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Investigation of Physical, Chemical, and Structural Characterization of *Areca Catechu.L* Fiber

Dr. S. Yamuna Devi

Assistant Professor, Department of Costume Design and Fashion, NIFT-TEA College of Knitwear Fashion, Tirupur, India

Abstract: ***Researchers and scientists are looking forward to the new fiber sources for sustainable processing. The ultimate goal is to produce an organic fibrous material that can be utilized in the textile industry and to manufacture eco-friendly products. In this circumstance here emerges a fiber from Areca catechu .L(sheath) which has been attracted worldwide as a threat to biodiversity. Hence this paper highlights the physical, chemical and structural characterization of the fiber extracted from Areca catechu. L sheath fiber. The fiber was examined for the physical properties such as fiber length, diameter, elongation, moisture absorbency, and fineness as well as mechanical properties by analyzing its tensile strength test. The structural and functional characterization of the fiber is examined using the Scanning Electron Microscope (SEM) and IR spectroscopy (FTIR).The thermal behavior of the fiber is analyzed using the Differential Scanning Calorimetry (DSC).***

Keywords: Eichhorniacrassipes, fiber properties, SEM analysis, FTIR analysis, DSC

1. Introduction

Nowadays the textile market has the trend of manufacturing go green products. Ultimately the consumers are also aware of buying eco-friendly fabrics [1]. Specifically, the present textile market is available with plenty of ecofriendly products made of emerging natural cellulosic fibers with top-ranking fibers such as organic cotton, hemp, and sisal. But in such cases, there is a possible risk of getting plenty of resources for bulk and continuous production. Keeping such factors in mind, the new fiber sources are identified by the researchers and scientists. But the goal is to produce improved and sustainable products made of fibrous material which can be used in the textile industry in various aspects such as garments, upholsteries and interior decorations. Natural fibers are the class of traditional fiber materials of renewable sources which experiencing a great revival nowadays [2]. Andespecially the plant fiber has characteristics such as resistance to water, thermal insulation, and related characteristics. Thus the newplant fiber has been identified to decrease the pressure of a handful number of species for the small scale industry [3, 4]. Today a vast resource from waste sources like agricultural, textile industries has given a generation to new fibrous materials called *Areca catechu.L*. is a waste material from sustainable plate making industry which belongs to the family Arecaceae. It reproduces rapidly using vegetative means. Some research is also been carried out to destroy the waste completely [5].

2. Materials

The fibers can be obtained in a large number from the matured sheath than in the younger ones [8]. Hence the matured areca catechu. L sheath was identified and collected from the Mettupalayam district, Tamilnadu, India. The matured sheaths are about 50 inches long and 50-70µm in diameter [9]. The sheath was separated from the plant, washed thoroughly in water and water retting process was carried out 2-3 weeks. The fibers are then extracted from the sheath manually using the needles [10].

2.1 Methods

2.1.1. Physical Properties of *Areca catechu. L* Sheath Fiber

a) Fiber Length
The *Areca catechu. L* Sheath Fiber is analyzed for its length manually using a calibrated metal scale. The fiber was stretched on the flat table and straighten with care to avoid elongation while measuring. The results are expressed in centimeters.

b) Fiber Diameter
The *Areca catechu. L* Sheath Fiber diameter is analyzed using a Scanning Electron Microscope (SEM). The average value can be calculated by analyzing the ten different areas of an individual fiber.

c) Single Fiber Tensile Strength and Elongation
The tensile strength of the *Areca catechu. L* Sheath Fiber is tested according to ASTM D 3822 using eureka single yarn strength tester. The principle of the machine is a constant rate of traverse were the preconditioned fiber sample is mounted between the two jaws having the gauge length of 15 cm. The strength and elongation of the fiber are determined and noted at the point of rupture.

d) Moisture Regain and Moisture Content
The moisture regains and moisture content of the *Areca catechu. L* Sheath Fiber is analyzed manually using BIS and ASTM D 629 methods. The predetermined amount of fiber (A) is conditioned in the oven at 1050 C and the constant mass of the fiber is obtained (B). Thus moisture properties are calculated from the measured values using (1) for moisture regain and (2) for moisture content.

$$\text{Moisture regain} = A - B / B \times 100 \quad (1)$$

$$\text{Moisture content} = A - B / A \times 100 \quad (2)$$

e) Fiber Fineness
The *Areca catechu. L* Sheath Fiber fineness is analyzed according to the ASTM D 1577 test method. The fibers of selected length (2 inches) were cut and bundled to the

nearest weight of 0.001 mg and the number of fibers in the bundle were counted. Randomly twenty bundles are selected for testing and the average was calculated.

2.1.2.FT-IR Spectroscopy of *Areca catechu. L*

The fundamental characterization of functional groups and the behaviour of *Areca catechu. L* Sheath Fiber chemical bonds were determined by TENXO27 using an Infrared spectrometer in a PR mode with a scanning rate of 32 scans min^{-1} and a resolution of $2cm^{-1}$[1]. The functional groups and its molecular bond structure in the wavelength ranges of 4000 cm^{-1} to 500 cm^{-1} were analyzed at room temperature [12].

2.1.3. Structural Analysis of *Areca catechu. L* Sheath Fiber

The surface morphology of *Areca catechu. L* Sheath Fiber is analyzed using Scanning Electron Microscope (SEM). The surface of the fiber iscoated with gold using Edward Sputter coater apparatus and then observed at an accelerating potential of 10 kV.

2.1.4.Thermal Behavior of *Areca catechu. L* Sheath Fiber(DSC)

The presence of transition temperature of *Areca catechu. L* Sheath Fiber is analyzed using Differential Scanning Calorimetry (DSC) ofNETZSCH STA 449F3 type instrument. The fiber sample of known weight was sealed in an aluminum pan and heated from 300 °C to 5000 °C under nitrogen atmosphere at the heating rate of 1000° C/min.

3. Result and Discussion

A. Physical Properties of *Areca catechu. L* Sheath Fiber

The length of the fiber depends upon the plant selected for extraction. *Areca catechu. L* Sheath Fiber has the length vary from 25 cm – 30 cm and diameter of 520 µm. The tensile strength of the *Areca catechu. L* Sheath Fiber was determined by randomly choosing the 20 samples from a lot and the accurate results are determined. The tensile strength of the *Areca catechu.L* Sheath Fiber range between 4180Mpa.The mean elongation of the *Areca catechu. L* Sheath Fiber is found to be 1.8 % and the standard deviation of 1.5 %. The moisture regains and moisture content of the *Areca catechu. L* Sheath Fiber is found to be 17.64 % and 15 % respectively. *Areca catechu. L* Sheath Fiber has the fineness of 17tex which shows the fiber is least bulk. (See Table I).

Table I: Mechanical properties of *Areca catechu. L* Sheath Fiber

Single fiber length	25-30cm
Single fiber diameter	520µm
Tensile strength	4180 Mpa
Fiber elongation	1.8%
Moisture regain	17.64%
Moisture content	15%
Fiber fineness	17 tex

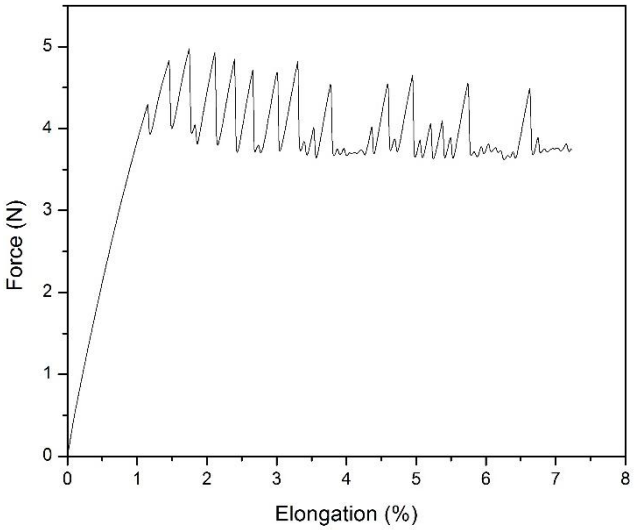

Figure 1: Tensile strength of *Areca catechu. L* Sheath Fiber

The *Areca catechu. L* Sheath Fiber has the water absorbency similar to that of cotton and other natural cellulosic fibers. Whereas the strength and elongation of *Areca catechu. L* Sheath Fiber is near to that of coir [14].

B. FT-IR Spectroscopy of *Areca catechu. L* Sheath Fiber

The properties of natural fiber are based on their chemical composition. The chemical composition of the natural fibers was highly influenced by the climate, region, soil condition, maturity of the plant and its extraction process [15]. The analysis has been made on the *Areca catechu. L* Sheath Fiber and analyses show that the fiber contains 41.8 (wt%) of cellulose, 31.4 (wt%) of hemicellulose, 22.3 (wt%) of lignin, 3.1 (wt%) of ash and 1.4 (wt%) of extractives. Table I shows the comparative chemical analysis of different agro wastes [16].

Table 2: Comparative chemical analysis of different agro wastes.

Fiber Name	Cellulose	Hemicellulose	Lignin	Ash	Holocellulose
Areca catechu. L	41.8	31.4	22.3	3.1	72.5
Cotton stalk	45.5	19.3	18.2	2.52	75.6
Rice straw	70.9	30.7	17.2	16.6	70.9
Rya straw	74.1	16	15.4	3.2	74.9
Corn straw	39	42	7.3	24.9	82.1

C. Structural Analysis of *Areca catechu. L* Sheath Fiber

The SEM image is used to analyze the presence of lignin and hemicellulose coating over the cellulosic fiber[15]. The fiber density and composite properties are affected by the small empty spaced called voids or lumen of the fiber [16]. The figure shows the SEM analysis of *Areca catechu. L* Sheath Fiber at the magnification of 200X (400 µm) and 500X (100 µm). The figure describes the *Areca catechu. L* Sheath Fiber is arranged as fibrils and has the hollow space describes that the fiber has the capacity to hold the liquid contents and also shows that the fiber has good absorbency.

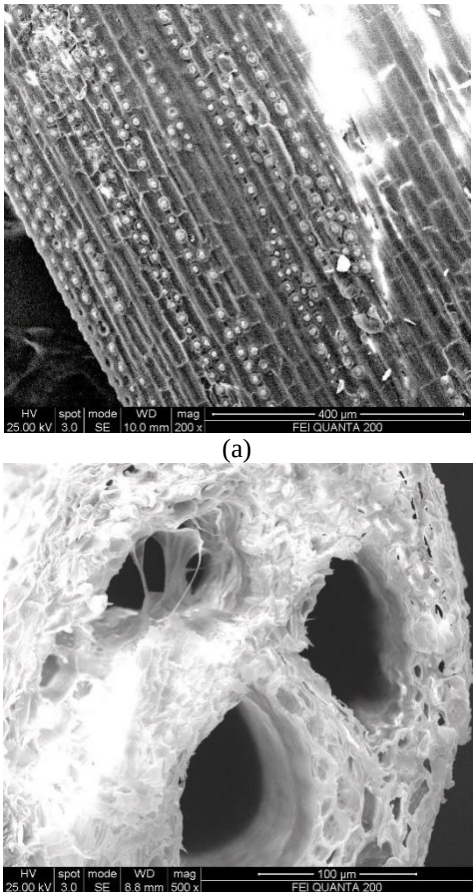

Figure 2: SEM Analysis of *Areca catechu. L* Sheath Fiber (a) 400 µm (b) 100 µm

D. Thermal Behavior of *Areca catechu. L* Sheath Fiber(DSC)

The Differential Scanning Calorimetry of the *Areca catechu. L* Sheath Fiber was shown in the figure. The glass transition (Tg) of the fiber begins approximately in the range of 72.70 C. The natural fiber does not melt and has lacking melting point (Tm). The fiber withstands upto 498.30 C and left as a residual mass without decomposing.

4. Conclusion

The purpose of this study was to investigate the effect of fiber extraction from *Areca catechu. L* Sheath. Fibers were extracted by traditional water retting combined with manualcombing process. Physico-chemical and mechanical properties of the sample were studied. Fiber showed the best mechanical properties in terms of strength and rigidity, they were less extensible. SEM investigation revealed that the *Areca catechu. L* Sheath., presence of shallow pores, which increase the surface roughness of the fiber. The cross-section of the fiber indicates that the fibers have a multicellular structure and its series as mechanical bonding in a composite matrix. The higher thermal degradation stability of the *Areca catechu.L* Sheath.indicates their ability to process with various polymer resin and the fiber having essential properties, the *Areca catechu. L* Sheath.seem to be an effective reinforcement phase in the composite for numerous application.

References

[1] Singha, A.S., Kaith, B.S and Khanna, J, "Synthesis and Characterization of Cannabis indica fiber-reinforced composites," BioResources, 2011, 6(2), p. 2101.
[2] Bledzki, A.K., and Gassan, J., "Composites reinforced with cellulose-based fibers, Journal of Polymer Science," 1999, 24, Pp. 221-274.
[3] Gullah, P.R., Irle, M.A. and Amartey, S.A., "Sisal fibers as a potential raw material for medium density fiberboard production in Tanzania," Annals forestry, 1998, 6(2), Pp. 159-172.
[4] Velasquez, J.R., Wounaan and Embera, "Uses and management of the fiber palm Astricaryumstandleyanum (Arecaceae) for backstories in eastern Panama," Econ Bot, 2001, 55(1), Pp. 72-82.
[5] Georgina Kenyon, Dealing with an invincible invader, the guardian – World news, December 21st, 2009,
[6] Carina C. Gunnarsson and Cecilia Mattsson Petersen, Water hyacinth as a resource in agriculture and energy production: A literature review, Waste Mangement, 2007, 27(1), Pp. 117-129.
[7] Md. RashedulAlam, Use of water hyacinth in sustainable fashion, Fashion Today, May-June 2010.
[8] S. Punitha, Dr. K. Sangeetha, M. Bhuvaneshwari, Processing of Water hyacinth fiber to improve its absorbency, International Journal of Advanced Research, 2015, 3(8), Pp. 290-294.
[9] BhawanaChanana and Tanushree, Water hyacinth: A Promising textile fiber source.
[10] M.Asim, KhalinaAbdan, M. Jawaid, M. Nasir, Zahra Dashtizadeh, M.R. Ishak and M. EnamulHoque, A Review on Pineapple leaf fibers and its composites, International Journal of Polymer Science, 2015, ID: 950567, p. 4.
[11] T.Natarajan, A.Kumaravel, and R.Palanivelu.2016. Extraction and characterization of natural cellulosic fiber from passiflorafoetida stem. Inter.J.of.poly.Analysis and characterization. 21(6):478-485.
[12] Muhamadkhusairy Bin Bakari, ElamaranJayamani. 2016. comparative study of groups in natural fibers: Fourier Transfer Infrared Analysis (FTIR),technical research organization India, 3(5): 154-161.
[13] Ramanaiah.K, A.V.Rathna Prasad and K.Hemachandra Reddy.2011.Mechanical Properties and thermal conductivity of Typha angustifolia natural fiber – reinforced polyester composites, Int. J.Polym.Anal.charact.16(7): 496-503.
[14] Ahmet tutus, Ahmetcenkezici and SaimAtes. 2010. chemical, morphologies and anatomical properties and evaluation of cotton stalk in the pulp industry, scientific research, and essay, 5(12): 1553-1560.
[15] Cerchiara, T., Chidichimo, G., Gallucci, MC. And Vuono, D., Effects of Extraction methods on the morphology and Physico-chemical properties of Spanish Broom (Spartiumjunceum L.) fibers, Fibers and Textiles in Eastern Europe, 2010, 18(3), Pp. 13-16.
[16] Dhakal, H.N., Zhang, Z.Y. And Richardson, M.O.W., Effect of water absorption on the mechanical properties of hemp fiber reinforced unsaturated polyester composites, Composites Science and Technology, 2006, 67(7-8), Pp. 1674-1683.