Relationships between the compounds causing scourable diffuse yellow and yellowness of greasy and clean wool

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ABSTRACT

As part of a study of the chemistry of wool yellowing, a pilot survey was conducted to examine the frequency of occurrence of two yellow compounds previously isolated from the suint of a few yellow fleeces. The relationship between the amounts of these compounds present and the degree of discolouration was examined in clean and greasy wool from Merino (n = 48), Halfbred (n = 12), Corriedale (n = 26), Romney/Crossbred (n = 52), Cheviot (n = 10) and Perendale sheep (n = 8).

The numbers of samples analysed, the mean yellowness (tristimulus Y-Z) and the relative proportions of the two yellow compounds detected are given in Table 1. Because not all the data was obtained for all samples, the number of data points used in each analysis may vary from those in this table.

Of the 172 wool samples examined, one yellow compound was present in all of them, and a second yellow compound in 91%. There was little relationship between the amounts of these compounds and the yellowness of the greasy wool. Furthermore, there were no significant relationships between the amounts of either compound and the yellowness of the clean wool.

The results suggest that the coloured compounds isolated are universally distributed in the wool of New Zealand sheep and may be responsible, in part, for the degree of yellow discolouration in greasy wool. They would appear to have little, if any, impact on the colour of clean wool.

Keywords: wool; yellow; colour; chemistry; compounds.

INTRODUCTION

Because discoloured wool cannot be dyed pastel shades without bleaching, the presence of yellow discolouration is a problem for processors. Bleaching increases processing costs and causes some fibre damage, and consequently wool with yellow discolouration results in lower returns to the farmer than white wool. Increased understanding of the chemistry of wool yellowing is important in helping to develop methods to lessen the development of yellow discolourations in wool and to develop other treatment systems to reduce its impact during processing.

During a study to identify the compounds causing the yellow discolouration of wool (Wood, 1996), two yellow water soluble compounds were isolated from the suint of a small number of fleeces showing scourable diffuse yellow (SDY) discolouration. A pilot survey was then conducted to examine the relationships between the two compounds responsible for SDY and the degree of yellow discolouration of both greasy and clean wool.

This paper reports on the distribution of these two compounds in a range of fleeces from throughout New Zealand and describes the nature of the relationships between the amounts of these two compounds and the colour of the wool in a greasy and clean state.

EXPERIMENTAL

Wool samples were obtained from Merino (fine wool breed), Corriedale and Halfbred (medium wool breeds) and Romney, Perendale and Cheviot (coarse wool breeds) (Table 1). Samples of wool (approximately 20 g) from the mid-side region of approximately ten sheep (range 6-22) were received from 19 properties from Otago to Waikato. The samples were stored frozen before analysis.

In preparation for the chemical analysis, the weathered tips were cut from the ends of the staples to remove excess dirt, and any obvious vegetable matter was removed. These prepared staples were conditioned overnight before colour measurement and weighing for analysis.

The colour of the wool samples was measured using a Hunterlab reflectance spectrometer (DP-9000 and D25-M optical sensor). For greasy wool, 4 g subsamples were placed in the colour measurement cell and the colour measurements made on four faces in a manner similar to that laid down in the standard method for determining the base colour of wool (NZS 8707:1984). Between measurements the glass at the front of the cell was cleaned with petroleum ether. The samples were then cleaned and the base colour measured according to the standard procedures for determining wool colour (NZS 8707:1984).

The compounds responsible for SDY discolouration had previously been shown to be in the water soluble

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TABLE 1: Origin of samples analysed for the presence of compounds causing yellowness of greasy wool. Also given are the mean (and standard deviation) for the colour of the greasy wool (tristimulus Y-Z), and the relative proportions of the two yellow compounds examined (expressed as the percentage area under the UV trace represented by each compound).

Wool type	Breed	Location (no. of farms)	No. of samples analysed	Y-Z	Mean (SD) Compound 1	Mean (SD) Compound 2
Coarse	Romney	Otago	10	9.4 (1.2)	49.3 (7.9)	12.6 (6.7)
		Canterbury (2)	21	10.6 (2.3)	44.8 (17.6)	9.4 (7.3)
		West Coast	9	11.2 (1.8)	50.1 (9.7)	16.5 (11.8)
		Manawatu	4	9.6 (0.6)	52.1 (6.3)	11.6 (4.9)
		Waikato	11	9.5 (1.2)	50.8 (9.7)	10.1 (8.8)
	Perendale	Waikato	9	9.3 (1.2)	51.0 (5.2)	8.3 (7.7)
	Cheviot	Waikato	10	8.1 (1.3)	48.3 (12.4)	9.9 (5.6)
Medium	Corriedale	Canterbury (2)	18	10.3 (2.5)	45.5 (13.5)	10.3 (7.7)
		Marlborough	10	8.7 (2.1)	42.1 (21.1)	11.0 (5.4)
	Halfbred	Otago	8	7.5 (2.8)	45.8 (10.0)	14.7 (9.4)
		Canterbury	6	9.4 (1.1)	52.4 (10.2)	8.1 (8.6)
Fine	Merino	Otago	13	2.9 (2.1)	41.6 (27.5)	7.4 (7.7)
		Canterbury (3)	25	7.1 (3.3)	45.5 (17.2)	16.4 (17.2)
		Manawatu	9	7.9 (1.8)	40.3 (10.4)	15.7 (6.7)
		Waikato	9	8.7 (1.2)	48.9 (14.8)	11.2 (7.0)
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components of the suint (Wood, 1996). The compounds were extracted from the fleece samples (12 g) by washing the wool in distilled water after it had been degreased by washing thoroughly with petroleum ether. These water extracts were freeze dried, the residue dissolved in water and filtered through Alltech C18 cartridges to remove remaining lipids. The extracts were then diluted to between 1-10 mg of residue/ml depending on the subsample size and analysed on an HPLC fitted with a C18 reverse phase column (4.6 x 250 mm, 5 µm particle size, pore size 100 Å) with UV detection (wavelength 203 nm), eluting with a methanol/water mixture (10% methanol/90% water).

The two yellow compounds were identified as the first and fifth peaks on the UV absorption trace. The relative proportions of each compound were measured as the percentage area under the UV trace for each wool sample, as no pure standards were available.

The data were analysed within breed type by regressing the colour of the wool in either the greasy or clean state against the logarithm of the percentage of the total absorbance represented by the compounds of interest.

RESULTS AND DISCUSSION

There were significant differences in the yellowness of greasy wool between the three coarse wool producing breeds tested, with the wool from the Romneys being more yellow than that from Cheviots or Perendales. Samples from the Waikato were significantly less yellow than those from other areas. The greasy wools grown by Corriedale and Halfbred sheep in Otago and Marlborough were significantly less yellow than those grown in Canterbury. The Otago Merino samples were less yellow than those from Canterbury, Manawatu or Waikato.

Eight compounds were detected in all suint samples and a further three were occasionally found. Yellow Compound 1 (first peak on the UV trace) occurred in all samples and yellow Compound 2 (fifth peak on the UV trace) occurred in 91% of the samples.

There were no significant relationships between the amounts of any of the compounds isolated and the base colour of the wool samples after cleaning.

The yellowness of the greasy wool was related to the logarithm of the amount of Compound 1 extracted from suint of wool from Merinos and Perendales:

Merinos:

Y-Z = 1.35 + 3.40 * Log (Compound 1) $^{**}R^2 = 13.3\%$

SE (± 1.90) (± 1.18) n = 49

Perendales:

Y-Z = -29.23 + 22.62 * Log (Compound 1) $^{**}R^2 = 69.9\%$

SE (± 9.29) (± 5.45) n = 8

For the Merino samples, this relationship, although significant, explained only 13.3% of the variance in the colour of the greasy wool.

No significant relationships were detected for the Halfbred and Corriedale samples, either individually or when combined, or for the Romney and Cheviot. When data from the Perendales were combined with those from the other crossbred types, there were no significant relationships between the yellowness of the greasy wool and the amounts of either yellow compound isolated.

While some form of log-linear relationship existed in some of the data, the relationships were not strongly dependent on yellowness. The use of the colour of the greasy wool to estimate the likely effect of these two compounds imposed limitations on the likely relationships examined.

The presence of other extraneous material in the wool samples would affect the ability to accurately measure the extent of the SDY discolouration.

Visual perceptions of yellowness of greasy fleeces are likely to be used in culling and breeding decisions. Although the present work demonstrates very clearly there is always one, and usually two, decidedly yellow compounds present in suint, it is difficult with many fleece types to objectively relate an instrumental colour measurement to the quantity of the two chromophores.

There was no evidence from these pilot trials to suggest the yellow compounds within the suint mixture are actually staining the wool substrate prior to scouring, as the base colour of the clean samples bore no relationship to the variable amounts of either of the yellow compounds. This result does not exclude the possibility of the presence of high amounts of either of the compounds as an indicator of an increased propensity of the wools to develop yellowness later under suitable conditions.

CONCLUSIONS

The results show that the two compounds responsible for SDY discolouration were almost universally distributed in fleeces throughout New Zealand. Although the extent of their contributions was difficult to determine, it seems likely that they are responsible, at least in part, for the degree of yellow discolouration seen in greasy wool.

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