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Exploration of Physical, Chemical Properties of Raw and Alkali Treated Terminalia Catappa Fruit Fibers

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Abstract- *The environmental sustainability level is enhanced while using natural fibers as raw material in various industries like textile, building, plastics, and automotive industries due to acquiring properties like non-hazardous, light weight, recyclable, ample and reasonably priced. Terminalia Catappa fruit fiber is one such type fiber which was extracted from Terminalia Catappa fruit. The physical and chemical properties such as density, cellulose, wax, moisture, were experimentally found out from this fiber. In this paper, the Terminalia Catappa fruit fibers were treated with 5% and 10% of NaOH and the consequence of alkali treatments on the fiber properties were investigated.*

Keywords: *Fibers, Physical properties, chemical properties.*

I. INTRODUCTION

Over the past two decades, polymer-based materials reinforced with various natural fibers have been established everywhere from academic and industrial point of view. Environmental consciousness, legislation, and energy consumption have inspired academics and industrial researchers working in the area of cellulose fibers and fiber-reinforced composite. More than 1000 species of cellulose plants are being available in fibers forms and few of them are investigated to prepare the reinforced composite. The natural fiber composites have attractive features likes low cost, light-in weight, moderated strength, high specific modulus, moderate mechanical properties, easy to handle, and lack of health hazards compared to synthetics fiber composite. Structure of the fiber is framed with natural chemicals such as cellulose, lignin, and wax. The cellulose fiber-reinforced composites have been significantly used for industrial components, construction material, automobile parts, and home appliances. [1]

In practice, so far the use of okra fibres in materials has been confined to employing the mucilage as a moisture absorber [2]. Okra mucilage can be a source of polysaccharides, which can be used, with suitable chemical grafting e.g., using polyacrylonitrile, for the synthesis of biodegradable polymers [3] Various research works are being carried out with the natural fibers like bamboo, coir, jute, flax, sun hemp, ramie, kenaf, roselle, straw, rice husk, sugar cane, grass, raphia, papyrus, pineapple leaf fibers. Applying bark fibers and seed fibers as an alternative for fiber- reinforced composite was investigated in the study made by Ashori and Bahreini [4].

Edeerozey et al. [5] chemically modified the kenaf fibers and found that the alkalization treatment improved the mechanical properties. Symington and Banks [6] found that the excess treatment of natural fibers could have a negative effect on the base fiber properties. It was also ensured that less than 10 min treatment time was sufficient for removing celluloses. The natural based resins could also be used along with natural fibers for making complete biobased products. They do not induce allergic and irritation sensation to the human skin. The microstructures of the natural fibers contain cellulose, hemicellulose, lignin, moisture, wax and other impurities. But the properties of these fibers will depend on the type of the plant, the age of the plant, extraction method and the environment in

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which the plant grew. The natural fibers, in general, are available in the seeds, stems and leaves of the plants [7]. Malkapuram and Kumar [8] noticed that the chemical, mechanical, and physical properties of natural fibers vary from fiber to fiber. The mechanical properties were also lowered by the moisture content.

In the present study, the newly identified Terminalia Catappa fibers (TCFs) are extracted from Terminalia Catappa (TC) plant. The physical and chemical properties have been investigated.

III. Materials and Experiments

A. Raw Fiber Extraction

The grown Terminalia Catappa fruits were collected from Terminalia Catappa fruit trees and engrossed in water for two days. The flush which was bonded with the fibers absorb water and the retting of the same started. The flush lost its bonding strength at this stage. Now the fruits were taken out of water and thoroughly washed in running water. During the washing process the fruits were gently pressed for the removal of the retted flush.

The fruits were then immersed in water for one day and the process was repeated for the removal of remaining flush. The fibers were taken out and allowed to dry in the shadow for a couple of days. The fibers were then dried in sunlight for half an hour and extracted. The raw Terminalia Catappa fruit fiber is shown in figure 1.

Figure 1. Extraction of Terminalia Catappa fruit fiber (Raw fiber)

B. Alkali Treatment of Terminalia Catappa Fibers

The dry Terminalia Catappa fibers were treat with 5% and 10% NaOH solution separately for about half an hour at room temperature. The fibers were then cleaned with fresh water to take away any NaOH sticking on the fiber surface. The fibers were neutralizing with 2.5% Hcl solution at room temperature. The fibers were again cleaned in distilled water and dried at room temperature for one day. The 5% and 10% NaOH alkali treated Terminalia Catappa fruit fibers are shown in figure 2

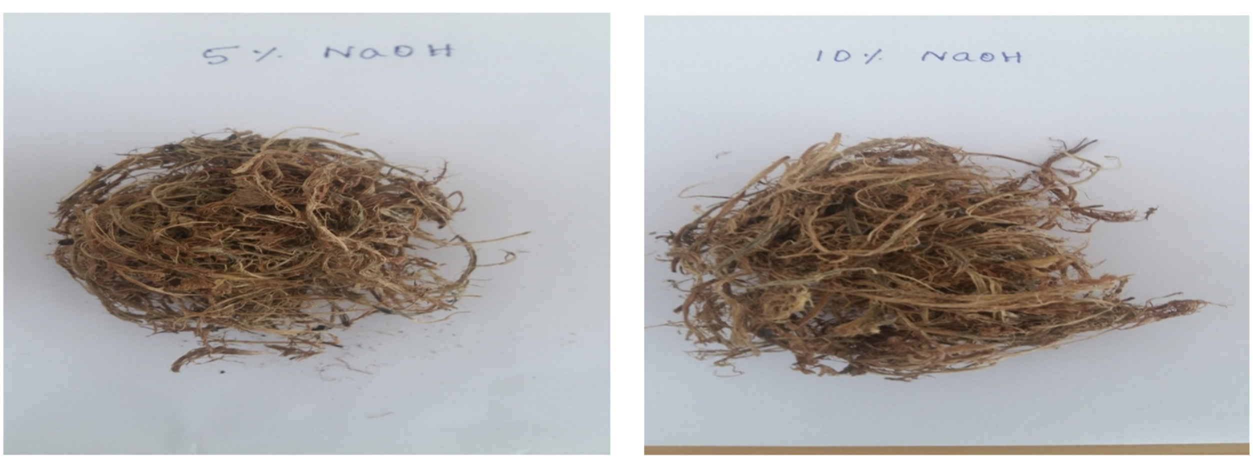

Figure 2. 5% and 10% NaOH alkali treated Terminalia Catappa fruit fibers

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C. Physical Properties

Fiber Density

The water displacement method was in use to find the density of the Terminalia Catappa fruit fiber. The weighed quantity of fiber was completely wrapped up in water and the volumetric displacement was observed. The weight to volume ratio yielded the density value.

D. Chemical Properties

Wax Content

The wax content was deliberate with the help of sox lot apparatus. Petroleum benzene liquid was heated to 70°C and one gram of Terminalia Catappa fruit fiber was wrapped up in the liquid. The 60 minutes reflux time was provided and the fiber sample was dried. After aeration the fiber, it was weighed and weight difference confirmed the wax content.

Moisture Content

The weighed quantity of Terminalia Catappa fruit fiber was placed in an oven at the temperature range of 105 ± 2°C for 4 hour. The weight of the fiber taken from the oven was measured and the difference in weight accounts for the moisture content present in the fiber.

Cellulose Content

The weighed quantity of Terminalia Catappa fruit fiber was wrapped up in a mixture of sodium chloride 1.72%, and three drops of sulfuric acid in water. One hour drenched time was provided. Then the excess fluid was taken away by suction process and ammonia was added. The residue was washed with distilled water, dried at room temperature and weighed. The percentage of cellulose was noted by the ratio of the residue weight to the dry sample weight.

IV. Results & Discussion

A. Physical Properties of Terminalia Catappa Fruit Fiber

The results are shown in Table I. It was noticed that the density values of the Terminalia Catappa fruit fibers were less than that of the synthetic fibers. These properties envisage that the Terminalia Catappa fruit fibers could be used as reinforcement in making the light weight composite structures. Moreover the biodegradability is an added feature for the use of this fiber in composites.

Table I Physical properties of terminalia catappa fruit fiber

S. NO	Type of fiber	Density value g/cc
1	Raw fiber	1.31
2	5% Alkali treated fiber	1.28
3	10%Alkali treated fiber	1.26

B. Chemical Properties of Terminalia Catappa Fruit Fiber

The Terminalia Catappa fibers were alkali treated with 5%, 10% NaOH solution and the outcomes are presented in Table II. The change in fiber properties was pragmatic due to alkali treatment. The raw Terminalia Catappa fruit fiber consists of cellulose (66.95%), wax (0.44%) and moisture (13.5%). The alkali treatment caused the cellulosic fiber to swell and removed the cellulose and other impurities from the fiber surface. The micro fibrils of cellulose remained unaffected due to alkali treatment. The removal of the impurities led to the better mechanical properties, fiber wetting characteristics and fiber– matrix adhesiveness in composite applications.

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Table II Chemical properties of raw and alkali treated terminalia catappa fruit FIBER

Fiber category	Wax content (wt%)	MOISTURE CONTENT (WT.%)	Cellulose content (wt.%)
Raw fiber	0.44	13.5	66.95
5% Alkali Treated fiber	0.24	14.8	65.49
10% Alkali Treated fiber	0.16	14.85	60.11

V. Conclusion

The alkali treatment of the Terminalia Catappa fibers removed the wax content and other impurities from the fiber surface and made the fiber surface soft. This led to the better fiber matrix interface, fiber wetting characteristics and bonding. The density values of the Terminalia Catappa fruit fiber appear less than the synthetic fibers and it is observed that application of these fibers could be used to make less weight composite structures

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