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# Physical, Chemical and Mechanical Properties of Fiber Extracted from *Yucca gloriosa*, L.

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***Abstract***

*Yucca gloriosa is an evergreen shrub with common name "Spanish dragger." It was collected from the Nilgiris hills. The fiber obtained from Y. gloriosa leaves is used for making ropes, baskets and mats. So this study shows that factors such as length, diameter, density, linear density, water sorption, lignin, cellulose estimation, load at break, extension at break, tenacity at break, tensile strain at break and tensile stress at break of Y. gloriosa, L. was found. On the microscopic analysis of the leaf, cross section samples of sclerenchyma cells were found. The plant showed yield and quality of plant fibers, which make them suitable for uses like composite, textile, geotextile, pulp, paper and other industrial uses.*

***Keywords:*** *Fiber, Yucca gloriosa, density, linear density, water sorption, tensile properties*

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## INTRODUCTION

Fibers naturally occur in both plants and animals. Mankind has been strongly dependent on plant fibers for all kinds of purposes. Extraction of fiber involves decomposition of the cementing material by microbiological method from stem, leaves, bark and seed crops. Plant fibers can be described as lignocellulosic, i.e., resources comprised primarily of celluloses, hemicelluloses and lignin [1]. Plant fibers can be grouped as soft fibers and hard fibers, in which leaves, seed and fruit fibers are called hard fibers, e.g., sisal and agave. Soft fibers come from the bast portion of the plant, e,g., hemp, flax, etc.

Spanish dagger makes a dramatic landscape statement. Its blue-grey to green, drooping leaves project from thick, soft, green stems and spikes of slightly reddish-tinged, white, fragrant blossoms appear in late spring or early summer. High salt tolerance makes Spanish dagger ideal for seaside plantings [2]. The aim of the project is to study the physical, chemical and mechanical properties of *Yucca gloriosa* fibers.

***Yucca gloriosa,* L.**

## MATERIALS AND METHODS

The above said plant materials were extracted by retting process of the leaf and leaf sheaths in tap water and cleaning by hand [3]. It was allowed to dry and weight was taken. The dried fiber was scraped off to remove the outer portion, so as to extract the fiber [4]. To study the physical properties, fiber length was measured by ammeter scale. The diameter was analyzed by using occular meter. Density of the fiber was tested using the specific gravity

bottle and linear density of the material was measured with standard length and weight [5]. Water sorption and moisture regain was also observed. In biochemical analysis, cellulose and lignin estimation was followed by ref. [6]. In mechanical properties load at break, extension at break, tenacity at break, tensile strain at break, tensile stress at break was recorded using Instron tensile tester 3345 UK [7].

## RESULTS AND DISCUSSION

Natural fibers have been used historically to produce cloth, carpets, cordage, paper and scale of ships, and insulating and building materials. A number of investigations have been considered on several types of natural fibers such as kenaf, hemp, flax, bamboo and jute [8].

The features of a fiber plant such as weight, length, diameter and density were found in *Y. gloriosa* The cross-sectional area of *Y. gloriosa* leaf shows vascular tissue strengthened by the sclerenchyma fibers (Figure 1). By applying retting process, this plant yield of fiber was recorded (Figure 2).

***Fig. 1:*** Cross-sectional Area of *Y. gloriosa* Leaf.

***Fig. 2:*** *Fiber Yield after Retting Process.*

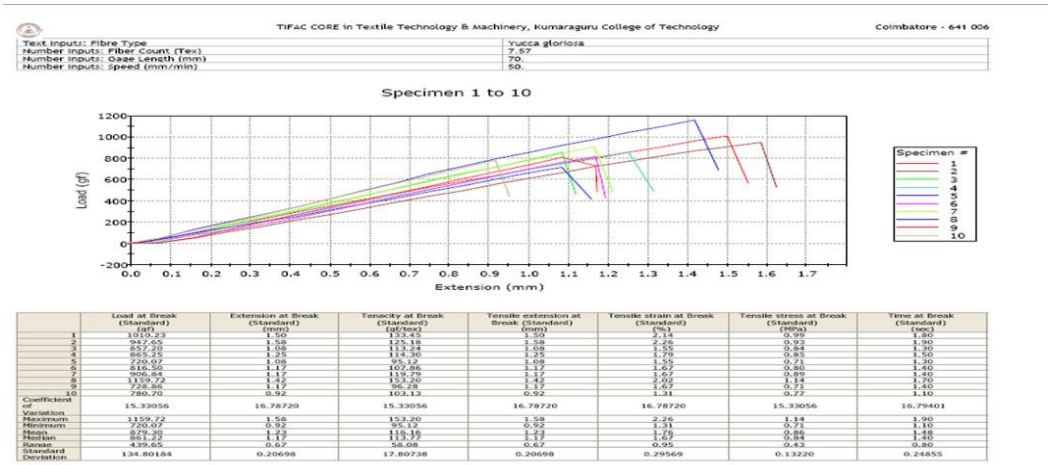
The fiber was analyzed with various dimensions. The yield of fiber determined after retting process, the maximum capacity of yields 23.85 g. Length of fiber is 21–25 cm which is longer. Diameter of *Y. gloriosa* fiber shows 0.12–0.27 mm which is less comparable with sisal fiber 0.1–0.46 mm. Density of *Y. gloriosa* (1.327 g/cm$^3$) fiber is more or less comparable with cotton fiber (1.33 g/cm$^3$) (Table 1).

***Table 1:*** *Physical, Biochemical and Mechanical Properties of Yucca gloriosa Fiber.*

| S. No. | Parameter analyzed | *Yucca gloriosa*, L. | Sisal* [9] |
|---|---|---|---|
| | **Physical composition:** | | |
| 1 | Weight (gm/kg) | 23.85 | 20–30 |
| 2 | Length (cm) | 21–25 | - |
| 3 | Diameter (cm) | 0.12–0.27 | 0.1–0.46 |
| 4 | L/B ratio | 1.026 | - |
| 5 | Density (g/cm$^3$) | 1.327 | 1.33 |
| 6 | Linear density | 1.14 | 28.6–48.6 |
| 7 | Water absorption (%) | 0.0196 | - |
| 8 | Moisture regain (%) | 32 | 11 |
| | **Chemical properties:** | | |
| 1 | Cellulose (%) | 37.6 | 65–88 |
| 2 | Lignin (%) | 24 | 9.99 |
| | **Mechanical properties:** | | |
| 1 | Load at break (gf) | 879.30 | - |
| 2 | Extension at break (mm) | 1.23 | 1.5 |
| 3 | Tenacity at break (gf/tex) | 116.16 | - |
| 4 | Tensile strain at break (%) | 1.76 | - |
| 5 | Tensile stress at break (Mpa) | 0.86 | - |

The fibers are predominantly composed of cellulose and lignin. Lignin is the main constituent of fiber, responsible for its stiffness. Partial removal of lignin was observed after retting process. It reveals that cellulose content (37.6%) in *Yucca* fiber than that of Sisal cellulose content (65–88%). Maximum of 24% of lignin is found in *Yucca* fiber than that of 9.99% in Sisal [9].

Tensile property mean values are depicted in Table 1, Figure 3. Load at break, tenacity at break, tensile strain at break, tensile stress at break and extension at rate is seen in *Y. gloriosa* (879.30 gf, 116.16 gf/tex, 1.76%, 0.86%, 0.83 mm). This result shows that *Yucca* has maximum tensile property which could be used as a source in textile industry.




| | Load at Break (Standard) (gf) | Extension at Break (Standard) (mm) | Tenacity at Break (Standard) (gf/tex) | Tensile extension at Break (Standard) (mm) | Tensile strain at Break (Standard) (%) | Tensile stress at Break (Standard) (MPa) | Time at Break (Standard) (sec) |
|---|---|---|---|---|---|---|---|
| 1 | 1010.23 | 1.50 | 133.45 | 1.50 | 2.14 | 0.95 | 1.80 |
| 2 | 947.65 | 1.58 | 125.18 | 1.58 | 2.26 | 0.93 | 1.90 |
| 3 | 857.10 | 1.08 | 113.24 | 1.08 | 1.55 | 0.84 | 1.30 |
| 4 | 865.03 | 1.25 | 114.30 | 1.25 | 1.79 | 0.85 | 1.50 |
| 5 | 770.97 | 1.17 | 101.84 | 1.17 | 1.67 | 0.76 | 1.40 |
| 6 | 728.86 | 1.19 | 96.26 | 1.19 | 1.69 | 0.68 | 1.40 |
| 7 | 966.84 | 1.17 | 119.79 | 1.17 | 1.67 | 0.89 | 1.40 |
| 8 | 1159.72 | 1.42 | 153.20 | 1.42 | 2.02 | 1.14 | 1.70 |
| 9 | 728.86 | 1.17 | 96.28 | 1.17 | 1.67 | 0.71 | 1.40 |
| 10 | 780.70 | 0.92 | 103.13 | 0.92 | 1.31 | 0.77 | 1.10 |
| Coefficient of Variation | 15.33056 | 16.78720 | 15.33056 | 16.78720 | 16.78720 | 15.33056 | 16.79401 |
| Maximum | 1159.72 | 1.58 | 153.20 | 1.58 | 2.26 | 1.14 | 1.90 |
| Minimum | 720.07 | 0.92 | 95.17 | 0.92 | 1.31 | 0.71 | 1.10 |
| Mean | 879.30 | 1.43 | 116.16 | 1.43 | 1.76 | 0.86 | 1.48 |
| Median | 879.30 | 1.43 | 116.16 | 1.43 | 1.76 | 0.86 | 1.48 |
| Sample Variance | 439.65 | 0.67 | 58.08 | 0.67 | 0.95 | 0.43 | 0.80 |
| Standard Deviation | 134.80184 | 0.20698 | 17.80738 | 0.20698 | 0.29569 | 0.13220 | 0.24855 |

***Fig. 3***

## CONCLUSIONS

*Y. gloriosa* is a common xerophytic plant grown along the edges of the field and can serve as potential source of textile fiber, thereby improving the income of farmers. This study provides a scope for new natural fibers in the market. More obtained studies on the properties of plant fiber would directly contribute to better utilization.

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