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Relationships of fleece and fibre traits with unscourable yellow discolouration in a survey of strong wool sheep flocks

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ABSTRACT

Wool samples were collected over two years from sixty two lines of sheep in flocks spread around New Zealand, to provide wool from a variety of strong wool genotypes and farming environments. Within-line relationships of unscourable discolouration with objectively measured and subjectively assessed fleece and fibre traits were determined by correlation and regression analyses.

The trait most highly correlated with the CIE measurement of yellow discolouration (Y-Z) within lines was Z ($R^2 = 0.58$). CIE X and Y values were more weakly correlated ($R^2 = 0.19$ and 0.18, respectively), as was the maximum visibly assessed yellow discolouration score along greasy staples ($R^2 = 0.22$). An index of four traits (maximum yellow score, fibre diameter, mid staple yellow score, and staple definition) accounted for 33% of the variation. Variation in other fleece and fibre traits within flocks was not associated with Y-Z. The reasons why the scoured wool of some sheep in a flock show more discolouration than that of others were not found among the 38 traits examined in this project.

Keywords: Wool; unscourable yellow discolouration; fleece; fibre.

INTRODUCTION

Discolouration of the wool in the fleece and during storage and dyeing, limits the range of shades that wool can be dyed. Unscourable discolouration of fleece wool exposed to natural and experimental challenges is influenced by both genetic and environmental factors (Bigham *et al*., 1983 and 1984; Morris *et al*., 1996; Ranford *et al*., 1991; Reid, 1993; Reid *et al*., 1995; Reid *et al*., 1996; Wilkinson, 1982; Wilkinson and Aitken, 1985; Wuliji *et al*., 1998). Within a flock of sheep there can be considerable variation between individuals in the extent of discolouration, despite a similar genetic background and environment.

This study was aimed at identifying differences in causes of unscourable yellow discolouration, between individuals within flocks. Unscourable yellow discolouration was measured in Commision Internationale de l'Eclairage (CIE) Y-Z units.

MATERIALS AND METHODS

Sixteen commercial and six research flocks at locations between Waikato and Southland were sampled over a two year period at various times of year to provide a range of wool types and environments. The research flocks usually contained more than one genetic type so the total number of lines of sheep sampled was 62. The number of sheep per line ranged from 20 to 68 with a total of 2117. Breeds represented were Romney, Perendale, Coopworth, and ¼ and ½ Texel and Dorset x Romney crosses. The flocks were not selected to be representative of their breed. In fact, commercial flocks with a history of discoloured wool were sought.

Midside wool samples were collected from 6 flocks of ewes within 8 months of the previous shearing and 5 flocks with near 12 months wool growth. They were also collected from 11 hogget flocks with 6 to 10 months wool growth. Objective measurement of weight, clean wool yield, length, fibre diameter, bulk, crimp frequency and colour were made using standard procedures. The cross-sectional area of staples was measured with a Caffin clamp (Caffin, 1976). Since data for research flocks was measured at different times and in different laboratories, some of the variation between flocks will be due to measurement differences. Within flocks, all measurements of each trait were made in one series in one laboratory.

A 1 to 5 point scoring system was used for subjective assessments of fleece and staple traits listed in Table 1. For each trait, standard samples for each score were referred to during assessment. For four of the traits, the staples were assessed in three sections; butt (being the end closest to the skin), mid and tip. All assessments were made by the same person.

Inter-relationships between unscourable yellow discolouration (Y-Z) and each other variable were examined by correlation and single and multiple stepwise regression analysis. The percent variation accounted for was adjusted for degrees of freedom.

RESULTS AND DISCUSSION

The mean value of Y-Z for all the lines of sheep was 4.86, with a range from 2.1 to 12.3 (Figure 1), and the standard deviations averaged 1.33 with a range from 0.14 to 3.13 (Figure 2). In addition to genetic effects and environmental effects, some of the variation between flocks may be due to differences in the manner in which samples were stored (Bray *et al*., 1999), and in the laboratory procedures used.

The mean within-line relationships between Y-Z and the fleece and fibre structural traits investigated, were generally weak (Table 1). Y-Z values were most closely correlated with Z, followed by the other CIE values, X and Y,

FIGURE 1: Frequency distribution of mean Y-Z for lines of strong wool sheep in the survey.

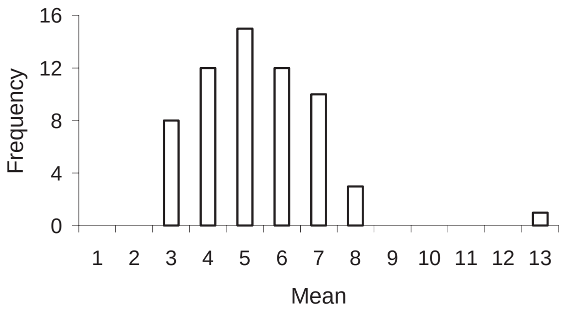

FIGURE 2: Frequency distribution of the variance in Y-Z within lines of strong wool sheep in the survey.

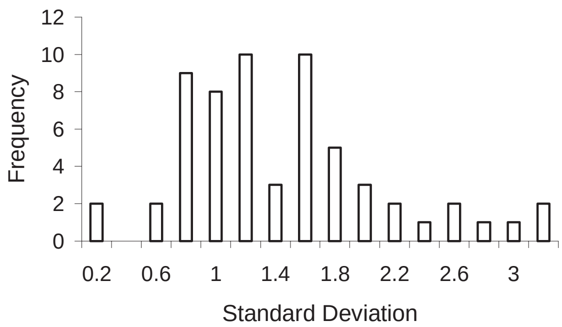

Table 1. Mean and standard deviations of 38 traits and within-line correlations (R^2) with Y-Z

Trait	No of Lines measured	Mean	Standard Deviation	Correlation with Y-Z
Liveweight (kg)	41	42.5	5.3	0.02
Greasy fleece weight (kg)	44	3.07	0.45	0.06
Patch weight (g)	40	34.5	7.9	0.02
Wt/unit area (g/mm^2)	40	3.91	0.67	0.02
Lustre	62	3.29	0.66	0.00
Fleece pigment	62	0.008	0.04	0.00
Weathered depth	62	2.51	0.57	0.01
Staple definition	62	3.11	0.77	0.02
Staple tippiness	62	3.25	0.66	0.00
Fleece cotting	62	1.87	0.49	0.02
Yellow discolouration – butt	62	1.81	0.55	0.05
Yellow discolouration – mid	62	2.19	0.65	0.15
Yellow discolouration – tip	62	1.99	0.52	0.05
Yellow discolouration – max	62	2.82	0.74	0.22
Crimp definition - butt	62	3.14	0.63	0.00
Crimp definition - mid	62	3.17	0.57	0.00
Crimp definition - tip	62	2.82	0.48	0.00
Crimp frequency – butt	62	4.49	1.17	0.00
Crimp frequency – mid	62	4.27	1.12	0.00
Crimp frequency – tip	62	3.22	0.95	0.00
Cross-sectional area – butt	51	2.13	0.26	0.01
Cross-sectional area – mid	51	2.37	0.35	0.01
Cross-sectional area – tip	51	2.38	0.40	0.00
Staple mass (g)	51	0.42	0.14	0.00
Staple length (mm)	57	129	14.7	0.00
Staple strength (Newtons/ktex)	31	34.3	9.8	0.00
Staple strength (Joules/ktex)	31	0.95	0.35	0.00
Fibre length (mm)	15	164	17	0.00
Fibre length standard deviation	15	15.7	5.7	0.00
Fibre length/staple length ratio	15	1.26	0.11	0.00
X (CIE units)	35	56.8	2.0	0.19
Y (CIE units)	62	57.8	2.2	0.18
Z (CIE units)	62	53.0	3.1	0.58
Y-Z (CIE units)	62	4.86	1.33	-
Yield (%)	62	78.0	4.1	0.01
Fibre diameter (µm)	55	34.9	2.4	0.02
Fibre diameter standard deviation	55	8.55	0.90	0.01
Core bulk (g/cm^3)	17	25.5	2.1	0.00
Loose bulk (g/cm^3)	12	19.8	2.0	0.00

and the subjectively assessed maximum degree of yellowing at any point along the staple. For four other traits, correlation coefficients with Y-Z greater than 0.2 were detected in five or more lines. They were the assessed yellow discolouration in the mid region of the staple, yield, fibre diameter and greasy fleece weight.

The relationships were re-examined after placing the lines into three genotype categories - high fleeceweight (Romney research lines selected solely for high fleeceweight, n = 19), high bulk (Perendale research line selected solely for high bulk plus Romney cross lines with at least 50% Texel and Poll Dorset genes, n = 7) and Others (all remaining lines, predominantly Romney and including those with less than 50% Texel and Poll Dorset genes, n = 36). Mean within-line correlations of objective and subjective colour traits with Y-Z were slightly greater for high fleece weight Romneys than the other two categories. Other than those, there were no great differences between genotypes in the magnitude of correlations between wool traits and Y-Z (Table 2).

TABLE 2. Correlations (R^2) of Y-Z with selected traits for lines of sheep grouped by genotype, adjusted for between-line variation.

	Genotype			
Trait	High fleece weight	Others	High bulk	All
X	0.27	0.20	0.08	0.19
Y	0.26	0.17	0.15	0.18
Z	0.67	0.57	0.50	0.58
Yellow discolouration – max	0.29	0.23	0.12	0.22
Yellow discolouration -mid	0.23	0.17	0.00	0.15
Greasy fleece weight	0.10	0.07	0.08	0.06
Clean wool yield	0.09	0.00	0.01	0.01
Fibre diameter	0.07	0.01	0.09	0.02
Staple definition	0.02	0.02	0.02	0.02

The lines were then rearranged into location groups of flocks in the Waikato/King Country area, in Canterbury and in Southland. Correlations of objective and subjective colour traits with Y-Z were similar for Waikato/King Country and Canterbury, which were higher than in Southland (Table 3). As for the genotype categories, grouping by location did not identify any new relationships of note.

TABLE 3. Correlations (R^2) of Y-Z with selected traits for lines of sheep grouped by location, adjusted for between-line variation.

	Location			
Trait	Waikato/ King Country	Canterbury	Southland	All
X	0.26	0.27	0.04	0.19
Y	0.24	0.23	0.02	0.18
Z	0.63	0.63	0.33	0.58
Yellow discolouration (max)	0.24	0.25	0.17	0.22
Yellow discolouration (mid)	0.22	0.14	0.00	0.15
Greasy fleece weight	0.08	0.06	0.07	0.06
Clean wool yield	0.03	0.01	0.00	0.01
Fibre diameter	0.03	0.01	0.03	0.02
Staple definition	0.03	0.01	0.00	0.02

Of the traits in the greasy fleece that could be used within flocks to select animals for retention or culling, or to class shorn fleeces for low discolouration of scoured wool, the best (maximum visually assessed yellow discolouration) individual one accounted for only 22% of the variation in Y-Z.

An index of the four most highly correlated traits accounted for 33.5% of the variation. It was:

Y-Z = 0.02 + 0.73Yellow(max) + 0.09FD
+ 0.37Yellow(mid) – 0.18Staple definition

CONCLUSIONS

This study shed no new light on reasons why the scoured wool of some sheep in a flock is more discoloured than that of flock mates. None of the fleece and staple architecture and fibre traits studied were closely associated with unscourable discolouration. Since the findings were consistent across 62 lines of sheep at 21 locations spread through New Zealand over two years, the findings have wide application within the strong wool section of the New Zealand flock.

The lack of association of some of these traits with unscourable discolouration is likely due to the limited variation in them within each of the flocks in this study. Where the variation is greater, there may be associations. For instance, larger differences in staple length can cause differences in Y-Z and so provide a reason for shearing more frequently than once per year in warm, moist environments.

The findings indicate that research efforts to identify causes of animal differences in unscourable discolouration should avoid the fleece and fibre traits studied in this project. Other studies indicate that non-keratin components of the fleece, particularly the suint component (Aitken *et al*., 1994; Cottle *et al*., 1992; Cottle and Zhao, 1995; Wilkinson, 1981; Winder *et al*., 1998a; 1998b), to be more worthy foci.

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