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Dark and Medullated Fibre Contamination in Merino Fleece from Damara Crossbred Lambs; Top and Noil Products

By

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SUMMARY

The benzyl alcohol test for dark and medullated fibres, developed by AWTA/AWI/CSIRO, was used to compare the levels of dark and medullated fibre between scoured cores from greasy fleeces and the resultant noil.

Samples used in this study were Merino fleeces contaminated through contact with Damara rams or their crossbred lambs. The pigmented and medullated fibres transferred generally had high fibre diameters, are highly medullated, relatively short and show characteristics of being shed fibres which could be broadly classified as kemp.

Both top and noil products were contaminated by dark and medullated fibre thus reducing the flexibility of end-use and downgrading their value. Based on a top:noil ratio of 95:5 (being the average result in this case study) the dark fibre content in the noil was 4.24-fold that of the core sample test with 87% of the variation explained in this case study.

The measurement of dark fibres was found to be more predictable than for medullated fibres. The poor relationships for medullated fibre measurements found in this study were heavily influenced by the results from one of the ten batches. For any regression model to be meaningful in a general sense, would require a much larger data set.

INTRODUCTION

Wetzold & von Bergen (1970) state “worsted combing has three distinct functions to perform: to remove the ‘short wool’ fibres below a predetermined length; to straighten and make the retained long wool fibres lie as parallel as possible; and to remove foreign impurities, such as burrs, straw, shives, kemps, neps and dust. Noil is a valuable by-product of combing and is usually sold by worsted manufacturers to woollen yarn spinners who use them as a component in the production of woollen yarns (Wetzold & von Bergen 1970). The presence of dark and/or medullated fibres (DMF) can limit flexibility of end-use or result in mending costs of woollen and worsted products (Appleyard & Perkins, 1965; Hatcher, 2002) so it is relevant to examine the levels of dark fibre contaminants in noil as well as top.

Harrowfield (1987) reported that worsted carding and gilling resulted in a 41% increase in dark fibre frequency. Robinson (1996) found that 32% of fibres break during carding alone but this depends on fibre properties, entanglements and machine interactions while further fibre breakages occur during combing (Atkinson, 1996). In mini-scale worsted processing of Corriedale (Fleet & Foulds, 1988) and Merino (Fleet *et al.*, 1995; Fleet, 2006) fleeces with inherent pigmented wool fibre faults (Fleet, 1998) there were higher levels of pigmented fibres found in the top than in the scoured fleece wool.

Based on the findings of a study of fibre transfer contamination, Hatcher *et al*. (1999) suggested "that up to 100% of kemp fibre transferred to Merino wool from contact with Awassi sheep could be lost through the early stages of worsted processing". In that case study, Merinos were kept in pens with purebred Awassi adult sheep. It was found that levels of pigmented and kemp fibres declined by 89% and 95%, respectively, between scoured fleece and top. However, in another case study involving contact with Damara crossbred lambs, Fleet *et al*. (2006) showed the level of dark fibre (with length >10mm) in top was about 40 – 50% of that in the scoured fleece wool.

A previous report (Fleet *et al.,* 2006) showed the recently developed benzyl alcohol DMF test (AWTA *et al.,* 2004) when used on top produced results for dark fibre closely related to those obtained with Optalyser (IWTO-55-99). Furthermore, the benzyl alcohol test on top found levels of dark fibre that were 50% of the core sample test with 97% of the variation explained. In this report, we present outcomes of the benzyl alcohol test for dark and medullated fibre in raw wool, top and noil contaminated by Damara crossbred lambs.

MATERIALS AND METHODS

The materials and methodology for this body of work have previously been reported (Fleet *et al.* 2006). The experimental data set comprised of ten (10) lots generated by the South Australian Research and Development Institute (SARDI) through the introduction of different levels of contact between Merino and Damara animals as summarised in Table 1.

Table 1: Summary of the SARDI wools samples.

Sample	Expected contamination Level	Merino	Ram contact	Cross-bred lambs contact	When shorn (particulars)
1 & 2	Low	Ewes	Merino	No	8 months (end of mating)
3 & 4	Low	Ewes	Damara	No	8 months (end of mating)
5 & 6	Medium	Ewes	No	Yes	8 months (3.5mths after weaning)
7 & 8	High	Ewes	No	Yes	7.5 months (day after weaning)
9 & 10	High	Lambs	No	Yes	7 months

Using Draft TM-13-01, individual fleece measurements were performed to determine the initial level of contamination (Fleet *et al.,* 2002) and thus the order of processing was determined (Table 2). Batches were processed by CSIRO-TFT in Geelong in order of increasing levels of dark and medullated fibre contamination. CSIRO developed and implemented techniques to ensure no extraneous contaminant fibres were introduced during processing. All batches were combed once on a NCS PB29 comb, with a noil or ratch setting of 34mm. In addition to top, all by-products were collected including the front box noil, which is the main focus of this report.

It is recognised that variation of comb settings influences the sliver cleanliness as well as the top:noil ratio (Wetzold and von Bergen 1970) and that re-combing can also improve sliver cleanliness. The mini-scale processing was intended to imitate commercial practice. While machinery adjustments and re-combing could have been adopted to improve sliver cleanliness this was not a goal of the project.

Table 2: Processing order of batches based on fault length for the expected levels of pigmented and medullated fibres in the raw staple wool (based on individual fleece sample measurement using Draft TM-13-01).

Batch	Processing Order	Pigmented fibres per 10g scoured staples 3-10mm	11-25mm	>25mm	Medullated fibres/10g[A]
1	1	0.08	0.04	0.08	0.00
2	2	0.06	0.08	0.08	0.00
3	3	0.08	0.16	0.10	0.00
4	4	0.20	0.06	0.10	0.04
5	5	8.75	5.86	3.05	0.32
6	6	8.99	4.50	1.94	0.41
7	9	17.73	15.89	13.54	1.90
8	10	32.92	17.54	14.86	3.66
9	7	9.73	9.01	6.60	5.01
10	8	13.69	10.12	9.59	6.02

[A] Qualifying fibres had pronounced medullation occupying greater than 50% of the fibre diameter for >10mm in length as determined using 100x magnification.

Sampling the Noil

The method for the sampling and measurement of noil have previously been reported (Fish *et al*, 2006), and will be repeated here for completeness.

The benzyl alcohol based DMF test, developed by AWI, AWTA and CSIRO (AWTA *et al*. 2004), was used to measure the number of dark and medullated fibres in noil. A single layer of noil was arranged on a flat surface. A 3 x 4-hole sampling board was placed over the noil, and sufficient material sampled through each hole until a 5g sub-sample had been obtained (approximately 0.4g per hole). The sampling board was repositioned and sufficient 5g sub-samples taken until there were 4 x 5g sub-samples per sample. A total of 3 x 20g samples of noil for each lot are reported (Figure 1). Due to the homogenous nature of the noil, it was not Shirley Analysed prior to sampling, so it retained some vegetable fault. The minimum dark or medullated fibre length to be measured was increased from 3mm (core sample) to 10mm (top and noil) to comply with specifications set out in current IWTO Methods for detection of Dark Fibres in tops (IWTO-55-99 and Draft TM-13-01 both of which specify a minimum dark fibre length of 10mm).

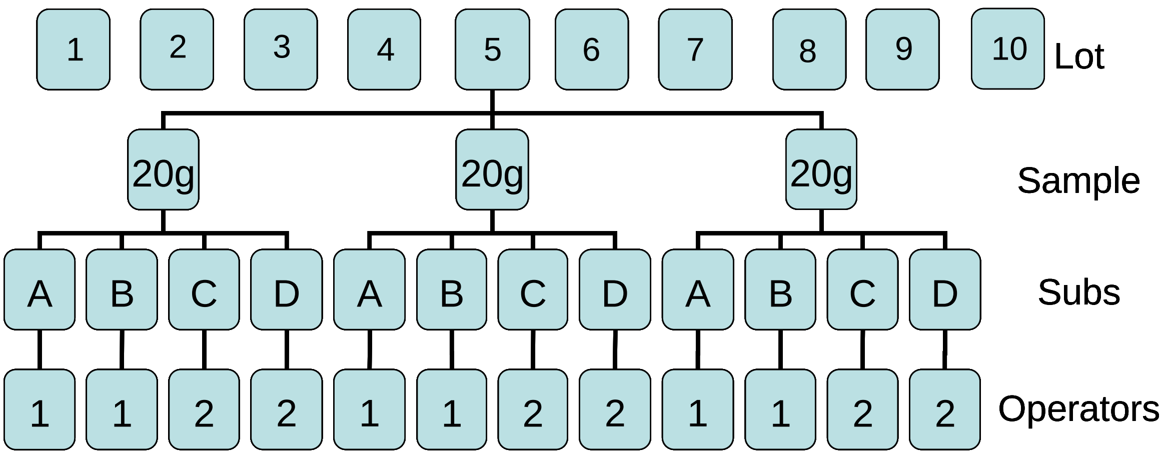

Figure 1: Schematic diagram showing the measurement of noil for dark and medullated fibre

Note: The dark and medullated fibre results are reported on a conditioned mass basis from a climate controlled room.

RESULTS AND DISCUSSION

Top and Noil Yield Comparisons

Despite starting with similar greasy wool weight (22–25kg) and using the same ratch setting (34mm) on the comb, there were marked differences in the weight of noil produced; especially for the lambs wool (batches 9 and 10). Feedback from CSIRO (Dennis Jones, pers. com., 2006) indicated that problems were encountered in combing the shorter wool batches (9 and 10) so the fibre overlap setting was altered to give the sliver more strength and the length of drawing was offset to suit the fibre length. Either these machinery changes, or differences in the greasy wool, or a combination of both have influenced the amount of noil product; varying between 2.7–12.6% of the top and noil weight (Table 3).

Table 3 shows the top and noil yields for the ten (10) batches. As would be expected the two (batches 9 and 10) batches of lambs wool had higher noil contents than the others.

Table 3: Comparison of the noil produced per sample, with the production of top.

Batch	Process order	Weight (kg)			Top as % of (Top + Noil)	Noil as % of (Top + Noil)
		Top	Noil	Total		
1	1	13.45	0.767	14.217	95.60	5.40
2	2	14.05	0.782	14.832	94.73	5.27
3	3	13.69	0.452	14.142	96.80	3.20
4	4	13.87	0.486	14.356	96.61	3.39
5	5	13.34	0.375	13.715	97.27	2.73
6	6	13.46	0.394	13.854	97.16	2.84
7	9	12.57	0.470	13.040	96.40	3.60
8	10	12.18	0.449	12.629	96.44	3.56
9	7	8.95	1.106	10.056	89.00	11.00
10	8	8.73	1.260	9.990	87.39	12.61
Average		**12.429**	**0.654**	**13.083**	**94.74**	**5.36**

Comparison of the Dark and Medullated fibre levels in the different components

Fleet *et al.* (2006) reported the relationship between raw wool and top on these same processing batches. Table 4 shows the levels of dark and medullated fibre present, as determined by the benzyl alcohol method, with length threshold set at 3mm for the core and 10mm for the top and noil.

The expectation would be that the more noil produced, the more dilute the incidence of dark or medullated fibres, given there was similar basis for separation of the contaminant fibres. In order to take this into account, the dark or medullated fibre content were adjusted to equate to the average noil yield of 5.36% and average top yield of 97.74%, by the formulae:

NAJ = actual count x [actual % noil / 5.36],

TAJ = actual count x [actual % top / 94.74],

where NAJ is the Noil Adjusted Count, and TAJ is the Top Adjusted Count.

Table 4: Comparison of the dark and medullated fibre contents for cores, tops and noil (fibres/10g). Proportion-adjusted top (TAJ) and noil (NAJ) counts.

Batch	Dark fibre (Df) / 10g				
	Core (≥3mm)	Top (≥10mm)	TAJ (≥10mm)	Noil (≥10mm)	NAJ (≥10mm)
1	0.00	0.04	0.04	3.83	3.86
2	2.16	0.34	0.34	2.88	2.83
3	2.59	0.22	0.22	2.83	1.69
4	0.00	0.22	0.22	4.21	2.66
5	5.60	2.89	2.97	36.58	18.63
6	9.48	2.84	2.91	59.54	31.55
7	29.31	14.40	14.65	136.33	91.56
8	27.59	14.57	14.83	250.08	166.10
9	29.31	13.49	12.67	50.04	102.69
10	23.28	8.84	8.15	42.89	100.90
Batch	Medullated fibre (Mf) / 10g				
	Core (≥3mm	Top (≥10mm)	TAJ (≥10mm)	Noil (≥10mm)	NAJ (≥10mm)
1	8.62	3.15	3.18	1.50	1.51
2	9.05	5.82	5.82	4.79	4.71
3	9.05	2.93	2.99	1.29	0.77
4	6.47	6.03	6.15	2.63	1.66
5	5.17	4.14	4.25	5.88	2.99
6	4.74	3.02	3.09	9.63	5.10
7	12.93	10.26	10.44	75.21	50.51
8	172.41	11.85	12.07	56.71	37.67
9	63.79	22.76	21.38	44.51	91.35
10	93.1	16.42	15.15	52.39	123.25

Table 4 shows the differences in the count of dark and medullated fibres detected in core, top and noil samples. In the case of dark fibre, higher count levels existed in the noil compared with the top. Whereas, in the case of medullated fibre the count is higher in the top than in the noil for batches 1-4, with the reverse situation for batches 5-10.

The level of medullation in batches 1-4 was unexpected because the Merino fleeces comprising batches 1 and 2 had no contact with sheep other than Merinos. Likewise, the ewes whose fleeces formed batches 3 and 4 were exposed to a single Damara ram (1 ram:65 ewes) for a period of 5.5 weeks. The medullated fibre count being lower than for top in batches 1, 3 and 4 may indicate some of the fibres identified as medullated in these lots may be long 'wool' fibres with fragments of medulla. Balasingam and Mahar (2005) found relatively high levels of medullated fibre in Merino lots (especially lambs wool), with the same threshold being used for the wool in that study.

Figures 2 to 5 show that the content of dark or medullated fibre present in noil increases with the corresponding levels present in the core sample. Simple linear regressions were undertaken using SAS (2006).

The estimated slope of any regression will differ from unity because of two factors. Firstly, the measurement procedures for the core test, top test and noil test use different length limits for counting dark and medullated fibres; and secondly, the impact of fibres being cut during coring or broken during processing will change the total fibre count from what was in the unprocessed wool. However, Fleet et al (2006) found the benzyl alcohol core test result for dark fibre (even though based on 3mm length threshold)was almost equivalent (0.95-fold) to the result obtained with scoured staple wool (using Draft TM-13-01 and the 10mm dark length threshold).

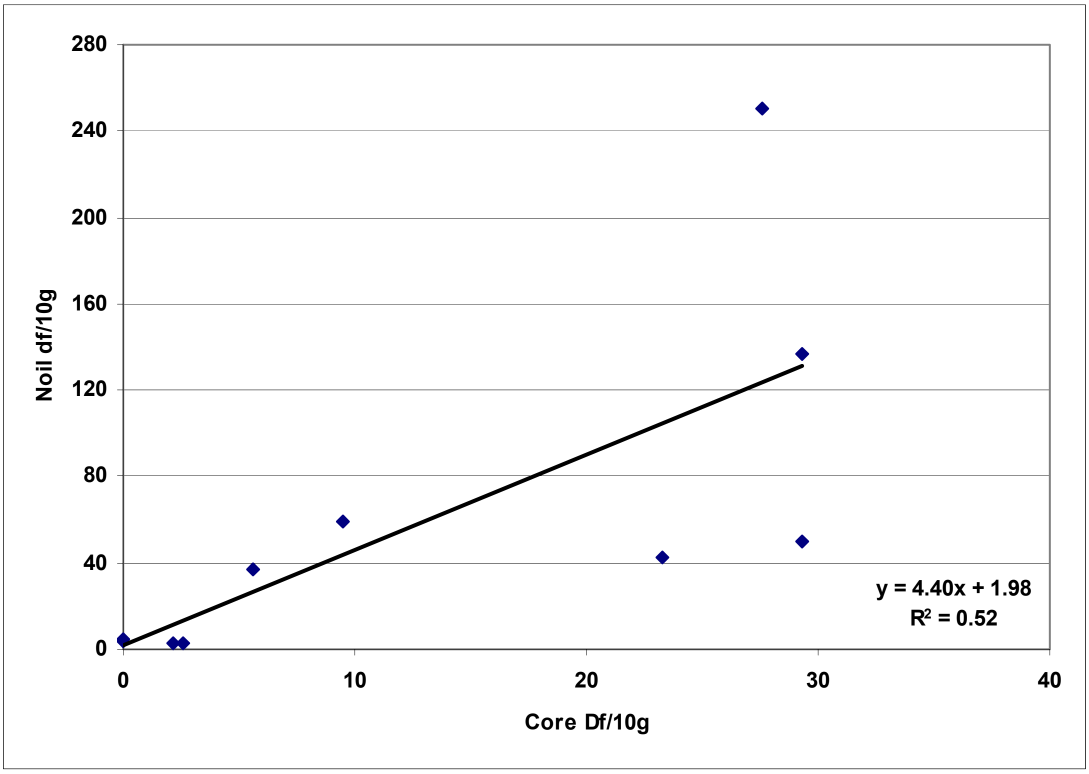

Figure 2: Relationship for dark fibre (Df) content of noil and core sample

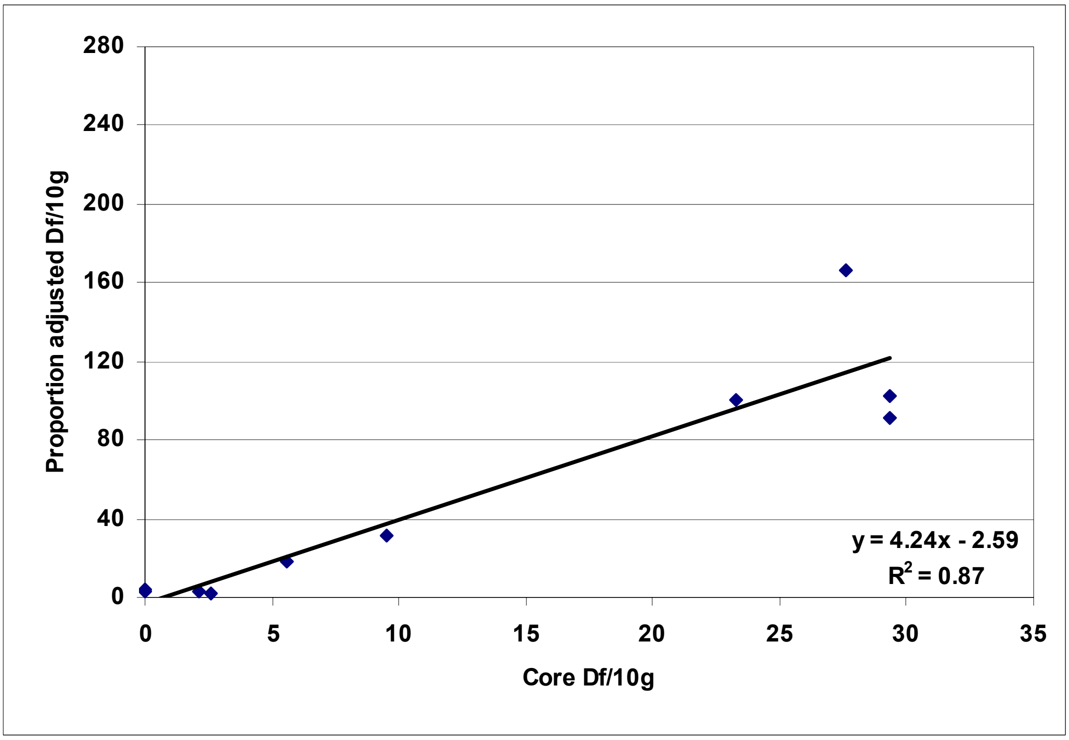

Figure 3: Relationship for dark fibre (Df) of portion-adjusted noil (NAJ) and core sample

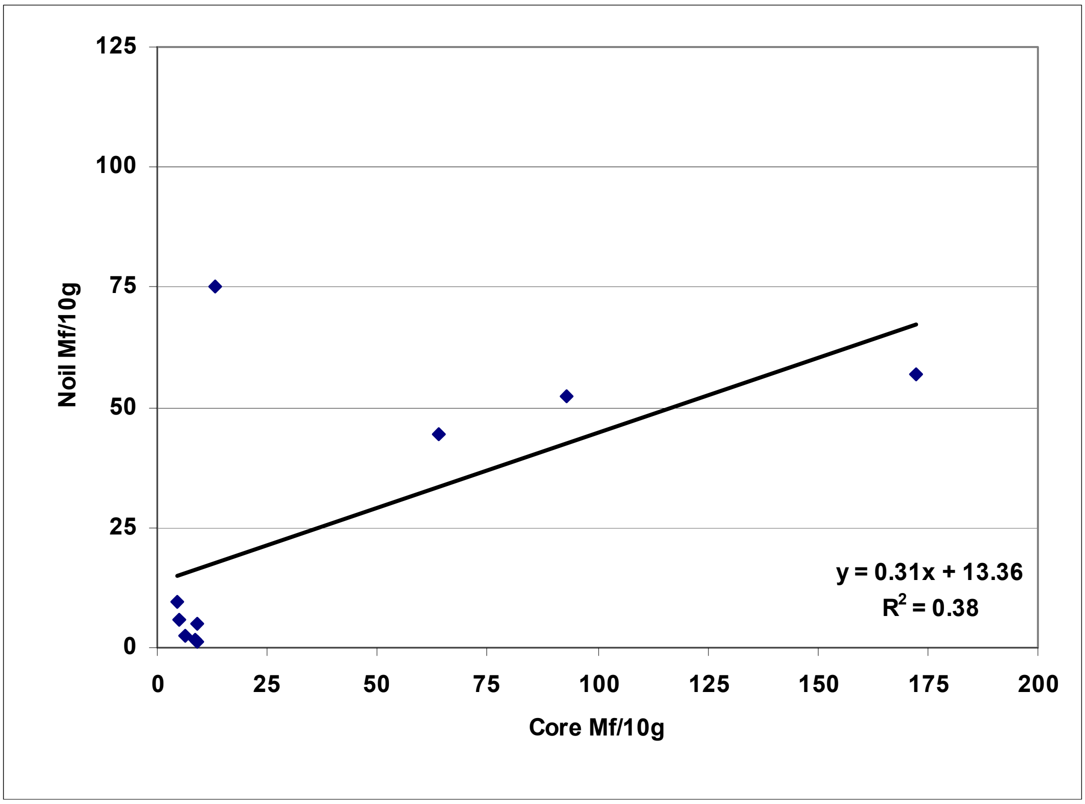

Figure 4: Relationship between medullated fibre content of noil and core

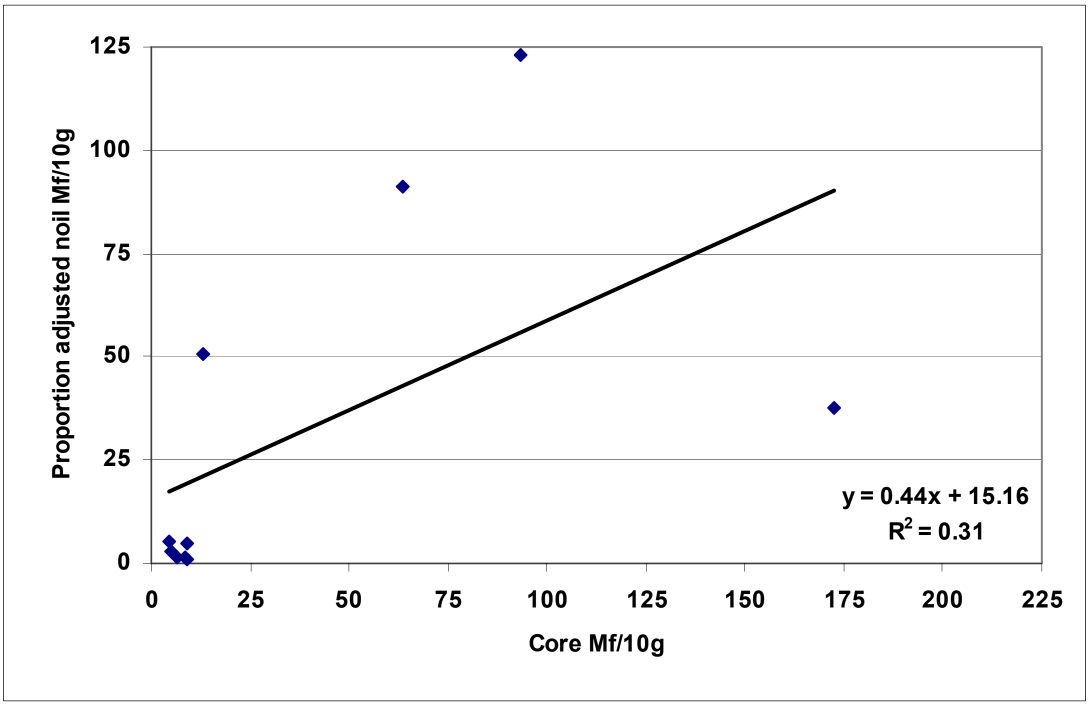

Figure 5: Relationship between medullated fibre content in core and adjusted noil count

For dark fibre, the noil content was 4.40-fold that of the core sample (P=0.019), the intercept (1.98) was not different from zero and the model R^2 was 0.52. Using the proportion-adjusted noil (NAJ) dark fibre content in top was 4.24-fold that of the core sample (P<0.0001), the intercept (–2.59) was not different from zero, and the model R^2 was 0.87. For comparison, Fleet *et al.* (2006) reported that the content of dark fibre in top was 0.49-fold that of the core sample, with 97% of the variation explained.

The relationships for medullated fibre (Figures 4 & 5) were not as strong (R^2 = 0.38 and 0.31, respectively) as those for Dark Fibre. The regression models for medullated fibre in the noil or proportion-adjusted noil (NAJ) and the core sample were not significant (*P*=0.058 and 0.096, respectively). The trend line slopes were 0.31 and 0.44 respectively. The statistics for both relationships are heavily influenced by one result (batch 7 in the unadjusted results, and batch 8 in the noil adjusted figures). More work is required to clarify these relationships.

CONCLUSION

Both top and noil products become contaminated by dark and medullated fibre contamination from Damara crossbred lambs reducing the flexibility of end-use and downgrading their value. The noil contained a higher proportion of the shorter dark and medullated fibres than the top reflecting one of the functions of the combing - removal of short fibre. Based on a top:noil ratio of 95:5 (being the average result for this study) the dark fibre content in the noil was 4.24-fold that of the core sample test with 87% of the variation explained. The relationship for medullated fibre content were not as strong as those observed for dark fibre content due to one of the batches having a marked influence on the calculated relationship.

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