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## Relationship between wool sulphur concentration and wool characteristics

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### ABSTRACT

It is well established that naturally occurring wool sulphur concentration is lower in high wool-producing sheep, however little is known of the relationship between wool sulphur concentration and wool fibre characteristics. Mid-side wool samples were collected from ewe hoggets differing in lamb wool sulphur concentration. Wool from hoggets, which had lower wool sulphur concentrations as lambs, had longer staple lengths, were higher yielding and had lower loose wool bulk values. There was no relationship between wool sulphur concentration and mean fibre diameter or colour. An increase in length should have a positive effect on the price of wool, especially for second shear crossbred wools. At present the price premium for bulk is poorly defined, but is unlikely to have a significant impact on the value of these wools. These findings suggest that selecting animals for low lamb wool sulphur concentration will, if anything, positively affect the per kilo price of wool produced.

**Keywords:** sheep; wool sulphur concentration; fleece characteristics; fleece weight.

### INTRODUCTION

A number of studies have shown that natural wool sulphur concentrations are lower in genetically high wool-producing sheep in comparison to either randomly-bred or genetically low wool-producing sheep (Piper and Dolling, 1966; Reis *et al.*, 1967; Antram *et al.*, 1991; Sun *et al.*, 1991). This has led Blair and Lee (1997) to investigate using wool sulphur concentration as a selection criterion in young lambs to improve fleece weight and to investigate correlated changes in wool characteristics.

Selection based on lamb wool sulphur analysis would have the advantage of reducing the generation interval, compared to conventional selection based on hogget fleece weight. However for the technique to be profitable, it must increase quantity without adversely affecting other production parameters. In the case of wool production it is important to ascertain the effect of selection for decreased wool sulphur concentration on wool characteristics of processing significance such as fibre diameter, fibre length and colour, which are important determinants of the value of a farmer's wool clip (Sumner, 1985).

The aim of this paper is to examine the phenotypic relationships between lamb wool sulphur concentration and hogget fleece characteristics under grazing conditions without dietary supplementation.

### MATERIALS AND METHODS

#### Wool source

A wool sulphur selection flock was established at Massey University in 1995 (Blair and Lee, 1997). It consists of two sub-flocks; replacements are selected randomly for the first sub-flock, while in the second replacements are chosen from those lambs with the lowest wool sulphur concentrations. Mid-side fleece samples are routinely collected from each lamb at 4 to 5 months of age, and analysed for sulphur concentration (Antram *et al.*, 1991).

#### Wool measurements

Mid-side samples were collected (n=52) from those first generation Romney ewe hoggets with the 26 highest (H) and 26 lowest (L) lamb wool sulphur concentrations, regardless of which sub-flock the hoggets originated from. Staple length was measured as the average length of ten staples. Samples were aqueously scoured in a four-bowl mini scour to obtain a washing yield. Clean-wool colour was measured on a Hunterlab spectrophotometer (Hunterlab, Colour Quest 45°/0° LAV, Hunter Assoc Laboratory VA, USA) (SANZ., 1984). Loose wool bulk was measured in a WRONZ Loose Wool Bulkometer (Bedford *et al.*, 1977). Mean fibre diameter, coefficient of variation of fibre diameter (CV), fibre curvature and percentage medullation were determined using an Optical Fibre Diameter Analyser (OFDA) (Baxter *et al.*, 1991; 1992). Loose wool feltability was measured by the tumble-drier technique (Kenyon and Wickham, 1999). Feltball diameter is an inverse measure of feltability.

#### Statistical analysis

Comparative least squares means between the H and L groups were estimated for measured wool parameters using the Generalised Linear Model procedure of the statistical package 'MINITAB' (Minitab, 1998). The effects of hogget liveweight were investigated but removed from the model when found to be non-significant.

### RESULTS

Table 1 shows that the chosen High (H) and Low (L) wool sulphur concentration groups had significantly different wool sulphur concentrations ( $P < 0.001$ ). The L group had significantly longer staples ( $P < 0.001$ ), were significantly higher yielding ( $P < 0.05$ ) but, had significantly lower loose wool bulk values ( $P < 0.05$ ). There were no differences between the two groups in mean fibre diameter, percentage medullation and unscourable colour (Y-Z) or its components. Wool from the L group tended to felt

**TABLE 1:** Lamb wool sulphur concentrations, hogget fleece weight and wool quality characteristics for the low and high wool sulphur groups (Mean, SE).

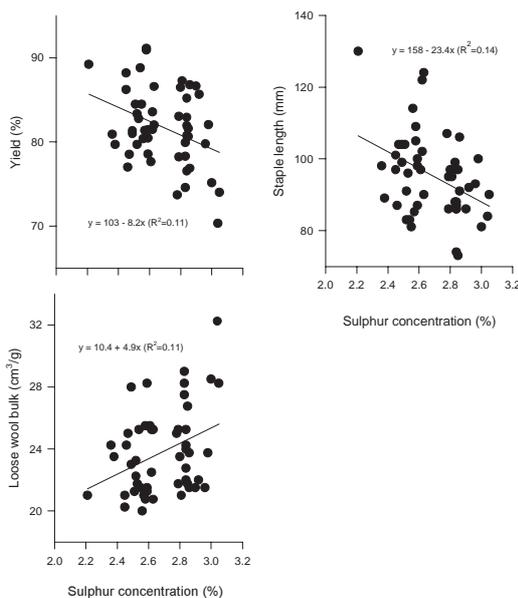
Trait	Low		High		Significance
	Mean	SE	Mean	SE	
Sulphur concentration (%)	2.5	0.02	2.9	0.02	**
Hogget live weight (kg)	42.0	0.8	44.4	0.8	*
Clean fleece weight (kg)	3.0	0.1	2.8	0.1	NS
Yield (%)	83.0	0.8	80.3	0.8	*
Staple length (mm)	99.3	2.1	90.8	2.2	**
Mean fibre diameter ( $\mu\text{m}$ )	37.5	0.6	37.2	0.6	NS
Loose wool bulk ( $\text{cm}^3/\text{g}$ )	23.1	0.5	24.6	0.5	*
Fibre curvature ( $\text{deg}/\text{mm}$ )	43.0	1.0	45.6	1.1	+
Y-Z	2.6	0.3	3.2	0.3	NS
CV of fibre diameter (%)	24.1	0.5	22.8	0.5	+
Percent medullation (%)	1.6	0.7	1.2	0.7	NS
Feltball diameter (mm)	25.9	0.2	26.5	0.3	+

**Note.** Symbols denote variables that are significantly different between the two groups (NS non significant, +  $P < 0.10$ , \*  $P < 0.05$ , \*\*  $P < 0.01$ ).

more readily ( $P = 0.08$ ), have straighter fibres ( $P = 0.09$ ) and to have a greater CV ( $P = 0.09$ ).

Based on the assumption that there is a linear relationship (over the total range of wool sulphur concentrations measured) between the wool sulphur concentration and wool characteristics, the nature of the phenotypic relationship can be determined by regression analysis. There was a significant linear relationship between the wool sulphur concentration of the lamb fleece and staple length ( $P < 0.01$ ), washing yield ( $P < 0.05$ ), and loose wool bulk ( $P < 0.05$ ) of the hogget fleece (Figure 1). There were no significant relationships between sulphur concentration and any of the other measured fleece characteristics.

**FIGURE 1:** Relationships between wool sulphur concentration of the lamb fleece and hogget fleece characteristics.



## DISCUSSION

The two sub-groups selected have significantly different average concentrations of wool sulphur allowing meaningful comparisons of their fibre characteristics to be made. The average clean fleece weight of the low sulphur group was approximately 200g heavier than that of the high sulphur group but this difference was not significant ( $P = 0.17$ ) due to the small number of animals in the trial.

Given that we expect sheep with low wool sulphur concentrations to have heavier fleece weights (Reis and Williams, 1965; Antram *et al.*, 1991; Sun *et al.*, 1991; Lee and Williams, 1993), it is desirable to know the mechanism by which this increase is achieved. Of the components of clean fleece weight (total fibre number, fibre diameter, fibre length and specific gravity), Lee and Williams (1994) suggest fibre diameter and length are the most likely candidates for increasing fleece weight. In addition, Liu *et al.* (1994) reported that the total number of fibres contributed to only 14.4% of the difference in clean fleece weight between sheep selected for fleece weight for over 35 years and sheep selected randomly over the same period. Others studying the same flock showed the line selected for high fleece weight had significantly lower sulphur concentrations (Antram *et al.*, 1991; Sun *et al.*, 1991).

Wools with a lower wool sulphur concentration had longer staple lengths. The regression analysis indicates that selection for lower wool sulphur concentration will be associated with an increase in average staple length at a rate of 10mm for every 0.43% decrease in wool sulphur concentration. In the 1997/98 New Zealand wool selling season a 10mm increase in length, for crossbred wools 37.5 micron and finer, increased price by 11c/kg (Wools of New Zealand, 1998). The increase is likely to be even more important for sheep farmers currently producing 2<sup>nd</sup> shear wool with a staple length shorter than 85mm.

Decreasing wool sulphur percentage had no effect on fibre diameter, a result previously found by Reis (1965) and Reis and Williams (1965) in small numbers of Merino and Merino-cross sheep. This should be regarded as a positive effect on quality, given that an increase in fleece weight is usually accompanied by an associated increase in fibre diameter and a decrease in the per kilo price.

The present data suggest that wools with lower sulphur concentrations are higher yielding. Given that sulphur concentration did not effect greasy fleece weight but appeared to be related to clean fleece weight, it would seem that the higher yields were not achieved by simply increasing wool production but also by decreasing the production of non-wool matter. If this decrease also involved a change in the wax/suint ratio, there maybe an effect on the susceptibility to yellowing (Winder *et al.*, 1998).

Loose wool bulk decreased as wool sulphur concentration decreased. At present there is little clear evidence of the extent of the price premium for bulk, but it is likely that lower bulk wools will have a slightly lower value. Elliott (1984) found that for wool assessed as having a loose wool bulk of over  $25\text{cm}^3/\text{g}$ , an increase of one bulk unit increased

price by 3 to 5.5 cents/kg. In the 1997/98 New Zealand wool selling season, wool assessed as having a bulk value of more than 25cm<sup>3</sup>/g attracted premium of 6 cents/kg over wools with a bulk value lower than this cut off (Wools of New Zealand, 1998). However in the majority of New Zealand crossbred flocks, which have bulk values below 25cm<sup>3</sup>/g (Sumner, 1994), selection for low sulphur concentrations should not affect the value of their clips.

In agreement with the results of Kenyon *et al.*, (1998) the low sulphur concentration group, with its lower loose wool bulk and longer staple length tended to felt more than the high sulphur group.

There was no significant difference in the percentage medullation of the L and H sulphur groups, suggesting that there was no relationship between wool sulphur concentration and medullation. However given that low levels of medullation usually found in the mid-side area, it is perhaps not the best site to measure this relationship.

### CONCLUSION

Fleeces from hoggets that had lower wool sulphur concentrations as lambs, were higher yielding and had longer staples, but had lower levels of loose wool bulk and tended to have straighter fibres and felt more. Lamb wool sulphur concentration was not related to hogget fibre diameter, variation in fibre diameter, percentage medullation or Y-Z. Using current market premiums for medium crossbred wool, the net effect of decreasing wool sulphur concentration was to increase the price per kilo. The data suggest that higher fleece weights produced by sheep with low natural wool sulphur concentrations are primarily due to an increase in the length of the fibre produced. Further work looking at the effects of selection for low wool sulphur concentrations is warranted and is in progress.

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