RESISTANCE TO COMPRESSION OF WOOL IN MIXED-AGED FLOCKS[1]

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ABSTRACT - Estimates of resistance to compression (adjusted for variations of both crimp frequency and fibre diameter) of 1852 wools derived from Corriedale breeding flocks varying in age composition (2-6 years old), where age group was pooled over four sampling years, were examined. Data are presented showing that age group did not influence the slope of the regression line of resistance to compression on crimp frequency and fibre diameter; however, the height of these lines (adjusted to a common value of crimp frequency and fibre diameter) were quite variable among age groups. It can therefore be expected a differential in processing performance of wools from flocks of different age structure. In addition, the non-significant contribution of fibre diameter on predictions of resistance to compression was confirmed.

Index terms: sheep, crimp frequency, fibre diameter.

RESISTÊNCIA À COMPRESSÃO DE LÃS EM REBANHOS OVINOS DE IDADE VARIADA

RESUMO - Estimativas de resistência à compressão (ajustadas para variações de freqüência de ondulações e diâmetro médio das fibras) de 1.852 lãs oriundas de rebanhos de cria Corriedale de diferentes idades (2-6 anos), foram examinadas. Dados são apresentados mostrando que a idade não influenciou a tendência da linha de regressão de resistência à compressão sobre freqüência de ondulações e diâmetro da fibra; entretanto, a altura destas linhas (ajustadas para valores comuns de freqüência de ondulações e diâmetro de fibra) foram muito diferentes entre os grupos de idade. Portanto, pode ser esperado um diferencial no desempenho de processamento de lãs de rebanhos de diferente estrutura de idade. Foi observada, também, a não-significante contribuição do diâmetro de fibra nas predições de resistência à compressão de lotes de lã.

Termos para indexação: ovelhas, freqüência de ondulações, diâmetro de fibra.

INTRODUCTION

The implications of resistance to compression (force required to compress a mass of wool to a specific volume) on the performance of wool at the different phases of processing, and on yarn and fabric properties, have been reviewed by Kurdo (1985). In general, it has been demonstrated that resistance to compression is a small but significant contributing factor in the prediction of the performance of a lot of wool, during processing. As the measurement of resistance to compression is of value in determining both the end-product uses and processing difficulties of wool, it should be included as a routine measurement in specification of wool. In summary, wools of high resistance to compression have a lower entanglement propensity and, in terms of processing into tops, produce more card waste and noilage, and a reduced mean fibre length. Spinning performance and yarn quality are consequently inferior (Standard Association of Australia 1985).

Resistance to compression has been shown to be linearly and positively related to both

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crimp frequency and fibre diameter of raw wool (Sebestyen & Hickie 1971, Whiteley et al. 1978, Wilkins et al. 1981, Kurdo 1985), or to their product (Van Wyk 1946, Slinger & Smuts 1967, Turpie & Gee 1978, Wilkins et al. 1981). However, there seems to be a general consensus among authors with respect to the secondary importance of fibre diameter.

For wools of the same mean fibre diameter, processing performance therefore varies largely with resistance to compression which, in turn, is then basically determined by variations in staple crimp frequency or, more specifically, by variations in fibre crimp frequency and fibre crimp form (Kurdo 1985, referring to several studies). Thus, it can be assumed that one should not expect any marked variation in terms of resistance to compression for wools of fixed mean fibre diameter and staple crimp frequency.

In view of these statements, and considering the results obtained by Oliveira & Kennedy (1989) regarding the large variation in mean fibre diameter at a given crimp number in flocks of different breeds and age composition, and within different environmental conditions, this work inspects the extent of the age effects on the estimates of resistance to compression, adjusted to both crimp frequency and fibre diameter.

It is not the object of this study to discuss the magnitude of effects accounted for by those parameters related to single fibre crimp (not measured), yet any probable trend observed may partly be due to their effects.

MATERIALS AND METHODS

Data analysed in this study derived from a long term field experiment aiming at productivity of Corriedale breeding ewes run on native pastures at the Sheep Research Station of the Brazilian Agriculture Research Corporation - EMBRAPA - Southern Brazil.

A total number of 1,852 fleece midside samples were used in this study, drawn as recommended by Turner et al. (1953), Young & Chapman (1958), Sumner & Revfeim (1973). The numbers of observations for each age group investigated (2 to 6 years old) are given in Table 1 as the total age column. They were pooled over four sampling years, to minimize biases caused by different age groups run in different environments.

Measurements

Staple crimp frequency (FC) was recorded as suggested by Short & Chapman (1955). Test specimen sampling, preparation and conditioning procedures for resistance to compression (RC) measurements followed the method described in the International Wool Textile Organization (1975) for fibre diameter (FD). As both estimates were done on the same test specimen, RC measurements were taken first (Standard Association of Australia 1985). Data on RC and FD were obtained at the School of Fibre Sciences and Technology, The University of New South Wales, Sydney, Australia.

The resistance to compression machine used here compressed a 2.5 g wool mass in a 50 mm internal diameter cylinder to a height of 12.4 mm. Two readings from the "frozen" digital display were recorded by inverting the test specimen, and the average was converted to the nearest Kilopascal (KPa) value (Standard Association of Australia 1985), where $1 KPa = 10.2 g/cm^2$. All measurements were carried out between 15-18 hours after carding by the Shirley Analyser, which is within the time limit recommended (Standard Association of Australia 1985, Thompson & Whiteley 1985).

Data analysis

The predicted RC (Y) estimates from CF (X_1) and FD (X_2) in this flock of varying age composition,

TABLE 1. Number of sheep sampled within age group and year.

Age group (years)	Sampling years				Total
	1978	1979	1980	1981	
2	107	60	45	33	245
3	252	108	120	104	584
4	152	155	96	95	498
5			183	87	270
6			130	125	255
Total					1852

followed the procedures established for the combined covariance analysis, e.g., comparison of the within group age regression coefficients and adjusted group means at a given X variable. A similar covariance approach was summarized by McKinnon & Whiteley (1974) and Oliveira (1986). An additional analysis was performed, in which a term consisting of the product of the independent variables was examined (Van Wyk 1946).

RESULTS AND DISCUSSION

A summary of the covariance analysis comparing both the within group regression coefficients (part a) and the adjusted RC means between groups (part b) is given in Table 2. This shows that the slopes of the regression lines for the prediction of RC from CF and FD were similar among all age groups investigated. There was, however, a highly significant effect of age on the height of the regression lines, when these pass through the overall group mean. The results, therefore, indicate that, within the range of CF (2-12 crimps/2.5 cm) and FD (21.9-38.9 μm) examined, the mean RC corresponding to a given staple crimp frequency and fibre diameter was not the same at different ages.

TABLE 2. Covariance analysis: comparison between slopes and intercepts of the regression of resistance to compression on crimp frequency and fibre diameter within different age groups.

	Source	df	MS	F
b	Adjusted means	4	19.19	40.83**
	Polled age groups residual	1846	0.47	
a	Slopes	4	0.69	1.50ns
	Within	1842	0.46	

Bartlett's Test for homogeneity of within group residual variance $X^2 = 37.77$**

a F-Test for age groups regression coefficients
b F-Test for age groups adjusted means
** ($P < 0.01$)
ns ($P > 0.05$)

In Table 3, results on the within group, pooled (group average) and total analysis of regression are presented. In addition, the R^2 (in %) obtained from the analysis using X_1X_2 is given. The overall multiple correlation coefficient between RC and both CF and FD (0.369) was slightly higher than the simple correlation between RC and CF x FD (0.349). This trend is in agreement with Wilkins et al. (1981), although the values obtained here were lower. The overall results agreed with all authors previously cited, with respect to both the positive contribution of CF and FD to RC, and the secondary importance of FD in predicting changes in RC.

Both the within group and pooled prediction lines of RC at different crimp numbers (actual values) are illustrated in Fig. 1. The regressed values were adjusted to the overall FD, even though results in Table 2 have indicated its non--significant contribution to RC variations. The regression lines depicted in Fig. 1 highlight the strong tendency of younger sheep having wools of higher RC than older sheep at a given CF and FD.

The adjusted group means are shown in Table 4. Wools from all age groups, other than four and five years old, had a significant difference in RC value. The maximum difference occurred between two and six years old sheep; 0.8 KPa (or 8.2 g/cm^2), which may be regarded as a rather large difference.

It is difficult to explain this pattern without also considering possible variations in the single fibre-staple crimp frequency relationship among age groups, yet it appears that these could well be associated with the trends observed. A probable indication of their effect might well be given by the values of residual SD (in KPa) and R^2 (in %) for the prediction of RC at each age group (Table 3). Their values show that a better relationship between RC and FD was obtained as the age of the sheep increased. The results suggest that there may be a differential in single fibre-staple crimp relationship among age groups, within which older sheep wools show better correspondence between both traits.

TABLE 3. Regression analysis of resistance to compression on crimp frequency (X_1) and fibre diameter (X_2) in five age groups.

Age group (years)	Regression analysis				Model residual SD (KPa)	% variation for after X_i	Accounted adjusting: X_1X_2
	Intercept		β i value	Se (β i)			
2	6.56	X_1	0.192**	0.034		9.3	
		X_2	0.032ns	0.020	0.80	10.1	11.0
3	7.81	X_1	0.141**	0.024		7.8	
		X_2	0.011ns	0.013	0.72	7.9	6.1
4	6.37	X_1	0.210**	0.026		17.1	
		X_2	0.019ns	0.017	0.65	17.4	16.6
5	5.20	X_1	0.221**	0.034		14.2	
		X_2	0.045ns	0.024	0.61	17.5	17.5
6	6.27	X_1	0.165**	0.034		14.5	
		X_2	0.020ns	0.019	0.56	15.0	15.1
Pooled	6.75	X_1	0.178**	0.013			
		X_2	0.015ns	0.008	0.69		
Total	7.22	X_1	0.188**	0.014		13.6	
		X_2	0.003ns	0.008	0.72	13.6	12.2

** ($P < 0.01$)
ns ($P > 0.05$)

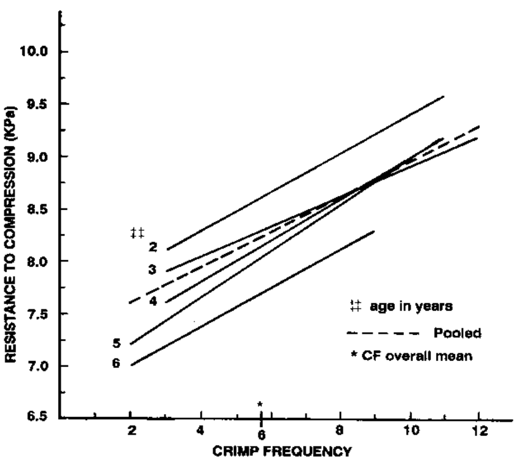

FIG. 1. Within age group regression lines of resistance to compression staple crimp frequency (adjusted to a common mean fibre diameter - 28.9 μm).

TABLE 4. Means of resistance to compression (RCa[1]), crimp frequency (CF) and fibre diameter (FD) within different age groups.

Means	Age (years)	RCa (KPa)	CF (crimps/ 2.5 cm)	FD (um)
Within group				
	2	8.6a	6.3	27.7
	3	8.3b	5.8	28.6
	4	8.1c	6.1	29.3
	5	8.0c	5.7	29.4
	6	7.8d	5.3	29.8
Total		8.3	5.9	28.9

[1] Adjusted to the overall CF (X_{1T}) and FD (X_{2T}) means using the pooled regression coefficients (β_{1P} and β_{2P}) of table 2 in the expression:
$Y_W - \beta_{1P}(X_{1W} - X_{1T}) - \beta_{2P}(X_{2W} - X_{2T})$ where W is the within group value.

Adjusted RC means not followed by common letter are significantly different ($P < 0.05$).

The results found for this sheep population broadly suggest that wool classing by staple crimp frequency as a mean of separating fleece lines of different RC values, could not be efficient if the age of the sheep is not considered. There does not appear to be any other comparative information, either on Corriedales, or other breeds, regarding the trends found. This additional source of variation upon resistance to compression should be taken into consideration when studies on this parameter involving wools from flocks of sheep with varying age structure are carried out.

CONCLUSIONS

1. Although the overall relationship between RC and both CF and FD, or even their product, was not as strong as reported in other studies, the direction of the contribution of both traits and the secondary importance of FD in predicting changes in RC were in agreement with previous findings.

2. The results indicated that the slopes of the regression lines for the prediction of RC from both CF and FD were similar at all age groups examined. However, it was clearly demonstrated that estimates of RC at the same CF and FD were quite different in several structures of age. Younger sheep produced wools with higher resistance to compression than older sheep.

3. It is believed that these trends would have a direct implication on processing of wool. It is likely that similar wools (considering CF and FD) would show different processing performance, if derived from sheep of different ages. In such circumstances, for example, wools from younger sheep would basically demonstrate more difficulties in processing, producing a yarn relatively inferior in terms of strength and softness (harsher handle).

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