International Journal of Research in Engineering, Science and Management
Volume-1, Issue-11, November-2018
www.ijresm.com | ISSN (Online): 2581-5792

# Characteristics of Natural Fibres - A Study

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*Abstract*: **Natural fibres are getting attention from researchers and academician to utilize in polymer composites due to their eco-friendly nature and sustainability. Natural fibres due to its renewable, eco-friendly and biodegradable properties find its application in the wide array of fields. Natural fibres conduct heat, can be properly dyed, resist mildew, have natural antibacterial properties, block UV radiation and can be easily made flame retardant. Genetic modification of natural fibrous raw materials improves their productivity and performance. This study is about discussing the properties of natural fibre and natural fibre composites. To understand the various test that has to be conducted in order to observe the characteristics of the natural fibres.**

***Keywords*: natural fibres**

## 1. Introduction

Natural fibre, any hair like raw material directly obtainable from an animal, vegetable, or mineral source and convertible into nonwoven fabrics such as felt or paper or, after spinning into yarns, into woven cloth. A natural fibre may be further defined as an agglomeration of cells in which the diameter is negligible in comparison with the length. Although nature abounds in fibrous materials, especially cellulosic types such as cotton, wood, grains, and straw, only a small number can be used for textile products or other industrial purposes. Apart from economic considerations, the usefulness of a fibre for commercial purposes is determined by such properties as length, strength, pliability, elasticity, abrasion resistance, absorbency, and various surface properties. Most textile fibres are slender, flexible, and relatively strong. They are elastic in that they stretch when put under tension and then partially or completely return to their original length when the tension is removed.

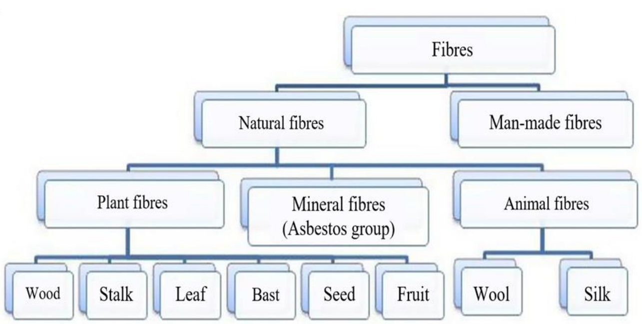


Fig. 1. Classification of the fibres

Fig. 2. Banana fibre

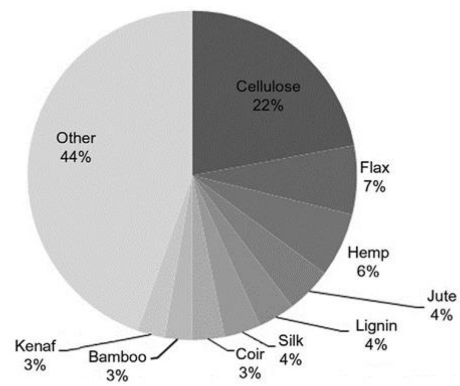


Fig. 3. The natural fibres used in bio composite related topics in Science direct from 2011 to 2015


Fig. 4. Hemp fibre used in car door

Driven by the introduction of regulatory norms demanding more environmental-friendly products, the use of natural fibres as reinforcements for composites materials has increased significantly in the last decade. Natural fibres such as flax, jute, hemp and kenaf offer low carbon footprint and biodegradability advantages combined with a high specific strength and stiffness at a low-cost. The application of natural fibres is motivated by a combination of environmental sustainability, cost-effectiveness, recycling and biodegradation properties. Natural fibres are used as reinforcement in structural applications in automotive industry. Natural fibres such as hemp and flax are used to manufacture door panels and the roofs of cars.

Fibre reinforced polymer composite materials have played an important role in a variety of applications. Fibre-reinforced composites are essentially axial particulates embedded in fitting matrices. The primary objective of fibre-reinforced composites it to obtain materials with high strength in conjunction with higher elastic modulus. The strength elevation is however affected with applied load transiting from matrix to fibres, interfacial bonding between fibre-matrix, their relative alignment and nature of fibre scheming the overall material behaviours. The alignment of fibres may however be continuous or random depending on the end applications. The choice of the fibre reinforcement and its fitting matrix also depends on application requirements.

## 2. Types of natural fibres

### *A. Leaf fibre*

Fig. 5. Leaf fibre

Leaf fibres or hard fibres are a type of plant fibre mainly used for cordage. They are the toughest of the plant fibres which is most likely due to their increased lignin content when compared to the other groups of fibres. They are typically characterized as being very tough and rigid lending them towards being used in rope production over clothing or paper like other plant fibres.

Leaf fibres can be found in the vascular bundles of plant leaves and therefore consist of both phloem and xylem tissues and any other vascular sheathing tissues. More specifically, leaf fibres are typically found in monocotyledonous leaves.

The fibres are harvested from plants in long, thin bundles mainly through the process of decortication which is where the non-fibrous tissues are scraped away from the plant fibres by hand or in a machine. For the majority of cases, the leaves must be hand-picked from the plant at maturity before undergoing decortication which causes the harvesting of hard fibres to be a very energy and time intensive task.

Sisal and abaca are the primary leaf fibres that are harvested and sold. These are both mainly used to make rope or matting but, as technology continues to advance these, and other, hard fibres are being able to be broken down and pulped to be used in paper products.

### *B. Stalk fibre*

Fig. 6. Stalk fibre

These are fibres from plant stalks, and are typically extracted from plants such as sugarcane, corn, eggplant, sunflower, wood and the straw of various grain crops such as barley, wheat, rice etc. Pulp from some of these fibres has been utilized in paper and paperboard products.

### *C. Seed fibre*

Fig. 7. Seed fibre

Coir fibre is a typical example of seed fibre, and it is extracted from the coconut husk. These lightweight and strong fibres are mainly used in the production of ropes, mats, sacks, brush, geotextile etc. Another set of seed fibres are also extracted from the pod or boll of some plant seeds. Examples are cotton and kapok.

### *D. Agricultural by-product fibres*

Fig. 8. Plate made from agricultural by-product

Lignocellulosic agricultural by-products are a copious and cheap source for cellulose fibres. Agro-based biofibres have the composition, properties and structure that make them suitable for uses such as composite, textile, pulp and paper manufacture. In addition, biofibres can also be used to produce fuel, chemicals, enzymes and food. By-products produced from the cultivation of corn, wheat, rice, sorghum, barley, sugarcane, pineapple, banana and coconut are the major sources of agro-based biofibres. This review analyses the production processes, structure, properties and suitability of these biofibres for various industrial applications.

*E. Bast fibres*

Fig. 9. Bast fibre

Bast fibres are collected from the inner bark or bast surrounding the stem of the plant. These fibres have higher tensile strength than other fibres. Therefore, these fibres are used for durable yarn, fabric, packaging, and paper. Examples are flax, jute, kenaf, hemp and ramie.

## 3. Characterizations of natural fibres

*A. FTIR analysis*

Fourier Transform Infrared Spectroscopy, also known as FTIR Analysis or FTIR Spectroscopy, is an analytical technique used to identify organic, polymeric, and, in some cases, inorganic materials. Fourier-transform infrared spectroscopy is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high-spectral-resolution data over a wide spectral range. This confers a significant advantage over a dispersive spectrometer, which measures intensity over a narrow range of wavelengths at a time.

The FTIR instrument sends infrared radiation of about 10,000 to 100 cm-1 through a sample, with some radiation absorbed and some passed through. The absorbed radiation is converted into rotational and/or vibrational energy by the sample molecules. The resulting signal at the detector presents as a spectrum, typically from 4000 cm-1 to 400cm-1, representing a molecular fingerprint of the sample. Each molecule or chemical structure will produce a unique spectral fingerprint, making FTIR analysis a great tool for chemical identification.

*B. Chemical study*

The major biochemical ingredients of Natural fibres such as cellulose, hemicellulose, lignin and wax content are determined using standard test procedures. The ash content is quantified as per ASTM E1755-61 standard, whereas the moisture content is determined by drying the sample in an oven at 104 ˚C for 4 hours.

*C. XRD analysis*

X-ray diffraction (XRD) is an effective method for determining the crystal structure of materials. It detects crystalline materials having crystal domains greater than 3-5 nm. It is used to characterize bulk crystal structure and chemical phase composition.

X-ray is a form of electromagnetic radiation having range of wavelength from 0.01-0.7 nm which is comparable with the spacings between lattice planes in the crystal. Spacing between atoms in metals ranges from 0.2-0.3 nm. When an incident beam of X-rays interacts with the target atom, X-ray photons are scattered in different directions. Scattering is elastic when there is no change in energy between the incident photon and the scattered photon. In inelastic scattering the scattered photon

Table 1
Chemical content of natural fibre

| Fibre | Cellulose | Hemicellulose | Lignin | Extract | Ash content | Water soluble |
|---|---|---|---|---|---|---|
| Cotton | 82.7 | 5.7 | | 6.3 | | 1.0 |
| Jute | 64.4 | 12.0 | 11.8 | 0.7 | | 1.1 |
| Flax | 64.1 | 16.7 | 2.0 | 1.5-3.3 | | 3.9 |
| Ramie | 68.6 | 13.1 | 0.6 | 1.9-2.2 | | 5.5 |
| Sisal | 65.8 | 120 | 9.9 | 0.8-0.11 | | 1.2 |
| Oil palm EFB | 65.0 | | 19.0 | | 2.0 | |
| Oil palm Frond | 56.0 | 27.5 | 20.48 | 4.4 | 2.4 | |
| Abaca | 56-63 | 20-25 | 7-9 | 3.0 | | 1.4 |
| Hemp | 74.4 | 17.9 | 3.7 | 0.9-1.7 | | |
| Kenaf | 53.4 | 33.9 | 21.2 | | 4.0 | |
| Coir | 32-43 | 0.15-0.25 | 40-45 | | | |
| Banana | 60-65 | 19 | 5-10 | 4.6 | | |
| Sun | 41-48 | 8.3-13 | 22.7 | | | |
| Hemp | | | | | | |
| Bamboo | 73.83 | 12.49 | 10.15 | 3.16 | | |
| Hardwood | 31-64 | 25-40 | 14-34 | 0.1-7.7 | 0.1 | |
| Softwood | 30-60 | 20-30 | 21-37 | 0.2-8.5 | 0.1 | |

Source: Jawaid, M., H.P.S. Abdul Khalil, 2011. Cellulosic/synthetic fibre reinforced polymer hybrid composites: a review loses energy. These scattered waves may super impose and when the waves are in phase then the interference is constructive and if out of phase then destructive interference occurs. Atoms in crystal planes form a periodic array of coherent scatters. Diffraction from different planes of atoms produces a diffraction pattern, which contains information about the atomic arrangement within the crystal.

## 4. Conclusion

Thus, the aim of the study is to understand the tests to find out characteristics of the natural fibres and its significance in reducing the use of synthetic fibres. The different types of natural fibres were listed out and the procedures to find out the characteristics of those natural fibres were discussed. Natural fibres and natural fibre composites can be used in engineering applications because of their environmental suitability. Now a day's lot of new composites are generated technical and economic issues are noticed. Natural fibre/ Natural fibre reinforced epoxy composites with high durability and effective mechanical properties were developed in the last decade. The main challenges for the near future are to further improve the durability and the mechanical performance of these composites by decreasing the costs of fabrication while developing an eco-friendly strategy.

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