Development And Performance Evaluation of Pongamia Pinnata – Infused Cotton and Banana Fiber Gauze for Medical Applications.

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***Abstract*—The gauze bandage is the type of medical wound dressing which is made from an open weave fabric. This wound dressing is mainly made up of cotton and banana fiber to treat skin anomalies. This Pongamia Pinnata finished gauze will show the breathability, absorbency, antimicrobial activity of the gauze bandage. This gauze bandage reduces the risk of skin infection. The banana fiber will maintain the moisture level creating the great healing property to the wounds. The leaves of the Pongamia Pinnata have the medicinal property which shows the good and fast healing property to the wound and infection which happened on our skin.**

By combining these things into a project makes the ecofriendly gauze bandages for wound dressing and skin infections. By this research we can absorb the natural properties such as wound healing properties, moisture absorbency, breathability, antimicrobial properties. This gauze bandage may reduce the bacterial growth and infection around the wound. While the banana fiber plays the role of breathability, long lasting and bio degradable product in the woven gauze bandage. The banana fiber which is taken from the "pseudo stems" of the banana plant which plays the significant role of both functional and comfortness in wound dressing.

***Index Terms*—Pongamia pinnata leaves, cotton fiber, banana fiber, gauze bandage, wound healing, antimicrobial activity.**

I. INTRODUCTION

The wound dressing plays the major role for millions of people suffering from skin anomalies, skin infections etc. The synthetic gauze bandage has some limitations such as less moisture absorbency, anti microbial activity and sometimes skin irritation also but the natural element which is added in the sustainable gauze has bio degradability and antimicrobial properties which may gain attention over peoples. The main ingredient of the gauze bandage will be Pongamia pinnata that is also called as Indian beech tree in which their native will be the India. The leaves of the Pongamia pinnata have the several biological properties such as anti-bacterial activity, anti-fungal activity, anti-oxidant activity and also anti diabetic activities.

The leaves, seeds and the flower of the trees are practiced to be used as the Ayurvedic medicine for various conditions such as fever, skin treatments. The recent studies show that leave of the pongamia pinnata leaves have the excellent wound healing properties, then improving the skin conditions and respiratory tract infections. Banana fiber is also called as Musa fiber. This banana fiber is derived from the stem part of the banana plant. The banana fiber is widely cultivated in tropical area for the cultivation of the fruits, fiber for the end uses of textile, paper and rope production.

Banana fiber has the various properties such as good moisture absorbency, bio degradability, high tensile strength and wound care. The performance of banana fiber makes an attractive option of various applications. Cotton fiber is among the most widely utilized fibers, serving as key material for a diverse range of products in our daily lives. It is derived from the cotton plant and is essential for delivering comfort, durability and sustainability across various applications. Cotton finds its use in clothing, home textiles and more. This versatile fiber effectively

bridges the gap between fashion and industrial applications.

II. MATERIALS AND METHODS

BANANA FIBER:

Fabrics derived from the banana fibers promotes breathability and provide a cooling effect during warm weather. In contrast to hemp or bamboo fiber the contemporary method of converting banana stalks into usable textiles fibers does not involve the lengthy bacterial retting process or mechanical operations of crushing or scrutching which are used to separate the textile fibers from the retting material. Consequently, the harvesting of banana fiber is relatively swift and requires minimal labor.The fibers can be easily sorted by thickness with the innermost stalk being the softest and most flexible while the outer fibers are thickest and more durable. This process stands in stark contrast to the more time - consuming and labor-intensive methods required to transform the woody stalks of bamboo, hemp or flax into fibers suitable for textile production. In prominent banana cultivation areas, discarded banana stalks accumulate annually, awaiting conversion into valuable textiles. Until recently an efficient and rapid method for this transformation was lacking. Additionally, a significant factor hindering the widespread adoption of banana fibers in the global textiles market is the abundant availability of inexpensive, mass- produced cotton.

In India boasts the largest area dedicated to banana cultivation globally, followed closely by brazil and accounts for approximately 30 percent of the world's total banana production. Among the various fruits, bananas risk first in both production and productivity within India, Maharashtra being the foremost state in banana production. Banana fiber possesses a unique affinity for colours, facilitating the creation of visual appealing designs. Although the weaving process may be intricate saris made from this fiber highly comfortable and enjoy significant demand. These saris are not only comfortable to wear but also provide cooling effects. They are distributed in both domestic and international markets, where demand remains strong. National research centre for banana in Tamil Nadu is conducting a study and if the findings prove favorable, the country the country may soon witness a surge in availability of banana fiber in textiles and garments in the domestic market.

Plate 1: BANANA FIBER

COTTON FIBER:

Cotton is the natural, soft and breathable fiber derived from the seed hairs of the cotton plant. It is the most utilized textile fibers for its comfort, durability and versatility. Their natural properties such as breathability, moisture wicking property and hypo allergenic qualities making them suitable for the clothing, furnishings and various industrial uses. The process of the cotton includes some steps including knitting, weaving, spinning. Cotton has various uses including medical uses, paper production and also oil extraction from the seeds of the cotton plant. Their medical property includes wound healing property, non-toxicity, hypoallergenic, anti-inflammatory property. The cotton fiber are used in the medical applications such as wound dressings, surgical meshes, hospital gowns, bed sheets and surgical drapes. The usage of cotton fibers includes comfort, hygiene and infection control. The cotton fibers is widely used in the industries and also in the medical textiles as it is natural, sustainable and breathable for wound care and medical textiles.

PLATE 2: COTTON FIBER

III. SELECTION OF HERBS

PONGAMIA PINNATA LEAVES:

Pongamia pinnata is often known as Indian beech tree or Karanja tree is a medium sized tree growing in the tropical and subtropical regions. This tree is known for its medical, agricultural and ecological uses. The leaves of the pongamia pinnata has the glossy, dark green and oval shaped rich in bioactive compounds including flavonoids, tannins and alkaloids. The leaves possess anti- inflammatory, anti- bacterial, anti -fungal and anti- oxidant effects. Traditionally the leaves are used in the ayurvedic practices to cure ulcers, skin ailments, wounds, inflammations. Additionally, the leaves are also used as the insect repellent making them useful for the natural pests for plants. Beyond the medicinal uses the leaves are also used in the natural fertilizers, nitrogen fixations and also used in the bio diesel. The pongamia pinnata leaves also comes under sustainability and ecofriendly materials and it is useful for both traditional and medicinal uses.

Nature has served as a valuable source of medicinal agents for millennia, with a significant number of contemporary pharmaceuticals derived from natural origins, many which are used in traditional medicinal practices. Pongamia pinnata has been acknowledged across various traditional medicinal systems for its efficacy in treating a range of human ailments. Various parts of these plants have been used for its traditional medical applications such as bronchitis, whooping cough, rheumatism diarrhea, gonorrhea and leprosy.

PREPARATION PROCESS

PREPARATION OF THE WOVEN GAUZE BANDAGE

Preparation of the non-woven includes bale opening, blow room, carding and so on. The preparation of the non-woven to make gauze bandages will be starts with

BLOW ROOM

The blow room process involves opening, cleaning and blending process. The blow room process involves the removal of natural impurities from the raw materials and helps to take to the next process such as carding or spinning process.

BALE OPENING

Bale opening for banana fiber and cotton are more or less same it is the process of the breaking the bale and loosen the bale of the given fibers. For bale opening specialized bale opening machine is used to open the bale. In which two rollers are used to gently tear the bale and helps to loosen the fibers. It is useful to handling the fibers and helps to take it next process. After opening the bale banana fibers have some natural impurities in it so it removed by the retting process and also banana fibers are undergoing the conditioning process to improve the smoothness and blend of the fabric.

CLEANING

Next step is to remove the various natural impurities from the fibers. The impurities are removed in blower which is used to blow out the dirt from the fibers. Also helps to separate the short fibers. For banana fibers they undergo retting or degumming process before sending them to cleaning process. In that degumming process the banana fibers are soaked in water or other chemical (spin finish) to remove the strong gummy substance and to achieve the softness and blending of the banana fibers. After this process the banana fibers undergoes cleaning process in which air flow cleaners or suction cleaners are used to remove natural impurities from the banana fibers.

BLENDING PROCESS

YARN PREPARATION

The integration of banana fiber with cotton fiber to prior the spinning process is essential for achieving uniformity, consistency and appropriate balance of strength, softness and absorbency. The blending procedure consists of carding which helps the fibers are opened, aligned and cleaned to remove any impurities. Cotton is separately cleaned, carded, and prepared to eliminate dust, seeds and shorter fiber. The fibers are loosened in a opening machine to separate clumps. The fibers are processed through blending rollers to ensure an even mix.

The combined fibers are fed into a carding machine, where they are further aligned and cleaned. The result is a carded sliver which is a continuous strand of loosely aligned fibers. The multiple slivers are merged and drawn through drawing frames to enhance uniformity. The drawn slivers are transformed into roving which is a finer elongated strand and slightly twisted. The roving is then spun into fine yarn using either ring spinning or open-end spinning techniques. The finished yarn is wound onto bobbins, preparing it for weaving.

WEAVING

The yarns are organized into warp threads using warping machine. The warp beam is then prepared for the loom. The weft yarns are woven together with the warp yarns on loom through leno weave which is typically used for gauze bandages. Weaving using the mesh tool is technique often used in weaving process in thread arrangement and construction. A mesh tool is essential for preserving the open and stable weaves typically associated with gauze bandages. The warp threads which run vertically are threaded through a mesh guide to ensure consistent spacing.

This mesh serves to prevent any misalignment of the threads, guaranteeing uniform openings in the fabric. The mesh tool facilitates the twisting of two warp threads around the horizontal weft yarns. This method secures the weave preventing fraying while ensuring the fabric remains open and breathable. Mesh tool plays a crucial role in maintain a grid-like structure in fabric making it ideal for use in medical bandages.

PREPARATION OF PONGAMIA PINNATA LEAF EXTRACTION:

This process involved the collection of the fresh green leaves from pongamia pinnata tree. Wipe the leaves as it has some dust and dirt in it. After drying shadow dry the leaves for 2 – 3 weeks under the shadow. After drying the leaves completely grind the leaves into fine powder. The powder is mixed with the ethanol solution in the soxhlet apparatus and started to heat the apparatus continuously. After the heating is finished the solution will be collected separately by dripping process. The whole process takes about 4 – 6 hours to complete to take the leaf extraction.

Plate no: 3.4

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3.4.1 PADDING METHOD:

Padding is the process of the finishing method where the fabric will be immersed in the solution and the fabric will be passed through the padding machine where the fabric passes through the rollers and squeezes the excess liquids from the fabric. Same as the process the woven fabric is immersed in the pongamia pinnata leaf extraction solution for hours in the bath. Then send the woven fabric into the padding machine where the rollers in the padding machine will squeeze the excess liquid from the woven. Then the n woven fabric is taken for drying and it is also shadow dried. After shadow drying the non-woven cut it into 5x5 for further medical applications and treating the wound.

ANNEXURE

Plate 4: Developed gauze bandage

IV. RESULT AND DISCUSSION

ANTIMICROBIAL PROPERTY TEST:

Antimicrobial treatments have become increasingly prevalent in the textile industry today. These treatments offer several advantages, including enhanced hygiene, odor control and preservation of textile products. In practical application such as hospital linens, sportswear and footwear where a high standard of cleanliness is essential, antimicrobial treatments play a crucial role in inhibiting the growth of bacteria and other microorganisms. Additionally, they assist in managing the unpleasant odors resulting from the microbial activity and prolong the lifespan of textile products by preventing the proliferation of microorganisms that deteriorate or harm the fabric over time. The American Association of Textile Chemists and Colorists (AATCC) has established several tests to evaluate the efficacy of antimicrobial treatments on textile products specifically AATCC 100, AATCC 30 and AATCC 147.

AATCC 100 METHOD OF ANTIMICROBIAL TESTING:

AATCC 100 is a recognized standard procedure used to evaluate the efficacy of antibacterial treatments applied to textile materials. This method assesses bacteriostatic bacteria from sample. The testing process entails placing a treated textile sample in contact with a bacterial suspension and subsequently measuring the decreasing in bacterial growth on the sample after 24 hours of exposure. The anti-microbial effectiveness is established by comparing the reduction in the viable bacterial count on the treated sample against that of the untreated sample.

AATCC 147 METHOD OF ANTIMICROBIAL TESTING:

This approach is effective for providing a preliminary assessment of antibacterial activity based on the size of the inhibition zone. AATCC 147 is also utilized to evaluate antibacterial, bactericidal, and bacteriostatic properties, demonstrating its efficacy in evidencing antibacterial activity against both Gram-positive and Gram-negative bacteria, including S. aureus and K. pneumonia.

This method is relatively swift and straightforward, allowing for the qualitative assessment of the antibacterial properties of diffusible antimicrobial agents on treated textile materials. Clients frequently seek this testing as part of product performance evaluations, development processes, and ongoing quality assurance.

While this method is a fast and dependable option for antibacterial testing, AATCC TM 147 is not appropriate for samples that encapsulate the antibacterial agent, hindering its diffusion, or that contain substances that neutralize antibacterial effects.

RESULT: While testing the sample according to this standard there is no bacterial activities found in the developed sample.

pH VALUE OF AQUEOUS EXTRACT TEST:

This Indian standard was officially adopted by the Indian standards institution on 31 October 1983 following the approval of the draft prepared by the chemical methods of test sectional committee by the textile division council. This standard outlines the procedures for measuring the pH value of aqueous extracts derived from textiles. The ph level of aqueous extract helps to confirms that the bandage is chemically neutral and suitable for medical applications. This test assesses the presence of any acidic or alkaline residue on the fabric post-processing which may influence skin compatibility and the healing of wounds.

These methods can be applied to textiles in various forms, including fibers, yarns or fabrics. Representative sample can obtain that is either in or can be processed into a form that allows for efficient liquid exchange between the material interior and the water used for the extraction. The pH value of aqueous extract from the textiles serves as the valuable indicator of their processing history. However, the pH values obtained from this method outlined in this standard should not be interpreted as a precise measure of the textile acidity or alkalinity. Such interpretation can mislead especially for ph values bellow 3 or 11.

Calibrate the meter at the temperature of the extract to be measured. Rinse the cell multiple times with distilled water until specified pH stabilizes. This process necessitates a significant amount of distilled water. Introduce the extract into the cell fully submerge the bulb of the gas electrode. Seal the flask again and let the cell sit for 3 minutes before measuring the ph. Afterward drain the cell and add a fresh portion of the same extract. Seal the flask once more and allow the cell to rest for 1minute and then

measure the ph again. Continue this procedure until the ph reaches a consistent maximum value.

Without rinsing the cell add a sufficient amount of the second extract to cover the bulb of the glass extrude. Measure the pH immediately. Drain the cell and add another portion of the extract then measure the pH again. Record the value and discard the extract. Measure the ph of the third extract using the same method without rinsing the cell.

RESULT: While testing the sample according to this standard, the pH value comes under the standard value in the developed sample.

ABSORBENCY (SINKING TIME):

The absorbency test (sinking time) is done according to the BP appendix method. Cut five samples from different places of the sample and loosely pack and keep it in the basket. Now take the weight of the basket its around 10 mg. Hold the basket in horizontal position and drop it from the height of 10 mm to the beaker containing the water. Take the stop watch and measure how much time is taken to the basket to completely sink into the beaker and calculate the results.

RESULT: While testing the samples under this standard absorbency of the developed samples are faster than the market samples.

ABSORBENCY TEST (WATER HOLDING CAPACITY):

Take out the basket from the beaker containing water and allow the samples from the basket to drain for around 30 seconds in the horizontal position. After 30 seconds of draining out transfer the basket into another beaker and take weight of the sample. Now calculate the weight of the sample which holds the water and then calculate the average value of the sample.

RESULT: While testing the sample under this standard water holding capacity of developed samples are high than the market samples.

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