STUDIES ON THE TENSILE CHARACTERISTICS OF THE LOHI WOOL

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Studies have been made on various samples of Lohi wool collected from the home tract of the breed. It has been tested for diameter, breaking strength, elongation and subsequently stress, tenacity and tensile strength have been calculated. The tensile properties of True, Heterotypical and Medullated wool have also been compared with that of Kaghani, Hashtnagri and Harnai wool.

Introduction

It has been found necessary [1] to find out the tensile characteristics which are important factors in the finished product of all types of wool existing in West Pakistan. Wakil and Amir [2,3] while working on Kaghani and Harnai wool for tensile characteristics have pointed out that it can be used for the manufacture of medium to low quality cloth from the strength point of view. Mumtaz [4] in this respect has also worked on Hashtnagri wool. The present paper deals with the tensile properties of Lohi wool. For this purpose three types of wool fibres i.e., True, Heterotypical and Medullated of 40 Lohi wool samples collected from Lyallpur, Multan and Montgomery (where 5.5 million sheep,[5] yielding 4-5 lbs. of wool/sheep annually are found) have been tested for breaking strength, elongation and subsequently the stress, tenacity and tensile strength have been calculated. The co-efficient of variation of diameter, elongation and breaking-strength of Lohi wool have been compared with the three breeds already tested. The relation between diameter and breaking strength, and diameter and stress of three types of wool fibres was also studied. The strength testing was carried out on a single fibre testing machine, while diameter was measured on projection microscope (Lanameter). As kempy fibres are very scarce in all the samples tested, these are not included.

Experimental

1. *Medullation.*—The representative samples from Lohi wool samples were cut down [6] to 1″, 2″ and 3″ length and weighed .03 g., .06 g. and .09 g., respectively. Each such sample was sorted out for True, Heterotypical and Medullated wool fibres with the help of benzene test.

2. *Dynamometric Measurements.*—A Schopper dynamometric apparatus with clamps 1 cm. apart and a pre-tension of 500 mg. weight was used. The length of the fibre between the two clamps of the hydraulic type single fibre testing machine was adjusted accordingly. The flow of water was maintained in such a way that the time to break the fibre was at least 20 seconds. The breaking strength and elongation were recorded from the dynamometric and elongation scales, respectively.

3. *Measurement of Diameter.*—Total number of each types of fibres, which have been tested for breaking strength, were tested for mean diameter (after cutting them disectionally as a whole) with projection microscope (Lanameter) The disectional cut fibres were aligned on a slide covered by a cover slip which was secured by glycerine. The magnification of the Lanameter was ×500.

Calculation.—The Stress, tenacity and tensile strength from breaking strength were calculated as follows:

Stress = breaking force in mg.wt./cross sectional area in μ^2.

$$= \frac{\text{mg. wt.}}{\pi r^2}$$

where r = radius of the fibre in μ.

Tensile strength (psi) = g./denier × 12800 × sp. gravity.

Where g./denier (Tenacity) = breaking strength in g./900000 × area of cross section in cm^2 × density.

Discussion

From graphs showing the relation between the diameter and breaking strength of True, Heterotypical and Medullated wool fibres (Fig. 1), in all the cases a straight line has been obtained which is also clear from the Tables 1,2,3,4 and 5 In case of diameter and breaking stress of True, Heterotypical and Medullated wool, (Fig. 3) a regular graph has been obtained, in which the breaking stress decreases as the diameter increases. The stress at the diameter of 22μ (True wool) has been shown at maximum while at 89μ (Medullated wool) it is minimum. The graphs between stress and elongation % (Fig. 2) of True,

Heterotypical and Medullated wool fibres show that elongation in % increases as the stress decreases.

Comparing the tensile properties of Lohi breed with the other breeds, it was established that the percentage elongation of True, Heterotypical

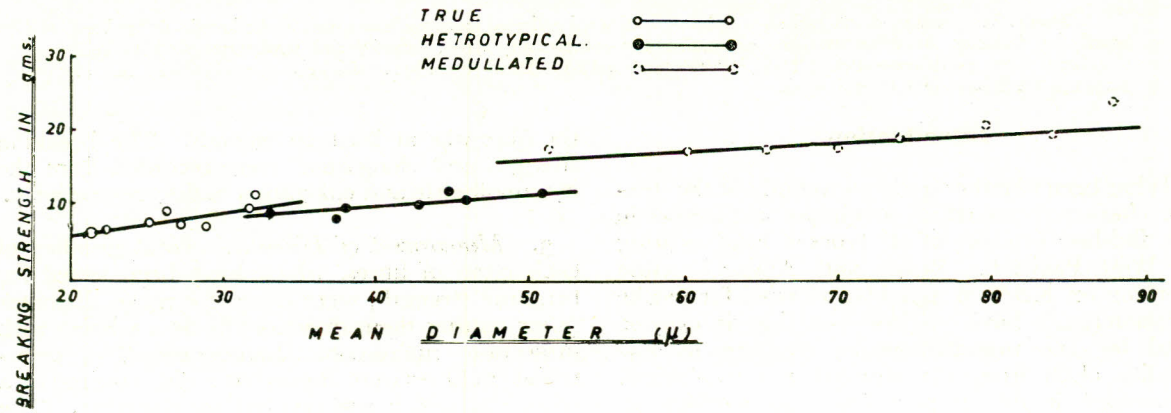

Fig. 1.—Showing relationship between the breaking stress and diameter (mean) of True, Heterotypical and Medullated wool fibres.

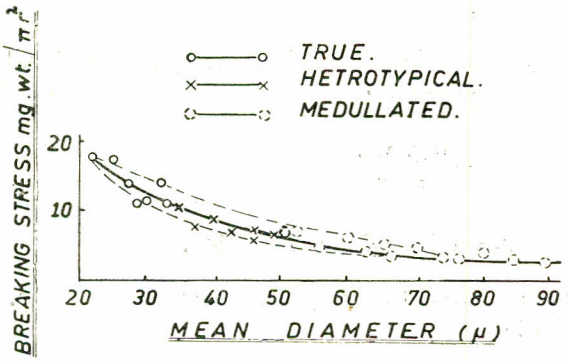

Fig. 2.—Showing relationship between breaking stress and mean diameter of True, Heterotypical and Medullated wool fibres

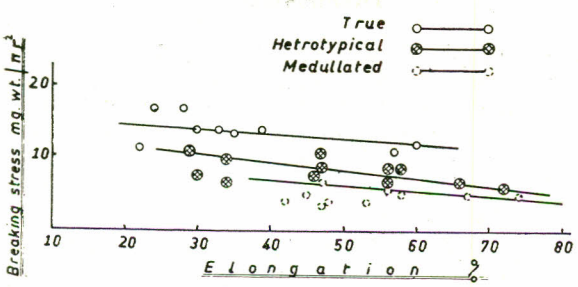

Fig. 3.—Showing relationship between the breaking stress and elongation % of True, Heterotypical and medullated wool fibres.

TABLE 1.—ELONGATION DISTRIBUTION OF TRUE, HETEROTYPICAL AND MEDULLATED LOHI WOOL FIBRE AT 55% RELATIVE HUMIDITY AND AT 47.3°F.

Elongation	True %	Hetero-typical %	Medul-lated %
10—15	4.92	—	—
16—21	11.16	3.43	.26
22—27	9.24	7.47	1.74
28—33	16.56	10.28	7.24
34—39	13.26	13.08	9.53
40—45	15.78	20.87	12.88
46—51	8.49	9.04	13.28
52—57	11.93	8.43	22.55
58—63	7.61	7.47	12.22
64—69	1.05	8.09	9.53
70—75	—	9.19	7.13
76—81	—	2.65	3.64

Total No. of fibres=2400

TABLE 2.—LOAD DISTRIBUTION OF TRUE, HETEROTYPICAL AND MEDULLATED LOHI WOOL FIBRES.

Load in g.	True %	Hetero-typical %	Medullat-ed %
0—1.9	1.26	—	—
2—3.9	11.84	1.3	—
4—5.9	27.24	11.06	—
6—7.9	24.13	17.14	.30
8—9.9	13.54	16.26	1.64
10—11.9	9.87	20.78	6.25
12—13.9	5.36	8.44	6.74
14—15.9	3.24	6.39	13.50
16—17.9	1.83	5.24	14.54
18—19.9	1.26	3.93	8.84
20—21.9	.43	6.25	10.94
22—23.9	—	2.18	8.24
24—25.9	—	1.16	7.20
26—27.9	—	.44	5.35
28—29.9	—	.29	7.79
30—31.9	—	.14	7.34
32—33.9	—	—	.74
34—35.9	—	—	.59

Total No. of fibres=2400

and Medullated wool (Table 7 b and 7 c) is greater while the breaking strength is less than that of three breeds. The mean diameter of Lohi True wool fibres is very near to that of the mean diameter of Hashtnagri True wool fibres i.e., 26.8μ and 25.2μ, respectively. Furthermore, the percentage of True, Heterotypical and Medullated wool of Lohi breed agrees more or less with that of Hashtnagri wool.

Within the same staple the coarse fibres were 43.9% stronger than the fine fibres. The average breaking strength per fibre was 20.5 g. (range 3.0 to 30.2 g.) and the tensile strength 923 kg./cm^2 (range 131-3445 kg./cm^2).

Conclusion

The percentage elongation of True, Heterotypical and Medullated wool fibres of Lohi breed was found greater while the breaking strength was less than that of the three breeds already tested.

TABLE 3.—SINGLE FIBRE, MEAN DIAMETER, BREAKING STRENGTH, ELONGATION %, STRESS, TENACITY AND TENSILE STRENGTH OF LOHI TRUE WOOL FIBRES AND CALCULATED VALUE OF BUNDLE STRENGTH IN KG.

Mean diameter of a fibre in μ.	No. of fibres for calculating bundle strength.	Breaking strength of Single fibre g.	Breaking strength of Bundle in kg.	Elongation in %	Stress mg. wt. $\frac{}{\pi . r^2}$	Tenacity g./denier	Tensile Strength kg./cm^2.
21.2	500	6.1	3.00	48	17.4	1.7	2083
22.4	635	6.9	4.38	35	12.8	1.9	2141
24.6	96	10.3	.98	34	21.7	2.1	2497
25.0	282	7.9	2.20	33	13.4	.7	788
25.0	87	8.2	.72	24	16.9	1.7	2083
25.2	344	5.5	1.89	22	11.0	1.09	1296
26.2	78	9.2	.80	28	16.9	1.6	1896
27.2	460	7.7	3.50	30	13.2	1.3	1480
28.8	109	7.1	.77	58	10.9	1.0	1188
29.4	125	7.4	.92	57	10.9	1.05	1249
29.6	56	7.8	.39	60	11.3	1.1	1308
31.6	78	9.7	.75	53	18.7	1.1	1308
32.0	200	11.15	2.23	39	13.8	1.2	1352

Mean Diameter=26.8μ (800 measurements).

Co-efficient of co-relation between Fineness and breaking strength	..	..	..	= .018	Bundle size 1"	— .03 g.
Fineness and tensile strength	..	..	..	= -650	2"	— .06 g.
Density	..	..	..	=1.304		

TABLE 4.—SINGLE FIBRE MEAN DIAMETER, BREAKING STRENGTH, ELONGATION %, STRESS, TENACITY AND TENSILE STRENGTH OF LOHI HETEROTYPICAL WOOL FIBRES AND CALCULATED VALUES OF BUNDLE STRENGTH IN KG.

Mean diameter of a fibre in μ.	No. of fibres for calculating bundle strength	Breaking strength of		Elongation %	Stress mg. wt. / π r²	Tenacity g./denier	Tensile Strength kg./cm²
		Single fibre g.	Bundle in kg.				
33.0	56	9.05	.50	29	10.5	1.05	1250
34.6	76	13.70	1.04	47	14.5	1.40	1645
37.3	107	8.2	.82	46	7.4	.77	999
37.6	167	10.8	1.80	34	9.7	1.00	1198
38.2	182	9.6	1.40	56	8.4	.91	1081
39.8	16	10.2	.16	58	8.2	.12	1094
42.8	80	10.0	.80	66	6.9	.99	1128
44.8	48	11.9	.57	30	7.5	1.10	1308
46.0	40	10.6	.42	34	6.3	.80	1041
46.4	182	14.2	2.58	47	8.9	1.30	1480
47.6	184	16.7	3.00	50	16.1	1.50	1857
48.8	58	19.3	1.11	47	10.3	1.70	2083
49.0	95	7.0	.66	56	6.2	.66	785
50.8	38	11.5	.43	72	5.6	.98	1161

Mean Diameter=39.8 μ (800 measurements)

		Bundle size
Co-efficient of co-relation between fineness and breaking strength	= .077	1″ — .03 g.
Fineness and tensile strength	= .380	2″ — .06 g.
Density	=1.172	3″ — .09 g.

TABLE 5.—SINGLE FIBRE MEAN DIAMETER, BREAKING STRENGTH, ELONGATION%, STRESS TENACITY AND TENSILE STRENGTH OF LOHI MEDULLATED WOOL FIBRES AND CALCULATED VALUE OF BUNDLE STRENGTH IN KG.

Mean diameter of a fibre in μ.	No. of fibres for calculating bundle strength	Breaking strength of		Elongation %	Stress mg. wt. / π r²	Tenacity g./denier	Tensile strength kg./cm²
		Single fibre g.	Bundle in kg.				
51.2	140	17.9	.89	47	8.7	.85	1011
56.0	158	12.1	.82	45	4.9	.57	678
60.1	136	17.3	2.35	47	6.1	.58	689
62.6	236	13.5	3.10	67	4.3	.43	511
64.0	67	23.6	1.50	72	10.1	.75	892
65.4	345	17.5	5.90	56	5.1	.54	641
70.0	250	17.6	4.40	58	4.6	.56	666
74.0	127	19.0	2.41	48	3.5	.45	535
76.6	54	15.2	0.82	42	3.4	.36	428
79.6	53	21.0	1.10	74	4.3	.50	594
84.0	125	19.5	2.43	53	3.5	.30	417
88.0	88	24.1	2.12	53	3.9	.38	451
89.0	98	18.7	1.83	37	3.0	.29	345

Mean Diameter =66.8 μ (800 measurements)

		Bundle size
Co-efficient of co-relation between fineness and breaking strength	= .304	1″ — .03 g.
Fineness and tensile strength	= .550	2″ — .06 g.
Density	=1.160	3″ — .09 g.

TABLE 6.—MEAN VALUES OF DIAMETER, BREAKING STRENGTH, STRESS, TENSILE STRENGTH AND THEIR CORRESPONDING STANDARD DEVIATION OF TRUE, HETEROTYPICAL AND MEDULLATED WOOL FIBRES.

Types of fibres	Mean Values of				Standard Deviation			
	Diameter μ.	Breaking strength g.	Stress mg. wt. / πr^2	Tensile strength kg./cm²	Diameter μ.	Breaking strength g.	Stress mg. wt. / μ^2	Tensile strength kg./cm².
True	26.8	7.4	13.2	1480	2.9	2.5	6.6	719
Heterotypical	139.8	10.6	10.3	1272	6.7	3.9	7.2	259
Medullated	66.8	19.0	5.5	717	10.7	4.6	2.2	419

TABLE 7 (a).—MEAN VALUE OF FIBRE DIAMETER.

Breed	True		Heterotypical		Medullated	
	Diameter μ	C. of V. %	Diameter μ	C. of V. %	Diamerer μ	C. of V. %
Kaghani	29.9	7.5	40.0	10.2	57.0	18.9
Hashtnagri	25.2	11.9	40.5	9.3	51.8	12.5
Harnai	28.7	11.7	45.1	9.1	75.2	15.3
Lohi	26.8	10.9	39.8	16.8	66.8	16.1

TABLE 7 (b).—MEAN VALUE OF FIBRE ELONGATION

Breed	True		Heterotypical		Medullated	
	Elongation %	C. of V %	Elongation %	C. of V. %	Elongation %	C. of V. %
Kaghani	34.0	17.9	41.0	8.8	49.0	6.7
Hashtnagri	28.0	13.9	29.0	11.2	31.0	9.3
Harnai	31.0	14.8	26.0	31.1	28.1	19.2
Lohi	40.0	32.5	48.0	26.2	54.0	20.0

TABLE 7 (c).—MEAN VALUE OF FIBRE STRENGTH.

Breed	True		Heterotypical		Medullated	
	Breaking strength g.	C. of V. %	Breaking strength g.	C. of V. %	Breaking strength g.	C. of V. %
Kaghani	16.4	9.1	21.6	9.4	29.9	7.7
Hashtnagri	8.3	20.5	20.2	19.3	31.3	7.7
Harnai	8.2	20.7	23.2	17.2	30.2	7.6
Lohi	7.4	34.3	10.6	37.2	19.0	23.3

TABLE 8.—PERCENTAGE COMPOSITION OF TRUE, HETEROTYPICAL AND MEDULLATED KAGHANI, HASHTNAGRI, HARNAI AND LOHI WOOL FIBRES.

Breed	Types of fibres as percentage of total fibres		
	True %	Hetero-typical %	Medul-lated %
Kaghani	60	22	18
Hashtnagri	54	25	21
Harnai	55	27	18
Lohi	53	20	27

The percentage of true wool fibre agrees with that of true wool fibre in Hashtnagri breed, that has already been standardized for carpet.

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