Pakistan J. Sci. Ind. Res., Vol. 18, Nos. 3–4, June–August 1975

COMMERCIAL UTILIZATION OF LILACEAE YUCCA, GLAUCA (BEAR GRASS)

ARBAB ABDUL WAKIL and FAIZULLAH KHAN

PCSIR Laboratories, Peshawar

(Received July 26, 1974; revised January 30, 1975)

Abstract. Yucca (glauca) i.e., bear grass is a plant, widely grown in Hazara district. Studies were carried out on the extraction of fibres from the leaves of the plant and all important physical and chemical characteristics of the fibres were determined and compared with the characteristics of bast fibres. It was found that most of the physical and chemical characteristics are similar to a considerable extent to the chief bast fibres i.e., flax, hemp, ramie and jute. The possibility of growing the plant and its commercial utilization have been discussed.

In Pakistan some varieties of monocotyledonous plants are grown from the leaves of which fibres could be obtained although they are not commercially utilized on any large scale within the country. The fibres are held[1] by cellular tissue to the leaf by gummy and waxy substances. For most of the plants included in this group the position of fibres in the leaf is not uniform and the fibres are located in the greatest quantity near the outer portion of the leaf. These substances also serve to hold the fibres to each other within the bundles. From the point of view of fibres production there are two types[2] of yucca, the low-growing stemless types and the long-stemmed yucca which are tree like in growth. The yucca also differ in flexibility of their leaves. Some have rigid leaves while other have flexible leave. *Yucca glauca* (S.R.), lily family: Liliaceae, comes under the later group of fibres. The plant grow wild in abundance in Hazara district, but in some cases it is cultivated as ornamental plant, irrespective of other types of the plant of the same botanical family such as sisal. The leaves are softer in handle and the fibres could be extracted from the leaves very easily giving a 90% yield. Even after two to three days retting[3] the skin of the leaf and the fibres could be separated very easily. The fibres are obtained in bundle form and the strands of the fibres are brown to creamy colour like jute.

If the leaves of yucca are collected in green and subjected to retting, useful fibres could be obtained. The material is similar to a considerble extent to most of the bast fibres and its characteristics are close to those of jute fibres.

In Pakistan a number of leaf genera are awaiting efficient cultivation and processing in order to realise their full potentialities. One of these is the yucca (bear grass or spanish dagger) which is not commercially exploited. No work is known to have been done on the extraction of fibres from this plant in Pakistan. In order to investigate the possibility of utilizing the fibres on cottage industry scale or on commercial scale it was considered essential to make a full study on the extraction of fibres from the plant, to determine the physical and chemical characteristics of the fibres, and to compare their characteristics with those of other bast fibres in order to determine its suitability for use.

Materials and Methods

Stock Collection. Green plants were collected in September/October 1973. About 10 samples from different areas of Hazara district were collected cutting the plants from the root ends. Only well grown and freshly grown plants were selected for cutting.

Retting. All the 10 samples of plants were placed in ten different containers with clean water at room temperature. To ensure complete immersion, plants were weighed by putting some load on them. Retting was completed in about 4 days, taking special care for complete retting. Under-retting results not only causes difficulty in removing fibres, but also in excessive gum adhering to the fibres which makes them harsh and stick to each other. Over-retting results in weak fibres with little or no lustre.

Fibre Stripping or Extraction. Where retting was completed fibres were extracted. The thin skin of the leaves were first removed and the fibres were collected in strands. These fibre strands were obtained and were immediately washed repeatedly in clean water to free them from gum and waxes and any pieces or straw and wood. The fibre strands consist, of individual fibres and are not in bundle form, as is the case with bast fibres. The strands were then spread on a concrete floor for drying in the shade.

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

Fineness Measurement. To determine the fineness, fibre 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 fibre were determined at $\times 500$ magnification. About 25 readings were taken along the length of each of 25 fibres and the average diameter was calculated.

Strength and Elongation Measurement. Tensile strength and elongation of single fibres were determined employing a dynamometer.[4] About 25 fibres from each sample were tested. The tensile strength in kg/mm^2 was calculated as follows.

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

Longitudinal and Cross-Section Studies. In order to study the structure of the fibres longitudinal and cross-section studies were made. For longitudinal studies fibres were aligned on microscope slides secured by Canada balsam with cover slips. For cross-section studies a Hardy Microtome[5] was employed.

Cellulose Determination. The cellulose content was determined as described by Luniak.[6] The specimen is placed in a flask containing 350 ml water and 680 ml H_2SO_4 (concd) (d 1.67). The solution is filtered after 1-hr treatment and the residue is washed with H_2SO_4 (dil). The loss in weight after treatment with H_2SO_4 indicates the cellulose–content of the fibres.

Results and Discussion

Table 1 shows the values of length, diameter, elongation and tensile strength, while Table 2 shows a comparison of yucca fibres with bast fibres.[9] This indicates that yucca fibre's maximum length is greater than the minimum length of flax and ramie, but smaller than hemp and jute. The fibre diameter is higher than for all the four types of bast fibres.[10] It is less elastic than all of bast fibres.[11] Table 3 shows cellulose, wax and ash percentages of yucca fibres. Table 4 shows a comparison of

TABLE 1

Filament length		Diameter (μ)		Elongation (%)		Tensile strength kg/mm2	
Mean range	Mean	Mean range	Mean	Mean range	Mean	Mean range	Mean
7·9–8·3	8·1	29·3–25·9	32·6	0·2–0·4	0·3	23·9–27·7	25·8
9·9–10·3	10·1	28·3–36·1	32·2	0·2–0·3	0·2	61·9–78·9	70·4
10·1–11·1	10·6	37·9–49·2	43·5	0·2–0·4	0·3	27·6–38·6	33·1
14·1–16·3	15·2	38·7–59·5	49·1	0·7–0·9	0·8	21·3–32·3	26·3
10·9–11·7	11·3	27·9–45·7	36·3	0·4–0·6	0·5	28·6–39·8	34·2
13·3–15·3	14·3	25·7–33·5	29·6	0·2–0·4	0·3	18·9–24·5	21·7
9·5–11·5	10·0	26·6–36·2	31·4	0·2–0·4	0·3	39·9–57·7	48·3
11·6–13·4	12·5	36·9–49·3	43·1	0·1–0·3	0·2	28·6–39·6	34·1
11·4–13·2	12·3	39·3–53·7	46·3	0·1–0·3	0·2	21·3–50·6	25·8
10·2–12·4	11·6	45·6–68·8	57·2	0·2–0·4	0·3	34·9–57·7	48·3
10·8–12·3	1·6	33·6–43·7	40·1	0·2–0·4	0·3	50·5–54·8	37·9

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

Physical character	Flax	Hemp	Ramie	Jute	Yucca
Filament length (in)	8·31–58	41·6–125	4–365	62·5–108	11·6
Average dia (μ)	15·37–26	25·50–37·5	13·5–31·5	20·25–23	40·1
Elongation (%)	1–6	1·6	2·7	2·8	0·3
Tensile strength (kg/mm2)	83·8	90·0	45·5	44·1	37·9

TABLE 3. CHEMICAL CHARACTERISTICS OF LILIACEAE *Yucca glauca.*

Cellulose (%)		Wax (%)		Ash (%)	
Mean range	Mean	Mean range	Mean	Mean range	Mean
74–78	76	0·54–0·58	0·56	70·0–75·0	0·73
73–77	75	0·49–0·57	0·53	63·3–77·0	0·70
75–82	79	0·54–0·60	0·57	65·0–71·0	0·68
77–83	80	0·54–0·58	0·65	69·0–73·0	0·71
75–82	79	0·49–0·59	0·54	70·0–75·0	0·73
76–78	77	0·47–0·63	0·55	66·0–73·0	0·69
77–83	80	0·53–0·61	0·57	69·0–73·0	0·71
74–78	76	0·54–0·65	0·56	65·0–71·0	0·68
75–82	79	0·49–0·59	0·54	69·0–73·0	0·71
74–82	28	0·53–0·61	0·57	66·0–73·0	0·69
75–80·5	72·9	0·51–0·59	0·56	67·2–73·4	0·73

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

Physical characteristics	Flax	Hemp	Ramie	Jute	Yucca
Cellulose (%)	77·3	83·21	77·7	63·01	77·9
Wax (%)	2·38	0·22	3·48	0·38	0·56
Ash (%)	1·01	2·66	0·82	0·68	0·73

chemical[12] characteristics with those of bast fibres. The cellulose content of yucca fibres in the present investigation is higher than in jute, flax and ramie but lower than in hemp fibres. The wax content is higher than for jute and hemp[13] but lower than for flax and ramie. The ash content is greater than for jute, but less than for flax, hemp and ramie.

The microscopic studies of the fibres reveal that the appearance of the fibres is cylindrical. They have heavy longitudinal striations, but no cross markings. The cells are evenly thick-walled and have a broad regular lumen. In cross-section the fibres are rectangular with no defined lumen. Like other bast fibres it ignites readily, the flame showing orange yellow edges and orange base with wips of black smoke after the flame extinguishes. Like bast fibres it burns with delicate blackish skeleton smouldering to blue colour. With 'shirlastain' dyes brown and with iodine and zinc chloride it gives yellow colour.

All the studies above reveal that yucca fibre is similar to a considerable extent to other bast fibres. In physical characteristics its maximum filament length could be compared to the minimum length of flax and ramie fibres while its diameter are close to the range for hemp fibres. Fibre extension is lower than for all the four types of bast fibres. The tensile strength is lower than for flax, hemp and ramie fibres, but is closer to the range for jute fibres. In chemical characteristics the wax percentage is higher with jute, but lower than ramie and flax. The wax percentage is higher than jute.

In our country the growers are almost ignorant of the fact that useful fibres could be extracted from yucca plants. The plant could be grown easily on small industry or commercial scale for obtaining useful fibres comparable with bast fibres. Due to its higher degree of flexibilty, with more stiffness and less brittleness it could be used easily in the cordage and brush fibres industries.

Acknowledgement. Our thanks are due to Javed Khan for some of the measurements.

References

1. H. R. Mauersburger, *Mathews Textile Fibres* (J. Wiley, New York, 1954), sixth edition, p. 361.
2. R. R. Kirby, *Vegetable Fibres* (Leonard Hill, London, 1963), p. 307.
3. Ref. 1, p. 362.
4. A.A. Wakil, N.A. Jamil and M. Taj Younis, Pakistan J. Sci. Ind. Res., **16,** 126 (1973).
5. A.N.I. Heyn, *Fibre Microscopy* (Interscience, New York, 1954), p. 194.
6. B. Luniak, *Identification of Textile Fibre* (Pitman, London, 1953), p. 142.
7. A.A. Khan, N.A. Khan, A.A. Wakil and M. Haq, Pakistan J. Sci. Ind. Res., **8,** 268 (1965).
8. Ref. 1, p. 268.
9. *Harris Handbook of Textile Fibres* (Harris Research Laboratories, Washington), p. 115.
10. N.A. Jamil, thesis submitted to the Agriculture University, Lyallpur, 1970.
11. Ref. 7, p. 43.
12. Ref. 1, p. 194.