Mechanical Characterization of Banana Fiber Reinforced Epoxy Bio-Composite

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ABSTRACT

Banana fiber reinforced epoxy composite show many advantages such as low density, low cost, environmental friendly, biodegradable and high specific mechanical strengthen. This work investigates the tensile, flexural and impact properties of bio-composites prepared by using banana fibre, boiled potato, boiled rice, natural rubber and epoxy. The composite was synthesized using Hand lay-up method with 30 wt. % of banana fiber constant and varying the wt. % of boiled potato, boiled rice and natural rubber into epoxy matrix. The results show that the addition of natural latex rubber results in increased in tensile, flexural and impact strength of bio-composites.

Keywords: *Banana fiber, Potato, Rice, Epoxy, Rubber*

1. INTRODUCTION

Natural fibers reinforced polymer composites have been subject of marvellous interest by the researchers and scientist since last four decades due of its advantages such as low density, less wear and tear, low cost, high specific strength and modulus, easy processing, recyclability, extensive availability and biodegradability [1-3]. Instead good properties these fibers have some limitations also such as low impact strength, poor compatibility, high moisture absorption and poor durability. These limitations of natural fibers can be overcome by using various types of chemical treatments, hybridization of synthetic fibers and addition of nano-particles as additives.

Gassan et al. [2] studied that the mechanical characteristics of flax fibers were optimized by using the NaOH treatment process to improve the properties of composite materials. Danny Akin et al. [3] studied that the linum ustitatissimum is the source of natural fibers that provides biobased products for a variety of existing markets, but considerable processing and cleaning is required. Zhang et.al.[4] studied that the series of static indentation and impact test s at different speeds were carried out to study the deformation behavior and damage resistance of reformed bamboo/ aluminum laminate composites. Luc Averous et al. [8] have investigated the plasticized wheat starch (PWS) and cellulose fibers composites for packaging applications. The materials and methods used by them are: wheat starch cellulose fibers (fiber length = 60 to 90 μm, diameter d = 20 μm, and l/d ratio =3 to 45) and glycerol of 99% purity grade as plasticizer. Starch, fibers and glycerol were mixed in a turbo batch-mixer. Wong et. al.[5]studied about the improvement of the inter faceial properties of composites consisting of poly (3-hydroxybutyrate) and flax fibers was provided by addition of 4,40-thiodiphenol (TDP) at various concentrations up to 10% v/v .The additive TDP is known to form hydrogen bonds with many functional groups . The flax fibers were initially treated with TDP before being used to prepare the composites.

From literature review it can be concluded that very few work on the banana fiber reinforced epoxy bio-composite using boiled rice and boiled potato and natural rubber reported till date. The aim of this study to synthesized the bio-composite and analyses of mechanical behaviour such as tensile properties, flexural properties.

2. MATERIAL AND METHODS

2.1 MATERIAL

The material system used incorporates the following.
1. Banana Fibre
2. Boiled Rice
3. Boiled Potato
4. Natural Rubber Latex
5. Epoxy Resin

The natural rubber latex was chosen as a constituent because of its sticky quality which might be more suitable for proper binding of boiled rice, boiled potato and banana fibres. Initially boiled rice-potato with banana fibre was fabricated but there was the problem of drying and sticking. It takes one week to dry and bonding with banana fire is not good. The raw materials used have been procured from different sources as given below. The density of material is given in Table 1.

1. Purchased from Chandra prakash and company No-1139, mishra raja ji ka rasta, Chandpole bajar, jaipur,302001 Rajasthan.
2. Natural rubber latex: Arranged from the rubber tree.
3. Boiled rice and boiled potato: Arrange waste boiled rice and boiled potato from Hostels.
4. Epoxy (AralditeAY-105 and Hardener Aradur HY951):Purchased from Universal Enterprises (Polymer Div.) 78/44, Latouche Road, Kanpur, India

Table 1 Density of material used in composite preparation

S.No.	Materials	Density(g/cm^3)
1	Banana fiber	1.42
2	Rice	0.74
3	Potato	0.79
4	Natural rubber latex	0.90

2.2 METHODOLOGY

The bio-composites of different compositions shown in Table 2 were fabricate design hand lay-up technique in open mold. Initially epoxy resin was not added in this work but there was a problem of bonding between fibre and matrix and also there was problem in getting the composite dry. In this work epoxy resins is used as a supporting material due problems of fabrication of neat bio-composites. The specimen of size (300 mm × 150 mm × 3 mm) the bio-composite sheet produced single ply having thickness between 3 mm and then left for 48 hours for curing at room temperature (18-35˚C). After 48 hours it is removed from the mould.

Table 2 Detailed compositions of prepared bio-composites

S.No.	Bio-composite and code	Details
1.	BF30 R15 P15(**B1**)	30%Banana fiber, 15%BoiledRice,15%BoiledPotato and Epoxy basedBio-composite
2.	BF30R15P15NR10 P15 (**B2**)	30%Banana fiber, 15%BoiledRice,15%BoiledPotato, 10%NaturalRubber and Epoxy basedBio-composite
3.	BF30R15P15NR20 P15 (**B3**)	30%Banana fiber, 15%BoiledRice,15%BoiledPotato, 20%NaturalRubber and Epoxy basedBio-composite

3. CHARACTERIZATION

3.1 Tensile testing Hounsfield Tensometer has been used for tensile testing of bio-composites. The Specimen is prepared according to ASTM Standard (ASTMD3039-76) [35]. Line diagram of specimen for tensile testis shown in Fig.1.The details of the specimen are as follows:

Length=150mm,

Width=20mm,

Thickness =3mm

Cross-sectional area =20x3= 60mm^2.

Strains are measured with the help of strain gauge, indicate The strain gauge rosette is mounted on the specimen, along the fiber direction (0°),X-axis is taken for linear strain, perpendicular to the fiber direction (90°),Y-axis is taken for lateral strain and along 45°. The specimen for tensile test is shown in Fig2 with strain gauge rosette.

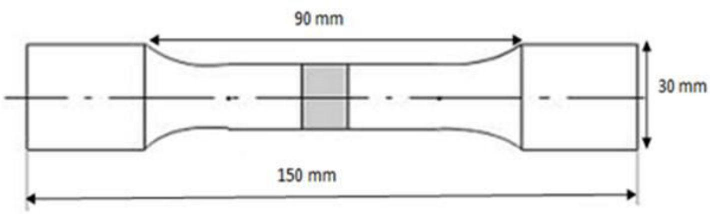

Fig. 1 Linediagramoftensile testspecimen

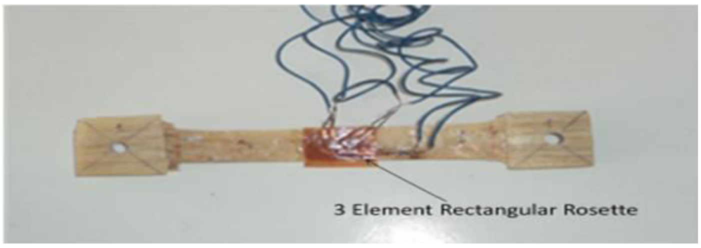

Fig.2 Tensiletestspecimenis shownwith rosette

3.2 FLEXURAL TEXTING

Bending testing of biocomposites has been performed.The specimen is prepared according to ASTM standard (ASTMD790) [35]. Line diagram of specimen for tensile testis shown in fig. 3. The specimen dimension for bending test was - Length=75mm,

Width=25mm,

Thickness=3mm,

Supporting length=40mm

Cross-sectional area= 25×3=75mm^2.

3.3 IMPACT TEST.

In the Impact testing of bio-composites assessment of shock absorbing capacity of material under suddenly applied or shock load is done. Two type of impact test are commonly conducted. These were both Charpy test and Izod test performed. The specimen is prepared according to ASTMd standard (ASTMD256-81) [35].In both the cases standard specimen is in the form of not ched beam. In charpy test the specimen is placed as simply supported beam while in Izod test as a cantilever beam the specimen have standard V-shape notched of 45°.The notched is located in the tension side of the specimen, during Impact testing. The depth of notch is taken=,where t is th thickness of specimen. Diagram of specimen is shown fig. 4 and specification in Table 3.

Table 3 Specification of samples for bending test

S. No.	Dimension	Value
1	Length	55mm for charpy test
2	length	75mm for Izod test
3	Width	10mm
4	Thickness	10mm
5	Thickness at the notch	8mm
6	Depth of notch	2mm

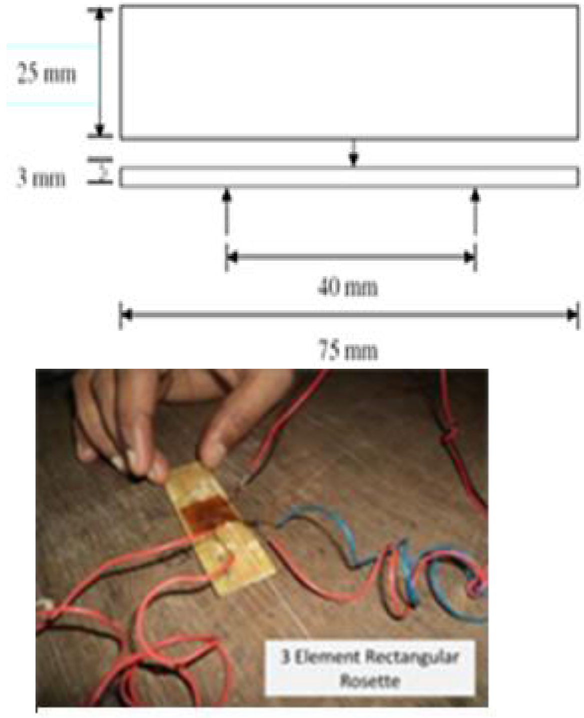

Fig. 3 Bendingtest specimen (a) Line diagram(b)specimen withrosette

Fig. 4 Impact testing machine with specimen

4. RESULTS AND DISCUSSIONS

4.1 TENSILE TEST

Stress strain curve shows linear behavior during initial portion of the curve, after it become on- line areas the stress increases. Tensile strength varies from 42.4MPa which is of 15% boiled rice 15% boiled potato 40% epoxy and 30% banana fibre bio-composite (Bio-composite1) to 46.55 MPa which is of 15% boiled rice 15% boiled potato 20% natural rubber latex 20 % epoxy and 30% banana fibre bio-composite (Bio-composite3) and tensile strength of 15% boiled rice 15% boiled potato, 10% natural rubber latex, 30% epoxy and 30%banana fibre bio-composite (Bio-composite2) is 44.2MPa.Thus we see 15% boiled potato 20% natural rubber latex, 20% epoxy and 30% banana fibre bio-composites the strongest in tension. The findings of tensile test are shown in Figure 5.

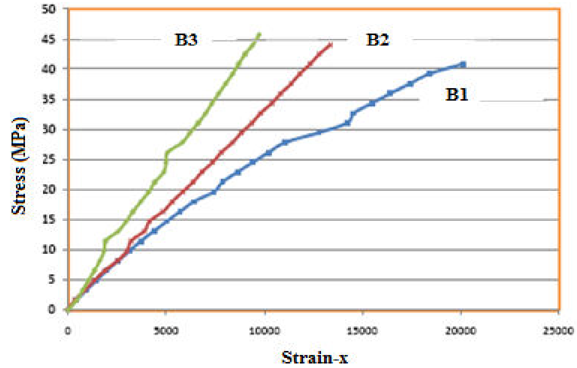

Fig. 5 Tensile properties of diffeent bio-composites

4.2 FLEXURAL TEST

Load-deflection curves show the non-linear behavior. Flexural strength varies from 73.37MPa to 94.08MPa which is for 15% boiled rice 15% boiled potato 40% epoxy 30% banana fibre and 15% boiled rice 15% boiled potato 20% natural rubber latex 20% epoxy 30% banana fibre, 15% boiled rice 15% boiled potato 20% natural rubber latex 20% epoxy 30% banana fibre bio-composite has higher flexural strength. The findings of flexural test are shown in Figure 6.

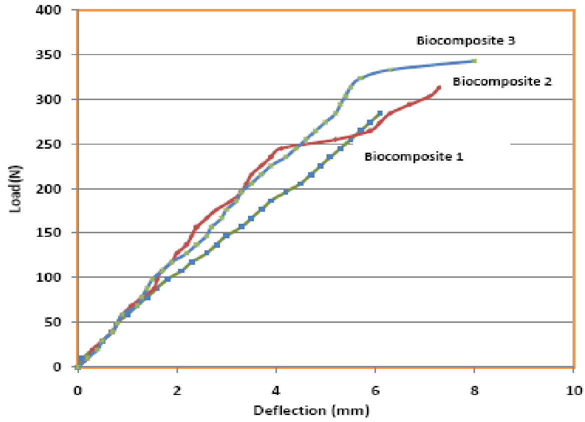

Fig. 6 Comparision among load deflection curve for various boicomposote during bending test

4.3 IMPACT TEST.

Changes in impact strength occurs after addition of natural rubber latex and impact strength varies from 0.3kgm which is of 15%boiled rice15%boiled potato,40% epoxy and 30% banana fibre bio-composite to 0.45 kgm which is of 15% boiled rice 15% boiled potato,20% natural rubber latex 20% epoxy and 30% banana fibre bio-composite. The specimen with higher natural rubber latex content has higher impact strength. The findings of impact test are shown in Fig. 7.

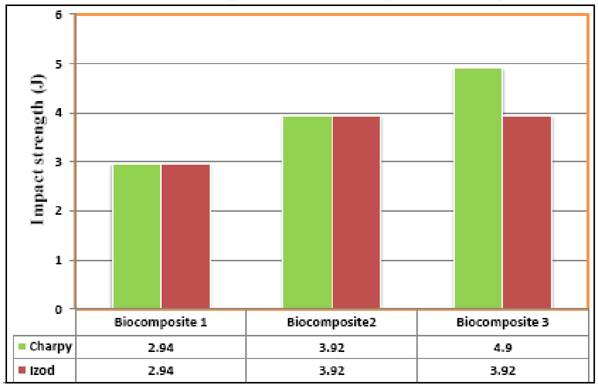

Fig. 7 Comparision amongs bar chart for various boicomposote during impact test

5. CONCLUSIONS

1. Tensile strength increase with increase percentage of natural fiber latex from 42.42MPa which is of 15% boiled rice 15% boiled potato, 40% epoxy and 30% banana fibre bio-composite to 46.55MPa which is of 15% boiled rice 15% boiled potato, 20% natural rubber latex 20% epoxy and

30%banana fibre bio-composite.

2. Tensile modulus increases with addition of 20% of natural rubber latex and decreases for addition of 15% jack fruit latex. It varies from 3543.4N/mm^2 which is of 15% boiled rice 15% boiled potato,40% epoxy and 30% banana fibre bio-composite to 4465.75N/mm^2 which is of 15%boiled rice15% boiled potato,20% natural rubber latex 20%epoxy and 30% banana fibre bio-composite.
3. Bending strength increases within crease in percentage of natural rubber latex. It varies from73.17MPa which is of 15% boiled rice 15% boiled potato,40% epoxy and 30% banana fibre to94.08MPa which is of 15% boiled rice 15%boiled potato, 20% natural rubber latex 20% epoxy and 30% banana fibre bio-composite. Thus there is an increase of 28.57%inbendingstrength.
4. Impact strength is increases from 2.94 J to 4.41J after addition of natural latex.

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