

FABRICATION AND MECHANICAL PROPERTIES CHARACTERIZATION OF COIR FIBER AND BETEL NUT HUSK FIBER REINFORCED HYBRID POLYESTER COMPOSITE

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Abstract - Natural fiber is a viable eco-friendly replacement for synthetic fibers. Natural fibers have been utilized for centuries due to their exceptional mechanical, thermal, and chemical properties. Because of the limited amount of conventional energy resources and rising environmental concerns, we need to shift towards renewable raw materials for the development of new materials. A variety of benefits that natural fiber reinforced composite materials can provide, conventional materials can't. These benefits have made them popular in various sectors. The use of natural fiber-reinforced composite materials rather than conventional metals has resulted in cost and weight reductions. It can decrease the weight of automobiles and airplanes. In this study, an investigation of the mechanical properties of coir fiber and betel nut husk fiber reinforced hybrid polyester composite has been carried out. To improve the properties of the composite 5% NaOH solution has been used for the alkaline treatment of the fibers. Five different combinations of composites have been made by varying the weight of the fibers. Hand lay-up process has been used for the fabrication of the composites. Maximum tensile strength has been found for the composite B75 C25, which is 22.94 MPa. In the case of impact energy, the B100 composite has 116.96% higher impact energy than the C100 composite. When betel nut husk fiber content has been increased by 50%, impact energy increased by 17.89%. Maximum Rockwell hardness number has been found for the B50 C50 composite, which is 72.5. Minimum water absorption has been found for the B75 C25 composite. Minimum density has been found for the composite B100 because the density of the composite depends on the density of the constituents.

Key Words: Betel Nut Husk Fiber, Coir Fiber, Hybrid Composites, Hand Lay-Up Process, Polyester Resin.

1. INTRODUCTION

Interest in research and engineering has switched from conventional materials to composite materials during the last few decades. Advantages of composite materials come from the combination of different properties, which a conventional material cannot do. In the modern era, composite materials replace conventional materials because

of their high specific strength, strong damping capacity, and high specific modulus [1]. Due to its low cost and superior properties, synthetic fiber-based reinforced composites were the only materials used in the past [2]. These composites use glass fiber or carbon fiber as reinforcement for composite materials. In modern times, sustainability is the major concern of all research. Every industry should replace non-sustainable products with sustainable ones, which is both a great need and a challenge for sustainable development [3]. Also, because of the limited amount of conventional energy resources and rising environmental concerns, we need to shift towards renewable raw materials for the development of new materials. Sustainability is the main driving force to produce natural fiber-reinforced composite materials. In the last decade, natural fibers are being preferred over synthetic fibers as the reinforcement in polymeric composites due to their environmental and economic benefits. Natural fibers also have many other benefits such as abundance, non-toxicity, easy processing at low cost, low relative density, high impact resistance, high flexibility, lower greenhouse emissions, non-corrosive nature, etc [4]. Modern composite materials make up a large part of the engineered materials sector, with uses ranging from commonplace items to complex specialized applications. The use of natural fiber reinforced composite materials rather than conventional metals has resulted in cost and weight reductions. Two or more fibers are combined in a single matrix to create hybrid composites. Artificial, natural, and a blend of both artificial and natural fibers can be used to create hybrid composites. In comparison to fiber-reinforced composites, hybrid composites can assist us to obtain a better combination of properties. Now natural fiber reinforced hybrid composites take researchers' attention because of their superior properties which cannot be obtained by single fiber reinforced composites.

Numerous studies have been conducted on coir fiber and betel nut husk fiber both separately and in combination. With these fibers, various types of resin, including epoxy and polystyrene, and polypropylene were employed to assess the mechanical, thermal, and chemical properties. Different types of alkali treatment have been done to increase the

properties of the composite and the researchers have become successful.

M.M. Rahman et al. [5] investigated the mechanical properties of chemically treated betel nut and coir fiber reinforced hybrid polypropylene composites. They found that coir and betel nut fiber composites with a 1:1 ratio demonstrated superior mechanical qualities to those with a 1:3 or 3:1 ratio. In comparison to raw fiber reinforced composite, alkali treatment of raw coir and betel nut fiber enhanced the mechanical properties. As a result, among all manufactured composites, the alkali-treated 15 wt% coir and betel nut fiber-reinforced polypropylene composite had the best possible set of mechanical properties.

L. Yusriah and S.M. Sapuan evaluated the mechanical properties of betel nut husk reinforced vinyl ester composites. In comparison to the effect of fiber content, it was found that the effect of fiber fruit age had a relatively small impact on the flexural characteristics of the betel nut husk (BNH) reinforced vinyl ester (VE) composites. The physical, mechanical, and thermophysical characteristics of the BNH/VE composites were improved by the addition of 10 wt% ripe BNH fiber to the VE resin. This finding is confirmed by SEM micrographs of the fractured surface of the composites, which demonstrate that at the fiber content of 10 wt%, excellent interfacial bonding between the ripe BNH fiber and VE matrix was achieved [6].

M.R. Ishak et al. [7] reviewed the mechanical properties of kenaf bast and core reinforced unsaturated polyester composites. The tensile, flexural, and impact properties of composites reinforced with kenaf bast fibers were found to be higher than those of composites reinforced with kenaf core fiber. The data showed that 20 wt% of fiber was the ideal amount of fiber to get the best tensile strength and flexural strength for both kenaf bast and core fiber composites. The results also showed that for kenaf bast and core fiber composites, 10 wt% and 5 wt%, respectively, were the best values to provide the highest impact strength.

A. R. Rozyanty et al. [8] studied the effects of the mechanical retting process and water retting process on the mechanical and physical characteristics of composites reinforced with kenaf bast fibers made of unsaturated polyester. In comparison to mechanical retted kenaf bast fibers, water retted kenaf bast fiber displayed higher mechanical properties and exhibited greater resistance to water absorption, suggesting that water retting is preferable for use on kenaf.

Sisal fibril and kenaf fiber reinforced hybrid polyester composites were developed by Subhash Nimanpure and S.A.R. Hashmi et al. [9]. They investigated the mechanical, electrical, and thermal properties. When compared to composites that had the same loading of 40 wt% with sisal fibrils and kenaf fibers, respectively, hybrid composites showed increases in tensile strength of 24% and 18%, the

flexural strength of 30% and 36.4%, and impact strength of 196.3% and 196%. The high electrical insulation capability of the hybrid composites was found by electrical characterization. Additionally, it was discovered that the thermal stability of hybrid composites was greater than that of sisal and kenaf fiber reinforced composites.

K Palani Kumar et al. [10] developed coconut flower cover fiber reinforced polyester composite. They used a hot compression molding process to fabricate the composite and found that the number of voids and air bubbles reduced. They also found that mechanical properties of the composites increase with the increase in fiber concentration and said that especially in the automotive industry, coconut flower cover fiber-reinforced polymer composite is a suitable option for industrial applications

Jute and palm leaf fiber-reinforced recycled polypropylene hybrid composites with varying fiber content were made by Rotich Gideon et al. [11]. They investigated the mechanical and water absorption properties of the composites. Due to the ideal interfacial qualities between the fibers and matrix, experimental results showed that the J25:P75 % (jute and palm leaf fiber) had the highest tensile strength of 62.2 MPa and flexural strength of 82.26 MPa. Jute fiber inclusion caused a rise in water absorption, which peaked at 1.26 % at composite J100:P0. However, due to the higher moisture content of jute fiber, water absorption was decreased at composite J0:P100%.

Ramengmawii Siakeng et al. [12] reviewed the effect of different surface treatments on tensile, thermal, and fiber-matrix bond strength of coir and pineapple leaf fibers with poly lactic acid. They treated the fibers with alkali (6%), calcium hydroxide (6%), and silane (2%). After surface treatments, all of the diameters of the fibers decreased, and it was clear from scanning electron microscopy that non-cellulosic components had been eliminated from coir fiber and pineapple leaf fiber that had been treated with alkali and silane. Particularly, the alkali treatment significantly increased the interfacial shear strength between the fibers and PLA matrix, suggesting that alkali-treated CF/PALF reinforced PLA hybrid biocomposites could be successfully fabricated.

Vikas Kumar Singh and Samrat Mukhopadhyay made a hybrid composite by using chopped and randomly oriented coir and banana fiber with polypropylene. The influence of fiber loading and arrangement on composites' ability to insulate sound was examined. The results of the experiments demonstrated that, up to a certain point, increasing the fiber loading significantly increased sound insulation [13].

Ramakrishna Hegde et al. developed areca nut fiber reinforced epoxy composite. The composite's tensile strength was determined to be 9.19 MPa. The new composite possesses sufficient hardness and strength, making it a suitable material for low-strength applications in the

construction, automotive, military, and packaging industries [14].

R. B. Ashok et al. [15] developed a composite by using areca leaf sheath and epoxy resin. Age of areca palms, surface modification, and layer number all had an impact on mechanical properties like tensile strength and flexural strength. They discovered that, when compared to all other categories, the mechanical properties of multilayered ALS composites had higher tensile strength (20.51 MPa for 10% NaOH treated, 5 layered, and 6-year aged ALS composites) and flexural strength (115.27 MPa for 10% NaOH treated, 4 layered, and 6-year aged ALS composites).

2. MATERIALS & METHODS

Chemically coir fiber and betel nut husk fiber are acceptable for use as reinforcement in composites. Betel nut husk fiber has a lower density than coir fiber. That's why when it has been used with coir fiber in a hybrid composite and polyester being a matrix, the weight of the composite decreases, and the whole composite has become eco-friendly. Fiber extraction, chemical treatment, fiber orientation within the matrix, and composite fabrication process all affect the mechanical and thermal properties of the composite.

2.1 Fiber Extraction

Fiber extraction, chemical treatment, fiber orientation within the matrix, and composite fabrication process all affect the mechanical and thermal properties of the composite. The three primary methods for extracting fibers are mechanical extraction, chemical extraction, and retting. The most often used methods for extracting plant fibers are dew retting and water retting. These methods require approximately 14 to 28 days to degrade waxes, pectin, hemicellulose, and lignin, depending on the type of fiber. In this study, the water retting process has been used to extract the fibers. The most popular technique, water retting, involves immersing bundles of stalks in water. Water seeps into the stalk's core, swelling the inner cells and rupturing the outer layer, increasing the absorption of moisture and bacteria that cause deterioration [16]. Because of the bacteria and moisture present in the plants, significant amounts of the cellular tissues and adhesive substances that wrap the fibers can be broken down during the retting process. Response times must be carefully considered when using dew or water retting since too much retting could make individual fiber separation challenging or weaken fibers.

2.2 Fiber Orientation

A fiber-reinforced polymer composite's fiber orientation defines how each fiber is placed to allow for the best possible structural arrangement and as the injected material flows through the mold, the resulting fiber alignment affects the geometry of the cavity, which directly influences the mechanical properties [17]. In composite materials, a part's

strength is significantly impacted by fiber orientation. Four of the most common fiber-reinforced composite orientations are unidirectional, random, bidirectional, and multidirectional. The mechanical and chemical properties of an injection-molded object may be considerably enhanced by fiber orientation, regardless of the direction of the fibers within the material. The mechanical properties of composites are different for each fiber orientation. In this study, random fiber orientation has been followed to make the composites. Different types of fiber orientation are shown in Figure 2.1.

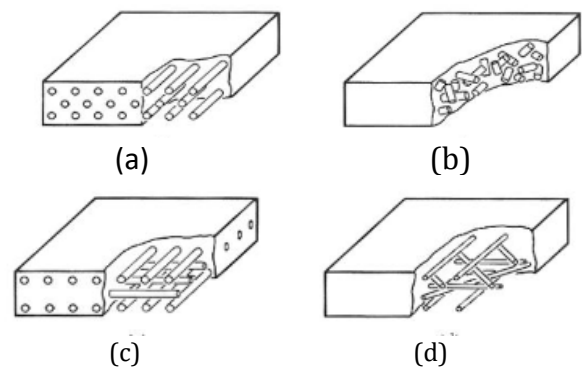
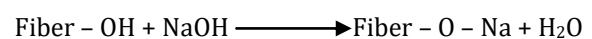


Figure 2.1: Different types of Fiber orientation (a) Unidirectional (b) Random (c) Bidirectional (d) Multi-directional [18].

2.3 Chemical Treatment

The hydrophilic characteristics of natural fibers and the hydrophobic characteristics of the polymer matrix are the two main fundamental problems with using natural fibers as reinforcement for polymer composites. Mechanical characteristics of natural fiber composites are harmed as a result of these issues [19]. Natural fibers can have their hydrophilic qualities lessened by applying a chemical treatment. The most common chemical treatments used to decrease the hydrophilic properties of natural fibers include sodium hydroxide (NaOH), potassium permanganate (KMnO₄), silane (SiH₄), and acetic acid (CH₃COOH). Chemically modifying fiber can change the fiber surface while enhancing fiber strength by improving adhesion between the fiber surface and the polymer matrix. Composites' water absorption is reduced, and they have improved mechanical properties [20]. NaOH has been used for the chemical treatment of fiber in this study. The fibers have been immersed in 5% NaOH for 30 min. The fibers have been cleaned with distilled water several times and have been dried at a high temperature. The reaction of fiber with NaOH is given below:



Chemical treatment of coir fiber and betel nut husk fiber is shown in Figure 2.2.

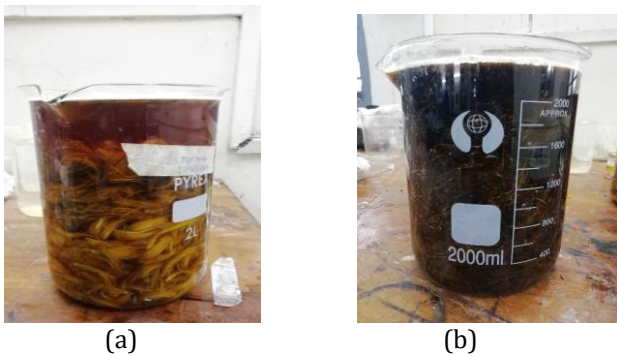


Figure 2.2: Chemical treatment of the fibres (a) Betel nut husk Fiber (b) Coir fiber

2.4 Fabrication Methods

There are several known techniques for creating components from natural fiber composites, including compression molding, hand lay-up, injection molding, filament winding, pultrusion, resin transfer molding, and vacuum bag molding. In this study, the hand lay-up method will be used to fabricate the composites. A typical hand lay-up process is shown in Figure 2.3.

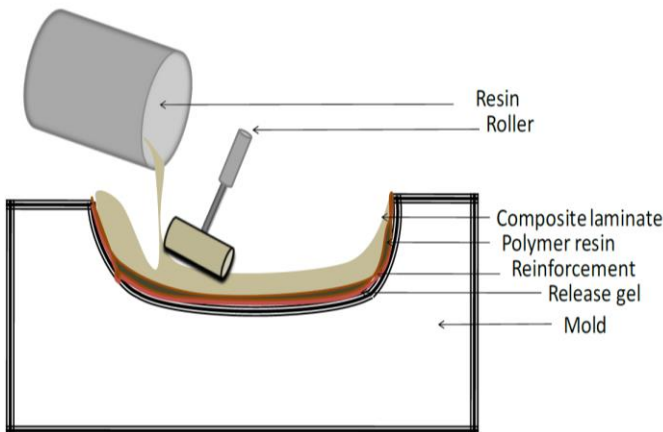


Figure 2.3: Hand lay-up process [21].

The materials and chemicals which have been used to make the hybrid composites are introduced by the following:

The coconut tree (*Cocos nucifera*) is a member of the palm tree family (Arecaceae) and the only living species of the genus *Cocos*. Tropical countries have substantial coconut (*Cocos nucifera*) plants. The countries of Indonesia, Sri Lanka, Brazil, the Philippines, Vietnam, Thailand, Malaysia, Bangladesh, and India produce the majority of the world's palm coconuts. Together, the top three producers—Indonesia, the Philippines, and India—account for almost 89 percent of global production [22]. Coconut husk is the source of the natural cellulose fiber known as "coir." It is the fibrous material that exists between a coconut's hard internal shell and outer coat. The demand for sustainable, renewable, biodegradable, and recyclable materials is driving an increase

in the use of coir fiber-reinforced biocomposites made from coconut husk. The coconut husk and shells are typically discarded as garbage, although they can be used as important raw materials for the production of environmentally beneficial biocomposite products. Coir fibers are stiff and strong in nature [23]. The chemical composition of coir fiber and coir fiber is shown in Table 2.1 and Figure 2.4 respectively.

Table 2.1: Chemical composition of coir fiber [24]

Components	Percentage (%)
Cellulose	43.44
Hemicellulose	0.25
Lignin	45.84
Ash	2.22
Pectin and related compounds	3.0
Water soluble	5.25



Figure 2.4: Coir fiber

Areca catechu, a type of palm tree native to Malaysia that is widely cultivated in Asia, Taiwan, and India, produces betel nut as its fruit. Many people chew betel nut along with betel leaves, and lime; a custom that dates back centuries that has been passed down through the generations. The fibrous portion of the fruit, which makes up between 60% and 80% of the betel nut's overall volume and weight, is known as the betel nut husk (BNH) [25]. The three stages of fruit maturity for betel nuts are raw, ripe, and matured. The betel nut fruit is green in color when it is raw and has a soft husk and nut. The husk of the ripe betel nut fruit is quite spongy and contains more juicy liquid than those of raw and matured betel nut fruits. The fruit is frequently yellow to golden in color. Typically, mature betel nut fruit has coarse fiber and brownish colors [26]. The chemical composition of betel nut husk fiber is shown in Table 3.2 and betel nut husk fiber is shown in Figure 3.5.

Table 2.2: Betel nut husk fiber chemical composition [25]

Components	Percentage (%)
Lignin	7.20
Hemicellulose	32.98
α - Cellulose	53.20
Fat and wax	0.64
Other materials	3.12
Ash	1.05



Figure 2.5: Betel nut husk fiber

Polyester resins are synthetic resins made by reacting polyhydric alcohols and dibasic organic acids. It is a viscous liquid, pale yellow in color, low cost, temperature resistive up to 80°C, water resistive, easily wetted to glass fiber, and low in cost. Isophthalic and orthophthalic are the two types of polyester resins used in the composites industry. When high temperatures, good mechanical properties, and good corrosion resistance are not necessary, orthophthalic resins are utilized. On the contrary, isophthalic resins are of good corrosion resistive and mechanical properties [27]. Polyester resin is shown in Figure 2.6.



Figure 2.6: Polyester resin.

A hardener is a synthetic substance that acts as a catalyst to transform liquid resins into solid forms through chemical reactions. As a result, a hardener may be applied throughout the curing process. Methyl ethyl ketone peroxide is the most often used hardener for polyester resin. Hardener should be used for 1 to 2% of the total volume of resin.

A base element is dissolved in water to create an alkaline solution. The range of its PH scale is 7 to 14. The base

element, such as potassium or sodium hydroxide (NaOH), etc. are dissolved in water to create the pretreatment and posttreatment chemicals NaOH and KOH solution.

3. PRINCIPLES OF THE TESTS

Based on the following principles all the tests have been done.

3.1 Tensile Test

One of the most popular techniques for examining a material's mechanical properties is the tensile test. Tensile testing is necessary in cases where an object is being pulled, as it gives an idea of how the object's material will behave under a tensile force. This test has been carried out by a universal testing machine according to the ASTM D638 standard. The tensile stress is determined by the following equation (1).

$$\sigma = F/A \tag{1}$$

Where σ is the tensile stress, F is the applied tensile load and A is the area of the cross-section of the specimen.

Specimens before and after the tensile test are shown in Figure 3.1 and Figure 3.2 respectively.



Figure 3.1: Specimens before tensile test



Figure 3.2: Specimens after tensile test components

3.2 Impact Test

The ability to sustain a load that is suddenly applied to an object is referred to as the impact strength. According to ASTM, an impact test is a type of dynamic test in which a V-

notch is machined into the specimen. The specimen is positioned so that it can be broken at the notched location by a single blow from a blower that is strategically placed. There are two kinds of impact tests:

- (a) Charpy impact test
- (b) Izod Impact test

The Charpy impact test method has been followed in this study. The impact test has been carried out by a pendulum impact testing machine according to the ASTM A370 standard. Impact strength is calculated by the following equation (2).

$$\begin{aligned}
 \text{Impact strength} &= \frac{mg(h_1 - h_2)}{A} \\
 &= \frac{WRg(\cos \beta - \cos \alpha)}{A}
 \end{aligned}
 \tag{2}$$

Where m is pendulum mass in kg, g is the gravitational acceleration in m/s², h₁ is the initial height of pendulum in m, h₂ is the final height of pendulum in m, A is the area of cross-section of the specimen in m², α is the angle of fall, β is the angle of rise.

Specimens before and after impact test are shown in Figure 3.3 and Figure 3.4 respectively.



Figure 3.3: Specimens before impact test



Figure 3.4: Specimens after impact test

3.3 Hardness Test

The resistance to indentation can be used to define hardness. By watching and calculating the depth of indentation, hardness is identified. Testing for hardness can be done using Brinell, Rockwell, Vickers, and Knoop types of procedures. Rockwell hardness test methodology has been employed in this project. This test has been carried out by a Rockwell hardness tester. Rockwell is a scale for determining the hardness of a material to deformation based on indentation. The penetration of an indenter under a major load is compared to the penetration under a minor load to measure this test. Different scales are used for different materials to measure this test. The result shows the dimensionless numbers denoted as HRA, HRB, HRM, HRL, etc where the last letter means the Rockwell scale which is used to measure the test. M scale has been used in this study whose indenter diameter is 6.35 mm and the load is 100 kg-f.

3.4 Water Absorption Test

Water absorption tests were performed by immersing specimens in a water bath at room temperature for a set period. According to ASTM D570, the water absorption test is a test to obtain the percentage of moisture content of any object of its dry weight and by equation (3) this is calculated.

$$\text{Water absorption (\%)} = \frac{w_w - w_d}{w_d} \times 100
 \tag{3}$$

Where w_d is the dry weight and w_w is the wet weight. Water absorption test has been carried out by placing the specimens in a beaker full of water at room temperature for 2.5 hours. The specimens immersed in a beaker for the water absorption test are shown in Figure 3.5.



Figure 3.5: Immersed specimens

3.5 Preparation of Hybrid Composites

Randomly oriented bi-layer hybrid fiber composites with varying weight ratios of coir fibers and betel nut husk fibers have been created by hand lay-up molding. The fibers have been placed in a mold, and the mixture of polyester resin and hardener has been continually poured until all of the fibers

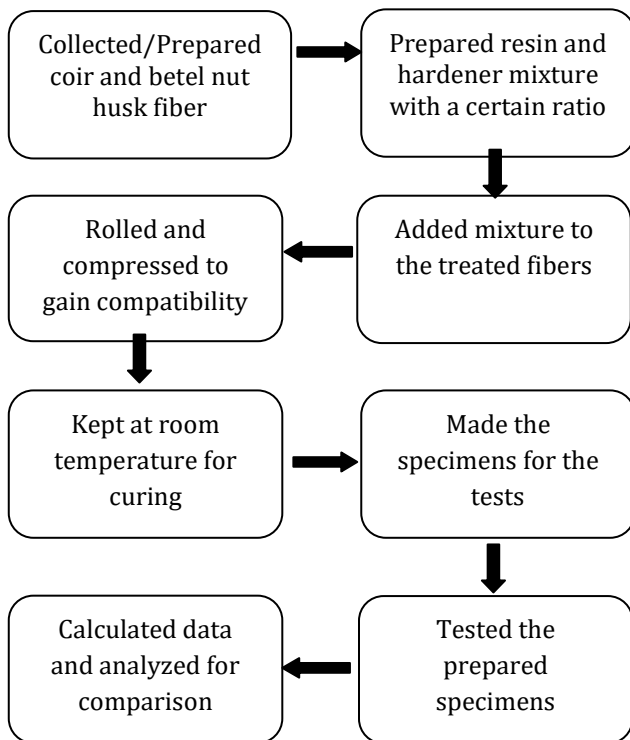
were thoroughly saturated. After allowing the mold to harden at room temperature for 24 hours, the specimens will be gently removed from the mold. The composite will have a total of 30 wt% of the fibers. The fiber ratio of the specimens is listed in Table 3.1.

Table 3.1: Percentage of fiber content in composite.

Composite	Coir fiber content (wt%)	Betel nut husk fiber content (wt%)	Total fiber content (wt%)
B100	-	100	30
B75 C25	25	75	30
50 C50	50	50	30
B25 C75	75	25	30
C100	100	-	30

C = Coir Fiber, B = Betel nut husk Fiber

The working procedure is shown in a flow diagram below:



4. RESULT AND ANALYSIS

4.1 Tensile Properties

From the tensile test reading, stress and strain have been calculated for two specimens of each composite and an average of them has been calculated. After that stress vs strain curve for each composite has been drawn. From the curve, variations of the stress and strain have been depicted clearly. Stress vs Strain curves of the composites mentioned in Table 3.1 is shown in Figure 4.1.

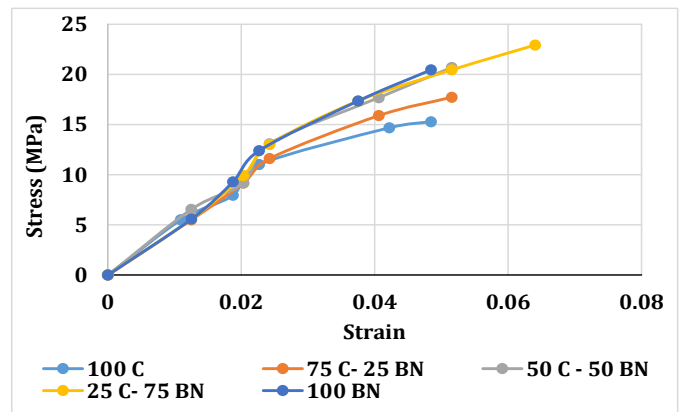


Figure 4.1: Stress-strain curves of the fabricated composites

Based on the following principles all the tests have been done.

Figure 4.1 shows the variation of stress and strain. From the curves, it can be said that the B75 C25 composite shows maximum ductility. Absorbed energy at a specific volume of material is evaluated by the area under the stress-strain curve. For that reason, it can be said that the B75 C25 composite has maximum absorbed energy compared to the other composites. B100 composite has higher tensile strength than C100 composite because betel nut husk fiber has high cellulose content than coir fiber.

The tensile strength and tensile modulus of randomly oriented coir fiber and betel nut husk fiber reinforced polyester composites are shown in Table 4.1 and Figure 4.2.

Table 4.1: Tensile strength and tensile modulus of the fabricated composites

Composites	Tensile strength (MPa)	Tensile modulus (GPa)
C100	15.29	0.32
B25 C75	17.73	0.34
B50 C50	20.70	0.40
B75 C25	22.94	0.36
B100	20.46	0.42

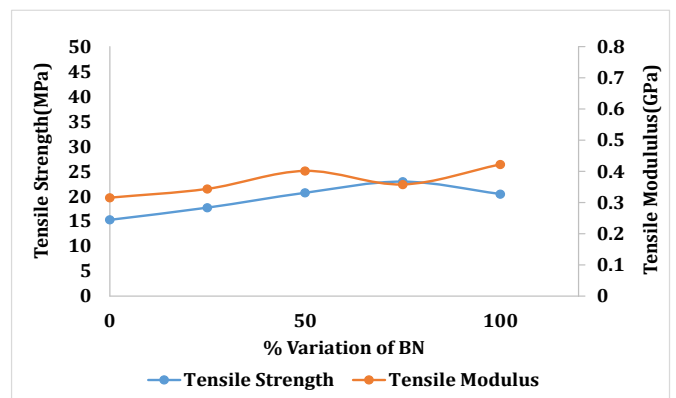


Figure 4.2: Variation of tensile strength and tensile modulus on the increase of betel nut husk fiber content

Tensile strength has been increased by increasing the amount of betel nut husk fiber content up to a certain limit. Maximum tensile strength has been found for the B75 C25 composite which is 22.94 MPa. Maximum tensile modulus has been found for the B100 composite which is 0.42 GPa. From the graph, it can be said that hybridization has a positive impact on tensile strength.

4.2 Impact Properties

Impact strength of the fabricated composites is shown in Table 4.2 and Figure 4.3.

Composites	Impact strength (KJ/m ²)
C100	5.96
B25 C75	7.92
B50 C50	9.07
B75 C25	10.97
B100	12.93

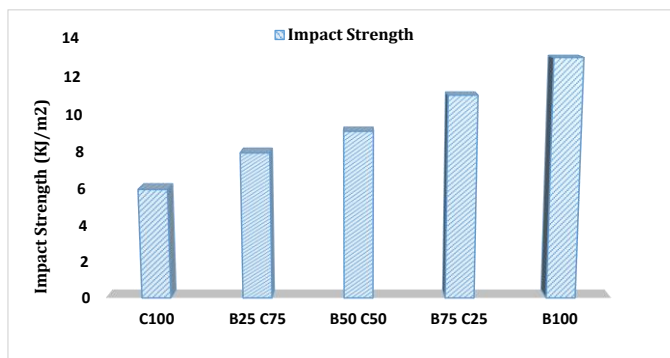


Figure 4.3: Variation of impact strength on the increase of betel nut husk fiber content

Hybridization does not affect the impact strength of the fabricated composite. Impact strength has been increased on the increasing amount of betel nut husk fiber content. B100 composite has 116.95% higher impact strength than C100 composite.

4.3 Hardness Number

Hardness is the resistance of a material to localized plastic deformation. The hardness number of the fabricated composites is shown in Table 4.3 and Figure 4.4

Table 4.3: Hardness number of the fabricated composites.

Composites	Hardness number (HRM)
C100	61.5
B25 C75	57
B50 C50	72.5
B75 C25	64.5
B100	54

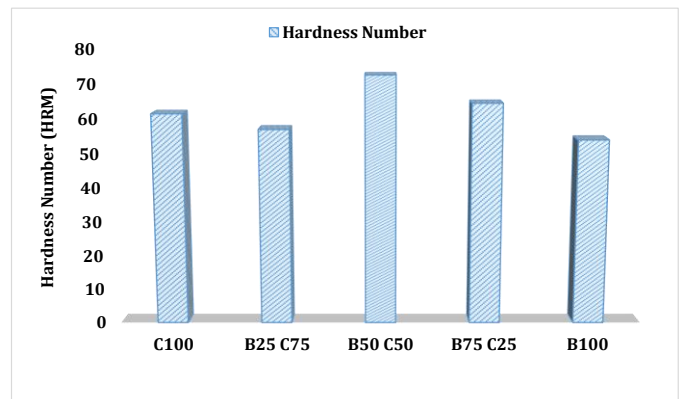


Figure 4.4: Variation of hardness number on the increase of betel nut husk fiber content

Maximum hardness number 72.5 has been obtained for the B50 C50 composite and minimum hardness number 54 has been obtained for the B100 composite. When betel nut husk fiber content has been increased by 50%, hardness number has increased by 17.89%.

4.4 Water Absorption

Water absorption of the fabricated composites is shown in Table 4.4 and Figure 4.5.

Table 4.4: Percentage of water absorption of the fabricated composites

Composites	Water absorption (%)
C100	1.63
B25 C75	1.02
B50 C50	1.18
B75 C25	0.48
B100	0.96

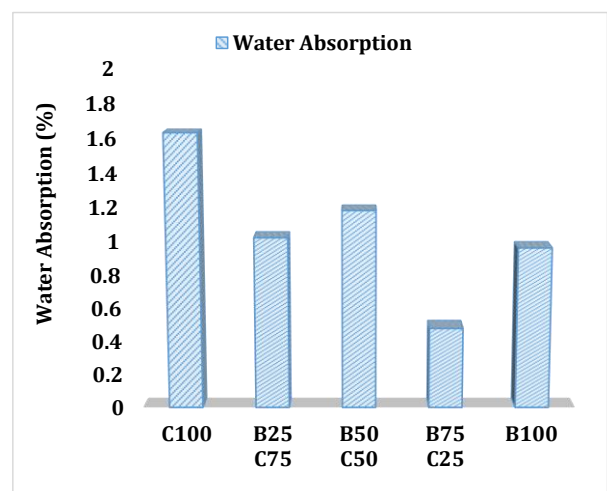


Figure 4.5: Variation of water absorption on the increase of betel nut husk fiber content

Figure 4.5 shows the variation in the percentage of water absorption among the composites. The maximum water absorption of 1.63% has been obtained for the C100 composite and the minimum water absorption of 0.48% has been obtained for the B75 C25 composite. The percentage of water absorption of the composites could be reduced by applying a suitable pressure at the time of molding.

4.5 Density

Density of the fabricated composites is shown in Table 4.5 and Figure 4.6

Table 4.5: Density of the fabricated composites

Composites	Density (kg/m ³)
C100	1171.36
B25 C75	1160.20
B50 C50	1140.61
B75 C25	1102.17
B100	1048.73

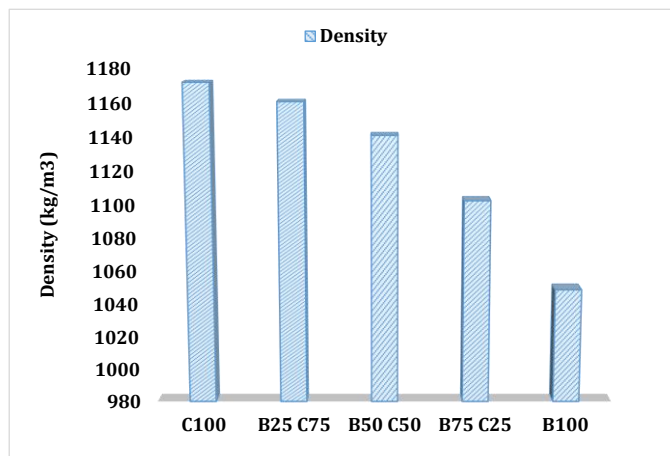


Figure 4.6: Variation of density on the increase of betel nut husk fiber content

4.5 Analysis and Comparison

Natural fiber reinforced composites have been used in many sectors like- automobile interiors, panels for partitions, false ceilings, roof tiles, packaging, furniture applications, etc. Natural fiber reinforced composites are light in weight, so when it will be used in the automobile sector, fuel consumption will be decreased and the cost of automobiles will also be reduced. Moreover, natural fiber-reinforced composites have low prices and are environmentally friendly. A comparison of the tensile strength between the fabricated composites and betel nut husk and glass fiber reinforced polyethylene composites done by Haque et al. [28] is shown in Figure 4.7.

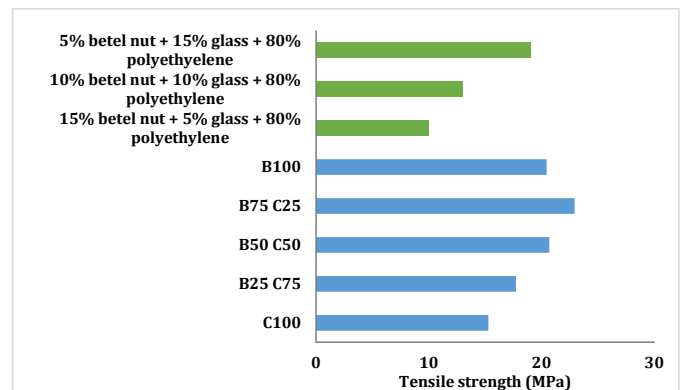


Figure 4.7: Comparison of tensile strength with betel nut husk-glass-polyethylene composites

A comparison of the impact strength between the fabricated composites and jute fiber-glass fiber reinforced polypropylene composites fabricated by Uawongsuwan et al. [29] is shown in Figure 4.8.

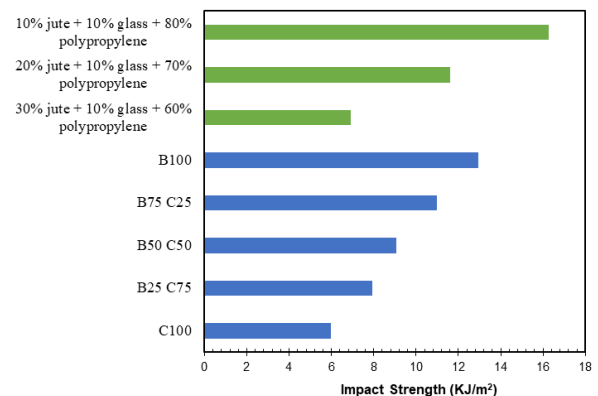


Figure 4.8: Comparison of impact strength with jute-glass-polypropylene composites

A comparison of the hardness number between the fabricated composites and the composites fabricated by Arputhabalm et al. [30] is shown in Figure 4.9.

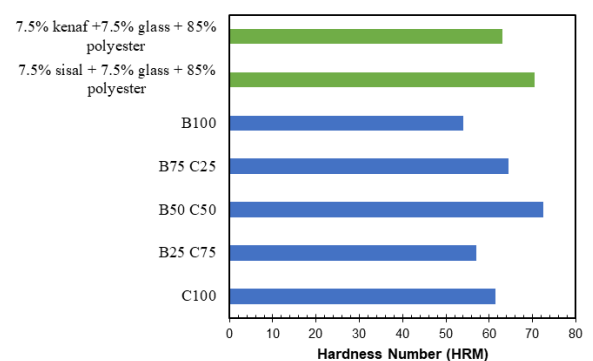


Figure 4.9: Comparison of hardness number with kenaf-sisal-glass-polyester composites

5. CONCLUSIONS

Alkali-treated randomly oriented betel nut husk fiber has been reinforced with alkali-treated coir fiber in polyester resin to make bi-layer hybrid composites. The composites have been tested and the following are the conclusions:

The tensile strength of the composites has been improved by increasing the amount of betel nut husk fiber. Comparatively, with the C100 composite, the tensile strength and tensile modulus of the B75 C25 composite have been increased by 50.03% and 12.5% respectively.

Betel nut husk fiber content is responsible for high impact strength. A higher impact strength has been found for the B100 composite which is 12.93 KJ/m² and the C100 composite has a lower impact strength which is 5.96 KJ/m². B100 composite has a 116.95% higher impact strength than C100 composite.

Maximum Rockwell hardness number has been found for B50 C50 composite and minimum hardness number has been found for B100 composite. The B50 C50 composite has a 34.26% higher Rockwell hardness number than the B100 composite.

The percentage of water absorption has been found minimum for the B75 C25 composite. Water absorption percentage could be reduced by applying a proper load during fabrication.

The density of the fabricated composites has been decreased with an increasing amount of betel nut husk fiber content. The main purpose of this study was to make a natural fiber reinforced hybrid composite, which will have better mechanical composites than the composites made with synthetic fiber. From the 4.6 section, it can be said that some of the fabricated composites have better mechanical properties than the composites fabricated by a combination of synthetic fiber and natural fiber.

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