Determination of Diameter of Loose Wool by Air Flow Method

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The diameter of loose wool was determined using an air flow apparatus and the results were compared with those obtained with a projection microscope. A linear relation was found between the average diameter and the height of air column. The effect of variation of diameter within a sample on the air flow value was also studied.

The Wool Industries Research Association’s (WIRA) air flow method for determining the fibre fineness is the single most widely used commercial method and has achieved the international standard for wool tops, cotton and jute. A simple and rapid technique, it gives a good measure of the mean fibre diameter; it is less sensitive to operator bias than the projection microscope method. Measurement of fibre diameter using a projection microscope is accurate but is time-consuming and impractical in many circumstances for large-scale experimental work. Earlier attempts to use the air flow apparatus for the estimation of fibre diameter of loose wool have been found to be satisfactory.

The U.S. Department of Agriculture, which conducted a study on samples of greasy wool homogenized on a small carding machine, found a curvilinear relationship between the float height and the mean fibre diameter determined by the projection microscope method. The standard error of estimate was ±0.82 μm. Working with Romney and its crossbred clean wools, Ross found that the standard error of estimate of fibre diameter observed on the WIRA air flow apparatus as compared with the projection microscope value was 0.92 μm. Lang and Wright suggested that careful hand-carding before testing was very important, as insufficient carding resulted in low micronaire readings.

The present investigation was aimed at determining the diameter of crossbred wools using the air flow apparatus and studying the feasibility of using this method as an alternative to the projection microscope method.

Materials and Methods

Sixty-two samples of Avivastra (crossbred) wool were used in the study, mid-side samples being taken as representative of the fleece in all cases. The samples weighing about 10-15 g were thoroughly cleaned with two changes of petroleum ether to remove grease, followed by hand-opening to remove extraneous matter like dust and vegetable matter. The cleaned samples were opened by being passed through the Laborimixer 2 to 3 times to get homogenized samples. Samples were conditioned at 65 ± 5% RH and 27 ± 2°C for 72 h before testing. From each sample, two subsamples of 2.5 g each were tested on the air flow apparatus according to IS: 6919-1973. The manometer reading (height of air column) was obtained at constant air pressure.

Projection microscope measurements were made on each of the sub-samples at a magnification of 500 x. The diameter was determined by using a projection microscope according to IS: 744-1977. The average fibre diameter, standard error and medullation percentage were calculated. The data were analyzed to obtain a relationship between the diameter and pressure from air-flow test and to compare the diameter obtained by using a microscope with that estimated from air-flow measurement.

Results and Discussion

The average diameter of the wool samples measured on the projection microscope ranged from 19 to 29 μm and the corresponding range for the standard error was 0.21-1.04. Of the 62 samples studied, 43 had less than 10% medullated fibres and the remaining had nearly 10-20% medullated fibres.

A linear relationship was found between the microscopic diameter D and pressure of air column P, the regression equation being:

\[ D = 14.55 + 0.987P \quad \ldots \ (1) \]

The correlation coefficient being highly significant with \( F = 111.04 \) and the correlation coefficient \( r \) being 0.8. This relationship is shown in Fig. 1. The scatter in this figure is largely due to the variation of the diameter within each sample. To account for the effect of this variation, the standard error (SE) obtained from the microscopic method was taken as the second independent variable and another regression equation was obtained:

\[ D = a + bP + cSE \quad \ldots \ (2) \]
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**Fig. 1—Relationship between the height of air column and microscopic diameter**

\[ D = 14.02 + 0.710 \, P + 7.05 \, SE \]  
(both regression coefficients are highly significant with \( F \) values of 59.70 and 153.50 respectively; correlation coefficient \( r = 0.9 \)).

This regression equation has a higher \( r \) value and this shows the effect of within-sample variation of diameter on the air flow value.

From Eq. (1) the estimated diameter values were calculated for each sample from the observed pressure of air column and this was compared with the diameter obtained using the projection microscope method.

The data yielded a linear relationship between these two parameters (Fig. 2). The regression equation is:

\[ D_e = 0.3527 + 0.9827 \, D_m \]  
(correlation coefficient \( r = 0.8 \))

where \( D_e \) is the estimated diameter and \( D_m \), the diameter obtained from projection method. \( \chi^2 \) test for the comparison showed that the diameter values were closely related. The diameter was also estimated from the tables supplied with the WIRA air-flow apparatus. \( \chi^2 \) test showed that the diameter calculated from Eq. (1) was closer to the diameter obtained from the projection microscopic method. Hence the suitability of this method for estimating the diameter of loose wool from the air-flow method.

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**References**