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Effect of wool length and season of shearing on the propensity of Romney, Coopworth and Perendale wool to yellow

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ABSTRACT

Propensity of wool to yellow is defined as its yellowness after incubation for 14 days at 40°C and 100% relative humidity. It was determined for mid-side wool samples from Romney, Coopworth and Perendale ewes shorn in summer and/or winter.

All samples had a high propensity to yellow (mean Y-Z after challenge 13.0 SD 3.2). The breed ranking from lowest to highest was Perendale, Romney and Coopworth (12.4, 13.1, 13.6, respectively; SED 0.2). Wool shorn in winter was less susceptible to yellowing than wool shorn in summer (11.7 vs 14.4; SED 0.26) and short wool was less susceptible than long wool (12.0 vs 14.1; SED 0.26). There was a highly significant interaction between wool length and time of shearing.

Propensity to yellow of wool sampled at hogget shearing was not a significant predictor of propensity to yellow of the adult fleece wool. The measurement was repeatable between some, but not all, successive shearings of adult ewes. This suggests that the method used may be useful in selecting adults to reduce yellowness by breeding.

Keywords: wool; propensity to yellow; Romney; Coopworth; Perendale.

INTRODUCTION

The colour of scoured wool is an important attribute affecting dyeing performance. Key environmental factors associated with wool yellowing are warmth and moisture. The expression of yellowing is, however, a reflection of both the propensity of the wool to develop yellow discoloration and the environmental conditions to which the wool has been subjected while growing on the sheep's body or during storage. Propensity to yellow can be estimated objectively in the laboratory using either a predictive test, as described by Aitken *et al.* (1994), Raadsma and Wilkinson (1990) and Wilkinson and Aitken (1985), or the colour of clean wool which has been incubated in a greasy state (Reid, 1993).

Reid (1993) and Wilkinson and Aitken (1985) have suggested that selecting flock replacements on the basis of the propensity of their wool to yellow may assist in reducing fleece yellowing at shearing. In view of the importance of wool colour in determining its dyeability, any reduction in yellowness at shearing would improve the acceptability of the wool to the wool industry and therefore potentially increase the price received by the wool grower.

For breeding and selection strategies to be successful, the characteristic under selection must be heritable and have a wide and repeatable phenotypic variation. Reported heritability estimates for susceptibility of fleeces to develop yellow discoloration range from a low value (0.19 ± 0.07) to a medium value (0.51 ± 0.10) (M.V. Benavides, M.J. Young, P.R. Beatson, A.P. Maher and T.C. Reid, personal communication; J.L. Dobbie and B.R. Wilkinson, personal communication; Raadsma and Wilkinson, 1990; Wilkinson and Aitken, 1985).

This paper reports the phenotypic range and between-year repeatability of wool yellowness after challenging greasy samples from three types of crossbred wool producing breeds in a warm, moist environment.

MATERIALS AND METHODS

Wool samples

This study used mid-side wool samples collected at Whatawhata Research Centre during a shearing trial which investigated the effects of varying timing and frequency of shearing on ewe productivity (Sumner and Scott, 1990). The shearing regimes had been imposed over three years (1987 to 1989 inclusive) with wool samples also having been collected from the ewes at hogget shearing before the imposition of the shearing regimes.

From this original trial, 450 wool samples were selected and sub-sampled to give a trial design consisting of:- three breeds of sheep (Coopworth, Perendale and Romney), two shearing seasons (summer and winter shorn) and either long or short wool at shearing (shorn either once or twice per year) using ewes born in 1984 and 1985.

Wool preparation

Greasy wool samples were prepared for incubation testing as described by Aitken et al., (1994). The weathered tips of the staples were removed and the remainder cut into 2 cm snippets. Each sample was blended by hand before testing.

Incubation Procedure

The technique used has been described by Reid (1993). Briefly, samples of approximately 8 - 10 g of greasy wool

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were incubated on petri dishes for 14 d. at 40°C and 100% relative humidity. Each sample was moistened initially and every alternate day, by spraying with approximately 3 ml of water saturated with thymol. Preliminary tests had shown that under these conditions, colour development ir the greasy wool was complete after 14 d.

After incubation the colour of the wool was measured by the New Zealand Standard method (NZS 8707:1984), with an ACS CS-3 spectrophotometer, but without the polyethylene glycol step, as there was very little vegetable matter present.

The effects of shearing treatments on the propensity to yellow were analysed using analysis of variance methods following a split plot design. The factors year of birth, breed, and year of sampling were blocked to allow the season of shearing and wool length effects to be determined.

Repeatability of the propensity to yellow was analysed using the general linear model directive of Minitab, with breed as a factor (3 levels) and the measurement from the previous shearing as a covariate.

RESULTS AND DISCUSSION

All samples gave results indicating a high propensity to develop yellow discoloration, with relatively little between sheep variation (mean Y-Z after challenge 13.0 SD 3.2). There was no significant breed by year of sampling effect. Wool from the adult Perendale ewes tended to have a lower propensity to yellow than that from ewes of the other two breeds (Table 1). This difference was significant in two of the three years and was highly significant when data from all three years were analysed together.

TABLE 1: Yellowness (tristimulus value Y-Z) of samples of wool from Coopworth, Perendale and Romney sheep sampled in summer and/ or winter in each of three successive years, measured after incubation at 40°C and 100% relative humidity for 14 d.

Year sampled	Coopworth	Perendale	Romney	SED[1]	Significance
1987	12.0	11.0	12.0	0.5	*
1988	14.6	13.4	13.8	0.6	NS
1989	14.3	12.8	13.5	0.5	*
Overall mean	13.6	12.4	13.1	0.2	**

[1] Standard error of difference

Effect of Season and Length

Within each year, samples collected in winter tended to be less yellow after incubation than those collected in summer, and long wool tended to be more yellow than short wool. When data from all three years were analysed together, the interaction between season and length was very highly significant (Table 2). The difference between seasons in propensity to yellow was greater in long wool than in short wool.

The data in Table 2 indicate that, for the three breeds tested (Coopworth, Perendale and Romney), the challenge test used gave highest Y-Z values for long wool sampled in summer and lowest values for short winter wool. However, these differences between long and short wool may relate, at least in part, to the difficulty in obtaining clean, unweathered wool from short samples.

TABLE 2: Effect of season of sampling and length of wool on yellowness of wool from Coopworth, Perendale and Romney sheep sampled in each of three successive years, measured after incubation at 40°C and 100% relative humidity for 14 d.

Year	Summer		Winter		SED[1]	Significance
sampled	Short	Long	Short	Long		
1987	11.6	13.5	10.4	11.1	0.48	†
1988	13.0	18.1	11.2	13.3	0.71	**
1989	14.1	16.0	11.6	12.7	0.62	NS
All years	12.9	15.9	11.1	12.4	0.36	***

[1] Standard error of difference

Aitken *et al.*, (1994) described highly significant correlations ($r = 0.852$) between propensity to yellow of samples of Merino wool (as indicated by the predictive test) and the concentration of the water soluble suint fraction of the fleece. The correlation between propensity to yellow and the major suint cation, potassium, was very high ($r = 0.947$). This suggests that the seasonal and length effects on propensity to yellow may result from differences in rainfall between seasons and in the relative ease with which short or long wools become wet during rain. Thus, in a predominantly winter rainfall area such as Whatawhata, suint concentrations would be expected to be lower in winter than in summer.

In the data reported by Aitken *et al.*, (1994) the relationship between propensity to yellow and washing yield (%clean wool/ greasy wool) was not significant ($r = -0.199$). Likewise, in this study the correlation between the yellowness after incubation and washing yield was also very low ($r = -0.13$).

Repeatability of Propensity to Yellow

The propensity to yellow of samples taken at hogget shearing was not a significant predictor of propensity to yellow for the samples taken from adult ewes at any of the later shearing occasions (Table 3a). However, when the data from the adult ewes were analysed, the repeatability of propensity to yellow on successive shearing occasions was variable (Table 3b). This indicates that while fleece samples taken from hoggets would not provide useful information on the propensity of the adult fleece to yellow, the property in adult crossbred ewes is often, but not always, repeatable across successive years and between seasons. The data would suggest that, within environments like Whatawhata, samples taken in winter may provide a more reliable measure of propensity to yellow than samples taken in summer. This difference may relate to the more reliable and regular rainfall in winter compared with summer.

In earlier studies of samples of Merino wool from the Central Otago Merino Wether Trial (Cottle and Wilkinson, 1989), the colour after challenge was more repeatable than the results reported in this paper (F.J. Aitken, unpublished observations), with a considerably greater range in the

TABLE 3: Repeatability of yellowness of wool from Coopworth, Perendale and Romney ewes sampled in summer and/or winter in each of three successive years, measured after incubation at 40°C and 100% relative humidity for 14 d. Repeatability is expressed as the regression coefficient for the relationship between (a) the values at hogget shearing and those at subsequent shearings or (b) the values on one occasion and that at the subsequent occasion for adult ewes.

a. Samples from hogget shearing

	Regression coefficient (standard deviation) Predicting values at:					
	1987		1988		1989	
	Summer	Winter	Summer	Winter	Summer	Winter
Short	-0.11 (0.31) NS	-0.20 (0.42) NS	-0.10 (0.48) NS	0.09 (0.28) NS	-0.13 (0.48) NS	-0.08 (0.34) NS
Long	-0.09 (0.47) NS	0.16 (0.13) NS	0.39 (0.59) NS	-0.04 (0.30) NS	0.25 (0.92) NS	0.14 (0.26) NS

b. Samples from adult ewes - predicting values at subsequent shearing

	Regression coefficient (standard deviation)				
	1987		1988		1989
	Summer	Winter	Summer	Winter	Summer
Short	0.65 (0.22) *	0.85 (0.22) ***	0.25 (0.11) *	0.30 (0.42) NS	0.25 (0.10) *
Long	0.47 (0.24)†	1.58 (0.39) ***	-0.04 (0.31) NS	0.31 (0.17)†	

data (Reid, 1993). These differences between breeds in the range of yellowness after challenge may reflect a breed, rather than flock, effect. The Merino samples were obtained from approximately 30 parent flocks. The base Coopworth, Perendale and Romney ewes used to establish the flocks from which the samples for this study were derived, were sourced from a large number of flocks in 1969 (Dalton and Ackerley, 1974). In each subsequent year, each breed group was joined with between four and six new rams, selected from different breeders, and replacements selected from the progeny. Thus, while the samples used in both studies represent a wide range of source flocks, some of the differences between them may relate to the different environments in which they were grazing. While the climate at Whatawhata is mild and wet with a predominance of winter rainfall, that in Central Otago is cold in winter and dry.

Additionally, the samples used in this study were collected three to seven years before testing and the effect of this storage prior to testing on the colour development was not examined.

Other studies of wool from Corriedale ewes (T.C. Reid and K.J. Botica, unpublished observations) from within a single flock showed a wider range in yellowness after challenge than the crossbred wool samples in this study. This suggests that the use of this method may be limited in crossbred wool type sheep by the lack of sheep producing wool which is resistant to yellowing. However, it may be of greater use in differentiating within-breed for Merino and Corriedale sheep, as both breeds show a wider phenotypic range then those tested in this study.

CONCLUSIONS

The results of this study indicate that for these breeds of crossbred wool type sheep, incubation of long wool samples taken in summer is likely to induce more yellowing than in short wool or wool shorn in winter. However, the repeatability of the colour measure was higher in short wool than in long wool. The samples taken from hoggets provided little information on the likely propensity of adult fleece wool to yellow. It is therefore unlikely that this measure will provide a useful criterion for selection of crossbred wool type hoggets as replacements for a breeding flock. However, the use of this criterion may be warranted in adult sheep, even though the breeds tested in this study were all highly susceptible to yellowing, with a narrow phenotypic range.

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