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Extraction and Characterisation of Natural Cellulosic Husk Fibre Areca Catechul

E.Devaki[1], Dr.K.Sangeetha[2]
[1]*Assistant Professor, Department of Costume Design & Fashion, PSG College of Arts& Science, Coimbatore.*
[2]*Professor & Head, Department of Textile and Apparel Design, Bharathiar University, Coimbatore.*

Abstract: Agro waste material utilization is an important area of concentration to conserve the environment from dumping large quantity in to bare land also helps in new innovative product development of no cost materials. The identified agro waste material areca catechu (Areca nut fiber) dried well matured fruit is collected in large quantities and the fiber is extracted with stagnant water retting method. The physical, chemical structural and mechanical properties of areca nut fiber are studied. The fiber shows good cellulosic content and little amount of lignin which is the reason for its stiffness. The surface morphology is examined with the help of SEM at various magnifications. Fiber is found to be shorter in length and has good strength properties. Moisture and density of the fiber is also analysed.
Keywords: Retting, agro-waste. areca catechu, fiber properties

I. INTRODUCTION

Cellulosic fibres are used in enormous forms in the field of textiles such as medical, geo textiles, automotive etc., where the need for increase in production and quality becomes a greater need of the hour. In turn the need for new surrogate is also a welcoming factor to satisfy increasing demand. As new natural fibres are in to the limelight, many researchers are contributing new facts about less utilized fibres which may be a start up for its improvisation. One of such a natural fibre is areca nut fibre (Areca Catechu).The shift towards bio-based economy demands alternatives that are common raw materials which are currently in large production, from fossil (petrochemical) or mineral resources, by products produced from renewable (plant and animal based) resources. Therefore, competitive products based on renewable resources need to be developed that have high quality, show excellent technical performance and harm the environment less than current products based on petrochemical materials(1). There are many such efforts put by the researchers to give some inputs for bio-based economy development.

As a cash crop which is in large production in India and used for various purpose finding its wings to spread in newer fields is Areca Catechu (areca nut).The utilization of betel nut (arecanut), as a masticator by humans has been known since the 4th century A. D. In different parts of the worldit is used in one form or another and is estimated to be over 600 million individuals. Also it is considered to be therapeutic agent in old Indian scripts, such as Vagbhata (4th century) and Bhavamista(13th century). Its use was recommended in many diseases, such as leucoderma, leprosy, anaemia and obesity. It was also reported to have de-worming properties. In China, it has been used as a vermifuge since the 6th century and is still employed as such in some parts (2). In the Philippines the flowers are sometimes added to salads. The nuts, husks, young shoots, buds, leaves and roots are used in various medicinal preparations (3)Among the palm trees, the coconut and arecanut palm are mainly put to use for economic purposes. The fibre characteristics are influenced by the environmental conditions of growing. As a plant fiber the chemical composition is mainly composed of cellulose, hemicelluloses, lignin, waxes, and water soluble substances along with other organic materials (4).The fibre is predominantly composed of cellulose and varying proportions of hemicelluloses, lignin, pectin and prospection. The total hemicelluloses content varies with the development and maturity, the mature husk containing less hemicelluloses than the immature ones. The lignin content proportionately increases with the development until maturity (5). Lignin is the main constituent of arecanut fibre, responsible for its stiffness. It is also partly responsible for the natural colour of the fibre (6).Areca seed revealed the best antioxidant properties in 3 fractions of areca by the DPPH assay, hydroxyl radical assay and reducing power assay, followed by husk and flower (7).The husk is about 15–30% of the weight of the rawnut. The fibres adjoining the inner layers are irregularly lignified group of cells called hard fibres, and the portions of the middle layer below the outermost layer are soft fibres (8).A larger wastage is estimated to be arisen from the outer husk which is of less or no utilization except as fire wood. Else thrown away to open bare land to get decomposed. This paper deals with identifying properties of areca nut husk fibre, such as chemical compositions, fineness, length, and strength. Also the surface evaluation of the fibre is done with help on SEM to understand the surface characteristics of the fibre. Where an effort is made to offer textile based product development of agro waste product which is available in surplus.

II. MATERIALS AND METHODS

A. Materials

Areca nuts were sourced in the areas around Coimbatore, Tamilnadu, India. Well ripen fruit are chosen for the sampling. The nuts inside are used in the factories for the production of supari, medicine, colouring and many other. The epidermis of the fruit is thrown out as an agro waste or been used as a material for burning. This outer husk is a rich source of cellulose which is been used as a raw material for this study.

B. Extraction Of Fibre

The rich husk covering the nut is been processed by natural water retting process. In this process of water retting, depending on the temperature, environmental conditions (the presence or absence of oxygen), and sometimes nutrients, different bacteria's take part, namely clostridium sp., Clostridium butiricum, Granulobacterpectinovorum, Clostridium felsineum, Clostridium guerfelli and Bacillus amylobacter. In the case of water retting under anaerobic conditions, pectin materials and hemi-cellulose which bond fibres, decompose and from volatile fatty acids, mainly butyric(80%), responsible for the odour of retting liquor and artificially dried fibres. When sun-drying is performed, the volatile fatty acids undergo decarboxylation and decompose, thus after such drying, water-retted straw, as well as fibre dried in the air, does not have any odour (9). Thus the fibre is exposed to retting process and the fiber is extracted by hand pick methods. The extracted fibre is rinsed with excess of water to make sure the fibre is out of impurities. The rinsed fibre is sun dried for a day to remove excess water content in the fibre.

Figure 1: Water retting of areca nut fruit

Figure 2: Fiber extracted by hand picking method

C. *Testing*

1) *Fibre Length And Diameter:* Fibre length and diameter being one of the primary property of a natural fibre. The length is been tested manually with steel measuring scale, since no suitable test method was possible for the fibre which is rough and brittle. One hundred samples were measured manually and the average length of the samples was taken for calculation. The width of the fibre was measured using SEM where individual fibre was taken to analysis
2) . *Fibre strength::*Single- fibre specimens are broken on a constant-rate-of-extension (CRE) type tensile testing machine at a predetermined gage length and rate of extension. Using the force extension-curve, the breaking force and elongation at break are determined. The force-elongation curve and liner-density are used to calculate breaking tenacity, initial modulus, chord modulus, tangent modulus, tensile stress at specific elongation, and breaking toughness (10). Following the above method the fibre samples are tested in two different modes (i.e) single fibre and bundle fibre. The single fibre strength is done using INSTRON with a guage length of 100mm and speed of 10 mm/min in ASTM D 3822 standards. The bundle fibre strength is calculated using the calibration of 100mm guage length with a speed of 10mm/min which counts 10 fibres in a bundle.
3) Density: These test methods cover the measurement of mass per unit length (linear density) of textile fibres and filaments. The sample is measured in terms of linear mass density, the weight of a given length of fibre. The apparent density of the fibre was examined using standardized measuring glass with water as the immersion liquid using Metler Toledo weighing balance. The experiment was repeated for 10 times and the average was calculated.
4) *Moisture Content:* The moisture content of the fibre is calculated by the ASTM 2495 method. In this the fibre samples were tested in an Oven-Dry method, where continuous monitoring of weight is done. the initial weight and weight after constant rate is measured and calculated with the Formula A-B/A.
5) *Dsc:* Differential scanning calorimetric (DSC) was used to study the thermal behaviour of Areca husk fibre. Differential scanning calorimetric or DSC is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference is measured as a function of temperature. Both the sample and reference are maintained at nearly the same temperature throughout the experiment. Generally, the temperature program for a DSC analysis is designed such that the sample holder temperature increases linearly as a function of time. The reference sample should have a well-defined heat capacity over the range of temperatures to be scanned.
6) *Chemical composition:*The chemical composition was examined by chemical testing where the samples are subjected to dissolve. It helps in determining the content of the fibres like cellulose, wax, pectin, etc.
7) *Se:* The Scanning Electron Microscope (SEM) allows visualization of surface features of a solid sample by scanning through an electron beam. SEM has better resolution capability and depth of field than a light microscope. As a result of which very good quality three dimensional like images are obtained. In advanced SEM machine, magnification can range from 10× to 5, 00, 000× and resolution of about 1 nm. This is about 250 times the magnification limit of the best light microscope (11).

III. RESULTS AND DISCUSSION

A. Fibre strength

1) *Single Fibre Strength:* of 10 numbers are drawn out of the bundle randomly. These fibres are subjected to tensile single fibre strength. The lowest strength of the fibre is 35.5 g where the highest value is 97.2g. The mean single fibre strength is 65.0g with a SD of 18.8 and CV% of 28.87%.
2) *Bundle Fibre Strengt:* This fibre bundle strength is calculated which numbers 10 fibres in a bundle which are randomly selected. The tensile property ranges from 608g to 1130g, with a mean value of 843g and the SD value is 144 with the CV% of 17.08. The elongation of the samples are calculates as 1.6%.

B. Length And Diameter

The fibre samples are randomly taken from the lot which counts in 100 numbers. The length ranges from 3.9 cms to 4.8 cms. The mean length of 100 samples is 4.35 cms. The width of the fibre is 24.25μm which can be seen in SEM text Figure of 2 μm magnification.

C. Density

Fibre density is calculated to be 1.3470g/cc which proves it is equal to cellulose acetate fiber.

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D. Moisture Content

The moisture property of the fibre is 11.76%, which shows it has good moisture content value which is almost near to jute, flax and hemp fibers.

E. Sem

The below are scanning electron microscope images which are under different magnifications where the retted raw areca nut fiber is examined, a bone like longitudinal structure is witnessed with wood like surface and traces of impurities in the surface of the fiber.

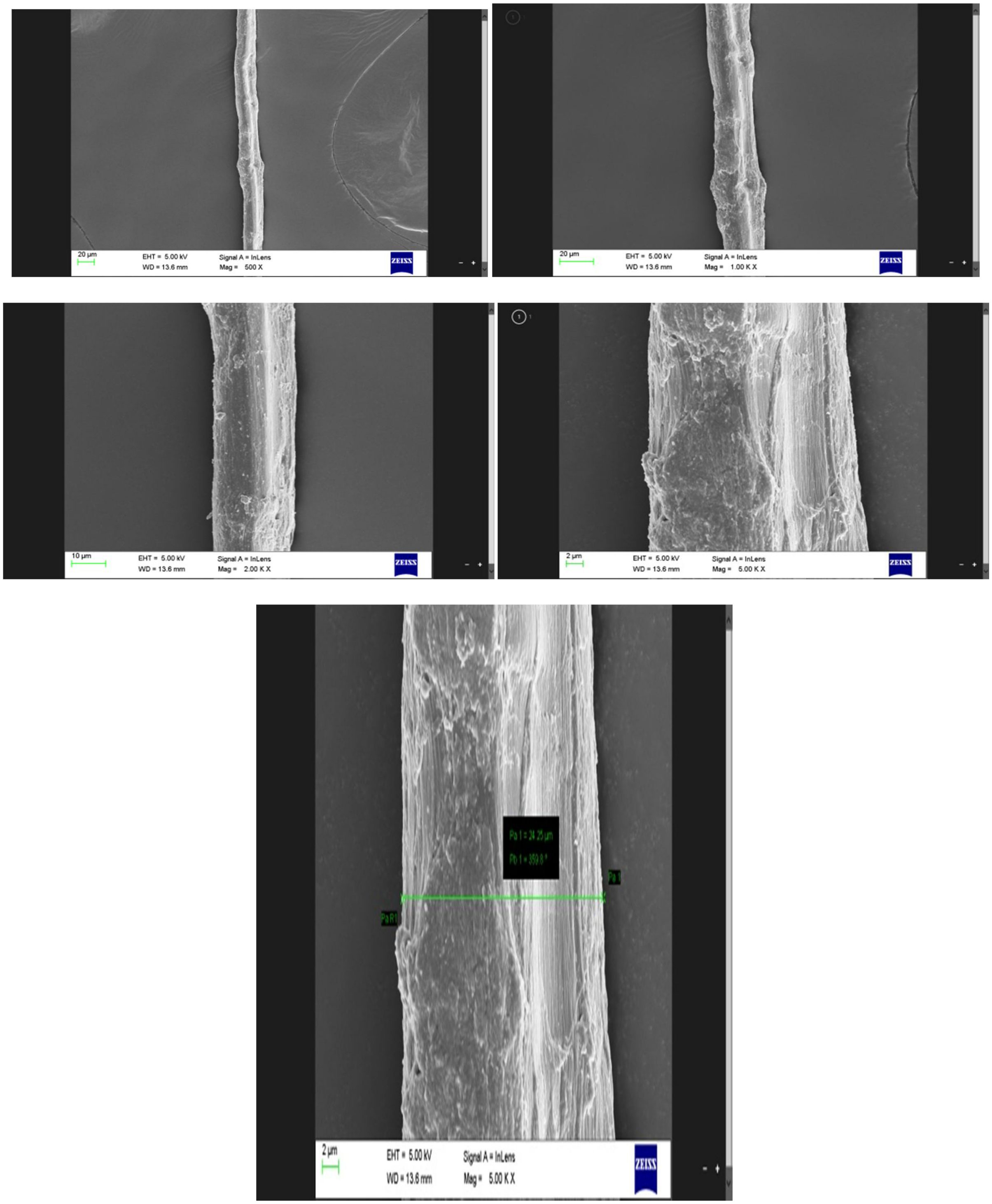

Figure 3: Scanning Electric Microscope

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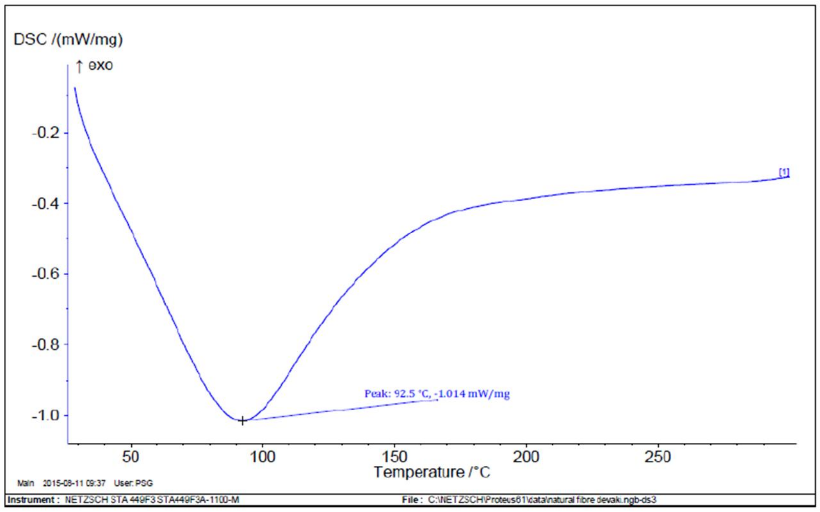
F. Dsc

Testing Standard: NA (30°C to 300°C)



The peak shows 92.5oC which is the crystallization of the fiberat -1.014 m W/mg.

G. Chemical Composition

The various chemical content are analysed and listed below which shows the fiber has maximum of cellulose content in it.

S.No	Chemical composition	Percentage (%)
1	Cellulose	70.09
2	Lignin	14.23
3	Wax	0.39
4	Ash	2.72

Table 1: Chemical composition of areca husk fiber

IV. CONCLUSION

The fiber is extracted and tested for various factors which help in understanding the property of the areca husk fibre. The agro waste areca nut huskfiber is identified to have cellulose, lignin and traces of impurities in it through the chemical composition analysis. The strength of the fiber is average with good elongation property. The density of the fiber is matching with a manmade fiber and the moistur property is near to bastfibers. SEM images show the bone like structure of the fiber. Areca nut husk the agro waste fiber has remarkable features to be used as an textile material.

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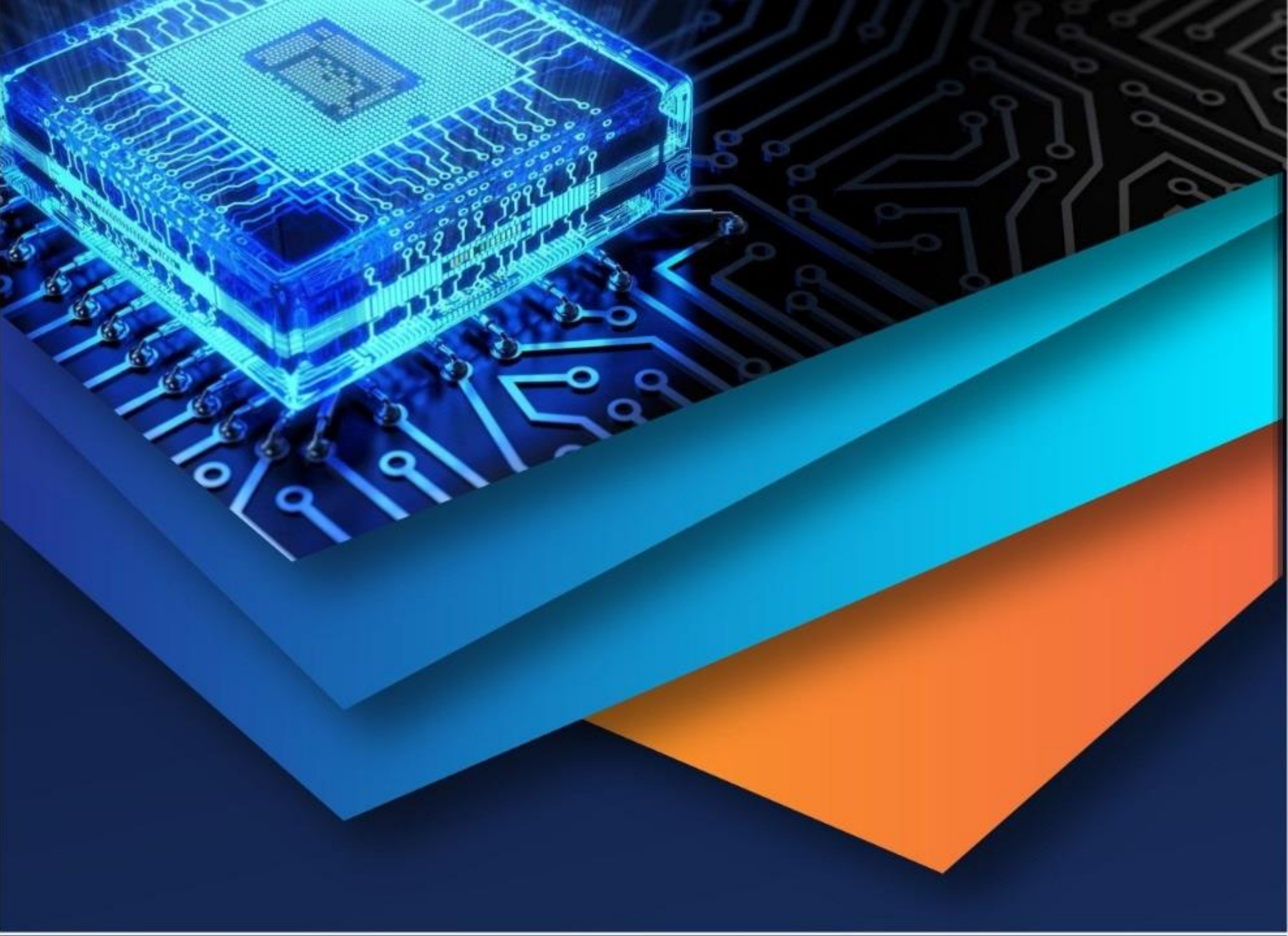

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