Pakistan J. Sci. Ind. Res., Vol. 13, No. 4, December 1970

FELTING POTENTIAL OF PAKISTANI WOOL

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(Received November 26, 1969)

The feltability of Pakistani wools has been investigated and an attempt has been made to examine correlations between this parameter and natural variations in the different wool characteristics. Product of number of crimps/inch and fibre diameter has been found to be an important factor, affecting the relative felting behaviour of various wools.

Most Pakistani wools are coarse and the bulk is exported for carpet manufacture. Some studies have already been made on their characteristics.[1,2,3] Preliminary investigations have revealed that most of these wools possess good felting properties. In fact, coarse felts for floor coverings are made from these wools by hand in some parts of the country. It is, therefore, desirable to study their felting behaviour in order to assess their suitability for different end uses.

Although most of the studies have revealed the scale structure of the fibre surface as the fundamental characteristic that imparts felting ability to wool, the differences in the felting behaviour of different wools, however, are largely determined by other factors, especially the variations in crimp parameters with the dimensional characteristics of fibres playing a minor role.[4] In continuation of these studies it is worthwhile to examine Pakistani wools so as to establish the factors affecting their relative felting capacity.

An examination of feltability is of considerable importance for other reasons; high felting wool is keenly sought by the manufacturers of nonwoven commercial felts. Besides tightly structured fabrics are obtained by milling (felting) after weaving because the limitations of textile machinary do not warrant the production of such garments by weaving alone. Poor felting wool is highly valuable in the production of suiting and hosiery so that these products do not lose their shape in spite of frequent washing while in service.[5]

Materials and Methods

The wool samples representing 13 breeds were collected from different regions of Pakistan. The samples were cleansed as usual[6] and carefully hand-carded in order to obtain thoroughly randomized fibre assemblies. A well-known method[7] which consists of three dimensionally shaking a fixed quantity of wool (1g) in a bottle containing a felting medium for a given time (60 min), was employed. The diameter of the resultant ball gives an indication of the feltability of the wool, lower diameters signifying higher felting and vice versa. In our case 3 g of wool was used for each test in an endeavour to obtain more representative results and to accentuate the felting differences. After preliminary experiments, the testing conditions were fixed at 120 ml of 0.1N HCl at room temperature as the felting medium which was contained in a wide neck screw cap cylindrical bottle 7.57 cm long, 6.72 cm internal diameter. The bottle was agitated for 60 min at 180 rev/min on a three dimensional shaker (Gallenkamp). At least 2 balls were produced from each wool and the diameter was measured in three mutually perpendicular directions with a vernier calliper.

Staple length was determined by employing a foot-rule and fibre diameter was measured with the help of a projection microscope (lanameter) at a magnification of $\times 500$. Frictional coefficients were measured in 0.1N HCl as reported in a previous publication.[1] Two-inch lengths of five randomly selected staples were cut from the root side. One hundred fibres were withdrawn (20 from each staple) at random and number of crimps/in was determined for each breed. A histogram (Fig. 1) shows the frequency of number crimps/in for Kail breed and indicates the type of

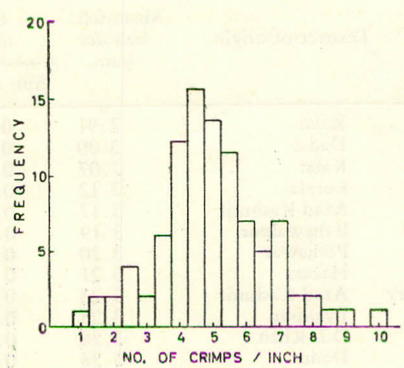

Fig. 1

variations encountered during these measurements.

Results and Discussion

Table 1 presents the change of ball diameter of Dumba wool with time and Table 2 lists the mean values of felt ball diameter, frictional coefficients, fibre diameter, staple length, number of crimps/in and the product of number of crimps/in and fibre diameter of the available wool samples. By visual judgement, the wools appeared to be either virtually crimpless or possessed regularly formed sinusoidal type of crimp except the crossbred Kaghani breed which had three dimensional (helical) crimp. All wool samples had some measure of medullation excluding Kail and crossbred Kaghani breeds.

As can be seen from Table 1, a decrease of more than 16% in ball diameter occurs within a span of 45 min (15 to 60 min) whereas further shaking for one more hour produces a change of only about 5%, justifying the selection of one hour as the shaking period. Shaking times of 15 and 30 min were not employed in order to avoid measurement difficulties associated with rather loose balls so obtained.

The felt-ball diameters are tabulated in the order of the feltability of the wools investigated (Table 2). The ball size varies from 2.91 cm

TABLE 1.—FELT BALL DIAMETER (cm).

Felting time (min)	15	30	45	60	120
Mean ball dia. (cm)	3.60	3.22	3.02	3.00	2.84

(Rakhshani breed) to 4.70 cm (crossbred Kaghani breed), the percentage difference in ball size is of the order of 61.5%. It can be seen that excluding the crossbred Kaghani wool, the difference in felt ball diameter among all other breeds is only about 16% which could be regarded as of little significance for practical purposes. In other words all these wools can be regarded having good felting properties and must, therefore, be shrink-proofed chemically or otherwise, if used for the manufacture of woven or knitted garments.

The reason for the extremely different felting ability of cross-bred Kaghani in comparison to the other breeds appears to be the difference in their crimp structure. It has already been demonstrated that wools possessing helical crimp are significantly poorer felters than those having straight fibres or fibres with sinusoidal crimp.[3,8,9]

Although, some of the earlier studies[8,10] have shown the direct dependence of feltability on the directional frictional effect (D.F.E.) this contention could not be verified in the present case as the frictional parameters studies were not related to the feltability of the breeds under investigation. Three of the breeds Hashtnagri, Kooka and Rakhshani have the same D.F.E. (0.25) but exhibited felt ball diameters of 2.91, 3.20 and 3.35 cm, respectively. Again Dumba, Baluchi and local country breed with the same D.F.E. of 0.22 produced felt balls of 3.00 cm, 3.21 cm and 3.23 cm, respectively. More especially Harnai and crossbred Kaghani breeds, possessing negligible different D.F.E. values of 0.16 and 0.14, gave felt ball diameters of 3.12 cm and 4.70 cm, respectively, differing by about 50%, thus excluding the possibility of a correlation between feltability and D.F.E.

TABLE 2.—WOOL CHARACTERISTICS.

Name of breed	District of origin	Mean felt ball dia (cm)	Frictional coefficients in 0.1N HCl		Directional frictional effect (D.F.E.)	Fibre dia (μ)	Staple length (cm)	No. of crimps/in	Product of no. of crimps/in — fibre diameter
			Anti scale	With scale					
Rakhshani	Kalat	2.91	0.70	0.45	0.25	34.6	8.5	2.8	97
Dumba	Dadu	3.00	0.61	0.39	0.22	41.2	7.9	1.8	74
Baluchi	Kalat	3.07	0.73	0.46	0.27	52.0	7.3	2.5	130
Harnai	Loralai	3.12	0.57	0.41	0.16	30.6	14.2	4.2	129
Kail	Azad Kashmir	3.17	0.65	0.39	0.26	27.2	8.4	5.0	136
Buchi	Bahawalpur	3.19	0.78	0.56	0.22	44.0	11.4	3.6	158
Hashtnagri	Peshawar	3.20	0.63	0.38	0.25	53.0	6.5	3.0	159
Kaghani	Hazara	3.21	0.64	0.42	0.22	33.8	5.4	4.5	152
Local Country	Azad Kashmir	3.23	0.64	0.42	0.22	37.4	7.0	4.2	157
Lohi	Lyallpur	3.25	0.74	0.46	0.28	39.9	8.8	4.2	168
Damani	D.I. Khan	3.26	0.73	0.44	0.29	41.1	7.0	4.1	169
Kooka	Dadu	3.38	0.73	0.48	0.25	49.3	5.0	2.7	133
Cross-bred Kaghani	Hazara	4.70	0.79	0.65	0.14	21.6	5.9	11.7	253

Vatiations in fibre diameter and staple length (Table 2) also do not appear to affect the feltability of the wools significantly in this investigation. An important point of general interest is that crossbred Kaghani which is the finest (fibre diameter 21.6μ) breed exhibits the lowest feltability (ball diameter 4.70 cm) in contradiction to the general trade opinion that fine wools are better felters. These observations are, however, in complete agreement with and confirm earlier reports.[3,8,9]

Crimp frequency alone has also been shown to affect the feltability significantly[4,8] but the present study did not reveal any such relationship which could be due to the exclusive use of carpet wools with the exception of crossbred Kaghani breed in this investigation instead of South African Merinos[4] or a combination of Australian Merino, English Long and Down wools.[8]

It has been shown that felting properties are largely controlled by the compressional resistance of wool i.e. better felting wools possess lower compressional resistance and vice versa[8] and since compressional resistance depends upon the product of crimp frequency and fibre diameter to a large extent,[6] it was decided to examine the effect of this product on feltability in detail.

Number of crimps/in × fibre diameter exhibited a highly significant (1% level) correlation of 0.86 with felt ball diameter. The regression coefficient of felt ball diameter on the number of crimps/in × fibre diameter was highly significant (1% level) and the latter accounted for 73.6% of the variations in felt ball diameter. The relationship follows the equation:

$$Y = 1.96 + 0.009X \quad (1)$$

where Y is the felt ball diameter and X the product of number of crimps/in and fibre diameter.

The actual values of felt ball diameter together with those estimated from equation (1) and the deviations are recorded in Table 3 and the effectiveness of number of crimps/in × fibre diameter in predicting the felting behaviour of the wools investigated in this study can be easily visualized. The highest differences are given by Dumba (12.33%) crossbred Kaghani (9.79%) breeds whereas the actual and predicted values of felt ball diameter are exactly equal for Harnai and only slightly different (0.31%) for Kail breed.

Besides helical fibres in crossbred Kaghani breed as stated earlier, various percentages of such fibres were also encountered, at least in some of the other wools e.g. Dumba, Baluchi, Lohi and Damani. A much better accounting of variations could, perhaps, have been possible if this factor was also taken into consideration since crimp frequency × fibre diameter and crimp configuration have been predicted to affect feltability significantly either singly or in combination with each other.[6] A few additional wool samples exhibiting felt ball diameter values between those of crossbred Kaghani and other breeds could have proved extremely useful in reaching more definite conclusions.

It appears that as long as fibres exhibit a directional frictional effect, they are prone to felting

TABLE 3.—ACTUAL AND PREDICTED VALUES OF FELT BALL DIAMETER (cm).

Breed	Actual	Predicted	Deviation	% Deviation
Rakshani	2.91	2.83	+0.08	+2.75
Dumba	3.00	2.63	+0.37	+12.33
Baluchi	3.07	3.13	—0.06	—1.95
Harnai	3.12	3.12	0.00	0.00
Kail	3.17	3.18	—0.01	—0.31
Buchi	3.19	3.38	—0.19	—5.95
Hashtnagri	3.20	3.39	—0.19	—5.94
Kaghani	3.21	3.33	—0.12	—3.74
Local Country	3.23	3.37	—0.14	—4.33
Lohi	3.25	3.47	—0.22	—6.77
Damani	3.26	3.48	—0.22	—6.75
Kooka	3.38	3.16	+0.22	+6.51
Cross-bred Kaghani	4.70	4.24	+0.46	+9.79

and the degree of felting is controlled by number of crimps/in × fibre diameter together with crimp structure to a large extent, although other surface parameters e.g. fibre diameter, length and D.F.E. could have slight influences.[3,4,8,11]

The carpet breeds under study can be profitably employed for the production of nonwoven commercial felts and rugs. The crossbred Kaghani wool, on the other hand, can be safely employed in the manufacture of hosiery and suiting fabrics. After a very slight chemical or other shrink-proofing treatment, this fine wool could become an important raw material for our manufacturing industry and, once grown in sufficient quantities, could help reduce the import of such wool.

Acknowledgement.—The authors wish to thank the Directors of Animal Husbandry Department of various regions in West Pakistan who supplied the carpet wool samples employed in this study. Thanks are also due to Dr. S.M.A. Shah for his useful suggestions. The assistance by Mr. A.A. Halim, Junior Technician, in carrying out the experimental work is thankfully acknowledged.

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