UTILIZATION OF WRIGHTIA TINCTORIA NANO SEED FIBERS AS A REINFORCEMENT IN THE PREPARATION OF EPOXY-BASED COMPOSITES

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Highlight
The main object of this paper is to explore the influence of WTNSFs in enhancement of tensile properties. The properties of epoxy-based fiber reinforced composites were presented in terms of tensile and flexural strength. Furthermore, the impact test is conducted to access the shock resistance of WTNSFs based epoxy composite.

Abstract
Natural seed fiber reinforced composite materials are replacing many conventional ones because of their excellent properties, less weight, easy availability, etc. Composite materials are used in many areas because of their superior features. Mechanical property is one of the vital parameters for choosing the material. The current investigation has revealed an importance of recently well-known *Wrightia tinctoria* nano seed fibers (WTNSFs), which are extracted physically. *Wrightia tinctoria* nano seed fiber reinforced composite was prepared with the epoxy resin by hand layup method. Epoxy resin is easy to handle and available at low cost. Mechanical tests are conducted reinforced composites of plain epoxy and WTNSFs to obtain strength properties like tensile, flexural, impact. Water absorption tests also performed on composites. Here, the developed composites are easy to handle, offered economically, and used primarily in marine applications due to less water absorption and good wax content. A comprehensive description of different tests and the properties of WTNSFs are studied and compared with the other existing natural fibers. This work showed that 35% combination of WTNSFs reinforced epoxy matrix offers enhanced mechanical properties with minimum water absorption compared with plain epoxy composites.

Keywords
wrightia tinctoria nano seed fibers(WTNSFs); plain epoxy composite; tensile; flexural; impact strength; water absorption tests.

Introduction
Many scientists and researchers are currently addressing environmental issues. With increase in global shortage of non-renewable resources and awareness on ecological protection, the utilization of natural fibers has drawn

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major consideration. These efforts were essential to make sure the survivability of humankind in future [1]. To reinforce the polymer composites, some reasons have attracted material engineers on natural fibers such as reducing timber usage and degrading unused ones. Also, additional advantages include their low-cost, excellent mechanical properties, abundant accessibility, renewability, and abrasive for easiness to recycle [2]. Due to the abundance of natural fibers from many existing plant types, many have not explored mechanical behavior as composite reinforcements. These unexploited fibers could be processed as composite boards or other forms suitable for various applications while to perverse the environment. All natural fiber composites are primarily based on few crop productions, leaving numerous types without a comprehensive study. Even though, natural fibers own some positive traits, due to their adverse characteristics like, high similarity to water, absorb the heat, and incongruities by a polymer matrix that disclose hydrophobic attribute [3]. Several natural fibers such as kenaf, roselle, jute, sugar palm, oil pump empty fruit bunch, sisal, pineapple leaf, rice husk, kapok, wood, coir, and abaca were helpful for the preparation of composites [4]. Natural fibers originate from countries such as India, Malaysia, Indonesia, and Thailand [5]. The significance of fibers yielding plants life has been considered next to food plants due to its utility in human civilization. At present, the value of plant fibers manifest in various range of products, as well as for production of ropes, papers, and a variety of domestic materials. Fiber's production also contributes a significant role to region's economy in multiple ways, include agricultural, clothes, small-scale business, and products used for domestic operation. Natural fibers attract enormous awareness for their simple ease of use, low cost, superior properties, non-abrasive nature, and renewable [6]. Composites are an essential kind of materials produced by a combination with two pure materials owing towards each material's synergistic result, obtain fastidious and unique properties. To employ natural fibers, as reinforcement in a composite has received consideration owing its demand intended for a light and additional valuable alternative to conventional artificial materials and led to new eco-friendly products and processes [7]. Natural fiber reinforcements can replace non-renewable raw materials with renewable ones, it allows to dump the petrochemical solid waste and carbon footprints. Thus, quite a few studies on the latest materials endeavor to restore usual ones, like concrete and steel composites with similar properties, like creep resistance, corrosion, and deterioration [7,8]. A broad study on usage of the natural fibers in bio composites was presented via [8]. Sfiligoj et al. [9] has effectively demonstrated their qualities while consider an environmental view of fiber materials. To design sustainable materials commencing natural resources have characterized a significant challenge in previous years. Awareness on sustainable resources for fibers, mostly from plant origin, has recently increased. Usage of natural fiber composite increases; these are helpful to restore conventional ones, which are made with synthetic materials. It has led to a rapid innovation research in natural fiber reinforced composite areas[9]. P Madhu et al. [10] explored that, various new natural fibers facilitate its usage as the major component in composites production. This work also presents comprehensive details on different properties of baobab fibers to enhance the utilization and probable application as composites [11]. La Mantia et al. [12] studied natural fiber reinforced composites usage in industrial applications. Due to environmental issues, the consumption of green fiber reinforced polymer composites has gradually increased in various countries during the last few years. It will positively affect industries for green fiber composites due its recyclable character and economy [12]. Satish Pujari et al. [13] discussed the research on natural fiber composites. Quiet, a lot of natural fibers were previously used in industries as fiber reinforced composites. The advantages of using them are reflecting a lower density than synthetic fiber composites and to save costs. Nowadays, a study on seed fibers has become a necessity. compare with other natural fibers, WTNSFs has numerous advantages: low density, high strength, and biodegradability [14]. Inside this perspective, authors attempt to examine the opportunity via WTNSFs. It is a new textile fiber and helpful as a reinforce material in the preparation of composites. No studies have been performed on applying WTNSFs as composites. This work used WTNSFs as reinforcement for epoxy-based composite. These fiber composites have investigated to potential usage as "green" composites in future development. It evaluates the mechanical properties of WTNSFs reinforced epoxy composites. The work presents by these authors emphasize the challenge on suitable utilization of WTNSFs into the polymer matrix composite. The authors evaluate a limit due to their widespread of natural fibers usage and the presence of significant physical properties between the different type and mainly connected towards farming methods, environment and processing conditions. Characteristics, which are required to observe bio composites preparation is the source, type, structure, composition, and mechanical properties of materials [15]. However, concerning WTNSFs, no work was accessible in the literature. Moreover, the hydrophobic/hydrophilic capacity of WTNSFs reduces hydroxyl groups in cell wall of fiber molecules. As a result, it declines water adsorption of natural fiber reinforced composites. Any composite's achievement is depending on raw materials and their features such as, tensile strength, bending, twisting, and fatigue; it must be considered before mixing [15,16]. The hydrophilic nature of WTNSFs decreases its water absorption capacity [17]. Environmental issues have motivated broad research on sustainable alternatives to replace materials, that mobilize a substantial economic resource and involve high energy costs

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[18]. In this perspective, lignocellulose fibers as reinforcement in composites associates a high mechanical performance with least impact on environment. The tensile properties of natural fibers enhance with an increment of cellulose content and decrease among an increasing range of non-cellulosic chemicals, such as lignin, hemicelluloses, pectin, and wax [18]. Adding up to this, the structure, microfibrillar angle, and cell dimensions defects overall properties of fibers [19]. Most of these aspects are difficult to control; therefore, to focus on how to yield and extraction of fibers, it has become a key towards getting the better quality and productivity [20].

Materials and Experimental details

Wrightia tinctoria nano seed fibers

Different natural fibers are available, but only a few be exploring, and a few were hidden in environment. One of such fiber was extracted from Wrightia tinctoria fruits, it is obtainable in plenty form, and this nano fiber is used as a reinforcement. These fibers were easily extracted without utilization of any power. It is sustainable and recyclable. Hence, this work investigates potential usage and suitability of this nano fiber as reinforcement to replace the synthetic fiber composites [20]. Wrightia tinctoria fruits were as shown in Figure 1.

a) b)

Figure 1. a) Collection of Wrightia tinctoria fruits, b) Fibers exposed from fruits.

Geographical details

Wrightia tinctoria material is collected from Guvvalacheruvu village, Seshachalam biosphere reserve forest area near kadapa to Rayachoti way, Southern part of India. Guvvalacheruvu village is in Ramapuram Tehsil of Y S R district in Andhra Pradesh, India. It is situated 10 km away from sub-district headquarter Ramapuram and 25 km away from district headquarter Kadapa. As per 2009 stats, Guvvalacheruvu village is also a gram panchayat. The total geographical area of village is 351 hectares. Guvvalacheruvu has a total population of 1,795 peoples. There are about 379 houses in Guvvalacheruvu village [15]. Kadapa is nearest town to Guvvalacheruvu, which is approximately 25 km away, as shown in Figure 2.

Figure 2. Satellite image of Guvvalacheruvu village Geographical data. *Source:* [*15].*

Properties of WTNSFs

Wrightia tinctoria nano seed fiber has a chemical composition as cellulose 69.47%, lignin 17.63%, wax 2.80%, ash 5.20%, density 8.07 g/c^3, moisture 1.26%. The collected fiber was tested for its tensile strength and elongation, and results are 185.43 MPa, 6.21%, respectively [21]. The average length of WTSFs was measured as 53.2 mm and the mean diameter is 0.0275 mm, aspect ratio of WSTFs is 1,935. Geometric characterizations of common technically natural plant fibers are presented in [22].

Selection of resin

The epoxy resin is used as a matrix in this study. Selected resin is LY556 unmodified liquid with medium viscosity, and hardener is HY95, a low viscosity curing liquid at room temperature. This combination was mainly chosen for hand layup techniques because, it is a reactive and short pot life [23]. WTNSFs were used as the reinforcement extracted from the Wrightia tinctoria tree.

WTNSFs extraction process

Collected fruits can get dried out under the sun to remove fibers easily. After extraction process fibers were stored in polythene bags. Extracted fibers were not chopped into small pieces for particular length. The original length of fibers varies depends upon the seed pods or fruits. Stored fibers with their pure original form were used for fabrication process. Extracted fibers from the Wrightia tinctoria fruits were as, exposed Figure 3.

a) b)

Figure 3. a) Extraction of WTNSFs, b) Fibers stored in polythene bag.

Manufacturing

Composite laminates are prepared by hand layup method. Two samples were prepared (one with plain epoxy without fibers another one with the composition of 35% WTNSFs [24]. The main objective of this work is to reveal the pure original behavior raw fiber usage in composite preparation. To check the behavior and performance of raw fiber volume fraction is suitable for making composite specimens. Hence, there is no alkaline treatment process was not adopted while fabricating the composite. Composite laminates were prepared without fibers and with fibers as standard size of 300·300 mm, and the thickness as 3 mm. After curing at room temperature about 24 h, samples were sized as per industrial standards. Later, these are used for tensile, flexural, impact strength, and water absorption tests [25].

Testing standards

The adoption of composite material for engineering applications depends on the material's tensile, flexural, impact, and water absorption testing. ASTM D 3039 standard was adopted to attain the mechanical behavior of fabricated composite materials. The tensile strength amplified with the crosshead speed increasing from 1 to 2 mm/min, attainment its maximum value at 2mm/min. It began to fall progressively for all the loading conditions. The stress-strain curve helps to record the values for ultimate tensile strength, elongation at break, and modulus of elasticity for the composite samples [25]. ASTM D 790 code investigated the flexural strength of epoxy, and WTNSFs reinforced composite specimens at three different crossheading speeds of 1, 2, and 3mm/min. The flexure specimen is simply a strip of test material of constant width and thickness. Test machine crosshead maximum strain rate is 0.01/min [26]. The impact strength of epoxy and WTNSFs composite specimens was measured as per ASTM D 256. The material's capability to withstand a suddenly applied load expresses in terms of energy. It often measures with the Izod & Charpy Impact tester (Notched Izod and Un-notched), both measure the impact energy requires to fracture the sample. Natural fibers tend to absorb moisture, which has noted cautiously. While, it is used in structures, which will be expose to environment. The fiber reinforced specimen used for this test is flat shape (30·30·3mm) size; it is oven-dried and weighed accurately with 0.1 mg weighing balance. Specimens were immersing in distilled water after the weights calculated after 24, 48 and 72 hours via taking out the specimens and exposure to air. By taking two accurate readings, water absorption percentage was calculated, using below mentioned formula. Where, W_1 is the weight of the sample after taken out from distilled water, and W_0 is the initial weight of the sample [27].

(1) $$\text{Water absorption (W)} = \frac{W_1 - W_0}{W_0}$$

Composite specimen prepared without fibers and reinforced with WTNSFs in the ratio of 35% are, as shown in Figure 4.

a) b)

Figure 4. a) Manufacturing of plain epoxy composite, b) Manufacturing of WTNSFs reinforced composite.

This study carried out different properties on new class fiber, and composites made by reinforcing these fibers are, as shown in Table 1.

Table 1. Various standards used for the tests.

No	Tests	ASTM Standards	Sample dimensions(mm)
1.	Tensile	D3039	250*50
2.	Flexural	D790	130*13
3.	Impact	D256	65*13
4.	Water absorption	D570	20*20

Results and discussions

<u>Tensile strength</u>

Here, Figure 5 shows, the experimental setup of tensile testing on specimens. The maximum tensile strength is 24.36 MPa and 18.71 MPa for composite specimens with 35% fibers and without fiber, respectively. Complete stress-strain curves for epoxy composite are as shown in Figure 6 and Wrightia tinctoria fiber reinforced composite is shown in Figure 7. Figure 8 shows the tensile strength values increases while adding fibers by volume fraction compared with plain epoxy. Hence, this was clear that the ultimate tensile strength increases steadily like 17.75 MPa, 20.64 MPs, and 24.36 MPa for 35% fiber volume fraction, respectively. Plain epoxy composite laminate shows tensile strength values as 13.52 MPa, 16.49 MPa and 18.71 MPa, respectively. The tensile modulus also increases with the addition of 35% volume fraction fiber as 293.15 GPa, 349.38 GPa, and 352.19 GPa, respectively. The tensile modulus results of plain epoxy laminate are 286.12 GPa, 322.45 GPa and 345.89 GPa, respectively. It shows a comprehensible correlation between fiber volume fraction and tensile

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modulus of epoxy. The reinforced composite increases tensile modulus values with the addition 35% volume fraction of WTSFs [28].

a) b) c)

Figure 5. a) WTNSFs reinforced Specimens; b) Epoxy specimens; c) Conducting tensile strength test on specimen.

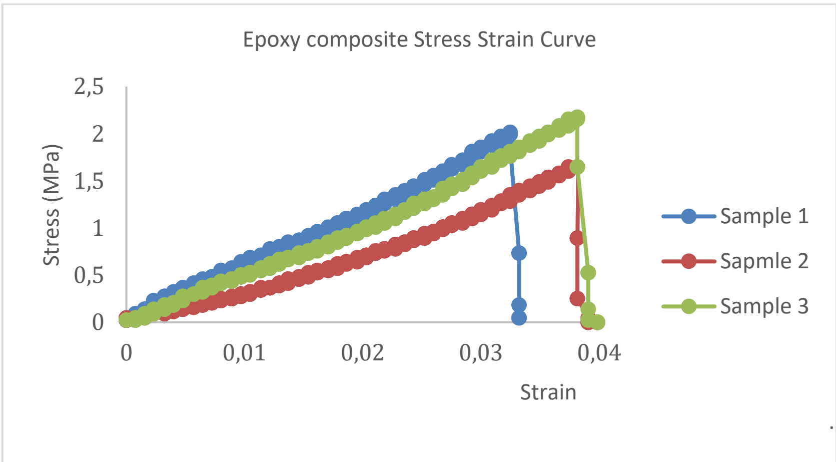

Figure 6. Epoxy composite Stress Strain Curve.

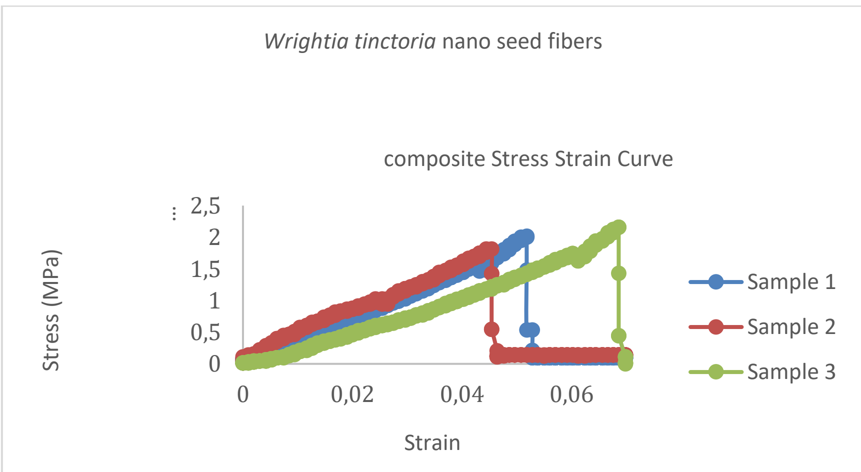

Figure 7. Wrightia tinctoria nano seed fibers composite Stress Strain Curve.

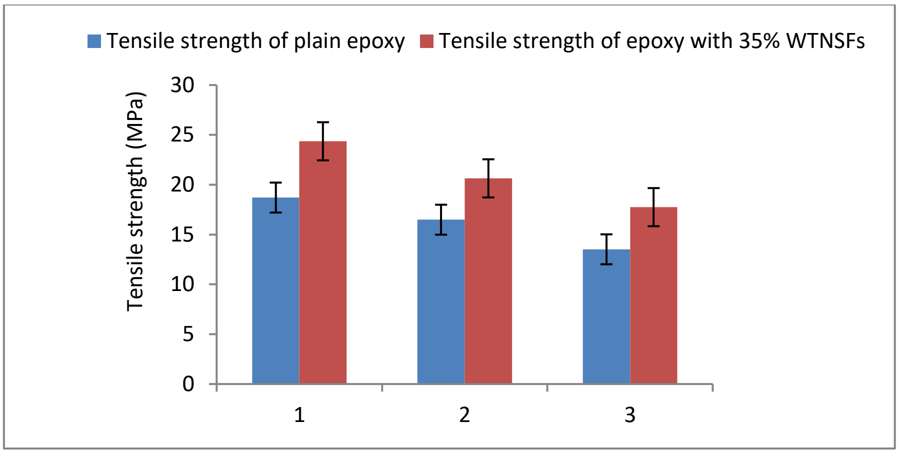

Figure 8. Tensile strength results.

Methodology and equation to find flexural strength

The three-point bending flexural test provides values for the modulus of elasticity in bending, flexural stress, flexural strain and the flexural stress-strain response of the material. The main advantage of a three-point flexural test is the ease of the specimen preparation and testing. The test method for conducting the test usually involves a specified test fixture on a universal testing machine. Most commonly the specimen lies on a support span and the load is applied to the center by the loading nose producing three points bending at a specified rate. The parameters for this test are the support span, the speed of the loading, and the maximum deflection for the test. These parameters are based on the test specimen thickness and are defined differently by ASTM and ISO [29]. ASTM D 790 code investigated the flexural strength of epoxy, and WTNSFs reinforced composite specimens at three different crossheading speeds of 1, 2, and 3 mm/min. The flexure specimen is simply a strip of test material of constant width and thickness. Test machine crosshead maximum strain rate is 0.01/min. The test is stopped when the specimen breaks. If the specimen does not break, the test is continued as far as possible and the stress at percentage of conventional deflection is reported. For the sake of accuracy in determination of flexural strength, for each type of reinforcement, three to five specimens were tested experimentally, conforming to the appropriate ASTM standards. For each specimen, the initial dimensions were measured, and then maximum load (F), i.e., the force causing the flexural stress in the specimen, was determined by means of the testing machine. The maximum fiber stress at failure on the tension side of a flexural specimen is considered the flexural strength of the material [29]. Based upon this value, the geometry of the tested specimen (width and thickness) and using the below equation, the flexural strength is found out. Calculation of the flexural strength for rectangular cross-section is as follows.

$$\sigma_f = \frac{1.5FL}{bd^2} \qquad (2)$$

In the above formula the following parameters are used:

σ_f = Flexural strength, (MPa)
F = load at a given point on the load deflection curve, (N)
L = Support span, (mm)
b = Width of test specimen, (mm)
d = Depth of test specimen, (mm)

Flexural strength

Figure 9 represents as the flexural strength test conducted on specimens. Figure 10 shows testing values in MPa. It increases while adding 35% WTNSFs. The flexural strength of 45.67 MPa, 42.81 MPa, and 32.15 MPa and plain epoxy composite laminate shows flexural strength values as 41.86 MPa,33.64 MPa, and 30.95 MPa, respectively. Flexural modulus in GPa increases gradually with a 35% percentage of WTNSFs, resulting in 785.85 GPa, 1157.091 GPa, and 1490.3 GPa, respectively. The flexural modulus results of plain epoxy laminate are 686.12 GPa, 1,028.9 GPa, and 1,345.89 GPa, respectively [28].

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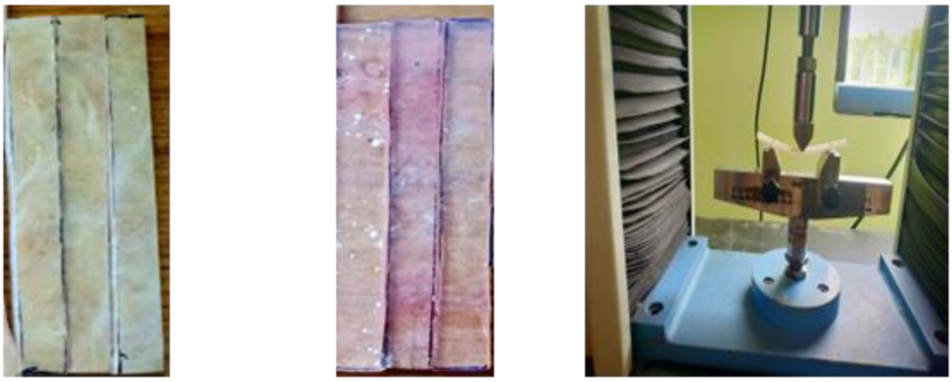


a) b) c)

Figure 9. a) WTNSFs reinforced Specimens, b) Epoxy specimens, c) Conducting flexural strength test on specimen.

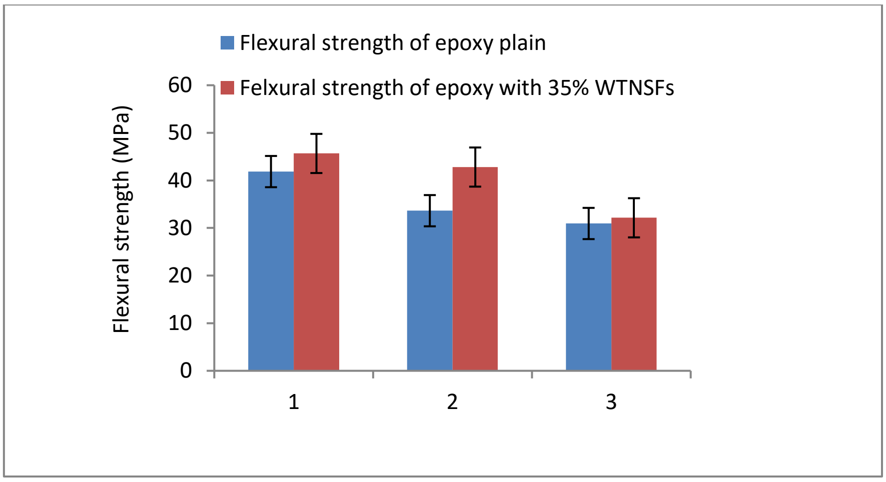


Figure 10. Flexural strength results.

<u>Methodology and equation to find Impact strength and Impact resistance</u>

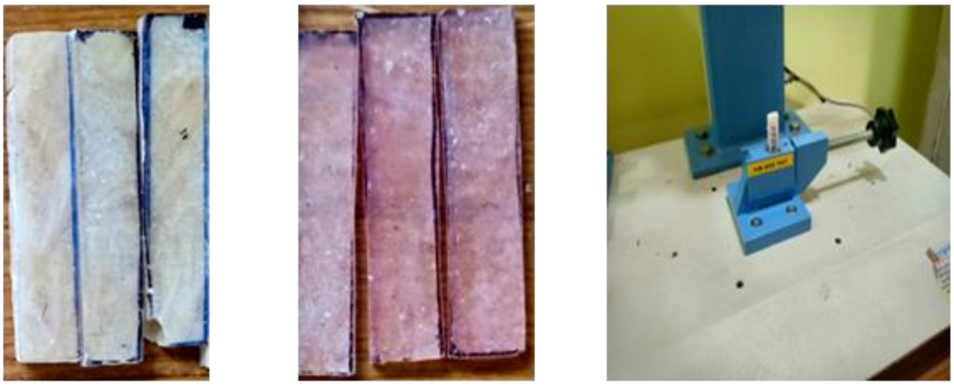
The impact properties of a material represent its capacity to absorb and dissipate energies under impact or shock loading. Charpy and Izod impact tests are performed on commercially available machines in which a pendulum hammer is released from a standard height to contact a beam specimen (either notched or unnotched) with a specified kinetic energy. A vertical cantilever beam specimen (unnotched) is used in the Izod test shown in figure. The energy absorbed in breaking the specimen, usually indicated by the position of a pointer on a calibrated dial attached to the testing machine, is equal to the difference between the energy of the pendulum hammer at the instant of impact and the energy remaining in the pendulum hammer after breaking the specimen. The Izod impact test is a standard test that measures the impact energy needed to fracture a material. Impact strength is calculated by dividing impact energy in J (or ft-lb) by the thickness of the specimen. The test result is typically the average of 3 to 5 specimens. ISO impact strength is expressed in kJ/m^2. Impact strength is calculated by dividing impact energy in J by the area under the notch. Impact energy is a measure of the work done to fracture a test specimen. When the striker impacts the specimen, the specimen will absorb energy until it yields. At this point, the specimen will begin to undergo plastic deformation at the notch [30].

$$\text{Impact strength} = \frac{\text{Impact strength of the composite specimen}}{\text{thickness of the composite specimen} \times \text{width of the composite specimen}}\ kJ/m^2 \quad (3)$$

$$\text{Impact resistance} = \frac{\text{Impact resistance of the composite specimen}}{\text{width of the composite specimen}}\ kJ/m$$

Impact strength and Impact resistance

Figure 11**Błąd! Nie można odnaleźć źródła odwołania.** shows, the impact strength testing on specimens. Thickness of the specimen is 3 mm. Impact strength increases with increased volume of a fraction of fiber as 35 in percentage, which results in 27.86 kJ/m^2, 24.62 kJ/m^2, and 21.32 kJ/m^2. Impact strength of plain epoxy laminate without fibers are 4.231 kJ/m^2, 3.43 kJ/m^2 and 2.072 kJ/m^2, respectively [31]. Impact resistance values for composite laminate without fiber results as 8.241 kJ/m, 6.58 kJ/m and 4.845 kJ/m and for WTNSFs reinforced composite results as 18.732 kJ/m, 15.95 kJ/m and 11.313 kJ/m, respectively.



a) b) c)

Figure 11. a) WTNSFs reinforced specimens b) Epoxy specimens c) Conducting impact strength test on specimen

Water absorption

Water absorption percentage of WTNSFs reinforced and plain epoxy composites results before and after weighing are 3.13, 2.42, and 4.25, 3.65%, respectively. The above results confirm that the addition of WTNSFs were best for preparing composite specimens due to its hydrophobic nature. It shows promising results for all tests. Therefore, it could be concluded that 35% untreated raw fiber reinforcement is suitable to manufacture the composites [32].

Mechanical properties comparison between WTNSFs composite and other natural fiber composites

Nowadays, a study on seed fibers has become a necessity. compare with other natural fibers, WTNSFs has numerous advantages: low density, high strength, and biodegradability [33]. Several natural fibers such as kenaf, roselle, jute, sugar palm, oil pump empty fruit bunch, sisal, pineapple leaf, rice husk, kapok, wood, coir, and abaca were helpful for the preparation of composites. Sisal fibers are used in the preparation of fiber reinforced composites panels by vacuum infusion processing method to the evaluation of mechanical strength. Mechanical strength was evaluated by means of tensile test and flexural three-point bending tests; the morphology of the fracture surface was evaluated by SEM images. The tensile strength of the panels resulted in values of 146.34 MPa, 9.19 MPa and 15.87 MPa for aligned, one-layer, three-layers panels, respectively. The flexural strength resulted in values of 23.23MPa for three-layers panels [34]. Sarikaya et al. [35] explained that production of epoxy resin composites reinforced by birch, palm, and eucalyptus fibers with resin transfer molding technique and molded fiber production technique combination. The tensile stress of birch, palm, and eucalyptus reinforced epoxy composites were determined as 29.53 MPa, 42.24 MPa, and 45.28 MPa, respectively. Bending stress of birch, palm and eucalyptus reinforced epoxy composites were found as 58.83 MPa, 68.58 MPa, and 79.92 MPa, respectively. The birch epoxy composite had 0.105 J impact energy while palm and eucalyptus epoxy composites were determined as 0.130 J and 0.124 J, respectively. It is clearly observed that fiber type was very effective on mechanical properties of composites. The results of studies showed that molded fiber production method had a very promising future for the development of natural fiber reinforced composites. Shahana Parbin et al. [24] proposed that as the treated (5% to 10% NaOH) jute fiber reinforced composite shows tensile strength as 12.46 MPa, 10.5 MPa, flexural strength as 39.08 MPa,32.5 MPa and impact strength as 2.63 J/m and 2 J/m, respectively. Bamboo fibers and jute fibers without treatment also shows good and flexural tensile are as 392,216 MPa and 226 MPa (for longitudinal fiber distribution) 11.89 MPa (for transverse fiber distribution) 158 MPa (for longitudinal fiber distribution) 25.7 MPa (for transverse fiber distribution). Bamboo fibers absorb moisture when they are exposed to water or kept in humid conditions. But composites made from these fibers exhibit better thermal properties and hence bamboo fiber is quite advantageous over other natural plant fibers. Agave fiber is

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composed of bundles of lignified microfibers and use of this fiber increases the resistance of the composite. These fibers adhere to the matrix better than other fibers [33]. Raju et al. [24] proposed three agricultural by-products such as groundnut shell, coir pith and rice husk were considered and their reinforcement in epoxy matrix. The 30% of particles and 70% of resin were considered for the preparation of composites. The rice husk-epoxy composites exhibited better value in tensile, flexural and impact properties [36]. Moreover, the impregnation of natural fiber and agricultural by-products as reinforcement materials in polymer composites offer advantages such as: utilization of waste materials, non-toxic & decomposability, low reinforcement cost and high specific strength behaviors [37,38] . The use of rice husk and boiled egg shell particles in coir polymer composites were analyzed by [39]. The hybrid reinforcement showed improved values of tensile at 31.5 MPa flexural at 33 MPa and impact strength of 43.5 kJ/m^2, which are better than the individual reinforcements. The usage of natural particulates as reinforcements along with natural fibers has been proposed by most of the researchers in recent years [40,41].Mechanical properties comparison between WTNSFs **c**omposite and other natural fiber composites are as shown in Table 2.

Table 2. Mechanical properties comparison between WTNSFs composite and other natural fiber composites.

Sl. No	Composites	Tensile strength (MPa)	Flexural strength (MPa)	Impact strength (kJ/m²)	Ref.
1.	Coir-epoxy	23.68	46.63	26.43	[33]
2.	Sisal-epoxy	37.40	52.8	56.7	
3.	Jute-epoxy	43.00	55.8	65.00	
4.	Banana-epoxy	59.00	76.53	149.66	
5.	Bagasse-epoxy	42.40	56.7	110.66	
6.	Flax-epoxy	59.85	75.40	191.71	
7.	Areca-epoxy	27.50	25.00	93.33	
8.	Ramie-epoxy	90.00	110.00	105.40	
9.	Lantana camara-epoxy	19.08	55.45	32.30	
10.	Pseudo stem Banana-epoxy	45.57	73.58	92.66	
11.	Groundnut shell-epoxy	18.09	28.00	24.17	
12.	Rice husk-epoxy	23.00	29.00	26.00	
13.	Coir pith-epoxy	9.00	23.00	18.67	
14.	Banana + sisal-epoxy	25.00	62.00	98.66	
15.	Luffa + Groundnut- epoxy	39.31	58.59	27.33	
16.	Wrightia tinctoria nano seed fibers-epoxy	24.36	45.67	27.86	

Impact

The current world economic circumstances highly influenced the cost of building materials due to the competency in world exchange currencies. These worse situations drastically affected several ongoing construction projects. Owing to this, the construction sector opts for new innovative materials that can develop sustainable, green and eco-friendly building environment. India, being a developing country, is enriched in agriculture and has given the finest path for the usage of natural fibers in construction sector. Natural seed fibers from agriculture and forests by products use as reinforced material in fiber reinforced composites. The utilization of cellulose/lignocelluloses based natural seed fibers in place of commercial synthetic fibers is highly recommended for the advantage of low cost, non-carcinogenic and biodegradable in nature. The good mechanical properties of these natural seed fibers and their processing easiness gained confidence to use as reinforced composites in constructions. Natural seed fibers extraction is easier from plants. Almost all developing countries are rich in agriculture plants. These are attractive materials in different lanes like biomaterials and bio composites. Urbanization and industrial development need sustainable construction materials in effective way. Biodegradable material is highly preferred due to increase with demands for renewable resources for consumer production. Seed fibers low cost, less density, specific mechanical strength and sustainable, completely biodegradable, recyclable. Seed fibers are small cross sections in dimension they are directly uses in engineering applications. Plant seed fibers from agricultural and forest by products full fill the future demands and impose to scientists, researchers and engineers to discover new engineering materials useful to structural applications as natural fiber-reinforced composites. Fabricated composites are cheaply used for fewer severe household and industries. Since it is sustainable, eco-friendly, and cheap, it replaces synthetic fibers in structural composites. Raw fiber is easily crushable into tiny particles, and it could be helpful as a cheap reinforcing filler in plastic formulations. It helps to make woven and non-woven wiping cloths for less demanding miscellaneous applications such as, sound dampers in ceilings, carry bags, interlinings, etc., cost-effectively without sacrificing the eco-logical consideration.

Conclusions

Wrightia tinctoria found to be a lignocellulose fiber and contains unique characteristics. Surface morphological studies reveal that, WTNSFs contain smoother surface, which is beneficial to develop a good bond with matrix while making composites. WTNSFs reinforced composite was developed, with supporting epoxy resin as the matrix. Two composite specimens were prepared without fibers and with 35% WTNSFs as reinforcement. Here, the developed fiber composites are sized as per ASTM standards to conduct the tests such as tensile, flexural, impact strength, and water absorption tests. It does not get wet quickly with water due to fatty, wax, mineral matters, and higher lignin content on the fiber surface, which means the fiber is soft compared with other natural seed fibers. While conducting water absorption test about to 24, 48 and 72 hours composite absorbs water in very slow manner. Due to fiber hydrophobic nature the fabricated composite does not get wet quickly with water. Hence, these unique properties of WTNSFs ascertain a s a suitable material for polymer fabrication process, which would be favorable to develop good bonding with the matrix for making composites and useful for insulating composite materials. These outcomes indicate that, the untreated WTNSFs composite reinforced by 35%fiber volume yielded the best results in all tests. 35% fiber reinforcement addition shows better mechanical properties, while compared with plain epoxy composite. Hence, a 35% raw fiber volume fraction is suitable for making composite specimens. Thus, it concluded that adding around 30-40 wt% of untreated WTNSFs as a reinforcement for making composite laminates needs good results. In all-purpose, these composites produced has superior mechanical properties with less rate. This product can replace panels, boards, injections, and molded parts and is also beneficial for lightweight applications in construction. Ultimately, this work advances the chance to employ the WTNSFs in a variety of applications, as reinforcement in composite structures.

Conflict of Interest

The author declares that there is no conflict of interest.

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