GRAVIMETRIC STUDY OF YIELD AND MEDULLATION OF BIBRIK WOOL

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A representative sample of a bibrik fleece of West Pakistan was sorted into three main types of fibres. The sample was degreased in benzene and studied by a chemical balance and specific gravity bottle for washing yield, density and medullation. Proportional method of sampling was employed to draw fibres from the three classes for the measurement of their stretched length. Difference in the mean length between any two classes of the fibres was significant at 0.01 level of confidence. Fibre density also varied from class to class. The relatively low density seems to arise from malnutrition which fosters the growth of inherited tendency of fibre medullation in Bibrik breed.

Introduction

The manufacturing potential and price of raw wool is mainly determined by its fibre fineness, length, colour, handle and yield as reflected in its suint, grease, dust and vegetable fault content. Where medullation is present, wool colour and handle are adversely affected since the medullated fibres appear to be chalky and harsh in handling. They also differ from the true wool in dye-uptake. Thus medullation can produce different shades in colour of the finished product.

Assessment of wool price is commonly based on its estimated yield which, for the purpose of the present work, is defined as the percentage of clean wool at standard conditions derived from degreasing a given weight of raw wool in benzene. The standard conditions are 65% relative humidity and 20°C at which equilibrium moisture content of wool fibres is about 16% regain[1] that is normally regarded as the British regain standard for wool commerce. The accepted regain standard may differ in the various commercial centres to suit their local atmospheric conditions. Regain is the percentage of moisture content expressed in terms of the weight of moisture-free wool.

Wool processing techniques, such as carding, combing and drafting are usually adjusted according to the length of fibres being processed. In view of these technological significances the study aims at estimating the following characteristics of Bibrik wool:

(a) Fibre length, (b) Density,
(c) Washing yield, and (d) Medullation.

Experimental

40 sub-samples each of 0.06 g were drawn by the random sampling method to represent an entire fleece of the Bibrik sheep variety. Each sub-sample was degreased in benzene[2] and sorted into their three main classes, viz., true, heterotype and kemp. The proportional method of sampling was used to draw fibres representative of the three classes for measurement of their stretched length. For this work a scale in inch was engraved on a black board.

As the sub-samples seemed too small in weight, four of them were combined to make one sub-sample of 0.24 g. Ten sub-samples thus obtained were studied by a chemical balance, specific gravity bottle and distilled water for yield, density and medullation. Dry weight was always taken at 20°C and 65% relative humidity. The Archimedes principle of buoancy was used to find the density of wool in each class.

MEASUREMENT OF MEDULLA IN KEMP FIBRES

Each fibre was mounted in cider wood oil and aligned as straight as possible on a slide by means of sliding to and fro a coverslip 4 cm long. The oil gave sharper definition of medulla than that could be achieved by liquid paraffin. The fibre was studied by a lanameter (magnification ×500) over its 4 cm length selected randomly and marked by China glass pencil. Continuous medulla was found almost in all the fibres.

Calculation.—The weighted mean fibre length (μ) of all classes was estimated as follows:

$$\mu = \frac{\Sigma\ c_i\ l_i}{100}$$

where C_i is the count percentage and li, the mean fibre length in the i^{th} class.

The difference between the mean length of any two of the three fibre classes was tested for significance by t-test (student ratio). However, the washing yield percentage was found from the difference in dry weights between given amount of raw and degreased wool weighed at standard conditions. Percent medullation by volume (Ph) in the sample of heterotypical fibres was calculated by the relation,

$$P_h = \frac{D_t - D_h}{D_t} \times 100$$

where D_t and D_h are density of true and heterotype wool respectively.[3]

This equation is valid for vacuole-like medullation as found in heterotype but is invalid for the type of medullation (network of collapsed cells) usually present in kemp. So, the percent medullation of the kempy fibres, P_k was obtained from microscopic study of the sample and the overall sample medullation (P) percent by volume was estimated as follows:

$$P = \Sigma \frac{W_i \ P_i}{d_i \times 100}$$

where W_i is the weight percentage P_i, percent medullation by volume and di, the density of wool in ith class of the fibres.

Results and Discussion

Table 1 summarises the percentages of fibres by count and weight, fibre length and density in various classes. The highest coefficient of variation 64.9% of weight percentage is recorded in the heterotypic fibres which, therefore, induces the corresponding variation in the fleece wool. Such irregularity of the fleece interferes with accurate yield estimation, efficient processing and uniformity of the finished product. Thus the heterotypic fibres can impair wool quality. But the medullated fibres are useful for tweed and carpet manufacture. A comparison of the sorting data (Table 1) with that in other carpet wool[4] shows the Bibrik wool to be more medullated. Hence the wool needs blending in proper proportion with the least medullated fibres so as to bring down the medullation of the blend.

TABLE 1.—DISTRIBUTION OF FIBRE TYPES, DENSITY AND MEAN LENGTH.

	True	Heterotype	Kemp
Count % (C_i)	65.2	6.8	27.9
Weight % (W_i)	40.1	6.4	53.4
Coefficient of Variation % of W_i	15.0	64.9	11.8
Density (d_i) g/cc	1.28	1.15	0.54-
Range of d_i g/cc	1.35-1.20	1.00-1.28	0.47 0.62
No. of fibres studied	2550	268	1090
Mean length (inch), l_i	2.65	2.45	2.05
Coefficient of variation % of l_i	2.56	2.20	2.58

Weighted mean $\mu = 2.47''$

Between mean length of heterotype and true fibres t (2816) = 45.6 (significant at 0.01 level).

Between mean length of heterotype and kemp fibres t (1356) = 110.2 (significant at 0.01 level).

The mean fibre length in the three classes differ significantly as found by t-test (Table 1). The mean length of the kempy fibres appears longer than one would expect. The reason is that the fibres shorter than 1″ which are mostly kempy and likely to be removed in early stage of the processing, were excluded for length measurements. Such length sampling will slightly lower the overall mean length 2.47″. Nevertheless, the mean length of the sample is shorter than that of ideal carpet wool.[5] The shorter length is due to biannual shearing of the Bibrik wool in West Pakistan.

The fundamental physical property, the density of matter is one of the means of distinguishing one substance from the other. The difference of density in the three classes of fibres, therefore, justifies the classification based on the subjective appraisal of the fibre characteristics. However, the mean density of the fibres are lower than that found by M. Ahmad[6] in Hashtnagri wool. He obtained 1.304, 1.172 and 1.160 g/ml as the density of true, heterotype and medullated fibres respectively (see Table 1). But the liquid used by him for density measurement is not known. Various degrees of wool swelling in different liquids can affect density measurement. Moreover, certain difference in physiological process of keratinization may produce different stratifications of α-keratin[7] inside a fibre giving rise to variable density of wool from breed to breed. The international critical table[8] provides 1.28 to 1.33 g/cc as the density of wool while the density of the Bibrik true wool is 1.28 g/cc. The technological significance of the low density is high covering ability of the fibres. But the low density of wool may arise from low protein content of the common fodder[9] of the Bibrik sheep. Further consequences of malnutrition may be as stated below.

Osmotic pressure due to solute derived from food and dissolved in the body fluids of an animal produces necessary blood pressure to counteract the atmospheric pressure compressing the animal from all directions. For example, high blood-pressure patients need reduced diet with minimum salt. Poor nutrition of a sheep can result in lower diffusion pressure in its body fluids than what is necessary to counterpoise the pervasive atmosphere. Consequently, more than normally required air is forced into the fibre-producing follicles. This excess air may occur as vacuoles of heterotype fibres or oxidise fibre cells producing network medullation of collapsed cell in kemp. This mechanism seems consistent to the medulla producing effect of exposure[10] after shearing when the normal nutrition level is relatively lowered by the additional thermal requirement of the sheep's homeostasis. Another relevant example is the initiation of hairy wool, *i.e.*, dogginess during the stress of nutrition.[11] Throughout the nutritional period, stress competition between the different types of follicle[12] remains unfavourable to the secondary follicles growing true wool fibres, since the blood supply to them is always via the relevant primary follicles usually, producing medullated fibres where the fleece is medullated. At the low level of nutrition the medullated fibres can grow at the cost of true wool fibres. These environmental agencies may account for the high percentage of medullation, 67% (Table 2) in the Bibrik wool. Moreover, fibre medullation is largely controlled by genetic propensity of the breed. Therefore, the breeding of the Bibrik sheep through selection breeding and improvement of its pasture with fertilizer practices are essential for reduction in the fibre medullation.

The washing yield 71.6% (Table 2) corresponds to the sample which was practically free from any vegetable fault. The range of yield of Asiatic carpet wool[13] is 65-75%. The high yield of the Bibrik wool (*i.e.* above the midpoint 70%) might result from poor secration of yolk usually associated with the low wool production during malnutrition. The coefficient of variation 36.2% shows variation in suint secretion and dust contamination in different parts of a fleece.

Table 2.—Yield and Medullation of Bibrik Wool.

Fibre characteristics	Mean values %	Coefficient of variation %
Yield	71.60	36.2
Medullation in heterotype (Ph)	8.60	77.5
Medullation in kemp (Pk)	67.23	17.5
Sample Medullation (P)	67.00	—

Conclusions

1. The Bibrik fleece comprises three chief types of fibres—true, heterotype and kemp which differ from one another in appearance, density and fibre length.

2. The heterotype fibres increase variation in in the wool weight which can produce corresponding unevenness in the yarn and hence in the finished product.

3. The low density of the wool seems to arise from low level of nutrition which accentuate the inherited propensity of fibre medullation in the Bibrik wool.

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