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THE CHARACTERISTICS OF HIBISCUS ESCULENTUS OKRA (BINDI) FIBRES

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In Pakistan some vareties of dicotyledonous plants are grown, from the stocks of which bast fibres are obtained, although they are not commercially exploited on any large scale. The stocks of *Hibiscus esculentus* Okra locally named as 'bindi' yield a fibre which has not been commercially exploited. After fruiting, the stocks are generally allowed to go waste or used as fuel. If the stock is collected in the green condition and subjected to retting[1] without drying, useful fibres can be extracted. The okra 'bindi' is a popular vegetable of the summer season in Pakistan and is grown in almost every part of the country. The plant can be grown on a variety of soils and needs moderate irrigation with little rainfall. No specific relative humidity or temperature is required to get a satisfactory crop. Likewise, no special preparation of soil for sowing the seed and recultivation is required. The plantation is started in February/March and fruits can be obtained in 1½ months only. The fibre is white, light cream or yellow, silky strong in nature and of fine to coarse qualities depending on the type of retting and the maturity of the plant.

Very little, or no work is known to have been done on the extraction of fibres from okra plant in Pakistan. In order to investigate the possibility of utilizing the fibres commercially it was considered essential to examine the physical and chemical characteristics of the okra fibres and compare its characteristics with other bast fibres.

Material and Methods

Stock Collection. Green okra(bindi) stocks were collected in September–October 1971, when fruiting season was over. About 50 stocks were selected in one acre field and were cut at the root ends. Only those stocks were selected for cutting which were least branched from root to the tip of the plant.

Retting. All the 50 stocks were placed in clean water tank which had a temperature of 80°F. To ensure complete immersion, bundles of the stock were weighed. Retting was completed in about seven days. Under-retting results not only causes difficulty in removing fibre from the stock, but also in excessive gum adhering to the fibre which makes the fibres harsh and stick to each other. Over-retting results in weak fibres with little or no lustre.

Fibre Stripping or Extraction. When rettin gwas complete, fibres were extracted from stocks. Fibre strands were removed from the stocks by running it between two fingers. The fibre strands, after they were freed from the stock, were immediately washed repeatedly in clean water to free them from gum and waxes and any pieces of bark and wood. The strands were then spread on the concrete floor for drying in the shade.

Length Measurement. For length measurement filament of okra fibres were streched out along a meter rod and distance between the two ends was noted. The length of 20–25 filaments from each sample of fibres was determined.

Fineness Measurement. To determine the fineness, fibres were aligned on clean glass slides and secured by cover slips using glycerine. These slides were then inserted into projection microscope (lanameter) and the diameter of the fibres were determined at ×500. About twenty-five readings were taken along the length of each fibre and the average diameter was calculated.

Strength and Elongation Measurements. Tensile strength and elongation of single fibres were determind employing a dynamometer.[2] About twenty-five fibres from each sample were tested. The tensile strength in kg/mm² was calculated as follows:

$$\text{Tensile strength (kg/mm}^2\text{)} = \frac{\text{Breaking load}}{\text{Area of cross-section}}$$

Longitudinal and Cross-Sectional Studies. In order to know the inner structure of the fibres longitudinal and cross-sectional studies were made. For longitudinal studies fibres were aligned on microscope slides secured by Canada balsam with cover slips. For cross-sectional studies Hardy's microtone[3] was employed.

Cellulose Determination. The cellulose content was determined as discussed by Howlitt.[4] The specimen is placed in a flask having 350 ml water and 680 ml H_2SO_4(concd) at room temperature (density 1.67). The solution is filtered after ½-hr treatment and the residue is washed with dil H_2SO_4. The loss in weight after treatment with H_2SO_4 indicates the cellulose content of the fibre.

Wax Determination. The wax content was determined with the help of Soxhlet apparatus. Five grams sample was placed in the thimble and its fat content extracted for 2–3 hr with ether. The ether left after extraction was evaporated to a constant weight at 110°C in the drying chest in about 20 min and the residual matter was placed in a desiccator for about ½ hr to cool and then weighed accurately.

Ash Determination. For ash[5] determination 4–5 g fibre was first heated at 105°C in a covered crucible in an air oven to expel moisture and charred over a burner until swelling ceased. The crucible was then heated in a muffle furnace at about 800°C for 4 hr.

Moisture Determination. Moisture content[6] was determind by heating 5–6 g of the sample at 105°C to a constant weight in an air oven.

Results and Discussion

Table 1 shows the values of filament length, diameter, elongation and tensile strength of okra fibres, while Table 2 shows a comparison of the okra fibres with those of other bast fibres.[7] This indicates that

TABLE 1. PHYSICAL CHARACTERISTICS OF *Hibiscus esculentus* OKRA (BINDI) FIBRES.

Filament length (in)	Dia (μ)	Elongation (%)	Tensile strength (kg/mm²)
5–36·5	24	0·9	38
4·5–33·3	26	1·2	41
6·5–34·5	29	1·1	40
4·8–29·9	23	1·0	37
4·5–27·8	24	0·9	42
6–30·5	28	1·3	36
4·5–34·6	27	0·8	39
7–35·5	24	0·9	38
4–30·8	25	1·1	41
5–35·9	26	1·2	39
5·1–32·4	25·6	1·4	39·1

TABLE 2. COMPARISON OF PHYSICAL CHARACTERISTICS OF OKRA FIBRES WITH BAST FIBRES.

Physical character	Jute	Flax	Hemp	Ramie	Okra fibre
Length (in)	62·5–108	8·31–58·3	41·6–125	4–365	5·1–32·5
Dia (μ)	20–25	15–37	25–50	13–50	17–36
Average	23	26	37·5	31·5	26·8
Elongation (%)	0·8	1·6	1·6	2·7	1·0
Tensile strength (kg/mm²)	44·1	83·8	90·0	94·5	37·2

TABLE 3. CHEMICAL CHARACTERISTICS OF *Hibiscus esculentus* OKRA (BINDI) FIBRES.

Cellulose (%)	Lignin (%)	Wax (%)	Ash (%)	Moisture (%)	Hydrolysis (%)	Mercerization (%)
80	9·6	0·27	0·72	10·1	30·8	6·8
78	9·5	0·36	0·69	10·2	32·6	7·5
83	9·3	0·35	0·59	10·1	30·9	8·0
85	8·9	0·37	0·63	10·5	33·8	7·6
86	9·6	0·35	0·58	10·3	30·2	9·0
80	9·4	0·30	0·65	9·9	29·9	8·9
79	9·2	0·31	0·59	10·5	28·6	9·3
78	9·5	0·25	0·70	10·2	33·0	9·9
80	9·9	0·28	0·69	10·1	30·5	6·9
82	9·5	0·29	0·58	10·3	30·8	7·5
Mean	9·4	0·32	0·64	10·2	31·1	8·6

TABLE 4. COMPARISON OF CHEMICAL CHARACTERISTICS OF OKRA FIBRES WITH BAST FIBRES.

Physical characteristics	Jute	Flax	Hemp	Ramie	Okra fibres
Cellulose (%)	63·01	77·03	83·21	77·7	81
Wax (%)	0·38	2·38	0·22	3·48	0·3
Ash (%)	0·68	1·01	2·60	0·82	0·64
Moisture (%)	10·11	9·67	9·52	8·88	10·2

Okra's filament length is smaller than that of all the four types of bast fibres, while fibre diameter is higher than that of jute[8] and flax fibres, but smaller than that of hemp and ramie fibres. It is less elastic than flax, hemp and ramie fibres, but slightly more elastic[9] than jute fibres. The tensile strength of okra fibres is maller than most of bast fibres, but it is close to that of jute[10] fibres. Table 3 shows cellulose, lignin, wax, ash, and moisture percentages of okra fibres. Table 4 shows a comparison of the chemical characteristics[11] with those of other bast fibres. The cellulose content of okra fibres in the present investigation is higher than those of jute, flax and ramie fibres, but lower than hemp fibres. The wax content is higher than that of hemp fibres, but lower than that of jute, flax and ramie fibres, but it is close to that of jute fibres. The ash content is lesser than that of all bast fibres, but it is close to that of jute fibres. The moisture content percentage is higher than jute, flax and ramie, but is close to that of jute fibres.

The microscopic studies of the okra fibres reveal that the appearance of the fibre is cylindrical. They have heavy longitudinal striations, but no cross markings; the width of the cells being 10-15 μ. The cells are unevenly thick-walled and have broad irregular lumen and blunt ends. In cross-section the fibres are ractangular with no defined lumen. Like other bast fibres it ignites readily with orange yellow edges and an orange base, with wipes of bluish smoke after the flame extinguishes. Like jute and ramie it burns steadily with delicate blackish skeletion smouldering to blue colour, with shiral-stain brown and with iodine and zinc chloride it gives yellow colour.

All the studies above reveal that okra fibres are similar to a considerable extent to most of the bast fibres, specially its characteristics are close to those of jute fibres. With the exception of length and cellulose content, all the other characteristics, i.e. fineness, elasticity, tensile strength, wax, ash and moisture resemble the characteristics of jute fibres. In our country farmers are almost ignorant of the fact that useful fibres can be extracted from okra plant. After the fruiting season is over the stocks are usually wasted or used as fuel. Now they can obtain fibres for making ropes and after extracting fibres the stocks can be used as fuel as usual. If okra plants are grown on a large scale, little effort will be needed to increase the height of the plant, quality of fruits and the percentage of fibre yield, by using modern techniques.

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