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A Review on Coconut Shell Reinforced Composites

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Abstract: Renewable natural fiber polymer composites include plant fibers could be extracted from bast fibers, leaves fibers, leaflets, seed fibers, grass and reed fibers, and all other types. The recent advances in biocomposite development are genetic engineering. In recent years, there has been a remarkable increase in interest in biodegradable bio-composite material for application such as packaging, agriculture, medicine, sportswear, insulation, coating and other areas. This effort to develop the biocomposites materials will decrease the need for synthetic polymer production at a low cost. The natural fibers are alternately producing a positive effect on both environmental and economical. The availability of coconut shells is increasing every year worldwide, which is hard liginocellulosic Agra waste. But mostly the coconut shells are left out in the garbage or burn as waste and produce large quantity of CO_2 and methane emission product after consumption water and meat from coconut. These coconut shell wastes can be used to fabricate fiber reinforced polymer composites for commercial purpose. Efforts to find utilization of this material have resulted mostly in low value. In this regard, coconut shell powder seems to be an interesting candidate due to its chemical composition. In present review is carried out to evaluate development of coconut shell fibers reinforced polymer composites with its manufacturing processes, methodology and also finding of mechanical properties, thermal analysis and its application.
Keywords: Biocomposite, Biopolymer, Biofiber, Coconut shell fibers, Coconut shell powder, Natural fibers, Polymer matrix.

1. Introduction

In the latest years, composites fulfill optimal requirement criteria for several designers' materials. In the last 50 years, there have been major developments in the design and fabrication of light-weight, high strength materials, primarily due to the increase of polymer composite materials[1]. Several researchers have aimed at their work towards defining abundant combinations of biodegradable matrix/natural fillers in order to promote new classes of biodegradable composites with enhanced mechanical properties, as well as to attain products with lower cost. Among several investigated natural fibers in this area, different fillers have the significant importance. For example, the development of wood flour composites has been actively pursued with the increasing consumption of wood-based raw materials. In their substitutions were inevitably needed. The Natural Fillers (NF) reinforced materials offer several environmental advantages, such as decrease dependence on non-renewable material sources, lower pollution and green house emission. Natural lignocelluloses fillers (flax, jute, hemp, etc.) represent an environmentally friendly alternative to conventional reinforcing fibers (glass, carbon). The Advantages of natural fillers over traditional ones are their low cost, high toughness, corrosion resistance, low density, good specific strength properties and reduced tool wear[2]. However, there are several disadvantages in natural fillers, like low tensile strength, low melting point, not suitable for high temperature application, poor surface adhesion to hydrophobic polymers, non-uniform filler sizes, degradation by moisture. Therefore, chemical treatments are done so as to modify the fiber surface properties[3].

1.1 Classification of natural fiber

A Natural fiber made from plant, animal or mineral sources, and is classified according to the origin. Plants that produce natural fibers are categorized into primary and secondary depending on the utilization. Primary plants are grown for their fibers (examples, Jute, hemp, kenaf, and sisal) while secondary plants are plants where the fibers are extracted from the waste product (examples, Pineapple, Bagasse, oil palm and coir). There are six major types of fibers namely; bast fibers (jute, flax, hemp, ramie, baggase, linen, bamboo, and kenaf), leaves fibers (abaca, banana, sisal and pineapple), leaflets (palm, coconut, etc.) seed fibers (coir, cotton and kapok), grass and reed fibers (wheat, corn and rice) and all other types (wood and roots) [4].

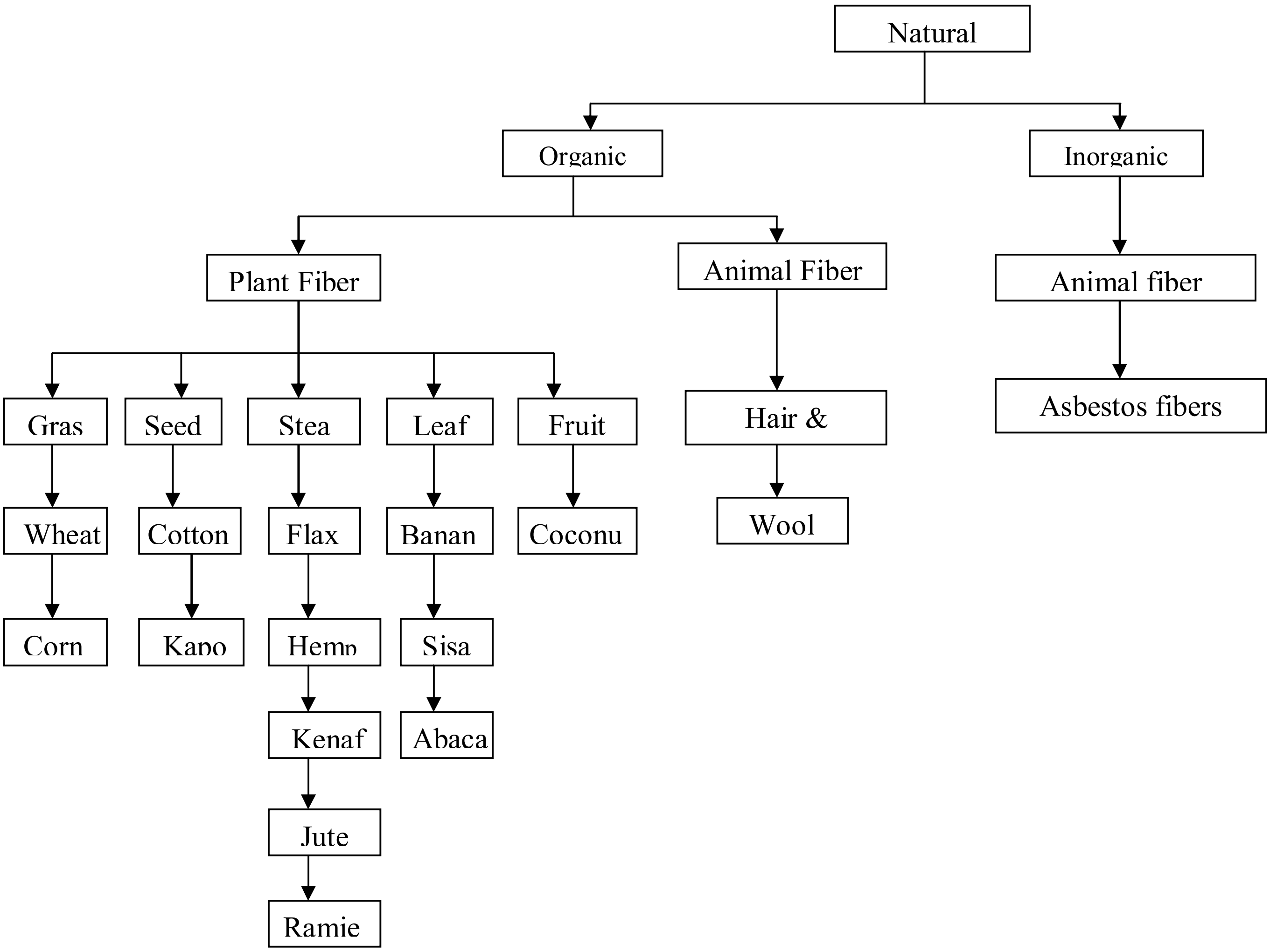

Chart 1. Classification of Natural Fibers

Figure-1 Pictures of Several Natural Fiber

A large variation is found in the mechanical and physical properties of natural fibers. Those properties are affected by many factors of natural fibers. The experimental conditions are different such as type of fibers, moisture content and form of fibers (yarn, woven, twine, chopped, felt, etc.). Moreover, the properties are also affected by the place where the fibers are grown, cultivation condition. The part of the plant they are harvested from growing period and retting or extracting process.

Table-1 Outlines the Physical Appearance of Natural Fibers, [5]

Type of fibers	Diameter (μm)	Texture and color
Hemp	26.5	Silky-fine; White to light brown
Sisal	50-200	Coarse-stiff; White
Jute	25-200	Fine; Light brown
Coir	100-450	Coarse; White to brown
Gomuti (Sugar-palm fiber)	50-800	Coarse-stiff; brown to black
Coconut fiber	Minimum 13cm	Clear light brown

An. Improved understanding of the chemical composition and surface adhesive bonding of natural fiber is essential for developing natural fiber-reinforced composites. The components of natural fibers are such as cellulose, hemicellulose, lignin, pectin, waxes and water soluble substances.

Table-2 The Composition of selected Natural Fibers[6]

Type of fiber	Cellulose (%)	Hemicelluloses (%)	Lignin (%)	Pectin (%)	Ash (%)	Moisture (%)	Micro fibrillar Angle(deg)	Waxes
A. Bast fiber								
Flax	71	18.6-20.6	2.2	2.3	-	10	5-10	1.7
Hemp	57-77	14-22.4	3.7-13	0.9	0.8	9	2-6.2	0.8
Jute	45-71.5	13.6-21	12-26	0.2	0.5-2	13	8	0.5
Kenaf	31-57	21.5-23	15-19	-	0.5-2	-	-	-
Ramie	68.6-91	5-16.7	0.6-0.7	1.9	-	16	16	2
B.Leaf fiber								
Sisal	47-78	10-24	7-11	10	0.6-1	16	16	2
Abaca	56-63	15-17	7-9	-	-	8	-	<1
Banana	64	10	5	11	-	-	-	-
D.Seed fiber								
Cotton	88	5.7	16	8	-	-	-	-

Table-3 Mechanical Properties of the Common Natural Fibers as Compared to Conventional Reinforcing Fibers [5, 6]

Type of fibers	Density (g/cm3)	Tensile strength (Mpa)	Young´s modulus (GPA)	Elongation %
Hemp	1.48	514	24.8	1.6
Flax	1.50	345-1100	27.6	1.2-3.2
Jute	1.3 – 1.45	393-773	13-26.5	1.3-4.6
Ramie	1.5	220-938	44-128	2-3.8
Sisal	1.45	468-640	9.4-22	2-14
Coir	1.2	175-220	4-6	5-30
Cotton	1.5-1.6	287-597	5.5-12.6	3-10
Softwood craft	1.5	1000	40	-
Bamboo	1.4	500-740	30-50	2
E-glass	2.5	2000-3500	70	2.5-3
S-glass	2.5	45 70	86	2.8
Carbon	1.4	3000-3150	63-67	3.3-3.7
Aramide	1.4	4000	230-240	1.4-1.8

1.2 Application of natural fiber

Natural fiber composites are very cost effective material and widely used for following applications:

Building and construction industry: panels for partition and false ceiling, partition boards, wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in times of natural calamities such as floods, cyclones, earthquakes, etc. **Storage devices:** (post-boxes, grain storage silos, bio-gas containers, etc.),**Furnitur**e: (chair, table, shower, bath units, etc.),**Electric devices:** (electrical appliances, pipes, etc.),**Everyday applications:(** lampshades, suitcases, helmets, etc.),**Transportation:** (automobile and railway coach interior, boat, etc.),**The reasons for the use of natural fibers in the automotive industry Include**: Low density: which may lead to a weight reduction of 10 to 30%?,Acceptable mechanical properties, good acoustic properties, Favorable processing properties, for instance low wear on tools, Options for new production technologies and materials, Favorable accident performance, high stability, less splintering, Occupational health benefits compared to glass fibers during production, No off-gassing of toxic compounds (in contrast to phenol resin bonded wood and recycled Cotton fiber parts),Reduced fogging behavior, Price advantages both for the fibers and the applied technologies[7]

Figure -2 Natural Fiber Applications in the Automobile Sector, Building Construction and Accessories

1.3 Work flow for biocomposite processing

The uncrushed natural fibers were cleaned, dried at room temperature or atmosphere air and chemical treated using Isocyanate, washing with an alkaline solution and hardener were applied. After treatment, the natural fiber was dried in an oven at 50^0C to120^0C for 1 to 24 hours or atmospheric air at 24 to 48 hours depending upon the method. And then to reduce the size in ball milled at 200 to 300 RPM for 5 to 6 hours. The natural fiber and polymer matrix were mixing in the reactor or z-blade mixer or two-roll Rheomixer. After the mixing composites were compressed under pressure from 10Mpa to 150Mpa at 150^0C to 180^0C for 5 to 10 minutes and finally dry the composites in dry air for proper curing.

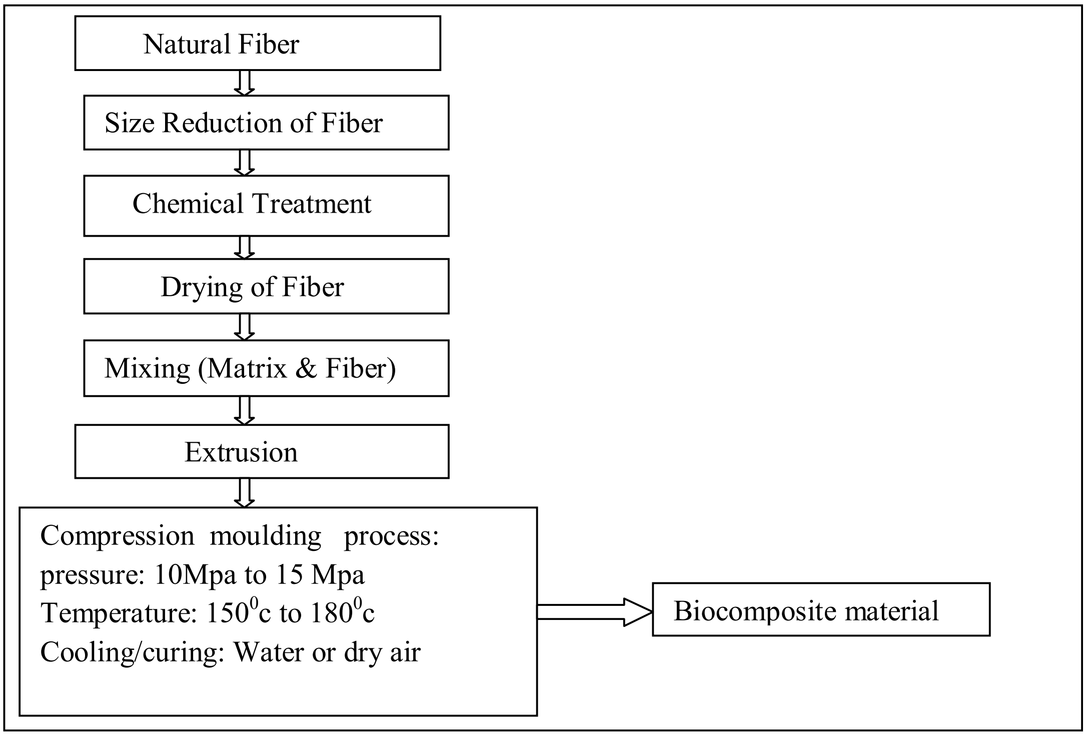

Fig- 3. Work Flow for Biocomposite Processing

1.4 Polymer Matrix Composites (PMC)

Polymer-matrix composites can be classified according to whether the matrix is a thermosets or a thermoplastic polymer. Thermosets are solidified by irreversible chemical reactions, in which the molecules in the polymer "cross-link", or form connected chains. The most thermosetting matrix materials for high-performance composites used in the aerospace industry are the epoxies. But thermoplastic-matrix composites are currently the focus of rapid development and even though the manufacturing technologies for thermoplastic are normally not as well developed as those for thermoset. The thermoplastic provide several advantages, such as low manufacturing cost, high toughness (damage tolerance), good hot/wet properties, high environmental tolerance and good corrosion resistance. The main disadvantages of thermoplastic-matrix are high processing temperature, high viscosities, high coefficient of thermal expansion and they generally do not resist heat as well as thermosets. However, improvements are being made in developing thermoplastics with a higher melting temperature. Overall, thermoplastics offer a greater choice of processing approaches, so that the process can be determined by the scale and rate of production required and by the size of the component. Fibrous polymer-matrix composites can be classified according to whether the fibrous are short or continuous. The Continuous fibers are more efficient at resisting loads than short ones, but it is more difficult to fabricate complex shapes from materials containing continuous fibers than from short fiber or particle reinforced material. This is because of the relatively low processing temperature required to fabricate polymer-matrix composites.

For thermosets such as epoxy, phenolic polyster, vinyl ester, cyanate ester and polymides, the processing temperature typically ranges from room temperature to about 200^0C. Thermoplastic polymer such as polypropylene, poly vinyl chloride, poly sulfone, poly ether ether ketone, polyamide, nylon, polycarbonate and polyphenylene sulfide, the processing temperature typically ranges from 300^0C to 400^0C. The molding methods are those conventionally used for polymer by themselves. For thermoplastic methods include injection molding, extrusion, calendaring and Thermoforming. For thermosets methods include compression molding or matched die molding.

Depending on the application and on the type of load to be applied to the composite part, the reinforcement can be random, unidirectional (aligned in a single direction), or multidirectional (oriented in two or three dimensions). If the load is uniaxial, the fibers are all aligned in the load direction to gain maximum benefit of their stiffness and strength. However, for multidirectional loading (for example, in aircraft skins), the fibers must be oriented in a variety of directions. This is often accomplished by stacking layers (or lamina) of continuous-fiber systems[8].

1.5 Fiber source

The plants which produce natural fibers, are classified as primary and secondary depending on their utilization. Primary plants are those grown for their fiber content while secondary plants are plants in which the fibers are produced as a by-product. Jute, Hemp, Kenaf and Sisal are examples of primary plants. Pineapple, Baggase, Oil palm, Coir and coconut shell are examples of secondary plants[9].

2. Coconut Shell

Coconut is a member of the palm family, which is one of the food crops in the world. It generates large amounts of waste material, namely coconut shell (CS). CS is non-food part of coconut which is one of the hard lignocellulosic agro wastes. Agro waste products such as CS is an annual increase every year and is available in abundant volume throughout the world[10]. Particularly CS is one of the most significant natural fillers produced in tropical countries like India, Malaysia, Indonesia, Thailand and Srilanka. Several workers have been dedicated to use of other natural fiber in composite in the latest post and CS fiber is a potential candidate for the improvement of new composites because of their high strength and modulus properties. Composite fiber can be used in, the board range of application such as, building material, furniture and fishnets. Coconut fiber is important reinforcement material in fabrication of various types of polymer based composites, due to cost effectiveness, high strength, etc[11]. Presently 90% CS was disposed as waste and either burned in the open air or left Seattle in waste ponds. This way the coconut processing industries waste according to him contributed significantly to CO_2 and methane emissions. Based on economic as well as environmental related issues, this effort should be directed worldwide towards coconut management issues i.e. of utilization, storage and disposal. Different avenues of CS utilization are more or less known, but none of them have so far proved to be economically viable or commercially feasible[12].

The CS agro waste lignocellulosic filler exhibits some admirable properties compared to mineral filler (e.g. Calcium carbonate, kaolin, mica and talc) such as low cost, renewable, high specific strength-to-weight ratio, minimal health hazard, low density, less abrasion to machine, certainly biodegradability and environmental friendly. However, due to the presence of strong polarized hydroxyl groups on the surface of lignocellulosic fillers, the formation of a strong interfacial bonding with Anon polar polymer matrix becomes complex as the hydrogen bonds tend to prevent the wetting of the filler surfaces. As a result, lignocellulosic fillers show poor mechanical properties in polymer composites due to the lack of interfacial adhesion. Alternatively, the interfacial adhesion among filler and matrix can be enhanced by surface modification of filler. Currently there are many methods to promote the interfacial adhesion between the lignocelluloses filler and polymer matrix, such as alkaline treatment, esterification, silane treatment, using compatibilizers and treatment with other chemical compound, when appropriate modifications and production procedures applied. CS displays improved mechanical properties such as tensile strength, flexural strength, flexural modulus, hardness and impact strength [13].

The low density, high cellulose content, and plenty of CS fiber, make them popular in Southeast Asia and other areas for a number of rope, fiber, and textile applications. Other benefits using the fibers of coconut coir include its toughness, low density, low cost and biodegradability. Several different types of biocomposites are already existing, including those composed of biodegradable plant-based or animal-based natural fibers, such as flax, jute, silk, or wool. When this biocomposite material was tested for dimensional stability, it exhibited very low water absorption rates of less than three percent and low thickness swelling of less than one percent. These results have shown that plant-based fibers may be used as reinforcement in a composite system to improve the properties and performance of polymer matrix resins. The better strength and stiffness, in addition to the lower weight of natural fibers can make the composite tiles useful in vehicle plates, some industrial applications and for walls and floors in construction.

The biocomposite technology tested hybrid composites of rubber wood, coconut shell and woven cotton or polyster textile fabrics. The aim was to discover how reinforcement provided by textile fabrics affects biocomposites. Several different hybrid composites were created, with two, three, or four layers of cotton or polyester fabric. The researcher conducted flexural strength, impact strength, water absorption and thickness swelling tests. The flexural strength and flexural modulus of fabric-reinforced hybrid composites improved compared to the control sample. The flexural modulus of composites reinforced with four layers of fabric tended to decrease slightly. The fabric also gives better impact damage tolerance, which increased with layer count. Since the polyster fabric did not adhere well to the rubber wood and coconut shell mixture, it was not as strong as the cotton fabric-reinforced versions. The researchers said that, if its adherence was improved, the polyster hybrid composite's flexural strength and impact properties would likely improve.The hybrid composites reinforced with cotton had better flexural but lower-impact strength than the polyster-reinforced composites. The composites reinforced with both fabric types had lower water absorption and higher values of thickness swelling than the control sample[14].

Coconut shell is low ash content. Conversion of coconut shells into activated carbons which can be used as adsorbents in water purification and municipal effluents would add value to these agricultural commodities, help reduce the cost of waste disposal and provide a potentially cheap alternative to existing commercial carbons[15].

Table-4 Selected coconut production statistics, (2010)

Country	Area (`000 haetr)	Production (million nuts)	Productivity (Nuts/haetr)
India	1895	16943.00	8965
Indonesia	3808	16332.24	4289
Philippines'	3400	15510.00	4562
Sri Lanka	395	2619	6630

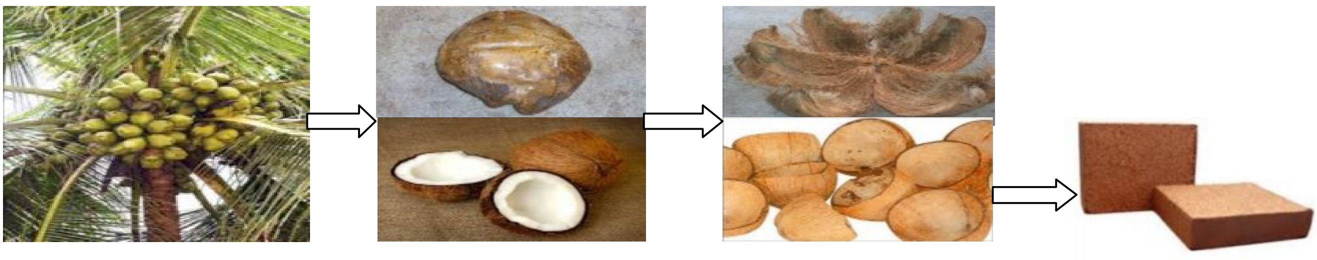

Fig 4. Formation of coconut shell Biocomposite material

Table-5 Chemical composition of coconut shell [16]

Sl. No	Chemical composition %	Coconut shell
1	Cellulose	26.6
2	hemicelluloses	21
3	Lignin	29.4
4	Pentosans	27.7
5	Solvent Extractives	4.2
6	Uronic Anhydrides	3.5
7	Ash	0.6

Table-6 physical and mechanical properties of coconut shell[17]

Sl. No	properties	Coconut shells
1	Maximum size (mm)	12.5
2	Moisture content (%)	4.20
3	Water absorption (24 h) (%)	24.00
4	Specific gravity SSDa apparent	1.05-1.20 1.40-1.50
5	Impact value (%)	8.15
6	Crushing value (%)	2.58
7	Abrasion value (%)	1.63
8	Bulk density (kg/m3) Compacted loose	650 550
9	Fineness modulus	6.26
10	Shell thickness (mm)	2-8

3. Table-7 Methodology

S. No.	Natural Fiber	Polymer Matrix	Pretreatment (Chemical)	Method	Mechanical & Thermal Test	Reference
1	**Coconut shell**	Epoxy resin	Sodium Hydroxide(NaoH) & Potassium Hydroxide (KoH) with 2%,5% and 8% soaking at 24 hours	Hand lay-Up technique	Flexuralstrength32.54Mpa, Impact strength 42.57 Mpa	**18**
2		Epoxy resin (Bisphenol-A- Co-Epichlorohydrine).	Untreated	Hand lay-up technique	Tensile strength-20N/sq mm Hardness -61 DHN	**19**
3		Recycled Polypropylene	1molar solution of Sodium Hydroxide (NaOH) for one hour, after which it was washed in pure water	Hand lay-up technique	Tensile strength-11N/sq mm Hardness -12 HBR Impact energy-11.5 J Water absorption-8%	**20**
4		Epoxy resin (MGS L285)	Untreated	Hand lay-up technique	Tensile strength-28 Mpa Hardness-77(shore D)	**21**
5	Coconut shell	Epoxy resin (Grade-VBR8912).	Untreated	Hand lay-up technique	Tensile strength-865.75 N Flexural strength-63.21Mpa Impact strength 0.25(kJ/sq m)	**22**
6		Unsaturated polyester resin	Untreated	Hand lay-up technique	Tensile strength-70 Mpa Flexural strength-30 Mpa Flexural modulus-1700 Mpa Hardness-200 BHN Impact strength-4.5 J	**23**
7		Epoxy resin Moditite EL 301	Untreated	Hand lay-up technique	Tensile strength-21.55 Mpa Flexural strength-94 Mpa	**24**
8		Polypropylene Composites Encapsulated with Epoxy Resin	Untreated	Hand lay-up technique	Tensile strength-30 Mpa Tensile strain -7% Impact strength-130J	**25**
9		Epoxy resin	Untreated	Hand lay-up technique	Tensile strength-33.3 Mpa	**26**
10		Recycled Polypropylene	Sodium Dedecyl Sulfate And Ethanol	Compression moulding	Tensile strength-25 Mpa Tensile modulus-2000 Mpa Elangation break -4%, Water absorption-2.5 % Thermal stability-700^{0}C	**27**
11		Epoxy resin SY-12(319)	Untreated	Hand lay-up technique	Tensile strength-30.60 Mpa Modulus of elasticity-856 Mpa % Elongation-25.44	**28**
12		Epoxy resin	Untreated	Hand lay -up technique	Tensile strength-18.34 Mpa Tensile modulus-3000 Mpa	**10**
13		Pilogrip	Untreated	Hand lay-	Tensile strength-25N/sq mm	**11**

		Epoxy resin		up technique	Flexural strength-45.37N/sq mm	
14		Epoxy resin Moditite EL 301	Untreated	Hand lay-up technique	Tensile strength-19.23 Mpa Flexural strength-86.45 Mpa Water absorption- 1.66 %	**29**
15		Unsaturated Polyester (USP)	Sodium Hydroxide (NaOH) 1% (v/v) diluted in distilled water at room temperature	Compression moulding	Tensile strength-33Mpa Elongation break-4% Flexural strength-57 Mpa Modulus of elasticity-1500Mpa Flexural modulus-2800 Mpa Thermal stability Temperature-600^{0}C	**15**
16	Coconut shell	Epoxy resin SY12(319)	Untreated	Hand lay-up technique	Ultimate strength-88 Mpa Modulus of elasticity-698 Mpa % Reduction-3.95 Water absorption-0.431%	**31**
17		Polyethylene	Untreated	Hydraulic pressing machine	Tensile strength-9 Mpa Strain-69.5 Mpa Modulus-70 Mpa Hardness-12 HRB	**32**
18		Polylactic acid	Acrylic acid was dissolved in to Ethanol (3%)	Compression moulding	Tensile strength-41 Mpa Modulus of elasticitry-3500 Mpa Elongation break -1.6% ThermalstabilityTemperature-600^{0}C	**13**
19		Epoxy resin 3554A	Untreated	Hand lay-up technique	Tensile strength-51 Mpa Load at break-2000 N Modulus-1000 Mpa Hardness-18 HV	**33**
20		Natural rubber	Alkali treatment 10mL NaOH solution for 5 hr	Compression moulding	Tensile strength-25MPa Young`s modulus-4.5 Mpa Tear strength-5.6N/sq mm Hardness-50(shore A) Thermal stability-900^{0}C	**34**
21		Epoxy resin LY 556	Untreated	Hand lay-up technique	Tensile strength-31 to 36 Mpa Microhardness-26 to 29 HV Flexural strength-60 to65 Mpa	35
22		Epoxy resin	Untreated	Hand lay-up technique	Tensile strength-26.63 Mpa Flexural strength-60 to 65Mpa Hardness-215	36
23		Unsaturated Polyester, Grade "Reversol P9509"	Untreated	Hand lay-up technique	Tensile strength-29 Mpa Elongation at break -3.5% Modulus of elasticity-1600Mpa	**37**
24		Epoxy resin	Untreated	Hydraulic press	Tensile strength-37 Mpa Hardness-9.5 HB Impact enegy-0.75 J Energy break-11.34 J Young modulus-688 Mpa	**2**

25	Coconut shell	Low Density Polyethylene	Acetic acid aqueous solution and stirred for 1 hr	Compression moulding	Tensile strength-13 Mpa Young`s modulus-200MPa	**38**
27		Polyurethane/ Polystyrene	Untreated	Hand lay-up technique	Tensile strength-12.27Mpa Hardness-62 to 83 (shore A) Thermal stability-341^{0}C to 525^{0}C	**40**
28		Modified Poly(Vinyl Alcohol)	Alkalization treatment 5% Sodium Hydroxide solution for 24 hr	Hand lay-up technique	Tensile strength -11.33N/sq mm % of Elongation-195, Elastic modulus-140N/sq mm Glass transition temperature-120^{0}C Melting temperature 180^{0}C	**41**
29		Modified Poly (Vinyl Alcohol**)**	Alkalization treatment 5% Sodium Hydroxide solution for 24 hr	Hand lay-up technique	Tensile strength-15.02 N/sq mm % of Elongation-229 Elastic modulus-18 N/sq mm	**42**
30		Low Density Polyethylene (LDPE)	Untreated	Hand lay-up technique	Tensile strength- 3 kN/sq mm Tear strength-15 N/sq mm Modulus elasticity1600 Mpa Elongation at break-50 mm	**43**
31		Ultrahigh Molecular Weight Polyethylene (UHMWPE)	Untreated	Hand-press machine	Compressive strength 65 Mpa Impact energy-25 J	**1**
32		Epoxy resin 3554A	Untreated	Hand lay-up technique	Tensile strength-35.48N/sq mm Modulus of Elasticity-3.25E+03 Mpa, Maximum strain-0.03(mm/mm)	**3**

4.Conclusion

The use of Natural fiber polymer composites filled with natural-organic fillers, in alternate of mineral-inorganic fillers. It is of great interest in the view of the reduction in the use of petroleum-based, nonrenewable resources and in general it is the more intelligent utilization of environmental and financial resources. These ‘‘Natural fiber’’ composites can find some industrial applications, although some limitations occur regarding mainly ductility, process ability and dimensional stability. Worldwide research has spent much effort in order developing suitable solutions through chemical modification of the Filler, Fiber dispersion, Fiber aspect ratio, Fiber orientation, Fiber volume fraction, use of adhesion promoters and additives. However, a full biodegradability and thus a really improved environmental impact can be obtained only by biodegradable ones instead of traditional polymers (coming from non-renewable resources). In these cases, however, new limitations arise and current scientific investigation has been focusing on the selection of the most suitable biodegradable matrix and the optimization of all of the preparation and processing parameters.

The utilization of coconut shell fibers in various applications has opened up new avenues for both academicians as well as industries to design a sustainable module for future use of coconut shell fibers. Coconut shell fibers have been extensively used in composite industries for socioeconomic empowerment of peoples. The fabrication of coconut shell fibers based composites using different matrixes has developed cost effective and eco-friendly biocomposites which directly affecting the market values of coconut shell. To design such composites thorough investigation of fundamental, mechanical, and physical properties of coconut shell fibers is necessary.

Thus, this analysis has made an attempt to gather information for both basic properties of coconut shell fiber based composites as well as their economic utilization. Current research on coconut shell fiber based composite using both basic as well as applied science either in terms of modification, mechano-physical, thermal and other properties. But, the ultimate goal of utilizing the coconut shell to its full extent is far behind than its projected milestone. The sustainable future of coconut shell based composite industry would help in utilizing the coconut shell in a way other than usual traditional mode. The effective characterization of coconut shell fiber as well as coconut fiber based composites should be more advance in terms of analysis and testing.

In this review, we have tried to gather the information about the analysis and testing methods used. However, researcher already done lots of work on coconut shell based composites, but it still required to do more research and innovation in this area to overcome potential challenges ahead. These things will make life easy for both urban as well as rural people who are more depended on synthetic based composites. As regards the commercial situation, it can be stated that the market is still in an opening phase, therefore much can still be done in order finding new applications, improving the properties, the appearance and the marketability of these materials. All of these issues require and continue to require, significant research efforts in order to find new formulations (virgin or recycled polymers, traditional or biodegradable polymers; type, appearance, quality and amount of the fillers), characterize them, apply them for the most suitable applications and in general, to refine processing techniques. As soon as the market for these composites increases, reduction of costs and improvement of the quality will be achieved.

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