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A STUDY ON SELECTION AND EXTRACTION OF FIBRES FROM MANGIFERA INDICA AND TAMARINDUS INDICA RESIDUES TO ANALYSE ITS CHARACTERISTICS FOR THE APPLICATION OF TEXTILE MATERIALS

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ABSTRACT

In recent trends of fashion rush, peoples are conscious with their outlook and want to keeps them perfect and presentable and the designers are work continuously to produce fashionable designs for various occasions. For those production of huge volume of apparel, it needs huge number of plants for the extraction of needed volume of virgin fibres and it consumes more time cost and energy. Instead that, non-consumable or non-usable plant portions and food-processed residues can be applied as a raw material can considerably reduce the volume of fibre plant cultivation, time, cost, energy, water, resources etc. These agro-residual fibres can provide excellent properties of textile fabrics, eco-friendly nature and may create high demand in the textile market. For that purpose, in this article some of the agro-industrial residues are selected and collected from agricultural land and food processing industries to examine their characterization, structure to know it's suitable application.

Keywords: sustainable fibres, agro-industrial residues, eco-friendly, textile products

1. INTRODUCTION

In textile industry, fibres are known as an essential raw material which is used to prepare yarn for woven and knitted fabrics, and prepared as web sheet for non-woven fabrics. These raw materials are usually categorised as natural & man-made fibre. Natural fibres are categorized as vegetable, animal, and mineral fibre. Usually, vegetable based natural fibres are extracted for the vast purpose of textile products. Natural fibres dominating the textile industry with its huge varieties of several products. But for extracting and processing the fibres in textile manufacturing, a major problem evolved is cultivation time and processing cost. For example, cotton cultivation needs 3-4 months and the production of one kg of cotton fibre cost around 180 to 230 as per recent market rate. Meanwhile,

there are lot of plant/ fruit/ food industry based bio degradable waste disposed as a landfill waste up to 1.3 billion tons. To limit this, selecting some recycled/sustainable/natural waste fibres are introduced to act as an eco-friendly raw material and alternative to the existing natural fibres by limiting the processing cost and time, also produce the products with enhanced properties of better qualities.

Now a days, these Emerging natural fibres are extracted majorly from the natural waste or unwanted/ non-usable part of the plant or from vegetable/fruit waste. These sustainable fibres have a high demand in textile industry to create a textile by products involved in the textile manufacturing as a raw material which are similar to the normal fibres but with quiet enhanced properties. In this article, two newly evolving natural waste fibres are introduced to discussed its properties and examine its structure are as follows.

1.1 Why natural waste/sustainable fibres are needed?

In the process of textile manufacturing, started from extraction of raw materials to the dispatch of end product, lot of process involving chemicals and toxication while using a usual natural fibres and artificial fibres. But with these sustainable natural waste fibres, toxication are considerably reduced as they are mostly treated with natural dyes and finishes. Most of the people prefer eco friendly fibres that are organic and free of toxication and some chemical treatments. So these are demandable in the textile market because of its easily degradable and also have similar qualities of usual textile fibres with enhanced properties. (textile school, 2018) (Mizharul Islam Kiron, 2022)

1.2 Some of the emerging fibres in textile industry

Fibres like banana fibre, pina fibre, lotus fibre, milk fibre, groundnut fibre, coconut fibre, sugarcane fibre, coffee ground fibre and orange fibre etc, are some of the emerging fibres in the textile industry which are extracted from the waste or non-consumable parts of plants. These are used for apparel as well as technical materials which yield higher application than the normal existing fibres. (Fibre 2 Fashion, 2013)

2. MATERIALS AND METHODS

2.1.Selection of fibres for study

In this study, natural waste/non-consumable waste of plants like *Mangifera Indica* and *Tamarindus Indica* are selected. These two are selected because of its fibres are non-consumable and non- usable parts of huge volume, disposed as a bio-waste from food industry and also collected from cultivation land. These fibres are extracted from outer layer of seeds and from fruit pulp which are left from food processing and fruit juice industries. These are collected and sorted based on their qualities then prepared for textile production process.

2.2.Mangifera Indica

2.2.1.History of fibre

Mangifera Indica belongs to the family of *Anacardiacea*. The genus Mangifera consists of upto 30 species of tropical fruiting trees in the family *Anacardiacaea*. *Mangifera Indica* is used as a medicinal plant from long back nearly 4000 years ago. It grows commonly in tropical, sub-tropical regions commonly. (M.H.A. Jahurul, I.S.M. Zaidul, 2015)

2.2.2.Medicinal uses

Mangifera Indica is known as a medicinal plant used as Aurvedic and traditional medical system for 4000 years and more. It contains highly effective bio active compounds. It is widely used traditionally for the treatments like gastro intestinal problems like dysentery, stomach upset, habitual constipation, piles, biliousness, respiratory ailments like bronchits, high cough, throat problems, asthma, and genito

urinary problems like leucorrhea, urinary discharge, vaginal problems and ophthalmic complaints. It is also applied as aphrodisiac, tonic, appetizer, beautifier complextion, diuretic, laxative, tanning and antisyphilitic purposes in several parts of world. (Victor Kuete, 2017) (Ian S.E. Bally, 2006) (K.Sairam, S. Hemalatha, 2003)

2.2.3Properties

Mangifera Indica have a property of anti-oxidant, anti-microbial, anti-fungal, anti-protozoal, anti-parasite, anti-viral, anti-tumour, anti-diabetic activity, anti-inflammatory, anti-allergic activity, immunomodulatory effect and other pharmacological properties. (Victor Kuete, 2017) (M.H.A. Jahurul, I.S.M. Zaidul, 2015)

2.3.Tamarindus Indica

2.3.1History of fibre

Tamarindus Indica also known as Tsamiya in Hausa belongs to the family of *Dicotyledonous*, *Fabaceae* subfamily of *Caesalpiniaceae*. It is native to west and sub-Saharan Africa, Asia, Central and south America. It is eaten and used as a vital ingredient in chewing gum, fruit drinks, beverages, jams etc. It is also used for treatments and preparing medicinal products. (Gali Adamu Ishaku, Bello Pariya Ardo, 2016)

2.3.2.Medicinal uses

Tamarindus Indica used for bile disorders, antiscorbutic, component of blood sugar & cardiac medication. It is also utilised as a laxative, expectorant, blood toxic etc. *Tamarindus Indica* is used for the remedy of swellings, sore throat, rheumatism, alcoholic toxication and sun stroke. (Victor Kuete, 2017)

2.3.3.Properties

Tamarindus Indica have Antibacterial, Antimicrobial, Anti-inflammatory, antioxidant, antimicrobial, antidiabetic, antivenomic, hepato protective, anti-asthmatic, anti-hyper lipidemic, laxative activity etc. (Santhosh Singh Bhadoriya, Aditya Ganeshpurkar, 2011)

2.4Extraction of fibres

2.4.1.Mangifera Indica

For the extraction of *Mangifera Indica* fibres, first to collect seeds of *Mangifera Indica* and sort it according to their growth of seeds and fibre length. Then rinse it properly with Luke warm water or running water to remove left over fruit pulp from outer layer of seeds. Then put the seeds in a vessel to heat with boiling temperature of 100°C for 15-30 mins according to its quantity. Then rinse the seeds with running water and let the water remove from seeds. After dried out the seeds, fibres are extracted from the outer layer of seeds by hand picking method or decortication method. After the extraction process, fibres are collected and dried under room temperature for further process.

2.4.2.Tamarindus Indica

For the extraction of Tamarindus Indica fibres, first fibres contained in the fruit pulp of Tamarindus Indica are separated from the fruit, collected, and rinsed properly to sort according to their length and quality. Collected fibres are placed in a container or vessel filled with water and remain soaked to 10 days for retting process. It is either placed in air circulating area or addition of enzymes to speed up the retting process. In this process, microbes are formed and destroy the pulpy content from outer layer of fibre surface. After this retting process, fibres are rinsed properly to get dried and prepared for further process.

3. RESULTS AND DISCUSSION

3.1.Characteristic Structure of fibres

3.1.1.SEM analysis

Scanning Electron Microscopy is used to examine the samples of scan with an electron beam to generate a magnified image of a sample for analysis. Above mentioned pictures are Scanned Electron Microscopy image of *Mangifera Indica* and *Tamarindus Indica* fibres with different angles of magnification. Above three pictures of samples are non coated and scanned to analyse its structure. (Jenny Ngoc Tran Nguyen, Amanda M Harbison, 2017)

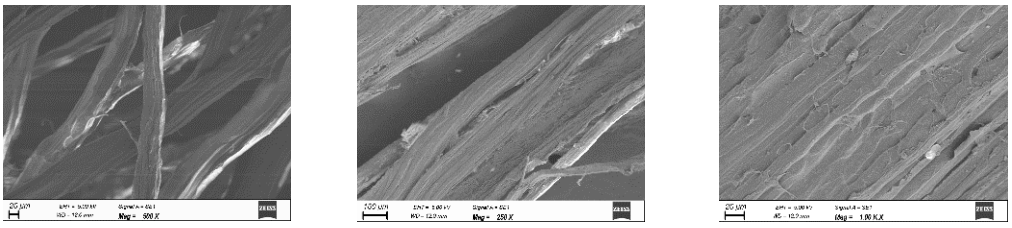

Fig. *Mangifera Indica* fibres under SEM analysis

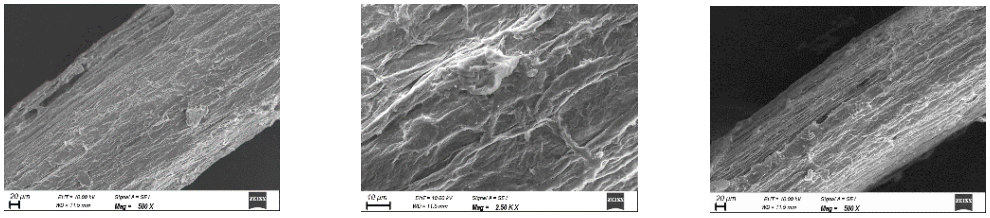

Fig. *Tamarindus Indica* fibres under SEM analysis

3.2.1.FTIR Analysis

FTIR spectrum is exploit to discover the functional group of different components based on the peak value in the area of Infrared radiation. In this FTIR analysis, *Mangifera Indica* fibres contains properties of a functional group of O-H (3698.63) Alcohol, N-H bond (3568.31) primary and secondary amine, O-H bond (2341.58) carboxylic acids, C-H (3020.53) Alkane, C=O (1737.86) Ester, N=O (1514.12) Nitro (R-NO_2), C-H (877.61) Alkene, C-H (686.66) Aromatic, C-CI (507.28) Halo compound in it. *Tamarindus Indica* fibres contains properties of a functional group of O-H bond (3657.04) alcohol, N-H bond (3124.68) primary amine, O-H bond (2524.82) carboxylic acids, O=C=O bond (2347.37) carbon dioxide, C=O bond (1737.86) Ester, C=C (1516.05) Aromatic, C-H (875.68) Alkene, C-CI (540.07) Halo compound in it. (Catherine Berthomieu, Rainer Hienerwadel, 2009).

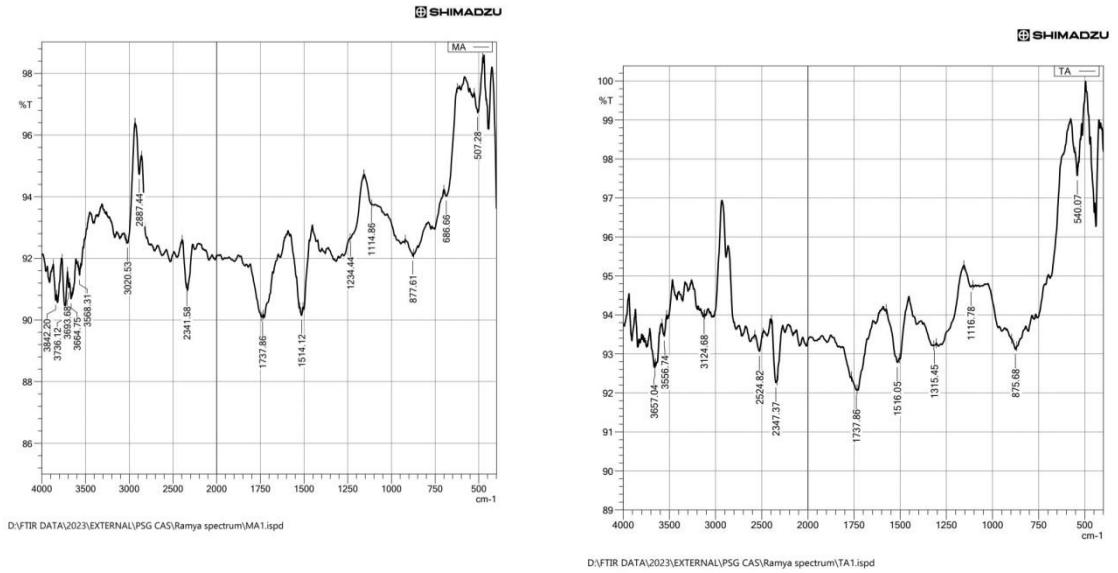

Fig. *Mangifera Indica* fibres *and Tamarindus Indica* fibres under FTIR analysis

3.3.1.XRD Analysis

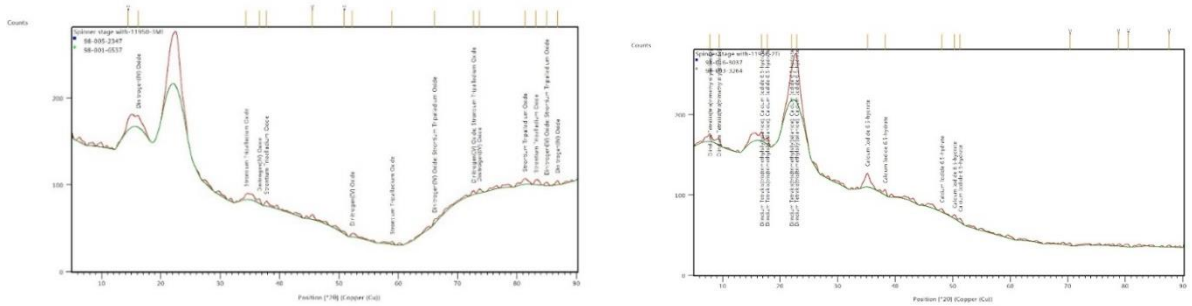

Fig. Mangifera Indica fibres and Tamarindus Indica fibres under X-ray diffraction analysis

X-Ray Diffraction analysis is utilised to detailing the crystallographic structure, physical properties and chemical composition of the selected sample. In this XRD analysis, *Mangifera indica* fibre have a cubic structure with the chemical compounds of Dinitrogen IV oxide (N2 O4) and Strontium Tripalladium oxide (O4 Pd3 Sr1) and *Tamarindus Indica* fibres have a Monoclinic structure with the chemical compounds of Diindium tetrakis (C36 H108 In2 Si16) and Calcium Iodide 6.5 Hydrate (H13 Cal12 06.5).

3.4.1.TGA /DSC Analysis

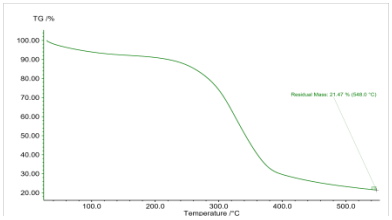

Fig. *Mangifera Indica* fibres under TGA.

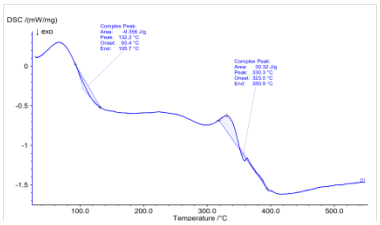

Fig. *Mangifera Indica* fibres under DSC analysis

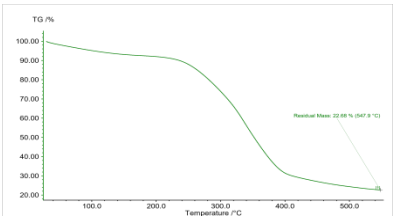

Fig. *Tamarindus Indica* fibres under TGA.

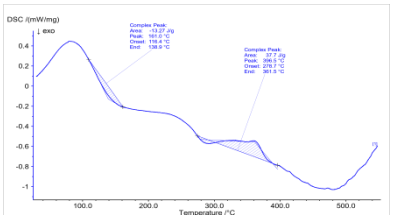

Fig. *Tamarindus Indica* fibres under DSC analysis

Thermogravimetric Analysis (TGA) is applied to examine the thermal stability of selected object or a material and its fraction of unstable components by analysing the weight change that occurs while sample gets heated at a constant rate. In Thermogravimetric analysis, *Mangifera Indica* fibres have a residual mass of 21.47% and *Tamarindus Indica* fibres have 22.68%. (K.R.Rajisha, 2011)

Differential scanning calorimetry (DSC) is a method of thermal analysis in which the difference in the rate of heat essential to increase the temperature of a selected sample and the variance is measured as a function of temperature. In Differential scanning calorimetry analysis, *Mangifera Indica* fibres have its peak melting point at 330.3 degree Celsius and *Tamarindus Indica* fibres have its peak melting point at 396.5 degree Celsius. (Ramdhane karoui, 2012)

3.2.Future works

Collected fibres will be prepared for physical testing like fibre length, Short fibre Index, fineness, etc, mechanical testing like tensile strength, elongation, break strength, moisture content, absorbency test etc and properties test like antibacterial, anti microbial, anti odour, heat resistant, UV resistant, mildew/cold resistance, sound/noise resistance, water/retardant tests etc.

3.3.Possible Application

After testing of fibres, properties of fibres and its structure will be examined and analyse the tests results to know it's possible Applications. Based on the past review articles both the fibres have a basic property of anti-bacterial, anti-microbial and anti allergic properties so these are suitable to produce hygiene, sanitary products and for medical sector. Above mentioned tests will conduct to analyse whether these two fibres are suitable for apparel, protective textile, geo textile and home textiles.

4. CONCLUSION

These natural based food waste and plant waste from cultivational land are extracted as a raw material to create a greater alternative for already existing textile fibre which requires specific sort of cultivation/ harvesting process that needs several months. It considered as a cost and time-consuming process. But with these natural waste sustainable fibres, cost and time of processing are considerably lower and it doesn't need any specific process of cultivation. By using these sustainable natural waste

fibres raw material extraction cost will be comparatively lower than usual natural fibres. Under the category of eco friendly textiles, these natural waste sustainable fibres will be highly demandable by the consumers in future and will have a greater possible position in textile Market to rule the future.

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