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# Development Of Biodegradable Product Using *Natural Fiber*

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## ABSTRACT

Banana fiber, which comes from the pseudostems of banana plants (Musa spp.), is gaining attention as a sustainable material. This natural fiber boasts a high content of cellulose, hemicellulose, and lignin, giving it impressive mechanical strength, thermal stability, and resistance to chemicals. These standout features make banana fiber a fantastic option for a variety of industrial uses, such as in textiles, composite materials, paper and pulp products, and even biomedical applications.In a closer look at banana fiber (BF), which is derived from the pseudostems of Musa spp., researchers examined its physical and mechanical properties to assess its potential in industry. Scanning electron microscopy (SEM) measurements showed that the fiber diameter ranges from 150 to 200 μm.Its unique characteristics make it a compelling alternative to conventional materials, offering benefits like biodegradability, renewability, and a smaller carbon footprint.

**Key words**:*Banana Fiber,Basket and diversified uses,cellulose, hemicellulose, lignin, and application*

## 1.INTRODUCTION:

Banana fibers, obtained from banana plant pseudostems (Musa spp.), are a potential renewable material with versatile industrial uses. Banana fibers, being a lignocellulosic biomass, consist of cellulose, hemicellulose, and lignin and exhibit superior mechanical strength, thermal stability, and chemical resistance. Banana plants are among the most cultivated crops in the world, with millions of tonnes of biomass produced every year. Banana pseudostems have been conventionally disposed of or used as low-quality animal feed. Due to increasing demand for renewable materials, the use of banana fibers as a valuable product has gained interest.

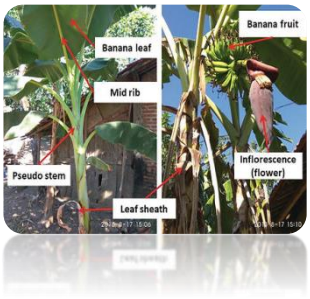


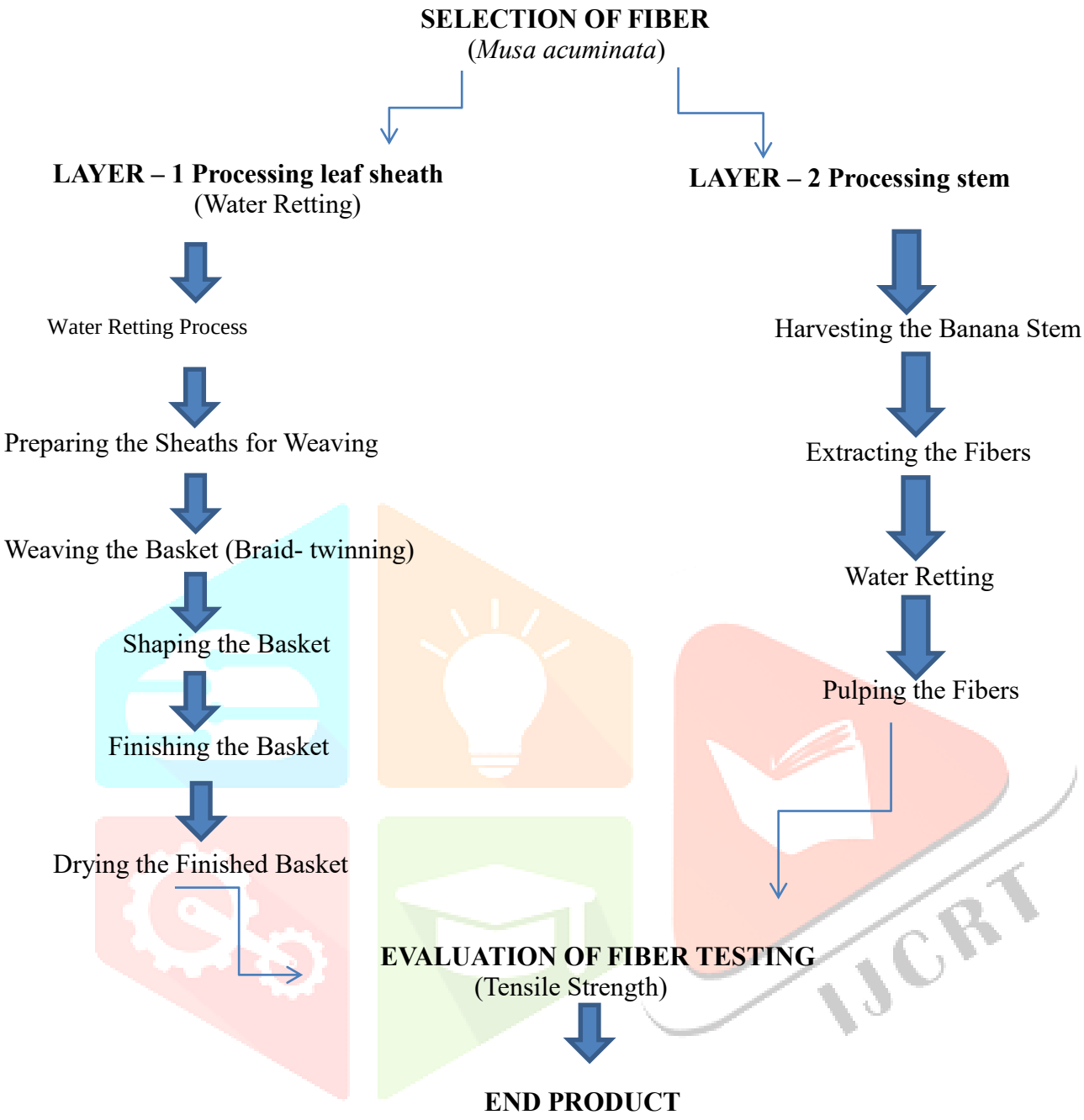

**Fig.1 Introduction of Banana Tree**

The banana plant has high-quality textile-grade fibres commonly referred to as banana fibre. The fibre is another untapped natural fibre employed for the fashion and technical textile sectors for sustainable product creation. The fibres are obtained from the pseudostem of the banana plant. Appropriate banana fibre extractors can be employed to remove the fibres from the pseudostems of the banana plant.

## 2.OBJECTIVES:

- To reduce the usage of plastic-free packing.
- To create sustainable production techniques for banana fiber.
- To explore the uses of banana fiber in other industries.
- To create value-added products out of banana fiber.
- To encourage banana fiber use as an environmentally friendly option over the use of traditional materials.

## 3. METHODS/METHODOLOGY – FLOW CHART:




## 4. SELECTION OF FIBER:

The banana leaf sheath, which is sometimes also called the "leaf stalk" or "pseudostem," is the base structure out of which arise the large broad leaves of the banana plant. It consists of closely wrapped leaf base layers encasing the emerging young developing leaves. The sheaths are often green and variable in length, depending on how mature the banana plant is. As growth occurs, the sheaths at the base of the plant become older and will dry out and drop off, but new sheaths form continuously. The sheaths are multifunctional in that they protect young leaves, give structural support, and play a part in the way a plant looks. Furthermore, in most cultures, banana leaf sheaths are employed in conventional practice for cooking, crafting, and even as a biodegradable substance for various applications.

**Fig.2 Banana Fiber**

**Fig.3 Banana Leaf Sheath**

## 4.2 LAYER – 1 PROCESSING (BANANA LEAF SHEATH BASKET):

Water retting is an important process in banana leaf sheath basket making since it softens and prepares the banana leaf sheaths for weaving. Retting is the process of breaking down or loosening the leaf sheath fibers through soaking them in water, softening them, and making them more pliable and easier to handle.

**Harvesting the Banana Plant:**

The process begins with the harvesting of mature banana plants. Once the bananas have been harvested, the pseudostem and its sheaths (the outer covering) are harvested

**Soaking in Water:**

The cut banana leaf sheaths are soaked in water, typically in a nearby river or pond, or in large water containers.This wetting process may range from a few days to weeks, depending on external conditions such as water temperature and the targeted softness of the fiber.

**Microbial Action:**

During retting, microorganisms like bacteria and fungi naturally degrade the outer sheath layers. The microbial activity loosens the fibers, making them more flexible.

**Flotation and Turning:**

During the process of retting, the sheaths can rise to the surface of water, therefore, are usually turned or stirred from time to time to achieve uniform retting.This avoids differential softening and ensures that all fibers are dealt with in the right manner.

**Washing and Rinsing:**

Once the process of retting is over, banana leaf sheaths are gently taken out of the water and washed thoroughly to leave no impurities, bacteria, or rotten material behind.This washing step also helps to stop the retting process and prepares the sheaths for the next stage.

**Drying and Preparation:**

The soaked sheaths are then left to dry in the sun or air-dried for a few days. Once dried, they become more pliable and ready to be used for weaving into baskets.

### 4.2.1 PREPARING THE SHEATHS FOR WEAVING:

Banana leaf sheaths must be prepared before they are woven into baskets. They should be flexible, durable, and easy to handle. Several steps are involved in the preparation of banana leaf sheaths for weaving, including cleaning, softening, cutting, and in some cases, dyeing. This is to prepare the sheaths for weaving

**Cleaning the Sheaths:**

- The cleaned banana leaf sheaths are washed thoroughly to remove dirt, dust, and other debris. This is done by washing them with water.Cleaning ensures that the fibers are free from impurities that might disrupt the weaving process.The sheaths are then retted and softened, and after that, they are cut into strips.

**Drying the Sheaths**

- The banana leaf strips are spread out and allowed to dry, typically in the sun, after retting, washing, and cutting.Excess moisture is reduced and the sheaths are made easier to work with through the process of drying.

**Softening and Conditioning**

- If necessary, the sheaths can be further softened by a gentle massaging or rubbing of them, frequently with a cloth or by hand. This procedure is used to attain the ideal degree of pliability without damaging the fibers.

**Final Inspection:**

- After the sheaths are softened, cut, and conditioned to the right standard, they undergo a final check. The strips are inspected for imperfections or unevenness.The strips are sorted and organized in sizes and quality, ready for use in the weaving process.

**Fig.5 Cleaning and Cutting**

### 4.2.2 WEAVING THE BASKET BRAID (TWINNING):

Braiding a banana leaf sheath basket in braid form is an old craft that calls for skill and accuracy. Braiding gives a strong and beautiful design to the basket. Following is a step-by-step process of braiding banana leaf sheaths into a basket:

**Preparation of Materials**

It is necessary to prepare all the materials before proceeding with the weaving process:

Banana leaf sheaths: Wash, ret, cut into strips, and dry.

Sharp scissors or knife: To cut and trim the sheaths.

Measuring equipment: As needed, in order to keep the strips consistent in size.

Begin the Braiding Process

**Start braiding:**

- Put the first strip on the left, the second in the middle, and the third on the right.Start the braiding by crossing the right strip over the middle strip, then cross the left strip over the new middle strip. Repeat this process, maintaining the braids tight and even.Make sure that every braid is tight enough not to have gaps but not so tight that it tears the sheaths.

**Fig.6 Braided the Fiber**

**4.2.3 SHAPING THE BASKET:**

In the conventional weaving of baskets, particularly using banana leaf sheaths, the vessel or "form" or "mold," is employed in shaping the basket and imparting its intended structure.

**Understanding the Role of vessel:**

The vessel is typically a round or oval mold, often made from wood, clay, or other materials, that serves as a guide during the weaving process.It is particularly useful for creating baskets with consistent and smooth shapes, such as round or cylindrical baskets.

**Preparing the vessel**

Choose the right size vessel: Depending on the desired size of the basket, select a Sumbu that is either larger or smaller. For a large basket, a bigger vessel is required, while a smaller one works for tiny baskets or delicate items.

**Weaving Around the vessel**

- Begin to weave: Start weaving or braiding the banana leaf sheaths over the vessel. As you are weaving, continue to shape your base into even curves of the desired shape.
- For baskets to be rounded: Guide the rounded shape by turning the base of the form progressively around while you weave upward with the aid of the vessel.
- For round baskets: Maintain the weave even, and use the shape to ensure the sides come up straight and even.
- Shaping the sides: As the base of the basket begins to take shape and grow, raise the sides of the basket gradually, bending the banana leaf sheaths upwards while weaving around the vessel.

**Fig.7 Shaping the Basket**

**Finishing the Basket:**

**Trim the edges**: Once the basket is removed from the vessel, trim off any remaining banana leaf sheaths on the top for a neat, clean edge.

**Finish the loose ends**: If there are loose ends or uncompleted parts of the weave, gently pull them in and secure to keep from unraveling.

**Steps for Drying the Basket:**

Put the Basket in a Dry, Well-Ventilated Space: After placing the basket on the vessel, put the basket in a cool, dry place that has good air circulation. This allows the banana leaves to dry evenly and prevents mold or mildew from developing.Preferably, the location should be neither too hot nor under direct sunlight, since a high temperature can make the banana leaves brittle, and humidity can slow the drying process and cause the shape of the basket to become distorted.

**Final Steps After Drying**

After the basket is dry, it will be more stiff and firm. The vessel will have kept it in its intended shape, yet a few more finishing steps remain.

**Steps After Drying:**

Remove the Basket from the Sumbu Carefully,After the basket is completely dry, carefully take it out of the Sumbu. Be careful not to twist the shape by pulling too hard.

Final Inspection: Check the basket for any imperfections. Check the weave to make sure it's still tight and there are no loose ends or holes.Inspect the form and size to make sure that the basket retained the desired shape. If necessary, press on any areas which have warped very slightly.

**Fig.9 Front and Side look of the basket**

**4.3 LAYER – 2 PROCESSING STEM:**

Banana stems are a sustainable and environment-friendly material, especially when utilized to produce natural fibers that are applied for different uses, such as tissue production. Banana stems contain a high proportion of fiber, and their processing into tissue is a process with various steps to obtain the fibers and further transform them into a form to be applicable for use in tissue products. The following is the step-by-step production of tissue from the banana stem:

**4.3.1 Harvesting the Banana Stem**

The procedure starts with the gathering of banana stems, usually from previously fruit-bearing banana plants. These stems are discarded after harvesting, so they form a perfect material source of eco-friendly materials.

**Procedure for Banana Stem Harvesting:**

Pick healthy banana plants that have finished their fruit-bearing stage. The stem should be pest-free or disease-free.

Cut the stem from the bottom of the plant using a machete or a sharp knife. The stem is usually fibrous, thick, and is between 2 to 3 meters long, depending on the plant species.

It is vital to process the stem immediately after cutting it so that it will not spoil or harden too much.

**Fig.10 Banana Stem**

### 4.3.2 Extracting the Fiber from the Banana Stem:

The banana stem consists mainly of a packed matrix of fibers. These fibers are those which will, in the end, be used to produce tissue. To extract it, peel the external layers and disentangle the fibers.

**Steps for Fiber Extraction:**

Peel the Stem:Strip away the outer layers of the stem with a sharp knife or specialized tool. The outer stem layers are hard and fibrous, and must be stripped away to expose the soft inner fibers

Remove the Fiber Strands: The innermost portion of the stem contains long, soft fibers that are ideal for tissue production. Use your hands or a mechanical process to extract these fibers.

Cleaning the Fibers: After the fibers are separated, they need to be washed in order to remove any leftover plant material, soil, or particles. Soak the fibers in water for a few hours in order to further soften them.

**Fig.11 Cleaning and Cutting the stem**

**4.3.3 Softening and Refining the Fibers :**To utilize the fibers in the production of tissue, they need to be refined and softened in order to render them appropriate for papermaking. Softening the fibers does this in preparation for their transformation into tissue.

**Procedure for Softening and Refining:**

Soak the Fibers:Soak the banana fibers in water for 1-2 days to further soften them. The longer the soaked fibers, the more manageable and easier to process they are make sure the fibers are fully immersed in water throughout this soaking process.

**Boiling the Fibers**

There are instances where boiling the fibers can further soften them and get rid of any remaining lignin or other natural compounds that may cause the tissue to be coarse. Submerge the fibers in a big pot of water and boil them for 2 to 3 hours. Once soaked or boiled, card the fibers to align and separate them. Carding is done by combing and untangling the fibers using a machine or hand tool to make them smooth and uniform.The process is important in order to obtain a fine and soft texture fit for use in tissue production.

**Fig.12 Water retting (process)**

### 4.3.4 Pulping the Fibers(Water retting):

After the fibers are washed, softened, and processed, they must be pulped to form a slurry that can be processed into paper or tissue.

**Steps to Pulping the Fibers:**

**Shred the Fibers**: Shred the washed banana fibers into small, manageable pieces so that the pulping process becomes simpler.

**Prepare the Pulping Solution:** To pulp the banana fibers, combine the shredded fibers with water. The proportion of fibers to water varies based on the final thickness and texture of the tissue, but usually, a 2:1 water-to-fiber ratio is employed

**Pulping Process**:The fibers are subsequently pulped with mechanical equipment, including a pulping machine, with a rotating blade or grinder that can crush the fibers into a slurry.

**Fig.13 Grinding**

**Fig.15 Applying inner layer of the basket**

**Fig.14 Paste**

**Fig.16 Completion of the product**

## 5. DETERMINING THE TENSILE STRENGTH OF PLANT FIBER

The tensile strength of a fiber refers to the maximum load it can carry before breaking.

**METHOD**

- The fiber should be attached to a clamp stand
- Attach a weight on the other end of the plant fiber
- Carefully continue to add one weight at a time until the fiber breaks
- Record the mass at which the fiber broke
- This represents the tensile strength
- To increase the accuracy of your results,this process should be repeated with more samles.

| S. No | Test Parameters | Testing standards | Standards | Test results | Remark |
|---|---|---|---|---|---|
| 1 | Tensile strength of the fibres | IS 235 (1989) | 50 to 600 MPa | 551.23 MPa | Developed sample pass and market sample pass |

**TENSILE STRENGTH**:

- Tensile strength is the maximum load that a material can support without fracture when being stretched,divided by the original cross-sectional area of the material.
- Tensile strength have dimensions of force per unit area.
- It measures the strength of the materials.

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## 7.ANNEXURE: