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Characterisation of Banana Fiber - A Review

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Abstract

Today engineering industries are seeking to produce eco-friendly materials.Natural fibers have distinct properties like high strength, low weight, low cost processing and bio degradability than synthetic fibers such as glass fiber and carbon fiber. Some of the annual natural fibers are banana, jute, coir, bamboo, hemp, etc.. ,among these fiber banana fibers have high strength and plenty in availability. Present work divulges extraction of banana fibers, study of mechanical, chemical, physical behaviour of banana fibers. Chemical treatments, processing techniques, surface morphology, hybridised characterisation of banana fiber has been reviewed.

Keywords: *Banana Fiber; Natural Fibers; Processing Technique; Surface Morphology.*

1. INTRODUCTION

1.1 Natural Fiber

Natural fibers are extracted from annual crops like plants, wood, chicken feathers and human hair. Natural fiber extraction possesses low cost processing techniques than synthetic fibers. Natural fibers are lingo cellulosic materialand their surfaces covered by hydroxyl and carboxyl end groups. They have better bonding with the resin matrix than glass and carbon fibers. Because natural fiber have micro pores on their surfaces. Natural fiber reinforced composites possess good engineering properties like high strength, fracture toughness, dimensional stability and biodegradability etc..,

2. BANANA FIBER EXTRACTION

Banana fibers were collected from waste part of banana tree after cultivation of banana in agriculture (Samrat Mukhopadhyay *et al.* 2008). The stem of banana trees were collected and soaked in water for 3 to 4days. Now banana stem was passed between rotating rollers 3 to 4 times. The wet fibers were dried in atmospheric temperature. Fig. 1 describes banana fiber extracting techniques. The diameter ranges of extracted Banana fiber lies between 240-260 µm (Raghavendra *et al.* 2012). The diameter of banana fibers should not be same throughout its length (Samrat Mukhopadhyay *et al.* 2008).

Fig. 1: Banana fiber extraction process: a). Banana trees, b).Separation of banana tree stem, c). Extraction of fibers by rolling process, d). Drying at atmospheric, e). Extracted Raw banana fiber, and f). Engineering application.

2.1 Chemical Treatments on Banana Fibers

Processing techniques that are used to increase strength of banana fibers, remove impurities

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on fiberand improve wettability called chemical treatments because natural fibers are affected by environment concerns like repeated seasons and pollution. There are number of chemical treatments are available to increase the strength and remove impurities of the natural fibers. Among these treatment alkali treatment provides better results. In this treatment fiber were rinsed in NaoH solution for 1hr and soaked in HCL solution for another 1hr.The pH value of solution describes acid levels of raw and alkali treated fibers.

2.2 Tensile Strength of Banana Fiber and BFR Composite

Alkali treatment on banana fibers improves its strength than untreated banana fibers. Hydroxyl group stretching during alkali treatment increase in cellulose percentage and affords strength to banana fibers. Tensile strength of raw and alkali treated banana fibers has shown in fig. 2. Some other cases alkali treatments on banana fibers affect its strength. Major causes are increased percentage of chemicals, NaOH and time duration for treatment.

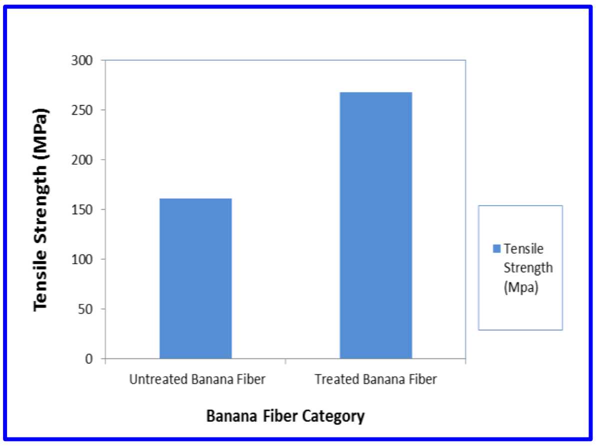

Fig. 2: Tensile strenth of raw and alkali treated banana fibers.

Alkali treatment removes impurities and exposes micro pores on banana fibers. Exposed micro pores on treated banana fiber accumulate more resins and produce better bonding between fiber and matrix. Cross section of banana fiber play major role to increase or decrease the tensile strength (Samrat Mukhopadhyay *et al.* 2008). Treated BFR composites have more tensile strength than untreated banana fiber composites (Raghavendra *et al*. 2012).

Banana fiber composites generally have tensile strength in the range of 529-914 MPa showed in fig. 2. Tensile strength of BFR composite may vary based on fiber length, volume percentage of fiber.

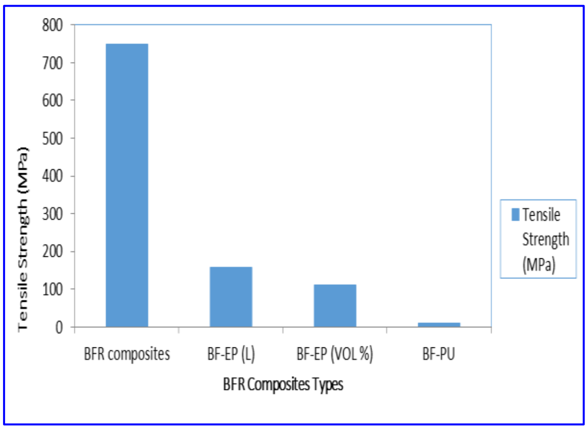

Fig. 3: Tensile strength of BFR composite with various resin matrixes.

Resin matrix and processing techniques among these factors resin matrix play major consequence to decide the strength of BFR composites matrix with various resins. 4 mm length of banana fiber and epoxy resin composite have tensile strength of 158 mpa. Hence length of banana fiber influences the tensile strength of BF-EP* composite (Raghavendra *et al.* 2012). Similarly volume percentage of BF-EP have tensile strength of 112 Mpa (Ramesh *et al.* 2014). Again when banana fiber were resin forced with low strength resin such as poly urethane the BF-PU* composite have tensile strength of 10.12. These results clearly show the factors that may affect the tensile strength of BFR composite.

2.3 Hybridized Characterization of BFR Composites

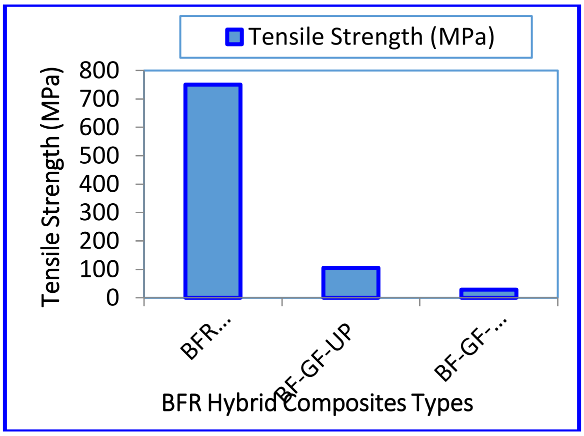

Fig. 4: Hybrid characterization on tensile strength of BFR Composites.

Tensile strength of banana fiber reinforced composite may vary when it was hybridized. Volume percentage of other fiber or filler materials might affect the tensile strength of BFR composite. Fig. 3

shows the variation in the BFR hybrid composite. Bananafibers reinforced with glass fiber in unsaturated polyester have tensile strength of 105 MPa. Banana fibers like have 28 MPa of tensile strength (Bhoopathi *et al.* 2014). These results mainly caused by volume percentage of fibers.

2.4 Chemical Properties Of Banana Fiber

Natural fibers have their botanical compositions in their structures. The botanical compositions were increase or decrease because of alkali treatment. The chemical properties of banana fiber was shown in Table 1.

Table 1. Chemical properties of banana fiber.

S.No.	Constitutions	Pseudostem fibers (%)	Banana fibers (%)
1	Cellulose	34	64
2	Hemicellulose	16	19
3	Lignin	15	5
4	Moisture	10	11

2.5 FTIR spectrum for banana fiber and BFR composites

FTIR Spectrum describes chemical groups that are present in the banana fiber before and after alkali treatment, also the results of BFR composites. Banana fibers have broad and strong band at 3326 cm^{-1} as assigned to hydroxyl groups. The untreated banana fiber have impurity n=c=0 at 2273 cm^{-1} . This impurity may be removed because of alkali treatment. When both treated and untreated banana fibers were prepared as composites the new band arrives at 2853 cm^{-1} assigned asmythylene groups.

2.6 Scanning Electron Microscopy

Scanning electron microscope reveals surface morphology, cross sectional view, fracture behaviour, bonding between the fiber and resin matrix as showed in fig. 5. Scanning electron microscope describes the impurities, wax, ash content on the raw fiber also removal of these materials on the treated fiber.

The exposes of micro pores on treated fiber also displayed. Banana fiber have elliptical shape hoses in its cross sectional structure. SEM ensures that the diametric cross section improves the tensile strength of the banana fiber. Fiber matrix interference and the various failure behaviours of BFR composites shown in fig. 6.

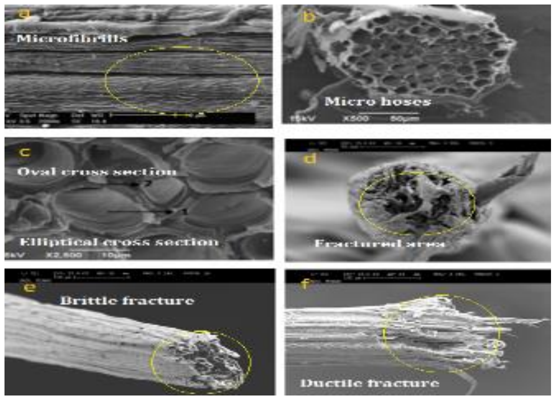

Fig. 5: SEM manages of single banana fiber (a) Surface morphology banana fiber (b), (c) Cross sectional view of banana fiber (d) Cross sectional view of banana fiber after tensile strength, (e), (f) Multiple angle views of banana fiber after tensile failure on fractured area.

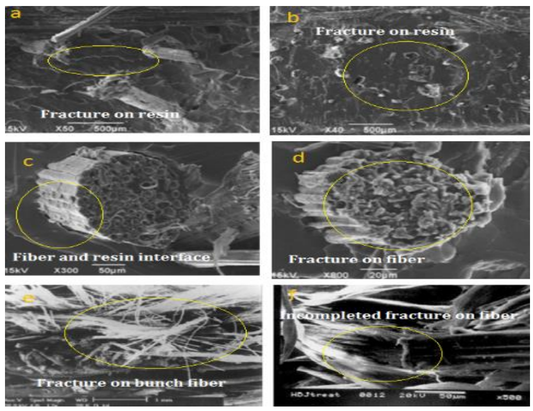

Fig. 6: SEM manage of BFR composite at fractured area (a), (b) Fractured surface of BFR composite (c), (d) Fiber matrix bonding at fractured area (e), (f) Fracture on banana fiber in BFR composites during tensile test.

2.7 Water Absorption Study

The raw banana fiber absorbs more water than treated banana fiber. The impurities and waste material on raw fiber absorbs more fiber. It is to be noted that the moisture absorption of the banana fiber is major issues to prepare then as composites. Absorbed Moisture percentages were quantified before and after immersion in water according to ASTM DS70 (Boopalan *et al.* 2013). The following formula used to calculate the moisture uptake percentages.

$$\% \, wet = \frac{S_i - S_0}{S_i} \, X \, 100$$

2.8 Banana Fiber Reinforced Composite Processing Techniques

BFR Composite specimen and application products are developed techniques like resin transfer moulding, injection moulding compression. Moulding and hand layer process among these process hand layer up process has been used widely to prepare banana fiber reinforced composite. Hand layer up process is most economic, efficient and effective process. This process gives better bonding between fibers and resin, distribution of material throughout the product, maintaining atmospheric temperature and pressure and uniform distribution of load area plates. The schematic diagram of hand layup process was shown in fig. 7.

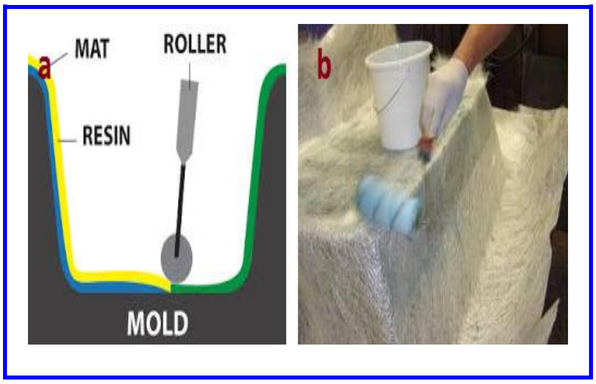

Fig. 7: Hand layup process: a) Schematic diagram, b) Practical work

3. CONCLUSION

The present review concludes that waste part of banana fiber can used as

- Banana fiber extraction process is low cost effective process
- Chemical treatment improves strength and removes impurities on fibers.
- Chemically treated fibers composite have more tensile properties than untreated fiber composite.
- Chemical composition on banana fiber and BFR composite can be predicted through FT-IR spectrum.
- Scanning electron microscopy reveals surface morphology and factor for failure of composites.
- BFR effectively composite can be produce by hand layup process.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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