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Effect of Fiber length on Physico-mechanical property of Euphorbia Coagulum Banana Fiber Composite

Bhuvneshwar Rai, Gulshan Kumar and Rajinder K. Diwan

Abstract

Presently composites are being made using either both the binder and the reinforcing fibers are synthetic or either one of the material is natural or synthetic. In this study we had prepared bio-degradable composite by using natural fiber i.e. banana fiber and pant based resin i.e. dried mass of euphorbia latex. Length of the fiber and its orientation play an important role in the mechanical properties of the fiber reinforced polymer composites. For better understanding of the effect of fiber length on the physico-mechanical property of the composite in this study we had prepared euphorbia latex banana fiber composite with varying fiber length and charactrised for water absorption, impact strength, flexural strength and flexural modulus. Results shows that with increasing fiber length of the composite from 1mm to 6mm, water absorption increases and impact strength of the composite increases from 20 to 30% and 37 to 43 J/m respectively whereas flexural strength and flexural modulus of the composite increases from 9.5 MPa to 12.9 MPa and 980 MPa to 1290 Mpa respectively with increase in fiber length from 1mm to 4mm further increase in fiber length result in decrease of flexural strength. Effect of surface modification on physico-mechanical properties of the campsite also studied. Result shows that hemicellulose and lignin presents on the fiber surface removed on treatment sodium hydroxide which results increase in surface roughness and improvement in mechanical properties.

Keywords: **Euphorbia coagulum, Banana fiber, composites, renewable resource, biodegradable, fiber length**

Bhuvneshwar Rai
m
Dr. R. K. Diwan

Shriram Institute for Industrial Research, 19, University Road, Delhi
India

Dr. Gulshan Kumar
S. B. A. S., Guru Gobind Singh Indraprashtha University, Sector - 16C
Dwarka, Delhi
India

Introduction

Presently natural fibers are used in the composite preparation along with the polymeric material to over come on the problem associated with global petroleum feedstock and voluminous waste generated after disposal of the composite material. Natural fiber used in composite gets biodegrade after use when disposed to the environment but the polymeric materials used as matrix in preparation of these composites are generally durable and remains as such for long-time after disposal. So emphasis of environmental pollution problems and land-shortage problem for solid waste management, such as non availability of landfills, public perception, and reduction of fertility of lands by accumulation of surface litter, environmentally degradable and 'environmentally friendly' polymers are of interest for researchers to develop composites.

Use of plant based natural resin, as matrix in the composite preparation will reduce the waste accumulation after disposal. Further, utilization of natural fiber and natural resin especially plant based resin will provide incentive to petroleum based products. Different Research paper has been found for development of composite based natural polymer with plant fiber such as poly (lactic acid)[1], starch plastic[2], soybean plastics[3], cellulosic plastics[4] and polyhydroxy alkanoates (PHAs)[5], Euphorbia resin[6].

In the present study we were developed Composites by using banana fiber having different fiber length with Euphorbia coagulum (dried latex) and studied the effect of fiber length on the physico-mechanical property of the composite.

Recently, hemp reinforced Euphorbia resin has been reported to improve mechanical properties especially impact strength[6]. Euphorbia latex of different species of Euphorbiaceae family has been used as a secondary plasticizer and impact modifier for PVC, adhesive for glass joints and in paint formulations[7]. It has also been reported that E. coagulum modified polyester jute fiber composites has remarkably reduce water absorption and thermal stability and impact properties has been improved to a large extent[8]. Another study based on Euphorbia coagulum polystyrene waste has been reported to replace 70% polyester in developing jute composites[9].

EXPERIMENTAL

Materials

Latex of Euphorbia royleana was collected from Sahashtradhara, in the foothill of Himalaya Dehradun, India. The coagulum (dried mass of latex) has been used as a binder for fabrication of banana composites. Banana fiber has been used as reinforcing agent and was procured from the Dhara Mitra, Pune, India. Methyl Ethyl Ketone Peroxide of lab grade used as initiator was procured from Otto Kemi Germany. Cobalt Naphthenate was procured from Otto Chemika- Biochemika- Reagents Germany and used as accelerator. Sodium hydroxide (Commercial grade) was used to modify the surface of banana fibers and was procured from S. D. fine-chemicals Ltd., Mumbai, India.

METHOD

Latex coagulation

Euphorbia latex was coagulated by using 5% aqueous solution of tannic acid[10]. The coagulated latex was washed several times with water till its pH became neutral and dried in hot air oven at 60±2°C10.

Surface modification of banana Fiber

The banana fiber was dewaxed followed with alkali treatment. Dewaxing of banana fiber has been carried out by washing it in solution of methanol/benzene with a liquid ratio 1: 2 for 72 hrs at 500C in a hot air oven[11]. Alkali treatment of banana fiber has been performed by soaking banana in 4% aqueous solution of sodium hydroxide for four hours and washed with water upto neutral pH. Treated fiber is dried in an oven for one hour at 100±5°C before use for making composites[12].

Chopping of banana fiber

Fibers after being chemically modified as described above were separated into strands and chopped into lengths of 1mm, 2mm, 4mm and 6mm using fiber-cutting machine

Composite preparation

Composites have been prepared using different length of the banana fiber and Euphorbia coagulum. Based on our previous study the coagulum fiber ration in the composite preparation is kept 55:45.[13] The banana fiber and Euphorbia coagulum was mixed homogeneously along with accelerator (cobalt naphthenate solution 1% by wt) and Methyl Ethyl Ketone Peroxide initiator (0.5% by wt.) in a Two Roll Open Mill (make Pyrotech Engineers, Delhi), heated with rows of cartridge heaters. The temperature of the front and the back rollers were maintained at 40^0C and 60^0C respectively. The composite sheets were made by pressing the coagulum mixed banana fiber on compression molding machine (Hydraulic press, Santec India) at 120°C for 30min. at 20 Mpa pressure. The molded sheets were cooled under pressure and released after attaining ambient temperature.

Spectral and thermal study

Raw and treated fibers were compressed in KBr to form pellets. The FTIR spectra of the raw and alkali treated fiber were recorded in a FT-IR Bomen spectrometer model no. FTLA - 2000-100.

Physico-mechanical property study

Water absorption

Rectangular specimens were cut from the compression molded sheet of banana fiber composites were evaluated for water absorption as per ASTM D-570.

Flexural test

Test specimens were cut from molded sheet. The dimension of the test specimens was 127mm x 12.7mm x 3.4 mm. Flexural strength and flexural modulus of Euphorbia coagulum banana fiber composites specimens were tested on Universal Tensile Machine (Instron, 4302 model, UK) at the crosshead speed of 5 mm/min and at a span length of 96 mm and temperature was 23±2°C as per guidelines of ASTM D-790.

Izod impact strength

Notched specimens of the dimension 60mm x 10mm x 3.4mm were cut from the compression molded sheet for Izod impact strength test as per ASTM D-256 –93a. Hammer of 2.75 J was used during testing with dissipation energy of 0.011 joule. Izod impact tester model no.6545/000 from Ceast, UK was used for impact strength.

RESULTS AND DISCUSSION

Effect of Alkali treatment on fiber

N. Sgriccia et al[14] observed that when untreated and treated surfaces of natural fibers were characterized using FTIR, and concluded that changes in the peaks of the FTIR spectrum at 1730, 1625 and 1239 cm−1 indicated that the alkali treatment removes hemicellulose and lignin from natural fiber surfaces. In this study, similar observations were found in FTIR spectra of untreated and alkali treated banana fibers. FTIR spectrum shown in fig. 1 and 2 shows absorption at 1718 cm−1 in the untreated fiber which vanished in the alkali treated.

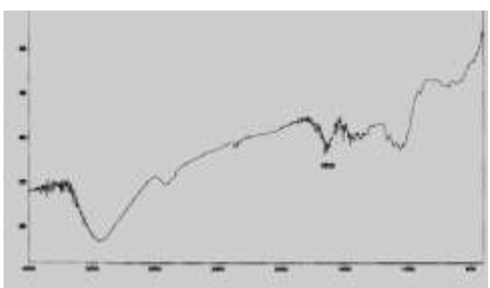

Figure 1: FTIR spectra of raw banana fiber

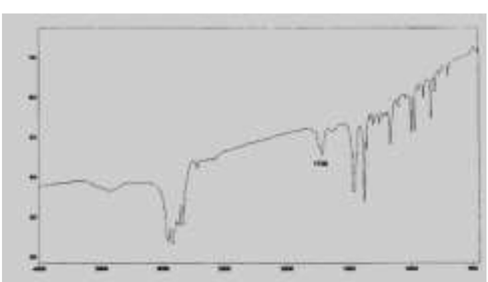

Figure 2: FTIR spectra of treated banana fiber

Physico-mechanical Property

Effect of fiber length on physico-mechanical properties of E. coagulum banana fiber composite. The variation in physical and mechanical properties of the composite as a function of fiber length is represented in Fig. 3 - 8.

Water absorption result shown in figure 3 supports the previous report[15] i.e. water absorption of composite increases with increase in fiber length. Water absorption for the composite using long fibers was higher than those made with short fibers. Therefore short fibers are more suitable for composites for use in moist environments. Low water absorption in short fiber reinforced composite might be due of a thin film coating of hydrophobic matrix on the fiber surface and with the increase of fiber length, water absorption increases this might be due to the presence of voids in the long fibers within the composite provide sites for water penetration.

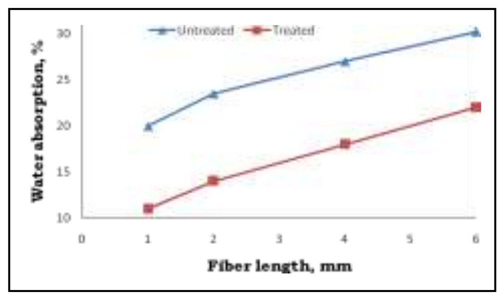

Figure 3: Effect of fiber length and alkali treatment of fiber on water absorption of Euphorbia coagulum banana fiber composite

Fig. 6-8 shows the variation in mechanical properties of composite with the variation in length of the fiber. In general the polymer composites showed an increasing trend in their mechanical properties with the increased fiber length[16]. However, the optimal result of the mechanical properties was achieved at a fiber length of 4 mm. The mechanical property of composite shows the decreasing tendency at the fiber length 6 mm. This might be happening due to two resinous, the existence of defects (such as voids} and weak interface bonding between matrix and fiber which leads to poor matrix/fiber adhesion and does not allow uniform transmission of the applied stress from coagulum matrix to the dispersed fiber phase.

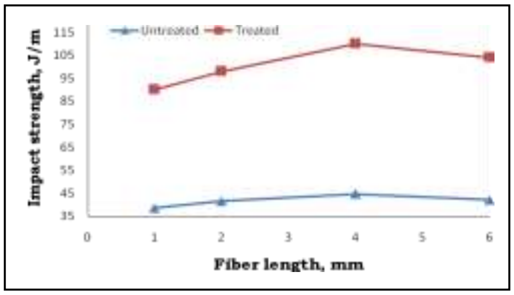

Figure 4: Effect of fiber length and alkali treatment of fiber on impact strength of Euphorbia coagulum banana fiber composite

Effect of alkali treatment of banana fiber on physico-mechanical properties

Alkali treatment of cellulosic fiber was carried out to produce high quality fiber. This process is also known as mercerization. Alkali treatment of the fibers improves the fiber-matrix adhesion as it removes the impurities from the surface of the fibers as well as gives fibrillation and results in the breaking down the bundle of composite fiber in to small fibers. Therefore, the development of a rough surface topography and enhanced the aspect ratio results better fiber-matrix interface adhesion and an enhancement in mechanical properties[17].

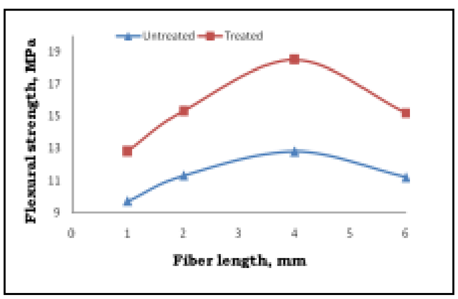

Figure 5: Effect of fiber length and alkali treatment of fiber on flexural strength of Euphorbia coagulum banana fiber composite

In the present study, it was found that the composite having same fiber length with the treated banana fiber have better physico-mechanical properties as compared to composite having untreated banana fiber. The result shows that the chemical treatment of the fiber result in surface roughness, which leads to better interlocking between the fiber and matrix resulting good coagulum fiber adhesion which allows uniform stress distribution.

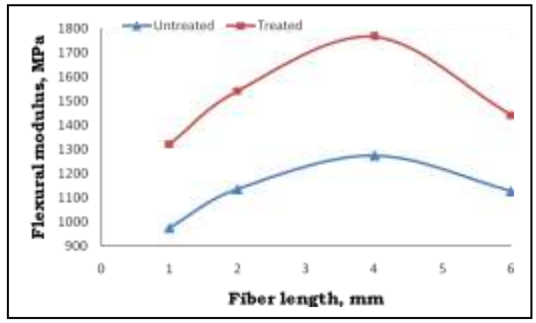

Figure 6: Effect of fiber length and alkali treatment of fiber on flexural modulus of Euphorbia coagulum banana fiber composite

CONCLUSION

In the present work, an attempt has been made to use coagulated latex of Euphorbia royleana as the binder in banana fiber composite. Banana fiber composite had been prepared by mixing banana fiber with Euphorbia coagulum in different proportion using two-roll mill and compression molding. From above study, it has been observed that coagulum banana fiber composite having 4mm fiber length shows better physico-mechanical property. A remarkable improvement in the water absorption was observed after alkali treatment of banana fiber. Surface roughens increases after alkali treatment of banana fiber, which allowed mechanical interlocking between fiber and matrix results in improved mechanical properties. In this way composites can be developed which will reduce global dependence on petroleum based polymeric material and environmental concerns. Such composites will have potential for application in different sector especially in hardboard**.**

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