations of adult FBD (mm) with hogget FBD (mm), fibre curvature (deg/mm) and fibre diameter (µm) presented at different adult ages and all ages grouped together

			Hogget	
Age	Number of ewes	FBD	Fibre curvature	Fibre Diameter
2	458	0.45**	0.31**	0.24**
3	303	0.15*	0.36**	0.15*
4	186	0.26**	0.48**	0.08
All aged	947	0.14**	0.37**	0.15**

**Phenotypic correlation is significantly different from zero at P<0.01

* Phenotypic correlation is significantly different from zero at P<0.05

Fibre curvature, fibre diameter, CV of fibre diameter and clean fleece weight at hogget age significantly affected FBD of ewes, but only fibre curvature and fibre diameter significantly affected FBD at 2, 3 and 4 years of age. CV of fibre diameter was only important in ewes aged 4 years while clean fleece weight was important in ewes aged 2 years. CV of fibre diameter, clean fleece weight and staple length are all important in predicting adult FBD for all aged ewes. These variables explain between 17 and 30% of the variation of adult FBD, leaving a very large proportion of the variation in FBD unexplained.

Table 2 Probability of significance (P-value) of the linear regression variables used to predict adult FBD for different age groups, and adjusted and unadjusted values across ages

	Age			All aged [1]	All aged [2]
Hogget Trait	2	3	4	Adjusted	Not adjusted
Fibre curvature (deg/mm)	0.000	0.000	0.000	0.000	0.000
Fibre diameter (μm)	0.000	0.000	0.005	0.000	0.000
CV of fibre diameter (%)			0.002	0.000	0.000
Clean fleece weight (Kg)	0.000			0.001	0.000
Staple length (mm)				0.012	0.000
Staple strength (N/ktex)					
Adjusted R^2 (%)	17.61	18.93	29.93	20.34	20.09

All traits with no value are not significant at P<0.05
[1]Regression adjusted for birth year across age groups.
[2]Regression not adjusted for birth year across age groups.

DISCUSSION

The phenotypic correlation between adult FBD and hogget FBD is very weak (r_p=0.14) indicating that FBD is probably not repeatable between ages 2-4 years of a ewes life.

The phenotypic correlation between adult FBD and fibre curvature (r_p=0.37) agrees with previous phenotypic correlations between hogget fibre curvature and FBD of 0.39 (Greeff and Schlink 2002) and 0.43 (Schlink *et al.* 2004). The phenotypic correlation between adult FBD and fibre diameter (0.15) is lower than previous studies with hogget wools of 0.32 (Schlink *et al.* 2004) and 0.26 (Greeff and Schlink 2002). Kenyon *et al.* (1999) did not find a significant phenotypic correlation between FBD and fibre diameter, however, their study was based on Romney sheep with a mean fibre diameter of 34μm compared to the 19μm of the Merino flocks examined in this study and Greeff and Schlink's (2002) study.

Fibre curvature and fibre diameter are significant traits that explain some of the variation in FBD across all linear regressions of different age groups. This is an expected outcome as numerous studies have come to similar conclusions (Scheepers and Slinger 1968; Chaudri and Whiteley 1970; Hunter *et al.* 1981; Greeff and Schlink 2002; Schlink *et al.* 2002; Schlink *et al.* 2004). However, feltball dimeter is obviously a complex measure as other traits vary in significance between years with clean fleece weight being significant in 2 year old ewes, CV of fibre diameter being significant in 4 year old ewes and in the ewes of differing ages the significance of the traits of CV of fibre diameter, clean fleece weight and staple length varied in importance. With all the significant traits accounted for in the FBD regression, only 17 to 30% of variation was explained, leaving a large proportion of the variation in FBD unexplained.

CONCLUSION

Repeatability of the FBD measurement does not indicate a strong phenotypic correlation between hogget age and older ages. However, more work is required to determine the genetic correlation before conclusions can be made as to the merit of selecting on hogget FBD to improve adult FBD.

The regression results indicate that FBD is a complex trait and importance of the components changed over years. In addition, a large proportion of variation is unexplained and more research is required to elucidate this trait and to link FBD with shrinkage of fabrics.

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REFERENCES
Chaudri, MA and Whiteley, KJ (1970). *Textile Research Journal* **40**(4): 297.
Greeff, JC and Schlink, AC (2002). *Wool Technology and Sheep Breeding* **50**(1): 6.
Hunter, L, Shiloh, M and Smuts, S (1981). The Inter-relationship between fibre properties, loose wool felting and fabric felting. Port Elizabeth, South African Wool and Textile Research Institute of the CSIR**:** 1.
Kenyon, PR and Wickham, GA (1999). *Journal of the Textile Institute* **90 Part 1**(2): 266.
Kenyon, PR, Wickham, GA and Blair, HT (1999). *Journal of the Textile Institute* **90**(Part 1, No.3): 395.
Payne, RW, Baird, DB, Cherry, M, Gilmour, AR, Harding, SA, Kane, AF, Lane, PW, Murray, DA, Soutar, DM, Thompson, R, Todd, AD, Tunnicliff Wilson, G, Webster, R and Welham, SJ (2003). GenStat for Windows. Rothamsted, Laws Agricultural Trust.
Scheepers, GE and Slinger, RI (1968). South African Wool Textile Research Institute.
Schlink, AC, Greeff, JC, Ehni, J and Denning, R (2004). *Unpublished*.
Schlink, AC, Greeff, JC and Haigh, M (2002). *Wool Technology and Sheep Breeding* **50**(3): 443.