A Review on Composition and Properties of Banana Fibers

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Abstract— Last few decades have seen composite materials being used predominantly in various applications. There are many types of natural fiber in plastics including hemp, flax, jute, wood fiber, rice husks, straw wheat, oats, bagasse, barley, grass reeds, banana fiber, oil palm empty fruit bunch, coir, sisal, cotton, kenaf, ramie, water pennywort, paper-mulberry, kapok, abaca, pineapple leaf fiber. The production of banana in India is 13.5 million tons per annual. Banana forming generates more quantity of biomass which goes as waste. The above ground parts like pseudo-stem and peduncle are the major source of fibre. Banana fibre used as a raw material in industry for production of papers, tea bags, currency and reinforced as a polymer composite. Natural fiber is used as an alternative resource to synthetic fibres as well as reinforcement for polymer composite materials and the manufacturing is inexpensive, renewable and environment friendly. Natural fibers have low cost, low density and low durability as compare to synthetic fibers but with the help of fiber treatments, mechanical properties of natural fibres are improved. In this paper, banana fibers are compared through their applications, use and properties and thus it is concluded that the banana fibres provide better chemical composition and properties.

Index Terms— Banana fibres, Composite material, Natural fibers, Synthetic fibres.

1 INTRODUCTION

Banana fiber is a lingo-cellulosic fiber, which obtained from the pseudo-stem of banana plant. Banana fiber is a bast fiber with relatively good mechanical properties. Banana fiber has good specific strength properties comparable to those of conventional material, like glass fiber. This material has a lower density then glass fibers. The pseudo-stem is a cylindrical, clustered aggregation of leaf stalk bases. Banana fiber at is a waste product of banana cultivation and either not properly utilized or partially done so. Useful applications of such fibers would regularize the demand which would be reflected in a fall of the prices. Banana fibers have highly strength, light weight, smaller elongation, fire resistance quality, strong moisture absorption quality, great potentialities and biodegradability. Banana fiber has recognized for apparels and home furnishings Banana fiber has great potentialities for paper making special demand of handmade paper. Banana fiber is making products like filter paper, paper bags, greeting cards, lamp stands, pen stands, decorative papers, rope, mats and composite material etc. Banana fiber is used in currency notes in Germany and trial run in India also. Polypropylene reinforced with banana fiber is used by automobile companies for making under floor protection panels in luxurious cars like Mercedes. Banana fiber mostly used in making handicrafts and home decorative. Composite material of banana fiber used in buildings boards and fire resistance boards. During the research it was found that paper made out of this fiber has long life of over 100 years as it is strongest of the long fibers over found other natural fibers, which can be folded 3,000 times. It can be used currency and value- able documents like

Fig 1.1 Banana fibers [1]

2. COMPOSITION AND PROPERTIES OF BANANA FIBRES

Table1 shows the classification of the selected plant fibers. These fibers could easily be used in the composite manufacture.

Table 1: Production details of fibers, origin of banana fibers

Botanical name	Musa Ulugurensiswarb
Palnt origin	Leaf, bast
Production per metric ton	200

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Table 2 is those of the single cell fibers i.e., the physical properties of banana fibers. Fibers with the highest aspect ratio will exhibit highest tensile properties provide high surface area which are advantageous for reinforcement purposes.

Table 2: Physical properties of the banana fibers

Dia(μm)	80-250
Length(mm)	1000-5000
Aspect Ratio(l/d)	150
Moisture content (%)	60

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Table 3 shows the chemical composition of banana plant fibers, and their physical properties. It is noted that cellulose is the main constituent of plant fibers followed by hemicelluloses and lignin interchangeably and pectin respectively. Cellulose is also the reinforcement for lignin, hemi cellulose and Pectin.

Table 3: Chemical composition of banana fibers

Cellulose (%)	60-65
Hemi cellulose (%)	6-19
Lignin (%)	5-10
Pectin (%)	3-5
Ash (%)	1-3
Extractives (%)	3-6

Table 4 shows mechanical properties of banana fibers, by which we use fibers as reinforcement for a good mechanical properties of composite materials.

Table 4 Mechanical properties of banana fibers

Tensile Strength (Mpa)	529-914
Specific Tensile Strength (Mpa)	392-677
Young's Modulus (Gpa)	27-32
Specific Young's Modulus (Gpa)	20-24
Failure Strain (%)	1-3
Density (Kg/m3)	950-750

3. LITERATURE REVIEW

S.M. Sapuan et al [2] find the Mechanical properties of woven banana fibre reinforced epoxy composites. The experiments of tensile and flexural tests were carried out using natural fibre with composite materials. Three samples prepared from woven banana fibre composites of different geometries were used in this research. From the results obtained, it was found that the maximum value of stress in x-direction is 14.14 MN/m²; meanwhile the maximum value of stress in y-direction is 3.398 MN/m². For the Young's modulus, the value of 0.976 GN/m² in x-direction and 0.863 GN/m2 in y-direction were computed. As for the case of three-point bending (flexural), the maximum load applied is 36.25 N to get the deflection of woven banana fibre specimen beam of 0.5 mm. The maximum stress and Young's modulus in x-direction was recorded to be 26.181 MN/ m²and 2.685 GN/m²respectively. Sapuan find only tensile and flexural stress in x and y direction but not find about the moisture absorption quality.

Samrat Mukhopadhyay et al [3] studied about the various diameter of banana fibre. Hundred fibers were chosen at random from the collection of banana fibers. There was a wide range of variation of diameter starting from 0.08mm to 0.32 mm. Based on a class interval of 0.029 mm, which establishes that the standard deviation has decreased with an increase of diameter of the fibers meaning that courser fibers were more regular in nature. The majority of the fibers, as evident from come in the diameter range of 0.17 to 0.19 mm. Hence such fibers were chosen for tensile testing. Results of tensile testing revealed that strain rates played an important role in the nature of the stress strain curves, the strength of the fibers' and the nature of failure.

V. Arumuga prabu et al [4] studies on Influence of redmud on the mechanical, damping and chemical resistance properties of banana/polyester hybrid composites The effect of varying parameters such as particle size (4, 6 and 13 lm) and weight percentage (2, 4, 6, 8 and 10 wt%) of redmud were analyzed on static mechanical, free vibration and chemical resistance properties of hybrid composites. The addition of redmud shown enhanced performance compared to the virgin BFRPCs in all the above said properties. The maximum increase of 50% in mechanical strength was observed for the BFRPCs with the addition of redmud having 4 lm particle size and 8 wt% of filler content compared to pure BFRPCs. The increased value of fundamental natural frequencies with associated modal damping characteristics of redmud filled BFRPCs were found using half-power band width method. All the fabricated composites performed well against various chemicals and it indicates that the resistance to the weight loss is due to the uniformly distributed redmud. To study the effect of redmud on interfacial bonding between the banana fibre and polyester matrix the Scanning Electron Microscope (SEM) image analysis was performed.

Nilza G. Jústiz-Smith et al [5] study on Potential of Jamaican banana, coconut coir and bagasse fibers as composite materials. It presents an evaluation of the alternative use of three Jamaican natural cellulosic fibers for the design and manufacturing of composite materials. The natural cellulosic fibers under investigation were bagasse from sugar cane (saccharum officinarum), banana trunk from the banana plant (family Musacae, genus Musa X para disiaca L), and coconut coir from the coconut husk (family Palm, genus coco nucifera). Fibre samples were subjected to standardized characterization tests such as ash and carbon content, water absorption, moisture content, tensile strength, elemental analysis and chemical analysis. The banana fibre exhibited the highest ash, carbon and cellulose content, hardness and tensile strength, while coconut the highest lignin content.

Lina Herrera- Estrada et al [6] investigated that banana fibre reinforced composite material with a thermoset, suitable for automotive and transportation industry application. Fibre surface chemical modifications and treatments were studied along the processing conditions for epoxy and eco-polyester banana fibre composites flexural tests show that banana fibre/eco-polyester composites have a higher flexural strength and modulus due to improved fibre/matrix interaction. Environmental tests were conducted and the compressive properties of the composites were evaluated before and after moisture absorption. The resulting banana fibre/epoxy composites were found to yield a flexural strength of 33.49 MPA and compressive strength of 122.11 MPA when alkaline pretreated, with improved environment exposure resistance. While the non alkaline pretreated banana fibre/polyester composites were found to yield a flexural strength of 40.16 MPA and compressive strength of 123.28 MPA.

N. Venkateshwaran et al [7] give a review on the Banana Fiber Reinforced Polymer Composites. This paper presents a summary of research work published in the field of banana fiber reinforced polymer composites with special references to the structure, physical and mechanical properties of the composites. Due to low density, high tensile strength, high tensile modulus, and low elongation at break of banana fibers, composites based on these fibers have very good potential use in the various sectors like construction, automotive, machinery, etc.

Satish Pujari et al [8] give a review on comparison of Jute and Banana Fiber Composites. The present review explores the potentiality of jute & banana fiber composites, emphasizes both mechanical and physical properties and their chemical composition. The utilization and application of the cheaper goods in high performance appliance is possible with the help of this composite technology. Combining the useful properties of two different materials, cheaper manufacturing cost, versatility etc., makes them useful in various fields of engineering, high performance applications such as leisure and sporting goods, shipping industries, Aerospace etc.

D. Chandramohan et al [9] study on natural fibers, this review paper discuss about worldwide review report on natural fibers and its applications and also concentrates on biomaterials progress in the field of orthopaedics. An effort to utilize the advantages offered by renewable resources for the development of biocomposite materials based on bio epoxy resin and natural fibers such as Agave sisalana; Musa sepientum; Hibiscus sabdariffa and its application in bone grafting substitutes.

V.S. Srinivasan et al [10] study on evaluation of mechanical and thermal properties of banana–flax based natural fibre composite. The result of test shows that hybrid composite has far better properties than single fibre glass reinforced composite under impact and flexural load. It is found that the hybrid composite have better strength as compared to single fibre composites.

R. Badrinath et al [11] study on comparative investigation on mechanical properties of banana and sisal reinforced polymer based composites. It is observed that sisal fiber/epoxy has better tensile strength than banana fiber. When fiber concentration increase the tensile strength also increase.

M. Boopalan et al [12] find on the mechanical properties and thermal properties of jute and banana fibre reinforced epoxy hybrid composites. The jute and banana fibres' were prepared with various weight ratios (100/0, 75/25, 50/50, 25/75 and 0/100) and then incorporated into the epoxy matrix by moulding technique to form composites. The tensile, flexural, impact, thermal and water absorption tests were carried out using hybrid composite samples. This study shows that addition of banana fibre in jute/epoxy composites of up to 50% by weight results in increasing the mechanical and thermal properties and decreasing the moisture absorption property. The mechanical properties such as tensile strength, flexural strength and impact strength are found to be maximum for 50/50 weight ratio of jute and banana fibers reinforced epoxy hybrid composites. Since 50/ 50 weight ratio hybrid composite has 44% more tensile strength than Palmyra/polyester composite. Moisture absorption study of hybrid composite shows the minimum moisture uptake is by 50:50 hybrid composites.

M. Jannah et al [13] study on effect of Chemical Surface Modifications on the Properties of Woven Banana Reinforced unsaturated Polyester Composites. Treated composite systems show improvements in flexural properties. The impact strength increased with the fiber content up to 15 vol%, with an obvious trend shown by acrylic acid-treated banana-reinforced polyester composites. Treated fiber composites reduced the water absorption compared to the untreated composites.

4. REVIEW OBJECTIVE

The present review concentrates on the properties and chemical composition of banana fibers. It is challenge to the creation of better materials for the improvement of quality of life with better mechanical properties. The present review also focuses on the physical properties, mechanical properties, fiber types, chemical composition of banana fibers. The objective of the present study is to utilize the advantages offered by renewable resources for the development of composite materials based on banana fibers. The present invention proposes suggestions of using natural fiber reinforced composite as a plate material which uses pure natural fibers that are rich in medicinal properties Banana fibers. It is yet another object of the present invention that the reinforced composite undergoes various tests such as tensile test, moisture test, flexural test, absorption test, impact test etc.

5. CONCLUSION

The present review explores the potentiality of banana fiber composites, emphasizes both mechanical and physical properties and their chemical composition. Properties of banana fibers are superior as compare to other natural fibers. The utilization and application of the cheaper goods in high performance appliance is possible with the help of this composite technology. Combining the useful properties of two different materials, cheaper manufacturing cost, versatility etc., makes them useful in various fields of engineering, high performance applications such as leisure and sporting goods, shipping industries, Aerospace etc. If we talk about the future of banana fibers, are very bright because they are cheaper, lighter and environmentally superior to glass fiber or other synthetic fibers composites in general. Hence, with this back ground, it is concluded that, the composites stand the most wanted technology in the fast growing current trend.

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