STUDIES ON CERTAIN CHEMICAL CHARACTERISTICS OF KAGHANI WOOL FIBRES

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A study has been made on various samples of Kaghani wool collected from Kaghan valley. Eight representative samples were analysed for certain chemical constituents and tested for physical properties. Wool with finer fibres contained a higher percentage of sulphur, wool wax and suint, but less ash, than did the coarser wool. The wool with fibres of larger diameters had a lower mean breaking stress and lower tensile strength but a higher mean breaking force and greater mean elongation than had the wool with finer fibres.

Results of the studies carried out on the characteristics of Kaghani wool fibres,[1] distribution and measurement of fibres[2] and relationship between breaking strength and diameter of these fibres[3] have already been published. Some of the chemical characteristics of these fibres have now been studied and the results are presented in this paper.

Experimental

The chemical methods employed in this study were those recommended by A.O.A.C. with certain modifications.[4]

1. *Scouring of Raw Wool.*—The raw wool was scoured in a bath at pH 10.6 containing one part by weight of detergent (Surf) and three parts by weight of sodium carbonate in one thousand parts of distilled water. The wool was treated thrice for five minutes with the scouring solution at different temperatures. The temperature of the first bath was kept at 50°C., the second at 40°C., and the third at 30°C. After scouring, the wool was rinsed repeatedly with distilled water as recommended by Von Bergen and Mauersberger.[5]

2. *Moisture.*—For moisture content, 5-6 g. of the wool sample were heated at 105°C. to constant weight in an air-oven. Samples were not conditioned previously for moisture content and were analysed under laboratory conditions.

3. *Ash.*—The wool samples (4-5 g.) was first heated at 105°C. in a covered crucible in an air-oven to expel moisture and charred over a burner until swelling had ceased. The crucible was then heated in a muffle furnace to about 800°C. for 4 hours.

4. *Nitrogen.*—A micro-kjeldahl method was used for the estimation of nitrogen content.

5. *Sulphur.*—For the estimation of sulphur, the Carius titrimetric combustion method was used.

6. *Wool Wax and Suint.*—Raw wool was first extracted with distilled water to remove suint and then with 60/80 petroleum ether to remove wool wax. About 10 g. of the raw wool were repeatedly stirred in three successive portions of 300 ml. of distilled water for five minutes to remove suint. The wool was removed and dried in an oven for wool-wax determination. The suint solution obtained was filtered and the filtrate evaporated to dryness and the residue weighed. For wax determination, the sample after drying was weighed and placed in a paper thimble and extracted in a Soxhlet apparatus by means of petroleum ether.

The determinations of wool wax and suint were carried out on the basis of the weight of the clean wool fibre content present in the sample, i.e. excluding dirt, earth and vegetable matter, wool wax and suint.[6] The analysis for wool wax and suint determinations was made on raw wool samples collected from privately owned herds in Kaghan valley. No history of previous washing etc. of the animals was available.

7. *Measurement of Diameter.*—Twenty fibres of each true, heterotypical and medullated type were taken separately from each representative sample. They were cut into pieces, mounted on a slide covered by a coverslip which was secured by glycerine. The magnification given by the lanameter used was ×500. The mean of the diameters of three types was calculated; this represented the actual diameter of that sample.

Results

The results of analysis of the samples arranged

according to the increasing average diameters of the fibres are given in Table 1. Each result represents the average of eight actual determinations conducted under laboratory conditions.

TABLE 1.—PERCENTAGE CONTENT OF DIFFERENT ITEMS IN KAGHANI WOOL HAVING FIBRES OF DIFFERENT DIAMETERS.

Samples	Diameter (μ)	Moisture (%)	Ash (%)	Nitrogen (%)	Sulphur (%)	Wool Wax (%)	Suint (%)
			Group A				
1.	26.6	13.0	0.8	15.7	3.7	6.1	2.0
2.	29.5	12.6	0.9	15.7	3.5	5.5	2.8
3.	30.6	12.4	1.0	15.6	3.3	5.2	1.8
4.	33.6	12.2	1.1	15.5	3.2	4.9	5.4
Mean	30.07	12.5	0.95	15.6	3.42	5.42	3.0
			Group B				
5.	37.2	11.8	1.2	15.4	2.9	4.0	1.1
6.	39.4	12.0	1.3	15.3	2.8	3.7	1.9
7.	45.1	12.4	1.4	15.2	2.7	2.5	2.9
8.	52.8	12.1	1.7	15.2	2.6	1.2	2.1
Mean	43.55	12.1	1.40	15.3	2.75	2.85	2.0
Mean of all the samples	36.81	12.3	1.18	15.5	3.088	4.137	2.5

Discussion

The present investigation is concerned with the determination of some chemical characteristics of the Kaghani wool fibres. These results are correlated to some of their mechanical properties such as tensile strength and diameter etc. The statistical analysis of the results have been determined according to the method of Shaw[7] and Youden.[8]

From the results of analysis (Table 1), it is found that the ash content of the samples ranges from 0.8 to 1.7 percent (average 1.2 percent). There is a significant correlation between ash content and diameter of the fibre; the ash content varies directly as the diameter of the fibre (Fig. 1). The coefficient of correlation is found to be +0.991 (standard error 0.0063). Fisher's t between ash content and diameter of the fibre was calculated and is found to be significant at both 1 percent and 5 percent level of significanc statistically. It was established that only a small proportion of the ash of the samples examined was present as sodium derived from soap used in scouring.

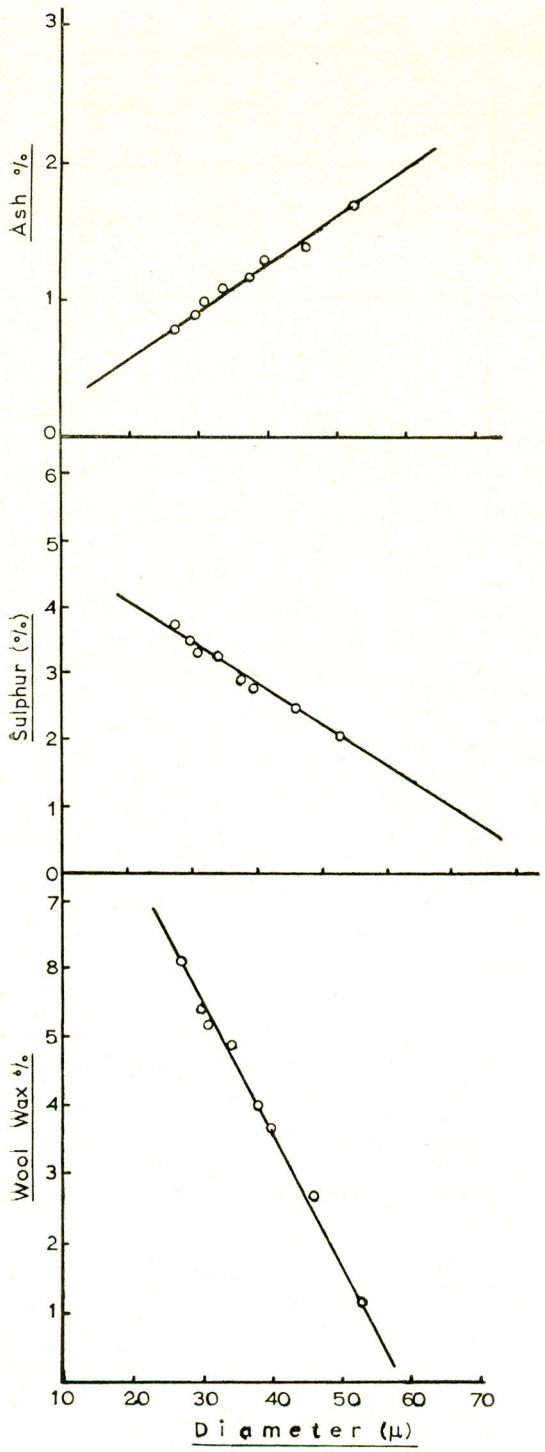

Fig. 1.—Showing the relationship between the diameter (μ) and Ash percent, Sulphur percent and Wool wax percent of Kaghani wool fibres.

The nitrogen content in the samples has an average value of 15.5 percent (range 15.2-15.7 percent). The value of nitrogen content obtained from different samples is found within the limits of accuracy of the analytical method employed, to be constant and not to vary with the diameter of the fibre.

The sulphur content of the samples has an average value of 3.0 percent (range 2.6-3.7 percent). It is clear from the data that the sulphur content increases with decrease in the diameter of the fibre (coefficient of correlation −0.957; standard error .030) i.e., the finer the fibre, the higher the sulphur content (Fig. 1). Fisher's t between sulphur content and diameter of the fibre was calculated statistically and found significant at both 1 percent and 5 percent levels of significance. Wool proteins contain comparatively large amounts of the amino acid cystine on which the important physical properties of wool depend.[9] Table 2 gives the relation between the diameter of the fibres and their mechanical properties.[1] From the two Tables it appears that fibres with the smaller mean diameter have the higher tensile strength and contain proportionally higher contents of sulphur. The analytical data for sulphur determination are probably not highly accurate and only relative values are intended to be given.

When the samples shown in Table 1 are split into two groups of A and B of 4 samples in each group, we find that the mean diameter of group A is 30.07μ with an average sulphur content of 3.42%, whilst in group B, the respective averages are 43.55μ and 2.75% of sulphur, respectively This also shows an inverse correlation to exist between the diameter and the sulphur content.

The average wool wax content in the samples was found to be 4.1 percent (range 1.2—6.1 percent). There is a marked relationship between the wool wax content and diameter of the fibre (co-efficient of correlation −.995; standard error .0035). The wool wax content decreases with the increase in the diameter of the fibre (Fig. 1). Fisher's t between wool wax percentage and diameter of the fibre was calculated and found to be significant at both 1 percent and 5 percent levels of significance statistically.

The suint content was found to be 3 percent in group A and 2 percent in group B. The higher suint percentage of the finer fibres is probably due to the larger number of wool fibres growing

TABLE 2.—VARIATION OF MECHANICAL PROPERTIES OF THE FIBRE WITH DIAMETER (1).

Samples	Diameter (μ)	No. of fibres tested	Mean breaking force (g.wt.)	Mean elongation (%)	Mean breaking stress (g.)	Tensile strength (P.S.I.)
1.	26.6	375	14.2	27.2	26.8	2704
2.	29.5	462	16.8	33.5	24.4	2514
3.	30.6	264	17.3	40.0	23.3	2402
4.	33.6	274	18.3	41.0	21.2	2049
5.	37.2	100	19.9	40.7	18.3	1649
6.	39.4	155	21.7	42.5	16.9	1524
7.	45.1	157	24.3	40.7	15.2	1387
8.	52.5	112	27.9	49.2	12.9	1160
Mean	36.81	237.3	20.0	39.3	19.9	1924

TABLE 3.—DATA SHOWING STATISTICAL ANALYSIS OF ASH, SULPHUR AND WOOL WAX PERCENTAGES OF KAGHANI WOOL.

Chemical constituent	Coefficient of correlation	Standard error of coefficient of correlation	Fisher's t		
			Found	Required	
				1%	5%
Ash ..	+ .991	.0063	18.255	3.707	2.447
Sulphur ..	— .957	.0300	8.080	3.707	2.447
Wool wax ..	— .995	.0035	24.620	3.707	2.447

per unit skin area and also to the larger total surface area of the fibres per unit weight.

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References

1. Mumtaz Ahmad, Sci. Ind., **1,** 99 (1963).
2. A.A. Wakil, Pakistan J. Sci. Ind. Res., **6,** 82 (1963).
3. A.A. Wakil and Amir Mohammad, Pakistan J. Sci. Ind. Res., **6,** 13 (1963).
4. John H. Skinkle, *Textile Testing* (Chemical Publishing Co. Inc., Brooklyn, New York, 1949), second edition, p. 10, 195, 196, 297.
5. Werner Von Bergen and Herbert R. Mauersberger, *American Wool Handbook* (Textile Book Publ. Inc., N.Y., 1948).
6. E. Vernon Truter, *Wool Wax Chemistry and Technology* (Cleaver-Hume Press Ltd., 1956), p. 4-5, 353-355.
7. F.J.F. Shaw, I.C.A.R. 16, India, *A Hand Book of Statistics*, Delhi (1936).
8. W. J. Youden, *Statistical Methods For Chemist* (John Wiley and Sons, Inc., New York, 1951).
9. R.W. Moncrieff, (Chemical Publishing Co., Inc., 212 Fifth Avenue New York, 1954), p. 30, 31.