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BIOSCREENING OF PLANT FIBERS FROM *ABUTILON INDICUM*

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ABSTRACT

Plant fibers are cellulosic accoutrements and have implicit artificial operations, in paper and packaging diligence. The stringy material from factory is renewable material and hence environment friendly because of its degradability in nature. Fibers may do in any part of the factory similar as root, stem, fruit indeed in the seed. *Abutilon indicum* is a particular lignocellulosic fiber developed from the stems of the Abutilon indicum plant. The physical parameters of the extracted fiber were evaluated, particularly density, linear density, and moisture regain. The fiber microstructure and functional elements have been studied using a scanning electron microscope and infrared spectroscopy. Differential scanning calorimetry and X-ray diffractograms were used for analyzing the thermal characteristics and the crystallinity index.

Keywords: DSC, FTIR, Mechanical, Physico-Chemical Properties and SEM

I. Introduction

In recent years, plant fibers have emerged as a significant class of reinforcing materials. The total consumption of biodegradable materials is expected to expand at an average annual rate of about 13%, with the largest global markets for materials consumption. However, the high price and limited properties of the fully degradable materials hinder the diversity of the usage. Therefore, in order to tackle these problems and retard the exhaustion of natural resources, different projects along the line of developing biodegradable materials have emerged recently, and it is generally believed that these are one of the most key materials in all industries in the coming centuries. Natural fibers constitute highly elongated substance produced by plants. A thin, and significantly elongated substance capable of being spun into yarn. All plant species consists of cells. A fiber is a cell which is significantly longer than it is broad. For example, wood fibers are often 50-100 times longer than they are wide. The fiber is like a microscopic tube. Moreover, when the cell wall is made up (85% or more) of cellulose, hemicelluloses, and lignin. Abutilon indicum fibers are used to make ropes, cordages, and twine. To explore the potential source of these fibers, the plant was selected belonging to the family Malvaceae for further study.

II. Materials and Methods

Extraction of fiber from plant sources:

Retting process (Sharma, 1996):

The plant material was gathered and separated into equal quantities. It is immersed in a container using 2 liters of tap water, allowed to rest for 2-3 weeks, then thoroughly cleaned to extract fibers.

Physical properties of extracted fiber:

The physical parameters were quantified as follows: density, linear density, and moisture regain.

Density (TAPPI, 1980):

The density of the fiber is determined using standard methods of TAPPI. The fiber sample was conditioned for 24 h at 65% relative humidity and 25 ˚C before carrying out the density test. 2 g of fiber sample was immersed in toluene in a calibrated glass tube (10 ml measuring cylinder), and the value of toluene displaced was equal to the volume of fiber in the solution.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Linear density (ASTM D 1577):

The linear density is measured using standard ASTM standards. The density of fiber determined was at standard atmospheric conditions and measured in deniers. The fiber samples were cut using a standard length (L) template (5-10 cm) and weighed (W) in grams. The denier (D) of the fiber sample is calculated using the formula.

$$D = \frac{9000 \times W}{L \times N}$$

Where N is the number of fibers in the sample.

Moisture regain (ASTM-1997, D 2654-76):

It is defined as the amount of water present in a specimen expressed as a percentage of its dry mass. The fiber sample was conditioned for 24h at 27±2˚C, and the weight (g) was taken (L). The conditioned fiber sample was then dried at 105˚C in an oven for 4 hours, and the weight was taken (W). The percentage of moisture regain was calculated according to the formula.

$$\text{Moisture regain (\%)} = \frac{L - W}{L} \times 100$$

Where, L = initial weight (g),

W = final weight (g).

Chemical Analysis of Cellulose, Hemicellulose and Lignin:

In biochemical analysis, estimation of cellulose was followed by the Updegraff (1969) method, the Zadrazil and Brunnert (1980) method was used for the lignin estimation, and the Maynard (1970) method for crude fiber estimation.

Mechanical Properties:

Tensile strength was expressed in terms of the length in kilometers of the fiber, which breaks under its own weight; this is termed as the breaking length. As the tension or weight is increased, the fiber is stretched or extended until it finally breaks and the amount of extension expresses as a percentage of the original length of the fiber is known as the percentage extension at break *i.e.*, elasticity.

FTIR analysis:

Abutilon indicum fiber was investigated by infrared technique with a FT-IR spectrophotometer in the range of 500-4000 cm1. Pellets were prepared by mixing 2 mg of fiber sample with KBR powder of about 1 mm thickness for identification.

Scanning electron microscope (SEM):

The morphological features of the fibers could be observed using scanning electron microscopy (SEM). It was used to study the surface of fiber. The specimens were coated with platinum JPC 1600 using super JOEL coating to avoid the sample. Charging under the electron beam.

Physical Structure Using X-ray Diffraction Method: (Wakelin *etal.,*1959)

The X-ray diffraction method to measure the crystallinity index of the cellulose crystals in a fiber to its axis. The crystal size of the fiber sample was measured using the Scherrer formula.

Differential scanning calorimetry (DSC):

Thermal analysis of *Abutilon indicum* fiber was carried out by using Netzsch Differential Scanning Calorimetry (DSC). 100 mg of sample was placed in the aluminum crucible with the lid pierced and sealed and then introduced into the heating cell of the calorimeter. Thermal scanning was performed at the programmed rate of 10K/m in the temperature range from 30-500°C under a constant nitrogen-flowing atmosphere (Kiruthika. A. V *et al.,* 2009; Azubike *et al., 2012).* The data were collected by heating the composite specimen from 35 to 200 °C at a constant heating rate of 10°/min.

III. Results and Discussion

Physical, chemical and mechanical properties of fiber from *Abutilon indicum* fiber were shown in Table 1 respectively.

Physical properties:

Fiber density is an important characteristic for the fabrication of lightweight composites. *Abutilon indicum* has a density of 1.5. As a result, the value is lower when compared to of E-glass.

The moisture content of the *Abutilon indicum* is 0.66 %. This is an important consideration when determining on the use of fibers for the manufacture of water-absorbing things including towels, doormats, napkins, tissue papers, blotting papers, etc.

Chemical properties:

The amount of cellulose in fiber effects its qualities and determines its suitability for various purposes. Many of the fibers tested, with cellulose content greater than 60%, are used in the paper industry.

Mechanical properties:

Mechanical properties consist of modulus, stress, strain, time at break and tenacity of the fibers was determined.

Table-1: Physico-chemical and Mechanical properties of *Abutilon indicum*

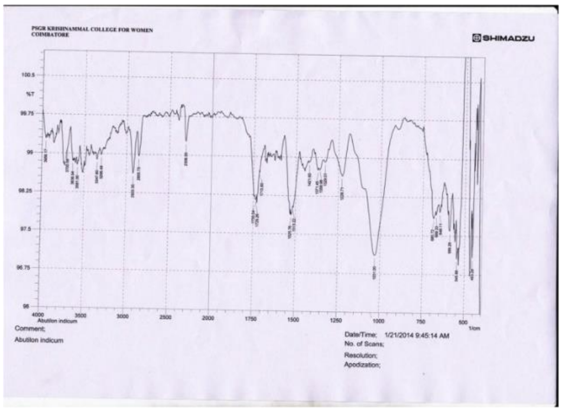
S.No	Properties	Values
	Physical	
1.	Moisture regain (%)	0.66
2.	Density (gml^{-1})	1.5
3.	Linear Density (den)	1.44
	Chemical	
4.	Cellulose	20
5.	Hemicellulose	10
6.	Lignin	32
	Mechanical	
7.	Modulus (gf/den)	25684.43
8.	Stress (MPa)	0.36
9.	Strain (%)	1.72
10.	Tenacity (den)	254.42

FTIR analysis:

The intensity of the band around 3956.17-3581.00 corresponding O-H stretching of α- cellulose; that of 3347.60-3296.49 N-H stretching; that of 2920.35-2306.00 to C-H stretching; that of 1735.04-1713.83 to C=O stretching of hemi cellulose; that of 1525.76-1513.22 to functional group of stretching; 1421.60 to CH_2 symmetric binding; 1329.01-122.71 to C-O stretching; 1031.00 to symmetric C-OH stretching of lignin; 685.72-545.88 to C-S stretching; 453.29 peaks indicate S-S stretching. The peak values are showed in figure-1.

The FTIR features of *Abutilon indicum* fiber is unique in that the S-H, NO_2, C-O-C were not observed.

Figure (1) - FTIR Analysis

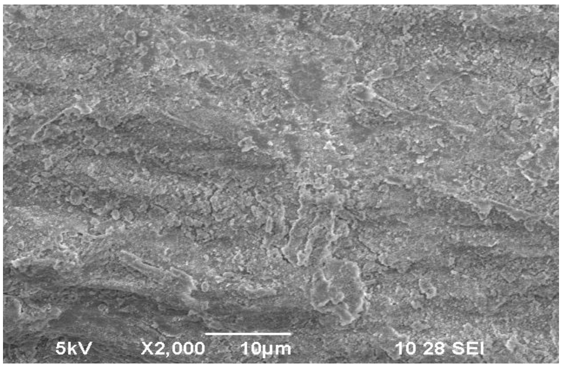


Scanning Electron Microscope (SEM):

The SEM analysis of *Abutilon indicum* showed (fig.2) surface without kinks or fissures and that each fiber bundle of cells.

Abutilon indicum show two major peaks at 31.8˚ and 36.2˚ at 2θ. From the XRD data crystallinity index was determined by titration methods as mentioned in materials and methods.

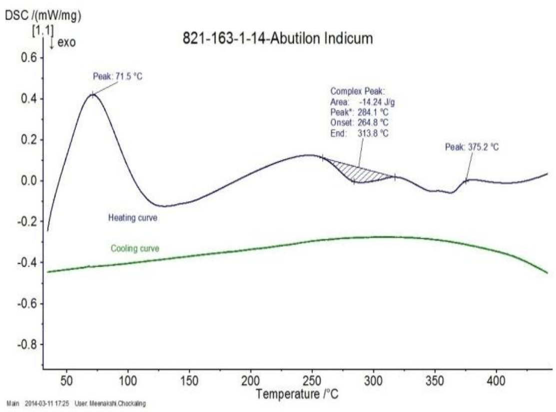
Figure (2) - Surface view of *Abutilon indicum*



Differential Scanning Calorimetry (DSC):

Figure 3 depicts the DSC curve from the Abutilon indicum fiber. The DSC can measure peak temperature (based on the weight vs. temperature curve). A thermal peak (crystallization temperature) of 71.5°C was observed. The loss temperature was 375.2°C. The cooling temperature varied around 50°C & 450°C. Higher onset temperatures are associated with greater thermal stability. This characteristic could be attributed to the high crystallinity of microcrystalline cellulose. The amount of crystallinity was 6.39%. In addition, it has been found that the degree of crystallinity remained constant throughout the gap-wise direction of the PP composites performed using ranged processing conditions.

Figure (3) – DSC curves from *Abutilon indicum*



IV. Conclusion

The biochemical properties of *Abutilon indicum are that* it has a high amount of cellulose and lignin content; these serve as rich lignocellulose fibers. Mechanical properties were determined by the fiber of *Abutilon indicum* Young modulus, which was 25684.43; the values were high. So it is used in the paper industry and other industries like geotextiles, the automobile industry, and aerobic fabric. DSC result 6.39% shows that using natural fiber blends, we can achieve the optimal physical and mechanical properties for particular applications in the automobile industry and other applications because of both environmental and economic benefits. Result in natural fiber blends replacing glass and mineral filters in the automobile industry.

V. References

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