Development of Fabric using Palm Fiber Blended with Bamboo and Cotton

By

SASIPREETHA.S

(21PTF017)

A Thesis submitted to the

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore -641043

In partial fulfilment of the Requirement for the

DEGREE OF MASTER OF SCIENCE IN

TEXTILES AND FASHION APPAREL

MAY, 2023

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Certified as Bonafide Research Work

16/5/23

Signature of the Head of the Department

Rakna

Signature of the Supervisor

DECLARATION

I declare that the dissertation entitled **"Development of fabric using palm fiber blended with bamboo and cotton"** submitted by me for the degree of Master of Science (M.Sc.,) is the record of work carried out by me during the period from 2022 to 2023 under the guidance of Dr. U.RATNA M.Sc., M.Phil., Ph.D., Professor, Department of Textiles and Clothing, Avinashilingam Institute for Home Science Higher Education for Women, Coimbatore -642043 and has not formed the basis for the award of any Degree, Diploma, Associate ship, Fellowship, Titles in this University or any other similar institution of higher learning.

Signature of the Candidate

CERTIFICATE FROM THE SUPERVISOR

I certify that dissertation entitled **"Development of fabric using palm fiber blended with bamboo and cotton"** submitted for the degree of Master of Science (M.Sc.,) Textiles and Fashion Apparel by SASIPREETHA.S (21PTF017) is the record of project work carried out by her during the academic year 2022 to 2023 under my guidance and supervision and this work has not formed the basis for the award of any Degree, Diploma, Associate ship, Fellowship, Titles in this University or any other similar institution of higher learning

Signature of the Supervisor

Signature of the HOD

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SASI PREETHA. S

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1.INTRODUCTION

An crucial component of a person's daily life is Textiles. Environmentalists have been urging businesses to apply sustainability concepts to their manufacturing procedures. When compared to other industries, the textile industry is seen as a major contributor to environmental pollution and is prone to causing a variety of ecological problems (waste generation, air pollution, water body pollution, etc.) throughout the supply chain from fiber production to fabric finishing.(Anupriya *et al.*,2017).Apparel designers should manufacture items utilizing ecologically and socially responsible design techniques and trends. Due to the life cycle resource consumption and environmental emissions of textile goods, an essential part of modern human existence, there has been a significant increase in interest from suppliers and consumers.(Rounak *et al* .,2022)

Numerous inventions are made to protect our mother planet since the textile business is a prime example of the most developed and environmentally damaging industry in the world. Bleaching, dyeing, and other steps are included in the textile production process .It contribute significantly to pollution, hence it's necessary to make it more sustainable.Therefore, "Eco-friendly" made of natural fibers like organic cotton and hemp, clothing that has been naturally colored with vegetables, or any materials that utilize minimal quantities of water, energy, and chemiclas should be used. Because of their inherent qualities, such as mechanical strength, low weight, and health benefits for the wearer, natural fibers are particularly appealing. "Eco" is an abbreviation forEco-friendly (or "ecology friendly") is a term used to describe products and services that are thought to have little or no negative effects on the environment. "Think globally, act locally" is the mantra of the future for the global textile industry. Ecology is the study of the interactions between organisms and their environment. (Suparna *et al.*,2016)

Natural fibers, which are an essential component of the human environment, are valuable raw materials utilized in the manufacture of both textiles and non-textiles. Natural fibers occur in a variety of climatic zones, which contributes to their diversity in shapes and forms. The variety of fiber sources sparks curiosity, provides a chance for more through research, and ultimately, leads to the discovery of new industrial uses for the fibers.(Edyta *et al* .,2016). Natural fiber is any hair-like raw material that may be obtained directly from an animal, vegetable, or mineral source and used to make nonwoven textiles like felt or paper or, after being spun into yarns, woven fabrics.Although fibers are abundant in nature, particularly those that are cellulosic, like cotton, wood, grains, and straw, very few of them can be utilized to make textiles or for other. (https://textilelearner.net/difference-between-natural-fiber-and-man-made-fiber)

Palm trees, also known as Palmyra, are one of Tamil Nadu's oldest and most naturally occurring vegetations that can resist intense drought. Tamil Nadu was a forerunner in the development of India's palm product sector. Tamil Nadu can expand and develop the palm products sector to a greater level in order to attract foreign exchange through palm product exports. Palmyra has been recognised as Tamil Nadu's "State Tree" .*(Djibrillaet al.,*2010)

The palm tree is known as the Fan Palm, Barb Tree, Toddy Palm, and Tala Palm and also Palmyra Palm Tree. This tree may be found in most tropical nations as well as the drier regions of India, Sri Lanka, and Burma. The stalk fiber is used to make brushes and ropes(*Thanga regini,2017*) The leaf ridge is known as 'Eekku,' and it is used in combination with leaves to weave baskets and brushes. The leaf stalk is stronger and used as basket bands, and when the stalk is torn into thin strips, it is known as Naar and is used to knot objects in various ways. The cot built of Palmyra wood and fiber, known as 'Naar Kattil' in local dialect, is said to have excellent therapeutic properties for humans .Palmyra grows best in hot, dry areas, although it may also thrive in alkaline and salty soil.At Palmyra Atoll ("Palmyra"), efforts are underway to change the rainforest community composition from C. nucifera dominated to native mixed-species(Senthil kumar *et al* .,2021).

Studies have been carried out , adopting the natural fiber as one laminate and sandwiching it with another natural fiber to improve the features of the hybrid testimony towards the use of natural fibers. Further, synthetic fiber laminate is layered with natural fiber to improve mechanical aspects and satisfy the current engineering industry requirements. Palm strands are extensively used as reinforcement in the production of natural fiber reinforced composite materials(Roja *et al.,* 2022).There are better ways to discard of trash than dumping it in the open yard, which causes a slew of environmental problems. The idea of palm fiber reinforced composite material has been evoked in order to correctly use this dumped material as a valuable product(Bharani Kumar *et al.,*2022).

Natural, hollow cotton fibers are soft, cool, known as breathable fibers, and are also absorbent. Water may be held in cotton fibers 24–27 times their own weight. They are robust, dye-absorbing, resistant to abrasion wear, and temperature-resistant. Cotton wrinkles, therefore adding polyester or a permanent finish provides clothing made of cotton the right characteristics. To maximize each fiber's greatest qualities, cotton fibers are frequently combined with other fibers like nylon, linen, wool, and polyester.(Hosseini *et al.,*2011). Numerous factors, such as the environment in which the fibers grow, influence the quality of cotton fiber. It is natural that fiber forms and maturities will vary greatly. As a result, there are noticeable variations in fiber characteristics inside bales, even within a single boll, and on a single seed. Cotton fibers typically have a diameter width of 8 to 20 m and a length of less than 20 mm to 35 mm and beyond (https://www.tandfonline.com/journals/lmsa19).

The largest contributor to national economies, especially in emerging nations, is agriculture, and cotton is a significant cash crop. Since it generates foreign currency, it is known as "white gold" in some nations. The world's textile industry use cotton fiber, which is a distinctive fiber, as a primary raw resource. (Abdul *et al .,* 2020).Since many years ago, cotton has been used to make clothing, paper goods, cottonseed oil, and other things. Cotton is the greatest textile fiber crop in the world. With an annual production of 20 million tons, it is grown in more than 80 nations.In the global textile business, cotton staple length is a critical factor in determining the quality of cotton fiber. For the enhancement of fiber elongation and quality, understanding the molecular mechanism and hormonal regulation of fiber beginning might be very helpful. Numerous hormones can have an impact on a single cell type, and a single hormone can have an impact on the development and differentiation of various tissues(Ahmadali *et al .,* 2018).

In the grass family's subfamily bambusoideae are the evergreen perennial blooming plants known as bamboos. The word "bamboo" was most likely taken from Malay by the Dutch or Portuguese languages .Due to its high tensile strength, longevity, and stability, it is employed for high performance end uses in addition to ordinary textile and is a great composite material. The bamboo plant is a resource that contributes significantly to socio-economic growth. It has been said that cultivating bamboo often requires no pesticides or fertilizers, making it inherently organic. Bamboo is also fast-growing and the majority of it is cultivated organically. Bamboo fabrics are soft, cool, breathable, and stylishly elegant(Textilesphre,2020).

Products made of bamboo for clothing and textiles are a recent innovation. Regardless of how they are created, products made from bamboo are frequently labelled as "green," "biodegradable," etc. Additionally, a lot of clothing producers frequently said that bamboo-based items had antibacterial qualities. (Nayak*et al*.,2016) .Bamboo fibers have offered some assistance in the development of recyclable, biodegradable, and sustainable products. Due to the greatest qualities of each component, natural fibers produce composites with exceptional strength-to-weight ratios. Researchers have discovered raw resources like bamboo fibers that may be used to produce industrial goods of the highest quality and sustainability. Bamboo fibers are frequently substituted for natural glass fiber due to their excellent strength-to-weight ratio. Because of this, its composites made from various matrix materials have received a lot of interest (Rahman, *et al.*,2018).

Blended fibers are made up of two or more distinct raw fibers. These are spun together to make yarn. Blended fiber have the most qualities of the original raw fibers. Due to the differences in fiber properties, certain yarns may have one fiber as the core and the other wrapping around the core. Other fibers may cluster together side by side within a yarn. Blended fibers composed of two natural fibers that are recyclable at the end of their life(Textile,2021). Blending is the process of combining two or more distinct fibers in the required proportion. Blending is the process of combining different types of fibers to create a homogenous aggregate. Blending is often done before spinning a staple fiber yarn or producing a staple fiber web in a nonwoven process. Fibers can be mixed without generating a homogenous mixture (blend). A fabric, for example, can be woven from two or more types of yarns, each of which is manufactured from a distinct type of fiber or fiber blend(Kiron,2013).

Weaving is the textile technique of interlacing two unique sets of yarns or threads, known as the warp and weft, at right angles to make a fabric or cloth. Cloth is woven on a loom, which is a mechanism that holds the warp threads in place while the weft threads weave back and forth through them. Woven fabric can be basic (one color or a simple pattern) or decorated or artistically designed. More intricate patterns need more elaborate looms with more heddles. The heddle is the section of the loom through which the warp threads pass and which helps to maintain the warp threads in line. The heddles may also move up and down, creating the interlaced look(Jennifer ,2013).

Weaving is important in many textile cultures. The most common device for interlacing threads is a loom, which holds the warp taut and has been used throughout history and around the world (Claudia ,2020).Weaving is technically described as the right-angle interlacing of two distinct strands of yarn or thread. This pattern produces a strong, yet flexible framework that holds individual threads in place, resulting in a solid cloth or fabric. Most textiles are still woven today, generally by machines that generate an extraordinarily tight structure, but the method is fundamentally the same as hand weaving (Jennifer , 2013).

Pit loom will be buried in the ground and given an overhang to make this loom. Thread work is done within the pit so that the warp threads can absorb moisture and produce better woven fabrics.This is woven using a mix of sley and shuttle boxes.In the evolution and history of weaving, this invention was incredibly significant. For finer yarn, this kind of loom is employed.This loom must have been in operation around 600 yarn B.C. Throw shuttle loom is used here. Either wood or metal.It must be weighty and slick.(https://textilevaluechain.in/in-depth-analysis/articles/textile-articles/types-of-hand-loom/) .The vertical frame loom is the only loom that is still an option. When two loom-pits in the North Tombs were studied, significant evidence of vertically erected weaving equipment first became apparent.The loom's side beams were likely fastened between the floor and ceiling pits, which prevented the entire structure from tilting. Tethering point in the upper pit's rim(Johanna *et al.*,2020).

Lot of research has been carried out in producing composites using palmyra ,cotton and bamboo but only few studies are done on woven fabrics .Hence the investigator selected the topic on “Development of fabric using palm fiber blended with bamboo and cotton with the following objectives:

- To select boracassus palm fiber .
- To blend selected palm fiber with cotton and bamboo.
- Blended yarn is converted into woven fabric.
- Evaluation of fiber, yarn and woven fabrics

2. REVIEW OF LITERATURE

2.1.NATURAL FIBER

2.1.1.INTRODUCTION

India is one of the most agriculturally productive nations, and many people work in agriculture as their primary occupation. The plants on agricultural land and woodlands provide a variety and abundance of natural fibers. Utilizing these natural fibers in different industrial products will require the development of new techniques (*Venkatachalam,2020).*Natural fibers are classified into three types based on their origin. Cotton , jute , wool , hemp, kenaf, jute, sisal , banana, flax, oil palm, and other natural fibers have been in high demand in recent years due to their eco-friendliness and renewable nature. Furthermore, natural fibers have a low density, superior mechanical and thermal qualities, and are biodegradable *(Mazharul ,2015).*

Natural fibers provide advantages such as life cycle sustainability, low density, light weight, non-toxicity, renewable, and instantaneous biodegradability, as well as high thermal insulating properties and a non-abrasive character for process equipment. Natural fiber manufacturing is less expensive than that of artificial fiber since it requires less energy.Natural fibers are also non-carcinogenic and secure for processing and handling (*Siewchoo et al., 2017*).

2.1.2.HISTORY

Nature has long offered a multitude of fibers-plant, animal, and mineral of various size and characteristics, as if cognizant of the importance of textiles. Natural fibers have fulfilled man's textile requirements for thousands of years, dating back to prehistory. In 8000 BC, the Swiss Lake Dwellers grew flax and woven linen into textiles. It advanced by 3000 to 2000 BC, and cotton weaving was well established in India and Pakistan. Beginning in the 1700s, advancements in spinning, weaving, and other equipment revolutionized fiber processing. Cotton became the king of fibers thanks to Eli Whitney's development of the cotton gin in 1793 *(Charles ,2006).*

Natural fibers have always been utilized in all civilizations to create utilitarian items. Historians agree that the earliest fiber used to make textiles came from the flax plant .To manufacture linen, the fibers in the plant's stem are extracted, washed, and weaved together.

Flax fibers were used to manufacture linen about 5,000 years ago, and it was so valuable that it was used for Egyptian Pharaohs' funeral shrouds. The Egyptians perfected the ability of manufacturing exquisite linen, as evidenced by linen objects discovered in tombs with threads weaved 200 to the inch. Natural fibers contain unique properties that cannot be replicated. After 5000 years later, people still desire and value the warmth of wool, the feel of cotton, the qualities of linen, and the beauty of silk*(Alan , 2007).*

Human communities all around the world and throughout history have employed a variety of natural fibers. Many of them are produced from plants that have either been tamed or are simply collected from the wild. For ages, people have made garments, blankets, and ornaments out of these fibers *(Christopher ,2022).* From the stem, leaf, and fruit of plants are naturally arranged into bundles and commonly referred to as fiber collections, but fibers from seeds are single cells and are called fibers. The procedures for separating fiber bundles from stem and leaf of the bast are relatively similar *(Leonard ,2006).*

2.1.3.CLASSIFICATION OF NATURAL FIBER

Natural fiber can be classified in a variety of ways ,including origin, application ,structure. Natural fibers are derived from plants,animals and minerals .The majority of natural fiber are derived from plant sources such as roots ,leaves, bark, wood ,and fruit shell/husk.Natural fibers in general may be categorized according to where they come from, and plant-based fibers can be further divided into groups according to which parts of the plant they are derived.

The term "fibers" refers to a group of materials that resemble hair and are either continuous filaments or come in isolated, elongated segments, much like thread. Rope, thread, and filaments may be made from them by spinning. They can be included into composite materials as a component. To create items like paper or felt, they can also be matted into sheets (*Wan et al.,2016).*

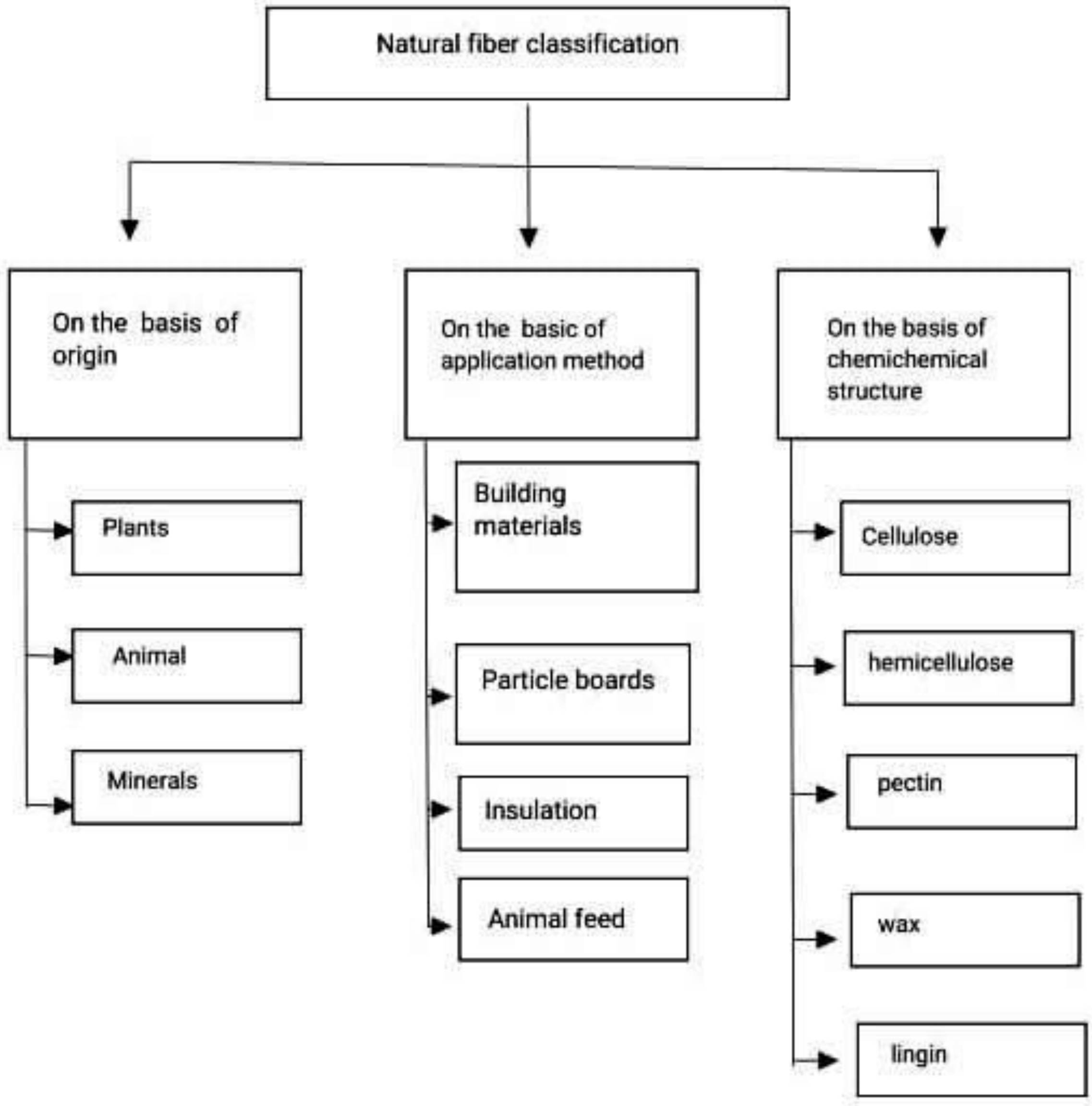


Figure 1: Natural fiber classification*(Arpithaet al.,2016), (Shyam Kumar et al., 2015),(Aruna et al.,2015)*

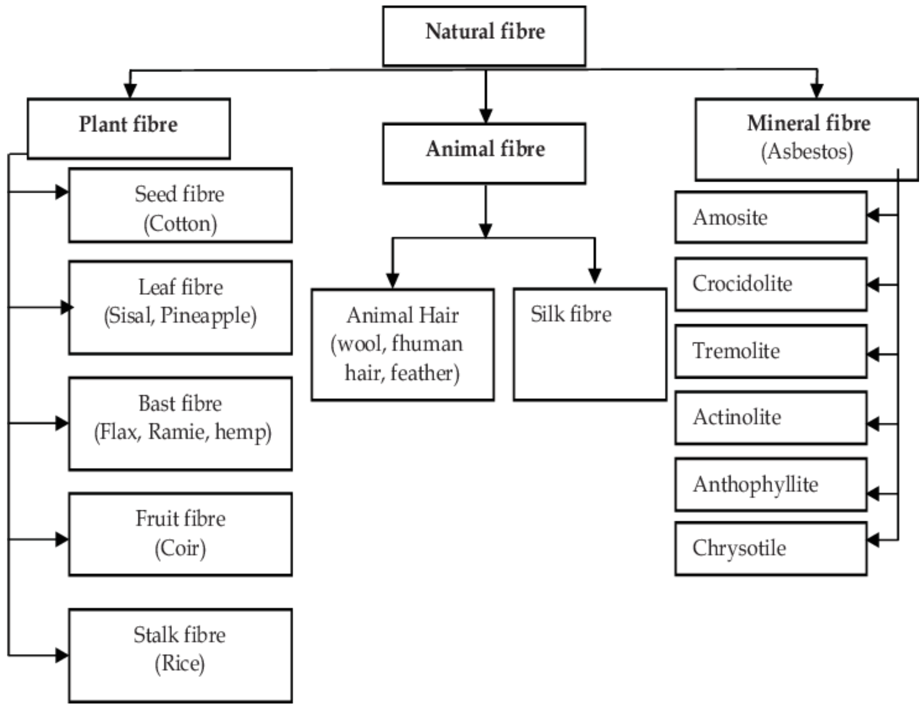


Figure 2: Classification of origin*(Asokan et al.,2011)*

2.1.3.1.Natural fiber classified according to their origin :

1.plant

1. stem or bast

Jute :

Typically, the ribbon of the stem is where jute are removed. It is utilized in several ornamental things, including bags for packing, ropes, yarns, and carpet backing.

2. Leaf

Sisal: The agave family includes the sisal plant. (Agavaceae). The plant resembles enormous pineapples. Both manually and mechanically, the soft tissue is separated from the s. Among other reinforcing materials, it is mostly utilized for mats, carpets, and other items(Mariana, 2017).

3.seed

Hemp , which are prized for their high strength and long length and frequently employed in the production of ropes, sails, paper, and textiles have a long history of use. Hemp is a resilient plant that thrives in a relatively climate.The primary ingredients of hemp are cellulose, hemicellulose, lignin, and pectin.

Ramie is a high cost material. The ramie plant thrives in textiles. It is frequently used to create wall paper, furniture coverings, and other things.

Cotton: The most significant fiber used in the textile industry is cotton. Cotton is often harvested through picking, a process that is typically done by hand. In contrast to other natural s, cotton is mostly used to make clothing, blankets, and carpets(Mariana, 2017).

Flax: One of the strongest natural fiber is flax. Flax has strong abilities to conduct heat. Sharp folds that crease continuously in the same spot, however often break.Flax is used to make ropes, bags, linen, and canvas.

4.Fruit :

Coir: Typically, coconut fibers are extracted from the fruit of the coconut palm's husk. These coconut fibers are resilient to heat and salt water and are light and robust.

5.stalk :

Actually, the plant's stalks are used to harvest these fibers. As an illustration, consider rice, barley, wheat straws, bamboo, and grass(Mariana, 2017).

2.1.3.2.Natural fiber classified based on their application method :

- **Building materials:**

  The typical sources of fiber include animals, geological processes, and plants (vegetable, leaf, and wood). Due to the rise in the cost of high-energy materials and the availability of solutions to increase the toughness of natural strands in concrete, the trend of research on naturally fiber strengthened solid composites is now developing. It was substantially adopted due to the attributes of eco-friendlyness, such as quality, easiness, and generally wonderful properties, and so forth.Due to the simultaneous increase in condition and energy, more attention is now being devoted to using normal filaments with high energies and safeguarding environmental concerns.Additionally, because to their low thickness, simplicity, and biodegradability, sisal, coconut, and bamboo have shown results that are even more promising than expected. Natural fibers are less expensive than standard reinforced concrete, but their long-term performance and durability are still unknown. They also take more skill to produce, place, and mix (Mariana, 2017)

.

- **Particle boards:**

  Applied Technology: The present disclosure relates to particleboard and methods for manufacturing particleboard (e.g., from natural fibers/materials, such as coconut-based materials), and, more particularly, to particleboard (e.g., formaldehyde-free particleboard) using natural fibers/materials (e.g., lignocellulosic materials), where the particleboard has improved performance characteristics and/or mechanical properties.

  Background Artwork: Particleboard, in general, is a type of engineered panel product made from wood and/or other lignocellulosic fibers and/or particles that are usually compressed and bound together using a binder. While some in the industry may generally distinguish some classes of bonded boards such as, for example, particleboard, fiber-board, and others, it should be noted that the term particleboard is used in the current disclosure to include the products (e.g., particleboard, bonded-board, fiber-board, etc.) that may be manufactured using the mechanisms and procedures of the current disclosure, which are explained below.

  However, because exposure to formaldehyde emissions has a negative impact on health, UF and PF resins are often neither eco-friendly nor secure. Products made of hardwood plywood and certain wood-based panels, ACS symposium series Release of formaldehyde from wood products, aldehyde Emissions from Particleboard and Medium Density board Products(Mariana, 2017)

  .

- **Insulation:**

  Natural insulation materials, such as expanded cork, rock wool, and wood , are typically more costly than their more widely used counterparts, such as fiberglass and polystyrene. Here are some things to think about while choosing your insulation. Theoretically, natural insulating materials are healthier for the environment and your health since they tend to have low toxicity levels, like the cork seen here. You should pay close attention to manufacturers' assertions that a product is environmentally benign, especially in the age of "greenwashing." It is not always cost-effective to spend more money on natural insulation since certain natural insulation materials, like normal insulation materials, may include glues or binders that release harmful compounds.

Wool from sheep: However, frequent absorption and release might result in the loss of the borate, which gives wool its fire- and insect-resistant properties. Wool's propensity to absorb moisture makes it particularly desirable for several uses .Sheep's wool works well as insulation. It handles condensation naturally and is highly effective. Because of its capacity to absorb some airborne pollutants, including formaldehyde, it doesn't clump or settle over time and may even have an air-filtering impact.

Hemp and wood: Although wood (seen above on the left; hemp fiber is on the right) is frequently used in Europe, it was only recently (as far as I can determine) introduced to the American market. Although it frequently occurs in the forms of flexible batts or stiff boards, loose fill can also be encountered. Wet process boards employ heat and pressure to organically bond the material into boards, but they may also contain additives to stave off moisture. On the other hand, the dry method can involve using a synthetic glue to create the boards. Wood- panels have the benefit of having high permeability, much like mineral wools, which makes it simple for water vapour to travel through. This might be an intriguing alternative for folks who are very worried that their wall assembly won't retain any moisture. Although hemp fiber shares many of the same characteristics as other, it is less dense and more quickly regenerated(Mariana, 2017)

- **Animal feed:**

Beetpulp: In the past, the US has frequently explored and incorporated microcrystalline cellulose and beetroot pulp to commercial pet feeds. They are incorporated in pet feeds because they have different chemical and physiochemical characteristics that impact physiological outcomes and fermentability. These conventional s can be contrasted to shed light on the function of various types in pet diets. A generally non-fermentable, soluble, and non-viscous is microcrystalline cellulose . The macronutrient makeup of microcrystalline cellulose has been documented in the literature with little variance

Corn : The most common and least valuable byproduct of the maize wet milling process is corn fiber . 2.04 kg of corn fiber are typically produced from a bushel of maize. Corn fiber typically contains 8.4% crude protein, 85.5% total dietary , and 0.9% crude fat [30]. Modifications to the wet milling procedure, however, might affect the chemical make-up of maize fiber and could have a variety of physicochemical qualities and physiological impacts once added to diets and consumed by pets.

Fruit : Fruit fibers and pomaces are by-products of juicing or pureeing fruits; they are dried, partially treated further, and crushed to a small particle size. Fruit fibers typically include more pectin and hemicelluloses than cellulose and have low (1%) fat and protein levels. This is a general property of fruit fibers. Fruit-based products offer high water-binding qualities, in addition to a balanced profile of soluble and insoluble , which may be employed in food processing to regulate food texture and rheological behaviour. The latter characteristic may be helpful in wet pet food diet matrices when high water content is necessary but low water activity and firm texture are preferred*(Katherine,,2013).*

2.1.3.3.Natural fiber classified on their chemical structure:

I. Cellulose:

When creating high-performance aerogels from cellulose materials of natural origin, the inherent qualities of the fibers are significantly damaged by the process of dissolving; moreover, the continued use of aerogels is constrained by their poor porosity, weak toughness, and high brittleness. robust covalent connections created by chemical cross-linking often increase the mechanical strength of cellulose aerogels, however it can be challenging to get robust entanglement and mechanical stability of such materials in aqueous solutions. As a result, while creating aerogels from cellulose solutions, the porous structure and mechanical characteristics are restricted. In addition to having the beneficial quantity and mechanical toughness of natural fibers, cellulose fibers also have high biocompatibility and biodegradability.

II. Hemicellulose

Heterogeneous polymers comprising pentoses (xylose, arabinose), hexoses (mannose, glucose, galactose), and sugar acids make up hemicelluloses. Hemicelluloses aren't chemically homogenous as cellulose is. Hardwood hemicelluloses are mostly made up of xylans, while softwood hemicelluloses are primarily made up of glucomannans. Xylans are heteropolysaccharides with homopolymeric backbone chains made of 1,4-linked -D-xylopyranose units that are present in many plant components*(Badal ,2003)*

III. Pectin :

Many chemical agents are used by the textile industry in its many wet processes. After being used, these chemicals pollute the effluent, some of which contain corrosion-causing agents that can harm the building's structure and machinery.Pectin breakdown is accelerated by pectinases.All of the enzymes work together in harmony. The pectin-degrading enzyme system contains pectin esterase, a nonpolymeres*(Kiro ,2012)*

IV. Wax:

Natural and synthetic waxes are the two main kinds of waxes. Beeswax, candelilla wax, rice-bran wax, Japan wax, and soybean wax are a few examples of natural waxes. The most widely used natural wax in the business is beeswax, which is more expensive due to the limited availability of honey and worker bees as well as the high demand for waxes, costing 1.5 to 3 times as much as other vegetable waxes and 8 times as much as petroleum-based waxes. Due to the high laten storing capacities of the wax, a lower cooling rate for beeswax coated substrate was discovered when compared to bare metal substrate and fluoro-polymer coated substrate.

V. Lignin:

Lignin is the second most common high molecular weight natural phenolic polymer that comes from plant tissues, and it has a three-dimensional phenolic structure built up by p-coumaryl alcohol, coniferyl alcohol, and sinapyl alcohol , which results in severe resource waste. lignin has only been used in a few industrial applications because of the co-productivity of burning it.

2.1.4. Functional properties of natural fibers:

2.1.4.2. Introduction:

The popularity of natural fibers can be attributed to their desirable qualities, including their high strength-to-weight ratios, low densities, affordability, acceptable mechanical characteristics, environmental friendliness, simplicity of manufacture, and availability. Natural fibers' weak mechanical and thermal characteristics, excessive water absorption, poor bonding, poor resilience, and low durability when compared to synthetic fibers limit their industrial applications, nevertheless *(Albert et al.,2021).*

One of the many resources that may be found in nature are natural fibers. They are inexpensive, readily renewable, biodegradable, and quickly broken down. It is extortable from a variety of plant and animal resources. For the development of natural-fiber composites, they are employed as reinforcing materials in polymers(*Srinivasan ,2020*).

2.1.4.2.Eco-friendly and bio-degradable:

- Biodegradable: Eco-friendly and organic fabrics spontaneously decompose over time. Eventually, synthetic fibers breakdown and release toxic fumes into the environment.
- Health: Many people have allergies to or are uncomfortable wearing synthetic fabrics. Eco textiles contain all the advantages of the most recent synthetic breathable fibers, plus more softness and drape. On the skin, they feel more comfortable.
- Absorption: Not only can their chemicals enter the groundwater, but they are also worn adjacent to the skin, which is the most porous organ.Organic and eco-fiber are all-natural and free of irritants. Additionally, several of them are regarded as hypoallergenic and naturally antibacterial*(* Textile School, *2018)*

Table I: Natural Fiber for Eco-friendly and bio degradable fiber.*(* Textile School, *2018)*

The following table shows the uses of Eco-friendly and Biodegradable fiber:

Table I:

S.No	**Ecofriendly & biodegradable fiber**	**Uses of ecofriendly and biodegradable fiber**
1	Aloevera	Antibacterial , it keep cloth cleaner.
2	Bamboo	100%biodegradable, spun into yarns, excellent drape.
3	Bamboo viscose	Due to its basic source's spontaneous regeneration, bamboo viscose is regarded as being environmentally benign.
4	Banana	It is simple to combine it with cotton or other synthetic fibers.
5	Coir	Extracted fibers are spun into strong yarn, typically with a brownish tint. They are strong, flexible, and light.
6	Corn	Manufacturers of maize fiber have asserted that these fibers may be utilized for sportswear, outerwear, clothing, etc.
7	Hemp	The cloth made from hemp is quite strong. Additionally, it is incredibly insulating, absorbent, and becomes better with use and cleaning. It shows a brand-new surface that gets softer with each wash. Additionally, it is hypoallergenic, non-irritating to the skin, very breathable, UV resistant, and rapid drying.
8	Jute	Jute fibers are used for making carpet, apparel, composites,
9	Pineapple	After several innovations, pina fabrics may rightfully be praised as heritage textiles utilized in home-tech, car mobi-tech, and geo-tech.
10	Ramie	Ramie naturally resists decay, insects, light damage, bacteria, mold, and mildew.
11	Seacell	It includes tiny fibers from marine algae that support cellular renewal.
12	Lenpur	The softness of silk, the feel of cashmere, and the lightness of linen are all qualities this biodegradable fabric "offers." It is manufactured from white pine tree clippings.

13	Lyocell	Its creation employs non-toxic solvents, which are subsequently recycled to provide a manufacturing process with a negligibly little amount of waste.
14	Soy silk	There is no need for synthetic colorsPalm fruit husk waste is used to make palm fiber. These fibers resemble coir, or fiber. from coconuts.These fibers offer several health benefits, including antioxidant capabilities.These fibers can lessen environmental problems and encourage the use of renewable resources. because soy has a high protein content and the fabric is particularly responsive to natural hues.
15	**Stingplus Nettle Fabric**	The fabric is made from stinging nettle, which "produces a uniquely strong, soft and naturally fire retardant textile fiber," and is "the ultimate environmental upholstery solution" when combined with pure new wool.

2.1.4.2. Nontoxic, Non abrasive and Lower density:

Natural fibers are readily accessible in nature, sustainable materials with benefits including affordability, lightness, renewability, and high specific characteristics. Natural fiber-based composite materials are more environmentally friendly, which has increased their use in a variety of manufacturing industries.Natural fibers have a lower density (1.2-1.6 g/cm3) than glass fiber (2.4 g/cm3), which enables the creation of lightweight composites. As a result, commercial applications of natural fiber-based composites are becoming more and more popular across a range of industrial sectors*(Thyavihalli et al., 2019).*

Eco-friendly bio-composites are no longer a priority due to rising environmental concerns and global warming. Natural fibers offer good mechanical qualities, are widely available, and are inexpensive to harvest. The primary driving forces behind the creation of bio-composites are the dangers of synthetic fibers, recycling problems, and hazardous residues. Bio-composites have qualities similar to those of synthetic fiber composites and are utilized in numerous applications across a variety of industries. They are biodegradable, renewable, non-abrasive, and non-toxic *(Mohammed ,2021)*

2.1.5.Advantages of natural fiber:

- Environment: Using natural fibers to make goods is less damaging to the environment.
- Not a skin allergy (https://www.onlinetextileacademy.com/advantages-and-disadvantages-of-natural-and-manmade-fibers/)
- Natural fibers are incredibly costly. Natural fibers are soft, opulent clothing, greater environmental benefit. Natural fibers don't require the chemical processing carried out in sizable facilities that consume a lot of fossil fuels.
- The majority of natural fibers have minimal or no allergy levels. This implies that the natural fiber won't affect those of us with sensitive skin.
- Natural fiber goods will treat you well if you take good care of them.
- Moisture is wicked by natural fibers. Natural fibers are unique in that they can wick moisture away from your skin, so if one perspire when exercising, working on a farm, or engaging in daily activities, it is drained quickly.So that you don't become excessively hot or chilly.Since much of the natural fiber comes from animals, the safeguards in place for those creatures also apply to humans when we use that fiber to make clothes.
- Transparent production :People are becoming more and more interested in learning where their food comes from, how their clothing are created, and if the products they buy were made ethically (https://nznaturalclothingshop.co.nz/our-blog/natural-fiber-advantages-and-disadvantages?setCurrencyId=9)

2.1.6. Disadvantages of natural fiber:

- Costly: Materials manufactured from natural fibers are often more costly than those made from synthetic fibers, which are simpler to manufacture.
- Shrink: Aggressive washing can cause natural fabrics to shrink.
- Natural fibers cannot be found in high tenacity (HT) and medium tenacity (MT), unlike synthetic fibers. Natural fibers are less resilient than synthetic fibers, thus the textiles created from them have a lower degree of crease recovery and are more prone to "baggy knee" creases.

- Natural fiber production is not entirely predictable. As a result, there are seasonal variations in the amounts of particular grades, which tends to lead to price changes in response to changes in demand that cannot be predicted until the fibers are created.
- Differences in the length, fineness, etc., of yarn produced from natural fibers is less regular and consistent than yarn generated from synthetic fibers.
- Natural disasters and the whims of nature have an impact on the availability of natural fibers.
- Utilizing land is necessary for both the production of natural fibers and the cultivation of agricultural items. Due to the limited quantity of land that is present on the earth's surface, it is necessary to strike a balance between the needs for food production, housing, and natural fiber production (https://www.onlinetextileacademy. com/ advantages -and-disadvantages-of-natural-and-manmade-fibers/)

2.2.Palmyra fiber:

2.2.1. Introduction:

The Borasseus Flabellifer is a tall, upright palm with a canopy of several dozen huge, fan-shaped leaves that spans three meters. It may grow to a height of 30 meters and survive for 100 years or more. For those in Southern India, the tree's whole structure has significant socioeconomic importance.From the standpoint of lightness, this trait is quite advantageous. Palmyra fibers are therefore best suited to create reinforcement in green composite materials (Damera Rao *et al.,*2013).The stalks of the palmyra leaf are where palmyra fiber, which is robust, affordable, and easily accessible, is obtained*(*Somen, *et al.*,2016).Palmyra (Borassus flabellifer) is a natural fruit fiber that is widely accessible. This fiber offers numerous benefits, including biodegradability, renewability, low density, and cheap cost, which opens up new potential for development (Manivannan*et al.,*2016).

2.2.2. History:

The "Borassus flabellifer" often known as the palmyra tree is a tall, swinging tree. The words "Borassus" and "flabellifer" are both derived from Greek words that indicate the leathery covering of the fruit.The 'palme' family of palm trees includes the palmyra palm. Kerala's Palakkad district is well-known for being the home of palmyra trees. The palmyra tree has a long history in literature, culture, and history. The Palmyra tree serves as Tamil Nadu's national tree. Because all of its components may be used, it is revered in Tamil culture as the "celestial tree," or karpaha. The Asian Palmyra palm, which is widespread across Cambodia, is a national emblem for the country (Hiralal *et al.,*2017).The species normally occurs close to the coast and is adapted to dry, sandy environments. The plant is fairly tall and slender since it grows slowly. The grey trunk of this tropical tree, which eventually reaches a height of roughly 30 meters, is made up of many scar rings from leaves that have fallen. Male or female palms exist; male blooms are smaller and female blossoms are much bigger. The female flowers can begin to produce fruits after being pollinated, but in the tropics this process takes at least 12 years to complete.

The plant may be kept as a houseplant that grows slowly. Because a deep taproot forms, it is crucial to use a high container (at least 60 cm). Also, make sure the soil is sandy, well-drained, and in a sunny area (https://onszaden.com/Borassus_flabellifer).

2.2.3. Properties of palmyra fiber:

- They are reasonably priced, possess good insulating qualities, high tensile strength, strong chemical resistance, and great dimensional stability.
- Composites made of natural fiber reinforced polymer matrix are extremely environment-sensitive. Properties of composites made of randomly mixed palmyra fibers with different fiber lengths and fiber contents(Velmurugan *et al.,* 2007*).*
- Major factors that confirm the suitability of biomaterials for commercial use are their physical qualities. In male and female Borassus aethiopum, the moisture content, density, swelling, and shrinking were measured.
- The oven-dry technique was used to test the density, green and dry moisture content, and shrinkage, while the water-saturation test and oven-dry methods were used to measure swelling and shrinkage, respectively.
- Contrary to moisture content, density dropped radially from the edges to the centers of the trees and towards the crowns (*Bernard et al .,2021*).
- Natural fiber known as palm fiber is derived from several sections of the palm tree (Borassus flabellifer), which is widely distributed in southern India. The cellular makeup of plant fiber can be used to characterise it.
- Natural fiber, often known as plant fiber, has the following chemical components: cellulose, hemicellulose, lignin, pectin, and foreign substances. Crystalline cellulose regions (microfibrils) that are joined by hemicellulose and lignin fragments make up each fiber cell (*Pradeep et al.,2015).*

2.2.4. Uses of palm fiber:

- The fiber exhibits good dye adsorption when dyed with reactive and basic dyes.
- It has a wide range of uses, including non-woven products, home textiles, fancy goods, ornamental purposes, disposable bags, home textiles, and various value-added products

  (Muthuvelammai,2017).
- The leaves are also used to make mats, baskets, fans, hats, umbrellas, buckets, sandals, and writing materials in addition to thatching roofs and fencing. The ripe leaves were traditionally sun dried after being seasoned with hot water and turmeric. They are then cut into writing-friendly shapes and given a spine*(senthil kumar et al.,2021)*
- Toddy or palm jaggery products are used in the production of ayurvedic remedies to lower the risk of cancer, diabetes, and obesity, among other diseases. Jaggery has numerous advantages over sugar, including calcium, phosphate, magnesium, and potassium (*Djibrilla et al.,2010*).

2.2.5. Advantages of palmyra fiber:

- It is 100% biodegradable and compostable, 100% biodegradable, and has the ability to naturally degrade into its basic constituents and return back into the environment.
- The yarn is unique in its characteristic pattern and is stronger than cotton.
- When woven, the fabric is high in drapability like linen, lighter than cotton, rich in lustered, and distinguished by the unique palm fiber pattern.
- Most importantly, however, is that it is 100% biodegradable and compostable*(Rani et al .,2021).*
- Palm fruit husk waste is used to make palm fiber. These fibers resemble coir, or fiber from coconuts. These fibers offer several health benefits including antioxidant capabilities.
- These fibers can lessen environmental problems and encourage the use of renewable resources.

2.3. Cotton fiber :

2.3.1.Introduction:

China, India, the US, Pakistan, and Brazil are the top cotton-fiber producers in the world. About 80% of the cotton in the world is produced in these nations. Cotton fiber is a seed fiber from a plant that must be extracted and then dissociated from the seed. Cotton can be manually harvested from the field or automatically harvested using a spindle picker. Ginning describes the process of extracting cotton fibers from seeds. The fiber is subsequently processed by opening, mixing, washing, carding, combing, and other steps (Gloy et al .,2015).

The finest form of cellulose, the most prevalent polymer in nature, may be found in cotton fibers. Cellulose makes up over 90% of cotton fibers. Various amounts of cellulose are present in all plants. The most important natural fiber is cotton fiber, which is also the purest source of cellulose. Cotton's dominance (more than 50%) among fibers for clothing and textile products demonstrates its economic importance on the worldwide market. The market price and the calibers of cotton goods are closely correlated with the calibers of the fiber (*Hsieh et et al , 2007*).

2.3.2. History of cotton fiber:

- The cotton plant produces cotton, a soft, fluffy staple fiber. Around the plant's seeds, it develops into a Cotton fiber. Cotton fiber is essentially pure cellulose. Independent of one another, a number of civilizations in the Old and New Worlds reported employing cotton for textile production. Since at least 5000 BC, cotton has been utlized in the Old World (http://www.historyofclothing.com/textile-history/history-of-cotton/).
- India and the Americas have utlized cotton as a fiber at least since 3000 B.C. In Pakistan's Indus Valley and Peru's coastal valleys, pieces of 4000-year-old cotton textile have been discovered. Ancient Peruvian mummies were wrapped in cotton, whilst Egyptian mummies were wrapped in linen. Nevertheless, cotton samples dating back to ancient Egypt have also been discovered. Cotton has reportedly been grown for more than 7,000 years, according to some experts. Thousands of years ago, several types of plants that are comparable to current cotton plants were domesticated throughout Central and South America and India.

- It was given the name "muslin" after the cotton-producing town of Mosul in modern-day Iraq by Arabs who brought it from India via Spain and Sicily. In the past, wool and flax (linen) were the primary materials used to make clothing, with silk being an expensive material only accessible to the wealthy.The long strands of cotton from the Americas—up to three inches long in certain cases—were better for producing soft, pleasant clothing than strains brought to Europe from the Middle East and India. What are currently the Mexican states of Tabasco and Veracruz are most likely where this cotton was initially grown (https:// factsanddetails .com /world /cat54 /sub349 /item1227.html).

2.3.3. properties and uses of cotton fiber:

- A waxy cuticle surrounds the major and secondary walls of a mature cotton fiber. It is made up of a combination of pectin, waxes, and cellulose fibrils.A natural polymer of pure cellulose remains after all remaining traces of pectin, waxes, proteins, etc. have been eliminated.
- Chemical finishes or treatments can be used to change cotton. For example, the process of mercerization involves treating cotton yarns or fabrics with sodium hydroxide to improve its absorbency, sheen, softness, and strength. The cross-section of the fiber grows rounder and swells during mercerization.
- Due to the swelling action, which causes the fiber to untwist and creep and further lowers the degree of crystallinity and the length of the crystallites, the strength of the fibers improves noticeably while their extensibility diminishes*(Wang et al .,2009).*
- Comfortable: Wearing cotton is really comfy.
- Cotton fabric keeps the naturally fluffy and delicate texture of the cotton plant.
- Cotton is formed from cotton fibers, a naturally occurring plant-based substance.
- Cotton is absorbent because of the space between its fibers, which allows it to drain moisture away from the skin.
- Cotton fabric is also breathable because of the spaces between the fibers.
- Cotton drapes in a form that fits the body organically.
- Durable: Cotton is tough, and when it's wet, it really grows tougher. Making your clothing last longer is the key to any sustainable wardrobe, which is why cotton is ideal for the fashion industry(https://cariki.co.uk/blogs/the-green-road/what-is-cotton-characteristics-and-properties).

2.4. Bamboo fiber:

2.4.1. Introduction:

Natural bamboo fiber, which is obtained by physically and chemically mixing natural bamboo fibers, makes up the majority of bamboo.Bed sheets, curtains, scarves, cloth, mats, and other items are made from bamboo fiber yarn. These sorts of fiber goods can also be made using high-quality cool jade fiber instead of it (*Nicole,2023*).The bamboo plant is used to regenerate bamboo fiber, a type of cellulosic fiber. It is a fantastic biodegradable textile fiber with strength on par with traditional glass fibers, making it a wonderful potential green fiber. The bamboo used to prepare fiber is typically 3–4 years old. Bamboo stems and leaves are alkaline hydrolyzed and multi-phase bleached to create fiber, which is then chemically treated to remove any remaining starchy pulp (*Isra et al ., 2014*).

Natural plant fibers have improved our everyday lives' sustainability and economic prosperity. Particularly, bamboo fibers have been utlized in a variety of industrial settings, including textile, paper, and construction. Bamboo fiber (BF) has recently attracted fresh interest, with the main goal of replacing or reducing the usage of glass fiber derived from non-renewable resources *(Jianwei et al .,2012).*

2.4.2. Properties and Uses of bamboo fiber:

- Bamboo fiber features a variety of micro-gaps, making it softer than cotton and improving its ability to absorb moisture. They are biodegradable, environmentally friendly, and elastic.
- The fiber is UV-resistant, bacteriostatic, antifungal, antibacterial, hypoallergenic, hydroscopic, and a natural deodorizer. Additionally, it has a significant tensile strength and is extremely stable, strong, and long-lasting.
- Bamboo fibers are employed because they have a variety of uses.mostly in the textile sector for the production of clothing, towels, and bathrobes. It is used to make bandages, masks, nurse wear, and sanitary napkins because of its antimicrobial properties.
- To decrease the impacts of microorganisms and the harm caused by ultraviolet radiation on human skin, bamboo fibers are also used to make TV covers, wallpaper, curtains, and many other items. Additionally used for decorating, bamboo fibers (*Isra et al ., 2014*).

- Natural bamboo fiber, bamboo pulp fiber, and bamboo charcoal fiber are the three categories of bamboo fiber. Using physical or microbiological degumming, natural bamboo fiber is a fiber that is directly removed from bamboo.
- Since the extraction procedure does not alter the original bamboo fiber's crystalline structure qualities, the fiber is natural. Bamboo pulp fiber is created from bamboo pulp that is appropriate for creating fiber and from which the fiber is subsequently derived.
- Although natural bamboo fiber keeps the qualities of the original bamboo, it is technically inefficient to produce since it takes more raw resources. The majority of bamboo fiber goods now available on the market are comprised of bamboo pulp fiber and bamboo charcoal fiber *(Haitao et al.,2021).*
- Bamboo fabric has a natural deodorizing characteristic, making it more antistatic than other types of fabric. Bamboo fabric also tends to perform better when it comes to smells.
- Bamboo fiber is similar in thickness and brightness to typical finely bleached viscose and exhibits a high level of toughness, stability, and durability. It has the properties necessary to spin perfectly and can withstand abrasion. All components of the quality criteria are used to designate the yarn and fabric manufactured from bamboo fiber as being of the highest caliber (https ://www. Bamboofabricstore .com.au /view/ properties/24).

2.4.3. Advantages of bamboo fiber:

1. Bamboo is a very soft material.

The fabric made from bamboo is opulently soft it practically glides on your skin. This is because bamboo fiber has a smooth, rounded structure without any harsh or pointed edges that might irritate skin.

2. Bamboo textiles breathe well.

The tiny openings in bamboo fibers provide for great airflow when used as cloth.

3. Bamboo is beneficial in warmer climates

When it's hot outside, bamboo fabric's thermoregulatory qualities help to stay cool. The material's ability to drain away sweat and breathe makes it the most comfortable material available.

4. Moisture-wicking bamboo fabric

Because bamboo fabric wicks moisture from your skin more rapidly, it actually helps to keep your skin pleasant and dry. Because bamboo is significantly more breathable than cotton, it is ideal for sports apparel and more personal clothes. Although they can absorb more water, bamboo clothing actually dries twice as quickly as cotton.

5. Antibacterial bamboo

Bamboo textiles areanti-bacterial properties, the fiber in help battle smells, keeping it fresher for longer. As we all know, fewer washes result in clothing that last longer and a more environmentally responsible closet.

6. Bamboo provides UV defence

Bamboo fabric filters up to 97.5% of UV radiation, providing natural protection from the sun's damaging rays.

7. Bamboo textiles are wrinkle-resistant

A remarkable characteristic of bamboo is that it's not readily wrinkle, even after repeated washing. This makes it ideal for those of us who don't enjoy using an iron, and it also makes it more environmentally friendly because it requires less energy to preserve our bamboo clothing. (https://cariki.co.uk/blogs/the-green-road/what-are-the-advantages-and-disadvantages-of-bamboo-fabric).

2.5.Blending:

2.5.1. Introduction:

In fiber technology, two or more fibers can be combined to create new features or combinations of existing ones. This process is known as blending and can take place in one of two ways. The first is the more established and older idea of fiber-to-fiber blending, which involves combining traditional synthetic or natural fibers to create what are known as fiber mixes. There are several methods for mixing fibers(*Paul,2000*).Mixed yarns can only be used to make thick textiles, handicrafts, and ornamental objects.The yarn is tougher than cotton and has a distinctive design that makes it stand out. The cloth has a high degree of drapability when it is woven.Lighter than cotton, lustrous, and distinguished by the distinctive palm fiber pattern, linen *(Chanphen et al.,2014).*

2.5.2.Advantages of blending fibers:

- A common technique for improving the functionality and appearance of a fabric is to blend various types of fibres.
- The special benefit of blended yarns manufactured from natural and synthetic fibres is that they successfully combine the positive aspects of both types of fibre, such as comfort in wear and ease of maintenance.
- These benefits also make it possible to produce a wider range of goods, which strengthens the marketing edge (Baykal *et al*.,2006).
- Lowers expenses by combining an inexpensive fiber with an expensive one.
- Combines fiber features to increase fabric performance and hide less desirable traits in a single fiber.
- Produces many textures and color effects.
- Enhances wearing characteristics.
- Taking care is simple.
- It becomes more supple, silky, crease-resistant, and pleasant to wear.
- It does not contract.
- It gets stronger to resist heavy use and many washings (http://textileclothinginfo.blogspot.com/2015/02/importance-of-blending-and-mixing.html).

2.6. Weaving:

2.6.1. Introduction:

One of the three fundamental requirements of humankind, along with food and shelter, is clothes. Weaving specifically and the creation of cloth in general are perhaps as old as human history. The process of weaving is a combination of science and art; despite technological advancement, it is still not a procedure that is strictly under control. Warp and filler threads are interlaced perpendicular to one another during weaving. There are essentially many methods to interlace warp and filler yarns. Every method leads to a distinctive fabric structure(*sabit,2001*).

Table II: Classification of Looms.

The following table shows the loom is classified as follows:

TABLE II

S.No	Classification	Definition
1.	Hand Looms	In the less developed nations, all sorts of textiles are still produced using this form of loom in reasonably big quantities.
2 .	Non-automatic Power Loom	Although these machines are becoming less and less common, especially in wealthy nations, they appear to still be somewhat helpful in the manufacturing of specialised textiles
3.	Conventional Automatic Loom	The machines became well-known on a global scale because to their benefits of adaptability and relative affordability
4.	Circular loom	These looms have extremely restricted uses, but since the weft is continuously inserted, they are able to insert the weft at high rates from rather slow shuttle speeds (https://textechdip.wordpress.com/contents/welcome-to-weaving/).
5.	Pitloom	The pit over which the manually operated pit loom is positioned is where it gets its name.The pit loom is thought of as an improvement over the handloom and the backstrap loom for a number of reasons, and as a result, it also has relatively greater output rates. They are frequently used to weave rugs and carpets, notably reversible ones, that are both thin and thick. Khadi is a textile that is frequently connected to pit looms (https://mapacademy.io/article/pit-loom/)

2.6.2. Plain weave:

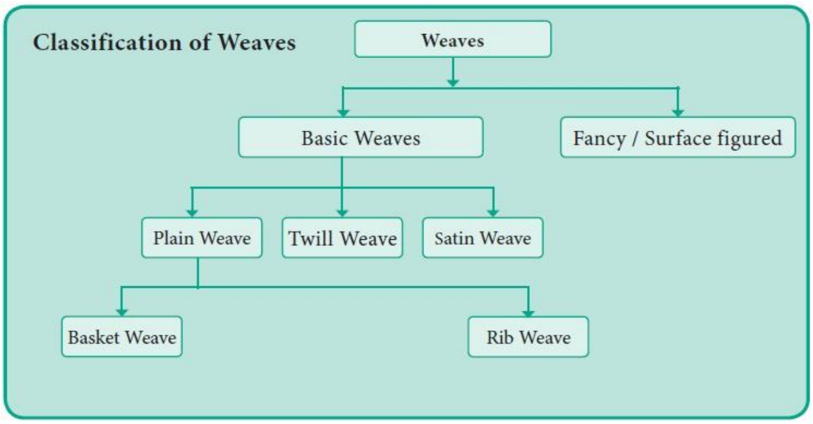


Figure 3. Classification of weave (https://www.brainkart.com/).

- Plain weave: It is easiest to interweave plain weave, creating a robust, fine fabric. The threads in this plain-weave fabric are weaving or moving vertically across the strands' weft. It keeps on until the right cloth is produced. This simple weave is the most popular due to its high level of strength, durability, and fabric quality.

- Rib weave: A more modern or somewhat modified variant of plain weave cloth is rib fabric. Either weft or warp yarn is laid out horizontally in this kind of fabric.

- Basket weave: A different type of plain weave that uses more than one thread is basket weave. This describes a yarn in which two or more weft threads alternately weave with more than one warp strand. The over-over, under-under pattern is used.

- Twill weave: The fibers run diagonally over and under the strands in twill weave fabrics. A strong, soft, more draping weave and a smooth fabric are produced as a consequence. The cloth surface's diagonal stripes guarantee its smoothness (https://fabriclore.com/blogs/journal/types-plain-weave).

2.6.3. Advantages of weaving:

- weaving is efficient and of high calibre.
- Making fabric from one or more sets of yarns is a simple process.
- Many different industries, including apparel, home furnishings, and industry, use weaving fabrics in their industries (*sabit,2001*).

- Cost: Time and labour expenses are reflected in the price of the goods, as in any industry. On looms, textiles are created and manufactured to be durable. The cloth won't shrink and can't be stretched. While this does result in higher-quality apparel, it also raises the cost of manufacture.
- Because woven textiles are strong, they are perfect for heavier work clothing like coveralls and jeans. Additionally, as a result, knit cloth feels softer than woven fabric.
- The majority of cotton weave textiles, like denim, are easy to clean and usually won't shrink or wrinkle.
- The use of this loom results in the production of cloth with texture.
- Because weaves outlive most other textiles, such as knits, by a significant margin, they are used to make so many heavy-duty fabrics (https://oureverydaylife.com/the-advantages-disadvantages-of-woven-fabrics-12566298.html).

2.6.4. Advantages of pit looms:

- The pit loom winding package can handle weft yarn of excellent grade.
- If using a pit loom, every weaver can produce something.
- Here, moisture is easily controlled.
- In order to eliminate fabric flaws like yarn breakage and knots, flu shuttle and back beams have been created (https://textiletutorials.com/pit-loom-in-weaving-definition-features-advantages-and-disadvantages/).

3. METHODOLOGY

Methodology pertaining to the study on **"Development of fabric using palm fibre blended with bamboo and cotton"** are discussed under the following headings:

3.1.Selection of materials

- 3.1.1. Selection of fibre

3.2. Palm fibre processing

- 3.2.1. Retting
- 3.2.2. Degumming of palmyra fibre
- 3.2.3. Cleaning of palmyra fibre

3.3. Spinning process

- 3.3.1. Fibre process
  - 3.3.1.1. Cutting
  - 3.3.2.1. Carding of fibre
  - 3.3.2.2. Sliver process
  - 3.3.2.3. Drawing
  - 3.3.2.4. Rotor Process

3.4. Weaving

- 3.4.1.Introduction
- 3.4.2 Plain weave

3.5. Evaluation

- 3.5.1. FIBRE TEST
- 3.5.1.1. Fibre denier
- 3.5.1.2. Fibre diameter
- 3.5.1.3. Fibre strength and elongation

3.5.2. YARN TEST

3.5.2.1 Twist per inch

3.5.2.2. Single thread strength

3.5.2.3. Elongation

3.5.3. FABRIC TEST

3.5.3.1. GSM

3.5.3.2. Fabric Thickness

3.5.3.3. Fabric Stiffness

3.5.3.4. Tensile Strength

3.5.3.5. Fabric Abrasion Test

3.1. Selection of materials

Material selection entails selecting a fibre that was easily biodegradable and environmentally benign.

3.1.1. Selection of fibre

Palmyra Palm botanically known as Borassus Flabellifer. The primary goal of the study was to extract the neat fibre, which was distinguished by its tensile and surface properties.Natural fibres are readily accessible, eco-friendly, and have a regenerative behaviour.(Suresh et al.,2013).This fibre was famous on south Tamil Nadu .Hence palmyra palm was selected (plate I) from Anaimalai it was taken.

3.2. Palm fibre processing:

3.2.1. Retting

The process of extracting the fibre involves either dissolving the cementing substance using a chemical process or a microbiological one, after which the fibre bundles are released from the tissues and removed by washing (zakaria et al.,2001).Retting was the biggest difficulty encountered while processing bast plants to make long fibre. The dew and water retting techniques are the conventional ways to separate the long bast threads. The hemicellulose and lignin must be broken down over the course of 14 to 28 days using both techniques.

Water retting can result in high-quality fibres, but because the process takes so long and the water was so contaminated, it was less appealing. Other alternatives have been described for thwas purpose, with variable results, including mechanical decortication, chemical, heat, and enzymatic treatments (Ahmed et al., 2011).Hence the retting process was done in Navamalai , Pollachi

3.3. Spinning process

3.3.1. Fibre process

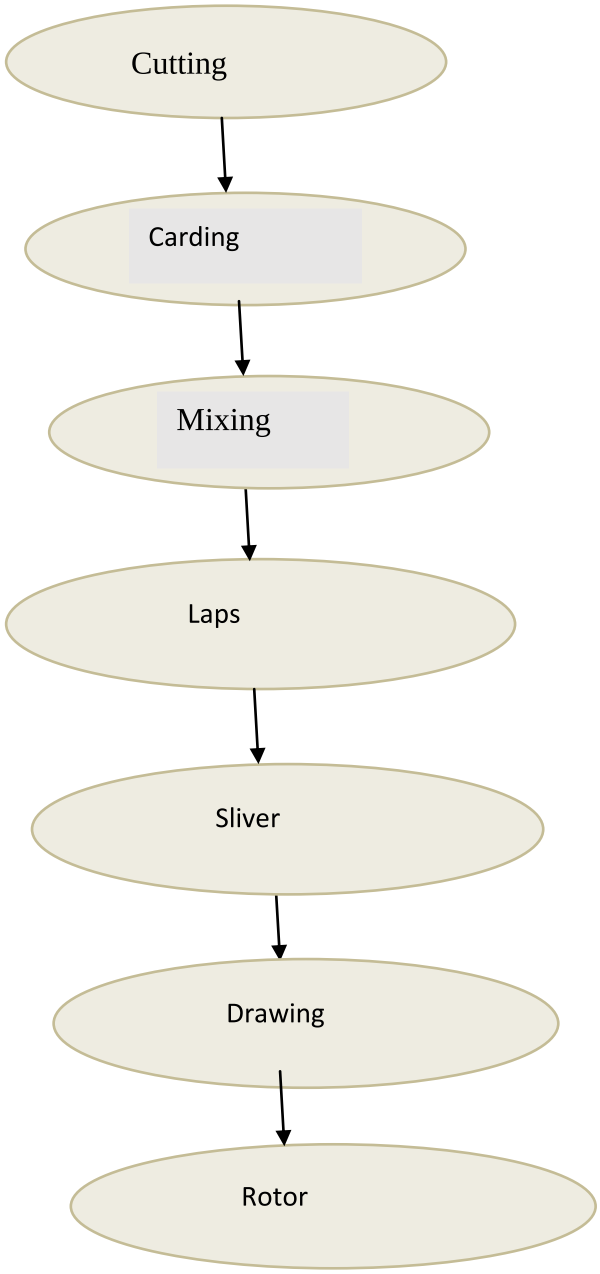


Figure 3: Fibre Process of flow chart

1. Opening:

- The fibrewas opened and blended manually or using a blower.

2. Carding:

- Although the tiny carding system was used to feed the fibre, the card web did not develop.
- The fibrewas then mixed with cotton in a 75:25 ratio,(75% cotton and 25% palm fibre).
- The mixed fibrewas then fed through the carding device, where it was eventually fashioned into a card web.

3. Mixing:

- Fibre mixing carried out while performing laps.
- Cotton fibrewas laid, palm fibre was distributed, and the carding machine was turned on.

4. Laps:

- In the process of lapping, fibres are squeezed and compressed fibre, which was frequently used to blend different fibres.
- In a single lap, these laps were rotated according to their times and numbers.

5. Sliver process:

- The sliver procedure was performed after lapping.
- In order to create a sliver, a lapping and a conical piece were attached.

6. Drawing

- In the carding machine's sliver processing was done.
- Thin fibre in the drawing frame was placed.
- The drawing was placed in a basket and saved for spinning after being placed into the machine.
- The same draw frame was used to feed the plied sliver once again for doubling.

7. Rotor process:

- A spring-loaded feed plate and a feed roller received the draw frame sliver.
- The fibres with in the sliver were then separated using a combing roller that was wrapped in saw tooth wire clothing
- The process was carried out in our Textile Production laboratory, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore.

3.3.2.5. Weaving

3.3.2.5.1. Introduction

Weaving was the process of creating fabric by crossing two sets of threads at right angles. This was often done using a hand or power-operated loom. The actual weaving process takes place on a raised, frame, or pit loom. The loom may use a fly shuttle or a throw shuttle. It might be equipped with a jacquard, a dobby, or even just a simple plain loom with two treadles or many treadles (Paul,2015).Due to their greater efficiency over pit looms at producing wider fabrics, handlooms were developed. People from various communities started weaving when the looms were changed since pitloom weaving no longer had caste connections (https://www.tilonia.com/blogs/artisans/weaving).The process was carried out in Pallipalayam ,Erode.

3.3.2.5.2.Plain weave

The most prevalent and compact fundamental weave structure was the plain weave, in which the filler threads alternate with the warp threads in the subsequent row to repeat the pattern and create a chevron-like surface. Though they do not easily ravel, they do have a tendency to wrinkle and are less absorbent than other weaves. The term "plain weave" can also refer to the Calico or Tabby weave. Tabby Weave or Plain Weave. This weave has a broad range of applications (Textile School , 2018).Hence the plain weave was selected.

3.4. EVALUTION

The connections between assessment, innovation, management, context, and a critical instrument in the development of language teaching and learning. The remaining portion of the selection focuses on various assessment goals, including those that could examine possible methods for assessing language instruction and learning (Pauline et al .,2003).

3.4.1. FIBRE TEST

The following fiber tests were carried out:

3.4.1.1. Fibre fineness

A finer count may be achieved while spinning a fine fibre than a coarse one. Less twist is required to achieve the required cohesiveness the finer the fibre, the bigger the overall surface area available for inter fibre content.If all fibres had perfectly circular cross-sections it would be a relatively simple matter to measure the diameter by means of microscope. The task would be even simpler if it were known that the cross section was uniform along the fibrelength and from fibre to fibre. Since ,the fibres exhibit a variety of cross-sectional shapes and they also vary in section along their length and vary from fibre to fibre.

The mass of cylinder or prism given by

Mass = volume x density

= cross-sectional area x length x density (Raul,2005).

This test was done in SITRA (south India Textile Research Association) , Coimbatore .

3.4.1.2. Fibre diameter:

Natural fibers like coir, palm, sisal and banana fibres due to their smaller diameter and antifungal properties, synthetic sound absorptive materials perform better acoustically than natural ones, but they also have a greater negative impact on the environment.By eliminating several significant components including lignin, pectin, and hemicelluloses from the fibre, mercerization raises the surface roughness of the fibre. Although the absence of these substances decreases the material's ability to absorb sound, it improves the adhesion of the fibres to the binder, increases the longevity and antifungal properties of the fibres, and most importantly, reduces the diameter of the fibres(Fouladi *et al.,2016*).

This test was done in SITRA(south India Textile Research Association) , Coimbatore.

3.4.1.3. Fibre strength and elongation:

The alignment of the bundle of long glass fibres along the loading direction is one of the strength-controlling factors taken into account throughout the experiment.Compared to glass fibres, the natural fibre offers less strength and durability. The specific strength and stiffness of low specific gravity materials are higher than those of glass. Natural fibres are easy to prepare without the need for equipment and have high thermal, dielectric, and acoustic insulation qualities(Raoetal.,2015).Tensile strength tests were conducted with varying amounts of matrix and fibre, as well as with varying fibre lengths. The single-fibre tensile test, the fibre pull-out test, and the predicted binding strength between the matrix and the fibres (Babuet al .,2022).

This test was done in SITRA(south India Textile Research Association) , Coimbatore .

3.5.2. Yarn test:

3.5.2.1. Twist per inch :

It has been investigated if twisting a fibre strand can improve the mechanical response stated above. Twist more successfully maintains each individual fibre in a skein of fibre without significantly altering density. Twist can enhance the interactions between individual fibres in terms of friction forces, enabling the fibres to carry loads even if part of them break(Songet al., 2015).The texture created by the core yarns that have been helically wrapped makes it possible to determine the twist level and its changes(Sule,2014).This test was done in Textile Committee, Coimbatore .

3.5.2.2. Single thread strength:

The manufacturers of the 'Uster' tester have created a set of criteria based on the results of tests on several yarn from various nations in order to compare one's own product with those of the other yarn producers.These guidelines were developed based on the outcomes of testing conducted on several yarns sourced from various nations.These requirements are for spun cotton yarn made from carded and combed cotton. The "breaking length" is a measure of the breaking strength (Raul,2005).This test was done in Textile Committee, Coimbatore .

3.5.2.3. Elongation:

In comparison to yarns with high breaking strengths and low elongation values, those with low breaking strengths and high elongation values take more energy to break.The amount of force needed to separate a group of fibres, such as a skein, or a single fibre depends on their breaking strength and elongation at break (Mathangadeera et al.,2020).These interesting fibre characteristics range from work-to-break traits to fibre maturity, short fibre content, and fibre elongation, among others. Work-to-break is the measure of force needed to break a fibre, and when it refers to a bundle of fibres, it may take into account interactions between the individual fibres as well as quantifiable fibre properties like elongation and toughness. This study looked at cotton that were bred with an emphasis on fibre elongation in order to evaluate spinning performance and yarn quality (Marin et al.,2019).This test is done in Textile Committee, Coimbatore.

3.5.3. Fabric test:

3.5.3.1. Fabric weight:

Standard test method used ASTMD2646 with expression- grams per square metre (ASM).The pad is placed on smooth surface table fabric was placed on the pad. The GSM cutter is gently placed on the fabric. The lock was removed by pulling and rotating the lock nut. The handle is pressed and rotated in lock-wise direction. The fabric was gripped between cutter rubber pad for accurate cutting of fabric the cut fabric weight was using electronic balance. This value is multiplied by 100 to get GSM of the fabric.

3.5.3.2. Fabric thickness:

Standard test method used – IS7702 and ASTM1777.Unit expression-mm. Loading weight is placed on the weight on specified pressure foot is fitted on mounting rod. Lifiting lever is pressed and pressure foot top is lifted. The specimen is placed on the anvil and lifting liver is released gently. The pressure down word is applied on pressure foot on specimen. Reading of the dial gauge is noted to get specimen thickness is mm. This procedure is repeated for 5 to 10 samples and recorded.

3.5.3.3. Fabric stiffness:

Standard test method – ASTMD1388.Unit expression bending length – cms .The instruments was placed on the table. So that horizontal plate from and inclined reference line are at eye level of thee operator. This was held in the horizontal plane and pushed along with the fabric leading edges project beyond the platform .The part of specimen will over hang and start bending under its own weight. This eye was kept in such a way that the 2 inclined line (41.5%) of the tester coincide. This pushing of specimen was stopped when its tip reaches the level of inclined edge is considered. The length of overhanging was recorded for the fabric .Four readings were taken for each side up ,first at one end and then at the other.

3.5.3.4. Tensile strength:

Testing is crucial step in production of textiles and assists business in creating textiles and that meet their desired standards and quality. The tensile testing machine comprises of two clamps to grip the specimen .The clamps are set at a distance of 50mm. The specimen is inserted such that the longer side is parallel to the application of the load with same length of fabric beyond the jaws at each end .the specimen is secured between the jaws of the clamps .Tension was applied between the jaws .On operating the machine the specimen ruptures at the centre when the movable jaw move downwards from the dial was noted in kilograms as strength of the fabric .The elongation reading was noted from the moniter. This was done for both warp and weft directions. This test is done in Textile Committee, Coimbatore .

3.5.3.5. Fabric Abrasion Test

Four specimen of 38mm diameter are fitted on the sample holders. The samples are unable to move vertically in the calmp. Sample holder and till more in the same plane in which the top plate shader. Because of its movement the cloth was rubbed against the cloth surface in hormonous patter at one stage it will be circular and then changed to ware of an equals until the straight line along the diagonal of the curve. In intial weight of the sample was noted. After the reading and abrasion was calculated and noted. Readings are taken and the mean value was calculated and rounded.

Plate I

Selection of fiber, retting process and cleaning

Plate I	**Plate II**	**Plate III**
Selection of fiber 	Retting process 	Cleaning of fiber 

Plate II

Spinning process

Plate IV	**Plate V**	**Plate VI**
Cutting 	Weight 	Carding value 
Plate VII	**PlateVIII**	**Plate IX**
Lapping 	Rolling on drum 	Sliver process 
Plate IX	**Plate IX**	**Plate IX**
Rotor value 	Winding 	Yarn 

Plate III

Weaving

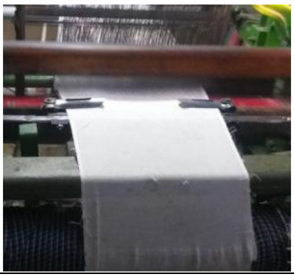
Plate XIII Weaving process 	**Plate XIV** Weaving 

Plate IV

Fiber test

Plate XV **Fiber fineness tester** 	**Plate XVI** **Fiber dimeter test** 	**Plate XVII** Tensile strength tester 

Plate V

Yarn test

Plate XVIII Lea count tester 	**Plate XIX** Twist tester 	**Plate XX** Single thread strength tester 

Plate VI

Fabric test

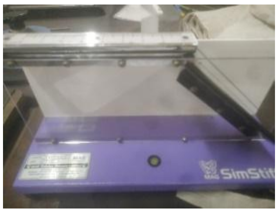
Plate XXI Fabric weight(GSM) tester 	**Plate XXII** Fabric thickness tester 
Plate XXIII Fabric stiffness tester 	**Plate XXIV** Tensile strength tester 

Plate XXV

Fabric abrasion tester

4. RESULT AND DISCUSSION

The research work’s findings on **“Development of fabric using plam fiber blended with bamboo and cotton”**are discussed below.

4.1. FIBER TEST

4.1.1. Fiber Fineness (Denier)

4.1.2. Fiber diameter

4.1.3. Fiber strength and elongation

4.2. YARN TEST

4.2.1. Lea count

4.2.2. Twist per inch

4.2.3. Single thread strength & Elongation

4.3. FABRIC TEST

4.3.1. Fabric weight (GSM)

4.3.2. Fabric Thickness

4.3.3. Fabric Stiffness

4.3.4. Tensile Strength

4.3.5. Fabric Abrasion Test

4.1. FIBER TEST

4.1.1. Fiber Fineness (Denier)

Table III shows fiber fineness of untreated palmyra palm fibers:

TABLE III

Series n=20	**F max (gf)**	**dL at F max**
$\bar{x}$	306	34.8
S	165	17.3
V[%]	54.15	49.92

FIBER FINENESS(DENIER)

Fibre fineness (cut &weight method)	**Palmyra fiber**
Fiber fineness (denier) cut &weight method	224.1

Samples tested at :R.H. 65% $\pm$ 2% and Temp .21 Degree C $\pm$ 1 Degree C

From the table III it is clear that fiber fineness is one of the most important properties of the fiber. The fibre fineness was observed with a projection microscope. The length of a single fiber was measured, and the fiber was weighed. The linear density of the fiber was then calculated in denier units. The fineness was found to be in the range between 677µm- 70.1µm with the average value of 606.9µm. The mean of the *palmyra fiber*diameter was found to be 224.1d. The diameter of *palmyra fiber* leaf fiber indicates that it is coarser (Figure 6). Hence, the distribution of fibre fineness values were statistically proved.

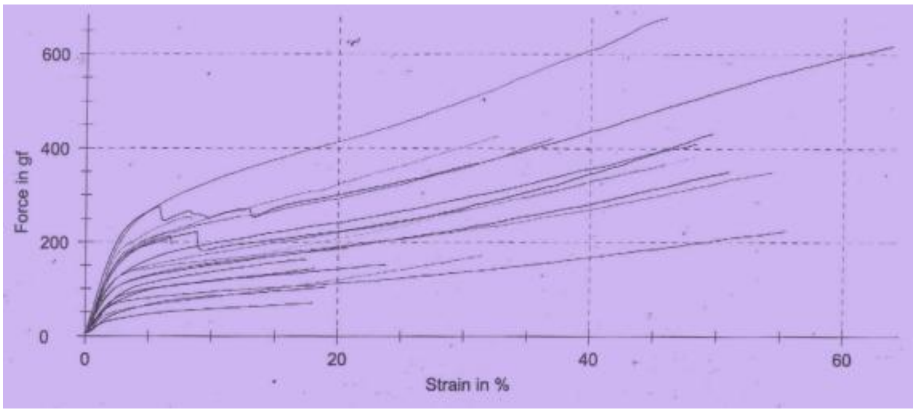


FIGURE: 5Fiber Fineness (Denier)

4.1.2. Fiber diameter

Table V fiber indicates diameter of untreated palmyra palm fibers:

TABLE IV

FIBER DIAMETER

Yarn Diameter (mm)	Fibre sample
Maximum	0.1564
Minimum	0.0931
Average	0.1188

From Table V it is evident that Diameter is one of the most important properties of the fiber. The fibre diameter was observed with a projection microscope. The dimension was found to be in the range between 0.1564µm- 0.0931µm with the average value of 0.0633µm. The diameter of *palmyra fiber* leaf fiber indicates that it is coarser (Figure 6). Hence, the distribution of fibre diameter values were statistically proved.

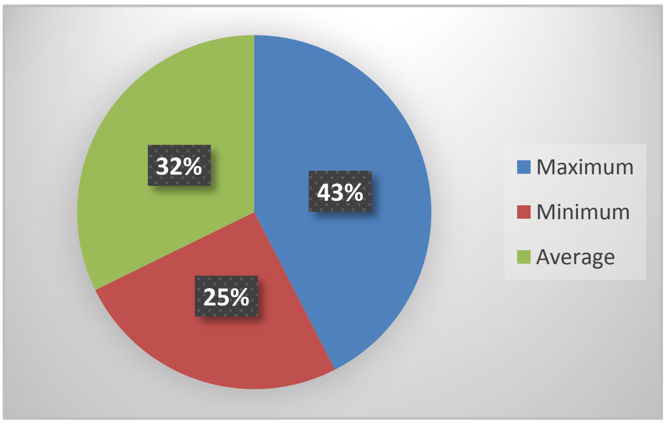


FIGURE :6Fiber diameter

4.1.3. Fiber strength and elongation

Table VI shows Fibre strength and elongation of untreated palmyra palm fibers:

TABLE V

FIBER STRENGTH ANG ELONGATION

Single fibre strength and elongation	**Palmyra fibre**
Mean breaking strength F_{max} (gf)	306
Mean breaking elongation F_{max} (%)	34.8

Samples tested at :R.H. 65% $\pm$ 2% and Temp .21 Degree C $\pm$ 1 Degree C

From the Table VI it is evident that the tensile properties of single STS were determined by a single-fiber tensile testing method as per the specifications of ASTM D-3822:07 standards. Strength and elongation of individual fibers based on the constant rate of elongation were measured. Before carrying out the tensile tests, the sample were conditioned in a standard testing atmosphere of 65%±2% relative humidity and temperature of 21°C±1°C for at least 24hr. Tensile strength is the maximum stress caused by a pulling force that a material can withstand without failing. The extracted *palmyra palm* fiber was found to have fiber strength of 306g/f and an elongation of 34.8%.Hence, the distribution of fibre strength values were statistically proved.

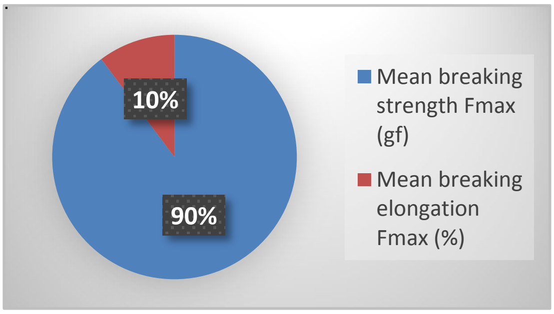


FIGURE :7 Fiber strength and elongation

4.2. YARN TEST

4.2.1.Lea count

Lea count of palmyra yarns are reported in Table VII.

TABLE VI

LEA COUNT

S .no	Wt of lea (g)	Count
1.	18.014	3.60
2.	20.325	3.19
3.	19.519	3.32
4.	19.091	3.39
5.	18.729	3.46

From the table VII and Figure 7 its is clear that the mean value (C.C) is 39.9_sNe.They are coarser yarns. This shows that palmyra yarns have very good strength. This has resulted in count CV% is 4.5 %.Hence, the distribution of stiffness values were statistically proved and lea count values were statistically proved.

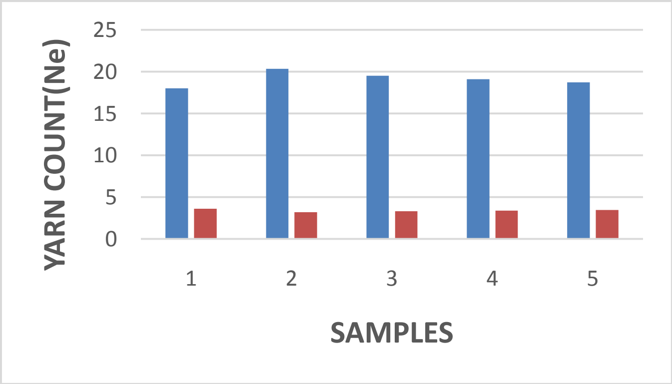


FIGURE : 8 Lea count

4.2.2. Twist per inch

Table VIII shows Twist Per Inch of untreated palmyra palm yarn:

TABLE –VII

TWIST PER INCH

S .no	TPI count
1.	24.50
2.	21.45
3.	22.40
4.	21.22
5.	22.17
6.	22.82
7.	20.77

From the Table VIII it is clear that twist per inch of yarns are reported in Table VIII. The mean value (C.C) is 22.2%.They are coarser yarns. This shows that plmyra yarns have very good strength. This was direction of twist resulted in “Z”.Hence, the distribution of twist per inch values were statistically proved.

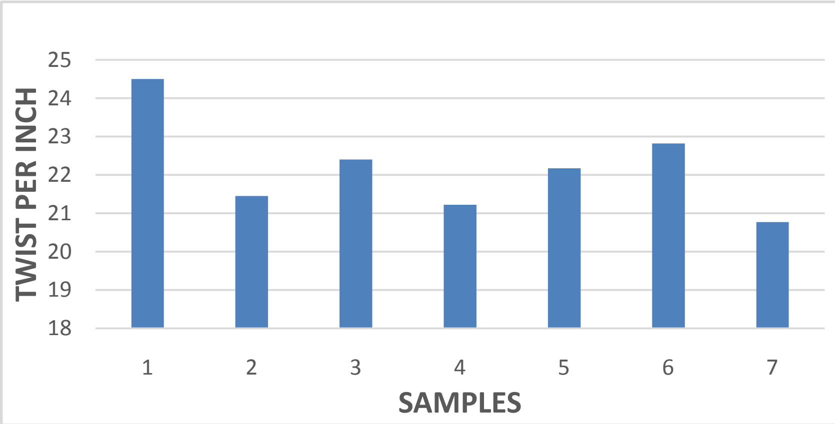


FIGURE : 9Twist per inch

4.2.3. Single Thread Strength & Elongation

Table IX shows Singlethread strength & elongation of untreated palmyra palm yarn:

TABLE –VIII

SINGLE THREAD STRENGTH& ELONGATION

S.no	F (kgf)	Ex (mm)
1.	622.7	172.0
2.	804.9	149.2
3.	623.9	147.9
4.	682.5	169.5
5.	636.6	165.6
6.	732.2	146.1
7.	710.1	159.5
8.	630.5	165.2
9.	826.0	188.7
10.	715.7	150.9

From the Table IX it is clear Single Thread Strength ofyarns are reported in Table IX. The average value of STS (g) force is 698.5f/g.They are coarser yarns. This shows that palmyra yarns have very good strength. This has resulted in count CV% is 10.6%.The Breaking Kilometer (RKM) values are 4.0 and CV% are 10.6. The elongation at break value mostly lies between146.1% and 169.5 %. Though the elongation values are resulted in 32.3%. Elongation of CV% is 8.3%.Hence, the distribution of single thread strength and elongation values were statistically proved.

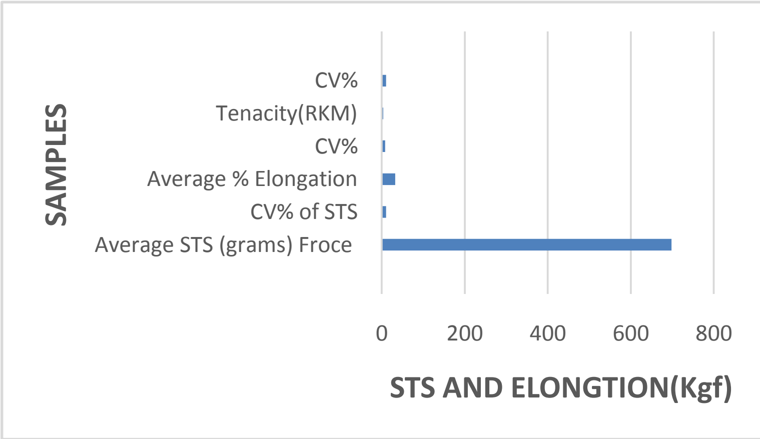


FIGURE : 10 Single Thread Strength & Elongation

4.3. FABRIC TEST

4.3.1. Fabric weight (GSM)

The fabric weight and analysis of standard deviation ,mean and variance of original fabric are shown in table X and figure 9

TABLE –IX

FABRIC WEIGHT (GSM)

S .no	Name of the sample	Mean	Loss over the original weight	% gain over the original weight	t-value t-critical one-tail
1.	O	8.747	0.105	90.052	2.306004^{NS}
2.	W	8.642			

NS-Non Significant

Table X and figure 9 shows that weight of fabric in grams was measured by theweight balance at the average weight of 8.747g. The weight of fabric grams was measured by the weight balance at the average weight of W,8.642g. The thickness has increased by 90% from the original cloth.The thickness has decreased by from 0.105 after the washing .The fabric weight (GSM) values has no change. Hence there is no significant difference.

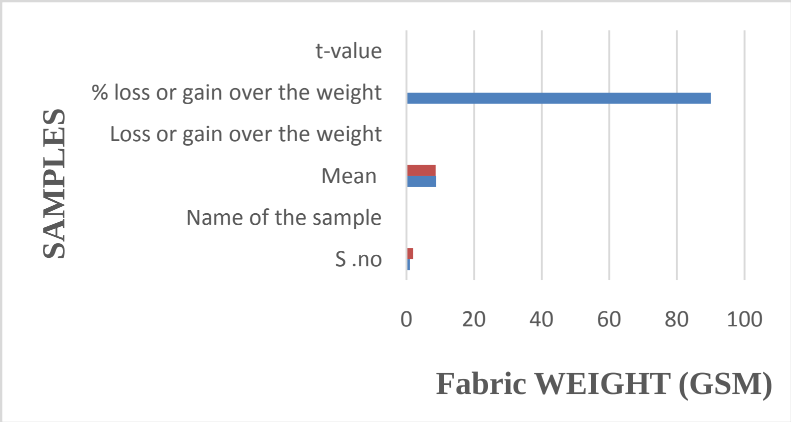


FIGURE :11 Fabric weight (GSM)

4.3.2. Fabric Thickness

The fabric thickness and analysis of variance of original fabric and washed fabric are shown in table XI and figure 11

TABLE X

FABRIC THICKNESS

S .no	Name of the sample	Mean	Loss over the original weight	% gain over the original weight	t-value t-critical one-tail
1.	O	0.3406	0.148	92.248	1.859548[NS]
2.	W	0.3.258			

NS-Non Significant

Table XI and figure 10 shows thatthickness of fabric in mm was measured by the thickness tester at the average weight of O,3406g. The thickness of fabric in mm was measured by the thickness tester at the average weight of W, 0.3258g.The thickness of fabric sample is displayed on the meter.The thickness has increasedby 92% from the original cloth.The thickness has decreased by from 0.148 the washed cloth .Here the weight varies from 20g/f to 1000g/f.The fabric thickness values has no change. Hence there is no significant difference.

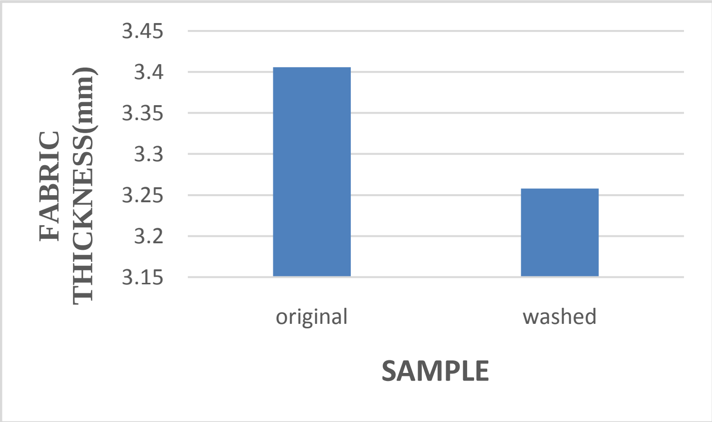


FIGURE :12 Fabric Thickness

4.3.3. Fabric Stiffness

The fabric stiffness and analysis of variance and mean of original fabric are shown in table XII and figure 13

TABLE XI

FABRIC STIFFNESS

S .no	Name of the sample	Mean	Loss over the original weight	% loss over the original weight	t-value t-critical one-tail
1.	O	2.35	0.01	55.096	2.919986 NS
2.	W	1.35			

NS-Non Significant

Table XII and figure 11 shows that stiffness of fabric in inch was measured by the stiffness tester at the average weight of 2.35g. The stiffness of fabric in inch was measured by the stiffness tester at the average weight of W,1.35g.The stiffness of fabric sample is displayed on the scale .The stiffness has decreased by 55% from the original cloth.The stiffness has decreased by from 0.01 the washed cloth .The fabric stiffness values has no change. Hence there is no significant difference.

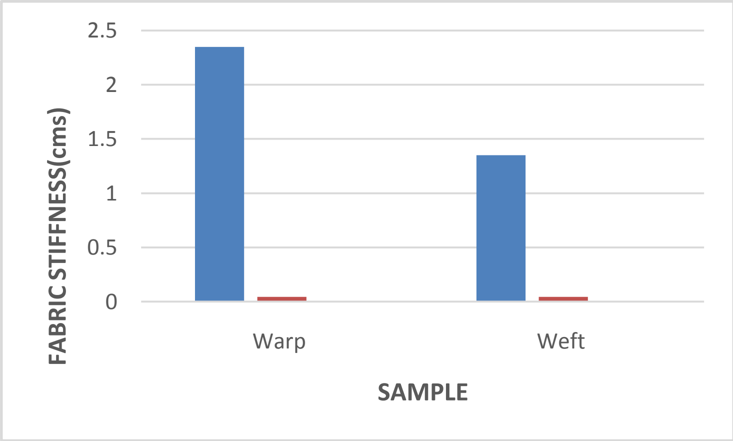


FIGURE :13 Fabric Thickness

4.3.4. Tensile Strength

The tensile strength and analysis of warp and weft of original fabric are shown in table XIII and figure 14

TABLE XII

TENSILE STRENGTH

S. no	Readings (kgf)		Average	
	Warp	Weft	Warp	Weft
1.	33.32	21.81	32.7%	20.6%
2.	32.38	22.67		
3.	32.53	19.99		
4.	32.05	18.98		
5.	33.45	19.94		

Table XIII and figure 14shows that the tensile strength of the force and elongation of the fabric. The size of the strip is 5cm x20cm. The average tensile strength on warp and weft is 32.7kgf and 20.5kgf as shown in the table XIII**.**Hence, the distribution of fabric tensile strength values were statistically proved.

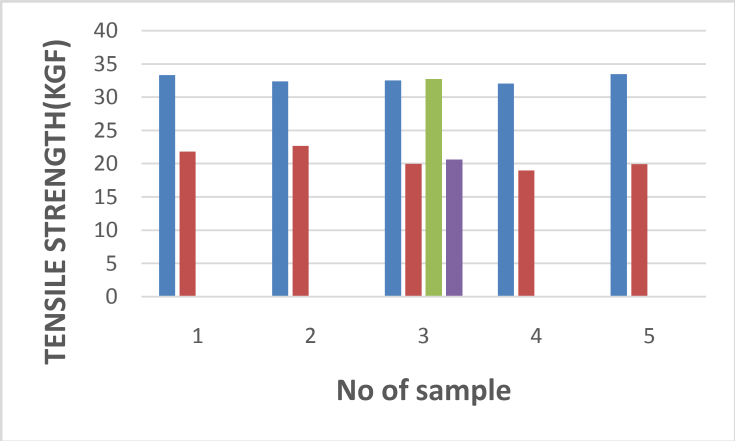


FIGURE :14 Tensile Strength

4.3.5. Fabric Abrasion Test

The fabric abrasion testand analysis of variance of original fabric and washed fabric are shown in table XIV and figure 14

TABLE XIII

FABRIC ABRASION

S .no	Name of the sample	Mean	Loss over the Original weight	% gain over the Original weight	t-value t-critical one-tail
1.	O	0.299	0.013	71.941	1.94318^{NS}
2.	W	0.216			

NS-Non Significant

Table XIV and figure 15 shows that the fabric abrasion of original and washed woven fabric. The thickness has increased by 71% from the original cloth .The fabric abrasion of original and washed woven fabric. The thickness has decreased by 0.013(l) from the washed cloth. The fabric thickness have increase due to washing. overall t-value obtained is 1.94*.Thus the abrasion of selected woven fabric has increased after washing. The fabric abrasion values has no change. Hence there is no significant difference.

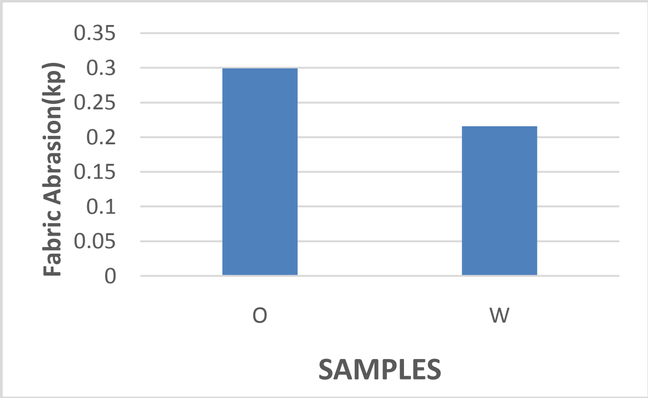


FIGURE :15 Fabric Abrasion Test

5. SUMMARY AND CONCLUSION

In India, the textile industry is one of the most important and significant with a compoundannual growth rate of 4.24 percent, the USD will total 1.23 trillion by 2025. The long-term viability of the textile business is negatively impacted by the use of synthetic fibres. Our health,wellbeing, economic well-being, social life, and safety all depend on a good environment.Natural fibres and recyclable components are used to create environmentally friendly fabrics. In addition to reducing harmful environmental effects, sustainable textiles also help millions of workers receive fair wages and do their jobs in secure environments.

In today's world of growing environmental awareness, everyone has become interested in natural fibres. In addition to its advantages for the environment and human health, the technique of employing natural fibres made from fruit and vegetable fibres has become increasingly popular for its creativity. Because they are harmless and biodegradable, natural fibres are better for the environment and can be used in close proximity to people.

Instead of synthetic fibre, which has a negative impact on the environment, palm fibre can be used successfully. This fibre can be a valuable non-woven textile source in applications where strength is desperately needed. The fibre can be used alone without mixing by altering its surface. The fibre can be utilised in geotextiles, other textile materials that provide reinforcement, and various products with additional value.

Considering the above facts in mind ,the present study designed on "Development of fabric using palm fiber blended with bamboo and cotton with following objectives:

- To select boracassus palm fiber .
- To blend selected palm fiber with cotton and bamboo.
- Blended yarn is converted into woven fabric.
- Evaluation of fiber, yarn and woven fabrics.

Methodology

- The retting and boiling procedure was used to extract palmyra palm. It was picked out and mixed with the cotton.
- Three natural fibres were chosen, and they were turned into yarns.
- The fibre must be blended with cotton to rotor yarn to generate yarn because it cannot be processed in a cotton processing machine which was done at Textile Production lab, Avinashilingam Institute for Home Science and Higher Education for Women ,Coimbatore.
- Bamboo fiber has wonderful qualities with good absorbency. It has anti-allergic qualities and is naturally smooth.
- Compared to cotton, bamboo cloth is far more flexible. Bamboo cloth is produced in an environmentally sustainable manner.
- One of the most often utilised types of fabrics worldwide is cotton. This fabric is chemically organic, thus there are no synthetic materials in it.Cotton was blended with plmyara (75:25).
- Bamboo yarn was used for weaving in pitloom in weft diection .
- In warp direction palmyra cotton blended cotton yarn was used.
- Evaluation of fibre,yarn and fabric was done

Findings of study

Objective Evaluation:

- **Blending:**

  Blending of cotton and palmyra fiber are belend in 75:25ratio.
- **Fiber fineness:**

  The fiber fineness of length of a single fiber was measured, and the fiber was weighed. The linear density of the fiber was then calculated in denier units(224.1).
- **Fiber diameter:**

  Diameter is one of the most important properties of the fiber. The fibre diameter was observed with a projection microscope and diameter was analysed(0.0633µm).

- **Fiber strength and elongation:**

  Strength and elongation of individual fibers based on the constant rate of elongation were measured .Tensile strength is the maximum stress caused by a pulling force that a material can withstand without failing (306 %and 34.8%).

- **Lea count:**

  This shows that present yarns have very good strength.. Hence, the distribution of stiffness values were statistically proved and lea count values were statistically proved(39.9$_s$Ne).

- **Twist per inch:**

  They are coarser yarns. The twist present yarns have very good strength and durable(22.2%.).

- **Single tread strength and elongation:**

  The STS of present yarns have very good strength and elongation(698.5f/g).

- **Fabric weight(GSM):**

  Fabric weight of palmyra fabric has decreased due to washing

- **Fabric thickness:**

  Fabric thickness of palmyra fabric has decreased due to washing.

- **Fabric stiffness:**

  Fabric siffness of palmyra fabric has decreased due to washing.

- **Fabric abrasion test:**

  Fabric abrasion of palmyra fabric has decreased due to washing

- **Tensile strength:**

  The strength and elongation of the warp and weft the palmyra fabric is high(32.7kgf &20.5kgf).

Conclusion

The natural fibers are part of social spectrum with the tradition of using sustainable resources. The textile industry’s major environmental determinal effects include discharge of large amount of synthetic loads as a result of high consumption used in this industry. Sustainability is the source of renewable and non-renewable resources on which civilization depends, and it shapes the societies in which we live in fundamental ways.Natural fibers have several advantages over synthetic fibers, including being more environmental friendly. These biodegradable fibers may be combined and blended to create a wide range of yarn and fabrics.

Natural fibres are readily accessible, eco-friendly, and have a regenerative behaviour. Extremely firm palmyra palm fibre has long been used to make brooms that are long-lasting and sturdy enough for harsh sweeping, like clearing snow or leaves. The palm tree produces a vast array of goods, some of which are well known to us and others which we are completely unaware. Palmyra fiber finds good applictions in textiles. Lot of research has been carried in composities using palmyra fibres. Only few studies have been carried out in waving of palmyra yarns with other blends. Hence the developed fabrics can be softened with enzymes and will be suitable for various applications in home textiles.These are 100% biodegradable and eco-friendly.

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APPENDIX

Palmyra Fiber – Original

Palmyra Cotton – Blend

Palmyra Cotton – Yarn

Palmyra Cotton – Original

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