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PRECISE MEASUREMENT OF WOOL FIBRE DIAMETER USING COMPUTERIZED PROJECTION MICROSCOPE

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ABSTRACT

A study was conducted to measure wool fibre diameter and medullation using advanced computerised projection microscope with image analysis software and results were compared with conventional microscope method. The variations in fibre diameter measured by two methods were significant at 5% level. However, the standard deviation and coefficient of variation of fibre diameter was lower for computerized microscope system than conventional microscope method. The new system provides quicker, reproducible results and requires less manpower as compared to conventional system.

Keywords: Image analysis, Medullation, Projection microscope, Wool fibre

Fibre diameter is the most important characteristic that determines quality and price of wool. Indian wool is known for its coarseness and presence of medulla. Medullated fibres are characterised by a central canal containing cell residues and air pockets, running either as continuous or fragmented form along with their length (Smuts and Hunter, 1987). The medullated fibres in wool are viewed different by the naked eye against a background of surrounding fibres. They appear chalky white and apparent unable to dye to the same shade as a normal solid fibre. They make the fabric stiff. Therefore, their accurate measurement is very important for wool processing.

In India, projection microscope is the well established technique for wool diameter and medullation measurements. It has certain disadvantages. First, it is laborious and time consuming. Secondly, the results vary from person to person, since precise readings of fibre on millimetre scale of microscope screen is cumbersome and requires skill. Moreover, results are not reproducible because of the manual paper work and non-availability of soft computing. The projection microscope method is a direct method of measuring fibre medullation but, it is unsuitable for extensive use both in commercial and research due to the cost involvement. The average time taken by two operators to measure 500 fibre sites is approximately two hours and the method relies on a considerable amount of interpretation by operators. It is known that wide variation occurs in the results (Kritzinger et al., 1964).

The medullation has three different categories, namely, hetero, hairy and kemp. Medulla of hetero type has irregular scale pattern while hairy type medulla has mosaic scale pattern and complete absence of crimp. Kemp fibres are chalky white in colour and tapering towards the tip. The kemp fibres are comparatively brittle and lack resilience. Highly medullated or kemp fibres has very thin walls that collapse to a flat ribbon (Baxter, 2001, 2002). New developments in the area of digital image processing facilitate accurate measurement of fibre diameter and help to store fibre images. The basic measurement principle is same but operation of equipment is userfriendly so it is quick, reliable and requires less human skill. The aim of the present study was to compare the performance of the computerized microscope installed with image processing software and conventional overhead microscope for measuring fibre diameter and medullation.

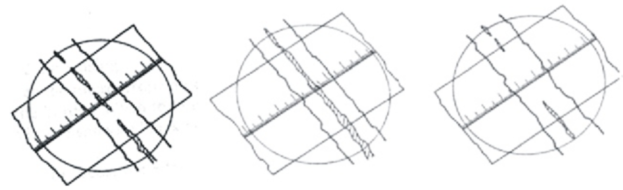

Plate 1. Fibre images of different types of medulla during projection microscope measurement

MATERIALS AND METHODS

Chokla sheep wool obtained from Central Sheep and Wool Research Institute, Avikanagar was used in the present study. Fourty-two wool samples were drawn at random for measuring the fibre diameter and medullation. The fibre diameter was measured according to the International Wool Textile Organisation-8-97, 1989 standard test method. The raw fibres were cleaned and degreased in liquid petroleum ether followed by conditioning at standard atmospheric conditions (temperature 27±2°C and relative humidity 65±5%) for 24 h. The degreased samples were separated and loaded in the sample holder of microtome, where snippet was prepared. The small snippet was put on a clean glass slide, with the help of mounting media and covered with a cover slip. Profile images of short pieces of fibres in the glass slide were projected on screen. The diameters of fibres were measured by means of a graduated scale (Plate 1). The readings were recorded in certain class intervals and multiplied by four to simulate it to 1000X magnification. ProgRes® CCD camera was used to capture the fibre images on computerized projection microscope. ProgRes® CapturePro 2.8.0 software was used for image processing. The camera was integrated with microscope via C-Mount and USB 2.0/ FireWire interfaces. The data were analyzed by analysis of variance (ANOVA) using the general linear model of SPSS 13.0.

RESULTS AND DISCUSSION

The mean fibre diameter obtained by computerized microscope (PM-IA) was higher for the same fibre lot with lower standard deviation and coefficient of variation as compared to conventional microscope (PM) (Table 1). The new system had more consistent results as compared to conventional microscope. It was attributed to automatic counting of stationary image and no human judgement since the software automatically measure and record accurate value of each reading. It had eliminated manual paper work and reduces degree of variability. The diameter readings by both the methods were comparable and significant reduction in CV % of computerized microscope led to more quick, precise and reproducible measurement of fibre diameter.

A good correlation was found between the two systems with correlation coefficient (R^2) of 0.64 (Fig. 1). It indicates that image processing feature of computerized microscope provided comparable and reliable results to that of conventional microscope. The most likely cause of the limitation of further agreement between PM-IA and PM measurements was due to poor accuracy and precision of the PM measurement when relatively small numbers of fibres are examined.

Table 1. Comparison of fibre diameter (µ) measurement by computerized and conventional microscope

	Minimum	Maximum	Mean	SD	CV
Projection microscope with image analysis software	32.71	50.73	39.41	13.71	33.60
Conventional projection microscope	30.66	52.24	37.26	15.75	42.15

It was also found that the mean values of hetero, hairy and kemp % measured by computerized microscope were comparable with conventional microscope (Table 2). The range for each type of medullation was quite high. There was no significant difference for SD and CV between PM-IA and PM methods. However, the CV observed for PM-IA was relatively on higher side due to wide variation in the fibre itself. The fibre diameter obtained by computerized microscope was statistically significant with that of conventional microscope at 5% of significance level. It could be attributed to the high variability in the results obtained from conventional microscope method. Further, there was no significant difference between mean values of various medullations when measured with both the systems.

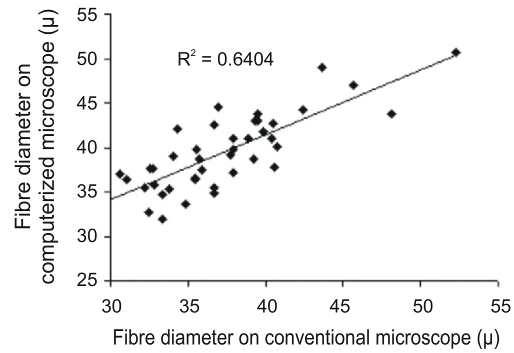

Fig. 1. Correlation between conventional and computerized microscope for fibre diameter

Table 2. Comparison of medullation (%) measured by computerized microscope and conventional microscope

	% Hetero		% Hairy		% Kemp	
	PM-IA	PM	PM-IA	PM	PM-IA	PM
Minimum	3.57	3.97	0.32	0.99	3.89	6.60
Maximum	36.76	32.18	88.89	91.96	94.95	98.67
Mean	13.70	12.16	12.16	13.66	25.86	26.00
SD	7.16	6.10	15.24	15.60	17.85	17.79
CV	52.30	49.51	125.29	114.19	68.90	68.44

PM-IA: Computerized projection microscope with image analysis software; PM: Conventional projection microscope

In conclusion, projection microscope with image analysis software had the same order of precision for measurement of wool fibre diameter and highly correlated with conventional measurement method. The fibre diameters obtained by new technique were more consistent and precise due to lower SD and CV%. Image processing enables to store the high quality images and results are reproducible. The combination of CCD camera and software make the microscope users friendly and increase the accuracy of diameter measurement. Medullations measured by the new system were comparable with conventional method. Further there is a scope of soft computing of the stored images for in-depth study of fibre diameter and medullation distribution within the fibre.

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