ANALYZATION OF ANTIMICROBIAL PROPERTY OF BAMBOO YARN AND ITS PRODUCTION METHODS

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Abstract - *In the way towards faster growth and development, the pollution level and exposure to the microbes are heightened. The possible solution to create the world without pollution and microbes free is switching over to the usage of eco friendly and natural material which will be sustainable. In this study work we tried to figure out one of the sustainable ideas of incorporating the natural bamboo yarn and regenerated bamboo for producing textile material along with study on utilization of their inherent property especially it's antimicrobial property And to investigate in which method of production it's inherent property is retained completely or in other words the process which has less effect on bamboo yarn's properties.in past studies it is proven that the inherent antimicrobial properties of natural bamboo are undisputed and Natural bamboo contains a substance called bamboo kum which gives the antimicrobial property and it is found in none of the other cellulosic fibre. After Comes the new regenerated bamboo yarn (also called bamboo viscose) which were branded as eco- friendly, green characteristic of the production process and of bamboo fibre having antimicrobial property, bacteriostatic, deodorization.*

Key Words: **Plant fibre, Bamboo yarn, Regenerated bamboo yarn, Antimicrobial property, Production process.**

1. INTRODUCTION

Bamboo is a bast fibre and considered as a "green" natural nanocomposite where cellulose nanofibrils are embedded in the matrix of lignin and hemicelluloses. Bamboo is well recognised for its multifunctionality and eco-friendly nature and has been serving the daily needs of over 1.5 billion people for centuries. The use of bamboo in medicinal applications has a long history. It was shown that the leaves of some bamboo species have an antioxidative activity. Bamboo's role in oral medicine is also portrayed where the crude extracts of Polygonum cuspidatum roots showed a wide range of antibacterial activities against both Gram-positive and Gram-negative bacteria due to the presence of phenolic compounds in its chemical constituents. Some researchers have also reported antibacterial activity of bamboo charcoal and bamboo vinegar.. Recently, bamboo clothing has entered the textile industry and many commercial bamboo fabric products are claimed to be eco-friendly and antibacterial. However, most of the claims are made by the industry stakeholders where little scientific evidence was presented. In particular, the compound responsible for antibacterial properties in bamboo has not been fully investigated. In some Asian countries, the antibacterial agent in bamboo plants is identified as "kum" that represents a hydroxyl functional group (–OH) in a direct translation, but it fails to describe the actual chemical compound and its location in bamboo. Bamboo is a lignin–carbohydrate compound that is a glycoconjugate where hydrophobic lignin is chemically bound to hydrophilic polysaccharides, such as cellulose and hemicellulose.

Fig 1. Bamboo fibre

2. ANTIMICROBIAL PROPERTY OF PLANT FIBRE

Generally some plants has it's own ability to protect them from pest attack, this because plants contain numerous biologically active compounds, many of them shows antimicrobial properties. Many scientists from different divergent fields in the world have studied the chemical compounds of plants with an idea to utilize the antimicrobial property of plants. The main reason for their antimicrobial property is because of phytochemical.

Phytochemicals are chemicals produced by plants through primary or secondary metabolism.They generally have biological activity in the plant host and play a role in plant growth or defense against competitors, pathogens, or predators.

Phytochemicals generally are regarded as research compounds rather than essential nutrients because proof of their possible health effects has not been established yet. Phytochemicals under research can be classified into major categories, such as carotenoids and polyphenols, which include phenolic acids, flavonoids, and stilbenes/lignans Flavonoids can be further divided into groups based on their similar chemical structure, such as anthocyanins, flavones, flavanones, and isoflavones, and flavanols. Flavanols are classified as catechins, epicatechins, and proanthocyanidins. In total, there have been over 25,000 phytochemicals discovered and in most cases, these phytochemicals are concentrated in colourful parts of the plants like fruits, stem, vegetables, nuts, legumes, and whole grains, etc.

The phytochemicals present in the plants can be classified into several elements like phenolic, polyphenol, terpenoids, essential oils, cannabinoids, alkaloids, lectin, polypeptides, quinones, flavones, flavonoids, flavonols, tannins and coumarins. These compounds contribute to their antimicrobial property especially in bamboo.

3. MORPHOLOGY OF BAMBOO

Morphology of bamboo refers to the external structure of the bamboo plant's components. Bamboo does not have a central trunk like other woody plants and its major components include roots, rhizomes, culms, branches, leaves, and flowers. The rhizome is an essential part of bamboo plants which bears roots. Stapleton reported that two major rhizome systems prevail but the terminology used to explain rhizomes has often been uncertain and indistinct. He reviewed the terminology and opined that the term pachymorph and leptomorph were the most appropriate than the terms sympodial and monopodial which concern more with the branching patterns than actual morphological forms. The growth and branching pattern of bamboo is dependent upon the rhizome systems, as this determines whether the plant will be clump forming or non clumping and will also determine the distances between individual culms.

Bamboos are broadly classified into clumping types with pachymorph rhizome systems and running types with leptomorph rhizome systems in certain circumstances a mixed condition of both monopodial and sympodial types, known as amphipods is witnessed. However, according to Stapleton the term amphipodial or amphimorph though often used is possibly misleading. The rhizome in bamboo is a well developed underground plant part that spreads to produce an interconnected network and often sends out shoots or new rhizomes from its nodes. The young shoots are protected by sheaths that fall off as they grow up into mature culms. In the pachymorph rhizome system the culms develop from the terminal buds whereas in leptomorph rhizome system these arise from the lateral buds of the rhizome. After reviewing the terminology, it was suggested that only monopodial bamboo possesses a true rhizome. The culm is the most distinguishable upper ground part in the plant, may be arching or erect semiscandent or scandent, characterized as a hollow cylindrical tube divided by nodes and internodes. The culm is complimented by the branching system which is more informative at mid position of the culm than the lower culm body.

The length of internodes appearing from the culm sheath towards the end of the growth period varies with the species and has a stable genetic basis; longer in those species in which the growth periods begin earlier. Two types of leaves—culm leaf and foliage leaf, which are functionally different, are observed in bamboo. The bamboo leaf develops from a sheath, which encircles the stems and is called a leaf-sheath. The leaf-sheath resembles a small culm-sheath but develops a large sheath blade that functions as a proper leaf (foliage leaf). The green foliage leaf essentially performs photosynthesis whereas the culm leaf protects the younger shoots. At the point of attachment of the blade of the sheath there are different combinations of features involving auricle, bristles and ligules which are as important as the colour of the culm sheath in the identification of individual species. The Olyreae tribes are discerned by their rather weakly lignified culms, lack of both well differentiated culm leaves and outer ligules; restricted vegetative branching and

4. CHEMICAL COMPOSITION OF BAMBOO

Bamboo is a natural ligno-cellulosic fiber obtained from bamboo culm. Its chemical composition is similar to bast fiber, so its structure and properties are often compared with other bast fibers such as flax and jute. Besides, it belongs to a cellulose crystalline structure, like that of cotton and ramie. Though bamboo fiber is like a bast fiber, it is often misinterpreted as a bast fiber. Bamboo does not have a bark and the fiber occurs on the outer culm unlike a bast fiber which takes place in the phloem or bark of the plant. Therefore, bamboo could appropriately be called a 'culm fiber' just as cotton is called—a 'seed fiber', or sisal—a 'leaf fiber'.

The major chemical constituents of bamboo are cellulose, hemi-cellulose and lignin accounting for over 90 % of the total mass and the minor constituents being soluble polysaccharides, waxes, resins, tannins, proteins and ashes And study it found that bamboo culms consist of 60–70 % holocellulose (cellulose + hemicellulose = holocellulose), pentosans (20–25 %), hemicelluloses and lignin (each amounted to about 20–30 %). On the whole, bamboo contains 40–50 % α-cellulose, which is comparable with the reported α-cellulose contents of softwoods (40–52 %) and hardwoods (38–56 %). Cellulose contents in this range make bamboo a suitable raw material for the pulp and paper industryIt is reported that bamboo fiber contains more than 70 % cellulose (Bamboo species: Neosinocalamus affinis, abundantly found in China). In general, the cellulose amounts as 'holocellulose' to more than 50 % of the chemical constituents. However, the contents of hemicelluloses and particularly lignin are greater than that of flax and little less than that of jute fiber.

Non-cellulose substances like pectin and hemicelluloses influence the fiber properties such as strength, flexibility, moisture and also density significantly. Cellulose and hemicelluloses are carbohydrate polymer constituents of simple sugar monomers. Cellulose, like other plant cellulose, consists of linear chains of β-1-4-linked glucose anhydride units. Above 90 % of hemicelluloses in bamboo comprise of xylan (4-O-acetyl-4-O-methyl-d-glucuronoxylan, a relatively short polymer, degree of polymerization 200) (Liese 1987; Liese and Tang 2015). Lignin (a typical grass lignin) is a polymer of phenyl-propane units (p-hydroxyphenyl) (H), guaiacyl (G) and syringyl (S) in a molar ratio of 10:68:22.The degree of polymerization (DP) for bamboo is higher than for dicotyledonous woods (a maximum of 15,000). However, the DP of bamboo fiber (species: Neosinocalamus affinis (at present known as Bambusa emeiensis 'Chrysotichus'), single fiber length: 2 mm) is close to jute fiber and lesser than flax and much lower than cotton fiber, the higher the lignin content the lower the degree of polymerization. Also stated that the DP is strongly correlated to the length and width ratio of a single fiber. They deduced that bamboo fiber has lower BP than flax and ramie, consequently the single fiber length is very short i.e. 2 mm with a length and width ratio of about 120:1 as against more than 1000:1 in length and width ratio for flax and ramie.

However, the length varies considerably between and within bamboo species and the range of length to width ratio lies between 150:1 and 250:1. It is reported average single fiber lengths of some bamboo species which are more than 2 mm, especially Dendrocalamus membranaceus (4.3 mm), Gigantochloa aspera (3.8 mm), Oxytenanthera nigrocilliata and Schizostachyum sp. (3.6 mm), and Bambusa textilis and B. tulsa (3.0 mm). Besides, the chemical composition varies according to species, the growth condition, age and the part of the culm. As the clump tissue matures within a year when the soft and fragile sprout becomes hard and strong, the proportion of lignin and carbohydrates is changed during this phase. Yet, after the full maturation of the culm, the chemical composition tends to remain rather constant

5. TESTING METHOD FOR PROPERTY OF A FABRIC

The following are standard methods followed for evaluating antimicrobial activity (%) under AATCC standard method AATCC 147-2011. According to this disc diffusion method with some minor modification was used for screening the fabric samples for antimicrobial activity. The dispensed, sterilized and autoclaved nutrient agar was poured into a flat bottomed Petri dish. Then, nutrient agar was allowed to gel firmly before inoculating. The nutrient agar plates were inoculated with 0.1 ml of an appropriate dilution of tested culture. The fabric samples of 1 cm diameter were placed on the surface of inoculated plates. The plates were incubated at the appropriate temperature for 24 hours. Then the diameter of inhibition zone (mm) including the disc diameter was measured for each treatment and the antibacterial activity against gram positive bacteria Staphylococcus aureus was calculated and microorganism inhibition is reported as relative percentage.

6. BAMBOO YARN AND ITS ANTIMICROBIAL PROPERTY

Bamboo is a unique plant created by nature. It is one of the most robust and rapid growing plants on earth. Much of this plant's popularity is because of the remarkable natural antibacterial traits of bamboo fibre. The antibacterial properties of bamboo are the most profound reason that bamboo grows so rapidly in nature. Because bamboo has an inherent natural barricade against bacteria, most varieties of bacteria and bugs that attempt to thrive on the bamboo plant are eradicated naturally on contact. Bamboo is one of the rare plants that can survive all that nature can throw at it. The most amazing fact is that the antibacterial properties of bamboo aren't completely destroyed during the manufacturing process. When bamboo tufts are processed into bamboo fibre, the antibacterial properties of bamboo remain in the bamboo fabric. This is great news for those of us who love sleeping with bamboo sheets. In short, it is the cleanest, most hygienic fabric to make bedding out of.

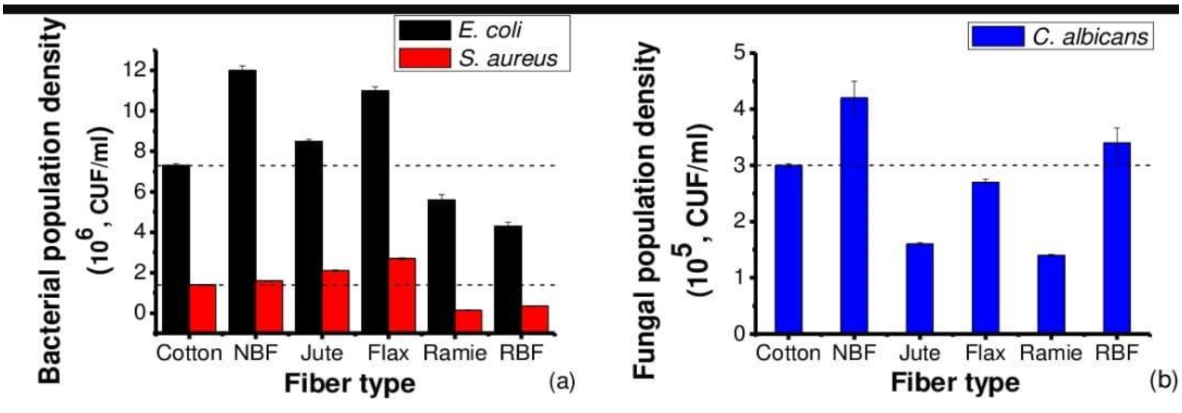

Chart 1. Antimicrobial activity of different fibre

7. CHARACTERISTICS OF BAMBOO FIBER

- **Softness:** The fibers of bamboo are regenerated cellulose fibers, so they are soft and healthy for the skin like cotton.
- **Luster:** Bamboo fibers have a bright color and a special luster like silk.
- **Anti-bacterial:** Bamboo is rarely eaten by pests or infections from pathogens because bamboo possesses antibacterial substances and a biological agent called Bamboo Kun. This substance binds with the bamboo cellulose molecule tightly throughout the bamboo fiber production process.
- **Moisture absorption:** Bamboo fibers have excellent absorption and ventilation because the cross-section of bamboo fibers is filled with fine gaps and various tiny holes. This gives a feeling of relief, especially on hot summer days.
- **Anti-ultraviolet radiation:** This property has differences around it; At the 235th national meeting of the American Chemical Society, Appidi and Sarkar of Colorado State University stated that the raw bamboo fabric allows nearly all harmful UV rays to pass through, and reach the skin, on the other hand, the viscose bamboo industry in China found that 100% bamboo fabric did not allow UV rays through when the UV fabric test was completed using the test method GB/T 18830-2002 (BambroTex 2008).
- Resistant to static electricity: Bamboo fibers do not contain a free electron, so they are resistant to static electricity and do not cling to the skin.
- Durability: Bamboo fibers are as durable as jute fibers.
- Dyeing ability: Fibers of bamboo have good dyeing properties and colorfastness.
- Eco-friendliness: Textiles made from bamboo fiber are biodegradable. It can be 100% decomposed in the soil by microorganisms and sunlight.

8. MANUFACTURING PROCESS OF BAMBOO FIBER

The manufacturing process of bamboo fiber is where the debate gets intense and the sustainability and green image of bamboo is tarnished. There are two main methods of producing bamboo fibers namely mechanical and chemical. The chemical process is of two kinds: one that follows the viscose process used to produce rayon where the fiber is broken down with harsh chemicals and extruded through mechanical spinnerets. The second one follows the closed solvent spinning loop which is essentially the same process used to produce Lyocell fibers). There is another category of bamboo fiber known as bamboo charcoal nano fiber which is beyond the scope of this subject and not discussed in detail.

9. FIBER EXTRACTION THROUGH MECHANICAL PROCESS:

The fiber extracted by mechanical process is often referred by the manufacturer as ‘natural’ or ‘original’ bamboo fiber and more or less the same manufacturing process used to produce ramies.

1. The bamboo culms are split mechanically followed by rasping off the woody part.

2. The crushed bamboo strands are treated with enzymes to separate the fibrous materials from the remaining culm-parts.
3. Individual fibers are then combed out.
4. Fibers are then spun into yarns.

Natural bamboo fiber would be recognizable as bamboo under microscope.Bamboo fiber produced by this process though considered eco-friendly is less used because it is time consuming, labor intensive, costly and serves a very specific niche of the textile market. Fiber extraction through chemical process (Rayon Process) The method essentially follows the same process as used to manufacture regenerated viscose rayon using hydrolysis alkalization with the multi-phase bleaching principle and the process is as follows.

1. The bamboo culm is crushed into smaller fractions and soaked in a solution of 18 % NaOH at 20–25 °C for 1–3 h to form alkali cellulose.

2. The bamboo alkali cellulose is pressed to remove excess NaOH solution, crushed by a grinder and left to dry for 24 h.

3. In this stage, CS2 is added to the bamboo alkali cellulose to sulfurise the compound, causing it to jell.

4. The remaining CS2 is removed by evaporation due to decompression, resulting in sodium xanthogenate.

5. A diluted solution of NaOH is added to the cellulose sodium xanthogenate, which dissolves it into a viscose solution consisting of about 5 % NaOH and 7–15 % bamboo fiber cellulose.

6. The viscous solution is forced through spinneret nozzles into a larger container of diluted sulfuric acid (H2SO4) solution which, hardens the viscose and reconverts it to cellulose bamboo fiber which are spun into yarns (to be woven or knitted).

This process produces regenerated bamboo fiber which is essentially a rayon fiber which is silky, strong and elegant but just like any other rayon, involves toxic chemicals and harmful byproducts. Unless methods are used to capture and recycle the caustic chemicals, harmful byproducts can be released into air and water.

10. BAMBOO YARN PRODUCED FROM RING SPINNING

Bamboo can also be produced using a ring spinning system by means of mixing them in the fibre stage with a blender. But in this whole process there will be more wastage since the bamboo fibre which are broken into small staple length are coarser and doesn't have cohesion with the cotton fibre which leads to huge loss of bamboo fibre as trash and also the appears of the yarn thus produced by means of ring spinning has more slubs because bamboo fibre which are in the different density when compare to the cotton fibre. This imperfection of yarn causes a series of problems in the weaving process and thus produces fabric with more fault.

10.1 Mechanical Processing Method:

During mechanical processing, the bamboo is crushed into pulp, followed by natural enzymes that are used to form a soft material, and after that, the fibers are combed out. Then the fiber is spun into yarn, and the yarn is converted into bamboo fabric products.

10.2 MECHANICAL PRODUCTION FLOW:

Stripes cut from bamboo

↓

Boiling of bamboo stripes to loosen and remove inner fiber

↓

To break the bamboo into soft mass the natural enzymes are added

↓

Fibers are combed into individual fibers

↓

Spinning into yarns then its utilized for textile application

Chart 2. Mechanical production flow

11. BAMBOO VISCOSE FROM VISCOSE RAYON PRODUCTION METHOD

Viscose rayon is a regenerated cellulosic fibre. It could be found in cotton like products as well as silk like products..Due to its silk like property it is also known as "Artificial silk". In its production process, Wood pulp is treated with alkaline solution (NaoH) and carbon disulphide and then they pass through a bath of sulphuric acid and zinc oxide. As this process of bamboo viscose yarn is produced, the only difference is that the wood pulp is replaced with bamboo wood pulp. Yarn produced as a result has luster and strength.

The manufacturing of viscose rayon involves following steps, let us study them in the order they are performed:

- Steeping
- Shredding
- Ageing
- Xanthation
- Ripening
- Preparation of spinning solution
- Filtration
- Spinning

11.1 Steeping:

Steeping is the very first step in the manufacturing of viscose. In this process, the pulp is treated for mercerization in presence of NaOH at the mercerizing strength. The pulp sheets are then steeped (immersed) in 18% NaOH. Alkali cellulose is generated as a product during the reaction.

11.2 Shredding:

During shredding, the alkali sheets are then converted in light fluffy mass with the help of a machine which consists of a pair of revolving blades rotated at a high speed in the opposite direction.

11.3 Ageing:

The crumbs obtained at the end of the shredding procedure are transferred to a steel container where they are stored under specific temperature for 3 to 72 hours which may vary according to the catalyst and the alkali. The presence of air in the alkali reduces the chain length which in turn decreases the viscosity as it is essential to prepare the desirable spinning solution. As soon as the correct viscosity is obtained these pieces are then transferred into a drum where it is kept in an inert atmosphere and kept at low temperature.

11.4 Xanthation:

During the process of xantation the aged alkali cellulose crumbs are placed in vats and are allowed to react with carbon disulphide under controlled temperature 20-30 degree Celsius which forms cellulose xanthate.

11.5 Ripening:

In this process, the viscose is allowed to ripen for a stipulated period of time. During ripening, two major processes take place firstly, the xanthate groups are redistributed and then lost. The viscosity of the solution first decreases and then rises to its original value.

11.6 Preparation of spinning solution:

The spinning solution contains the following:

- Water-69%
- Zinc sulphate-1%
- Sodium sulphate-18%
- Glucose-2%
- Sulphuric acid-10%

The sodium sulphate precipitates the dissolved sodium cellulose xanthate. The sulphuric acid converts xanthate into cellulose, carbon disulphide and sodium sulphate. The glucose provides softness and flexibility to the filaments whereas zinc sulphate helps in adding strength.

11.7 Filtration:

The viscose is filtered to remove undissolved materials that might disrupt the spinning process or cause defects in the rayon filament.

11.8 Wet Spinning:

In this process, the ripened viscose solution passes through a centrifugal pump due to pressure exerted on the solution by the compressed air. Then viscose solution is forced through a spinneret which has many fine holes with diameters ranging from 0.05- 0.1mm, as soon as a number of filaments emerge from the spinneret they are taken together to surface of the spinning bath and then it is guided to two roller from where they are wound on to a spindle.

However, all the man-made fibers are generally obtained in continuous filament form. For blending, the man-made fiber should be cut into staple form i.e., the fiber with definite length. The staple fibers, apart from their own advantageous properties, offer the following advantages:

(a) Required staple length
(b) Determined fineness
(c) Perfect cleanliness
(d) No fluctuations in quality
(e) Easy availability

In the manufacture of staple fiber, the filaments after solidification is collected in a rope-like form of parallel filaments. The rope is referred to as tow. The tow is generally converted into staple fiber form depending upon the end-product, or the sequence of machinery. The process is referred to 3 as 'tow-to-top', 'tow-to-silver' or 'tow-to-yarn' conversion system. In all the systems, the first process is the conversion of the tow into staple fiber

There are various systems of tow-to-staple conversion, which can be classified according to the basic methods used for severing the filaments. The methods are
(a) Cutting,
(b) Abrasion and
(C) stretch-breaking.
Of course, each method has its own advantages and disadvantages.

11.9 Staple Fiber Cutting Method

The cutting method is the most commonly used for tow-to-top conversion. In this system, a flat sheet of tow in the tensioned condition is fed to a rotary cutter. The principle of operation is to cut ‘a uniform spreadsheet of filaments between a revolving spiral cutter and a hardened steel roller. The cutter is generally projected in an angular manner.

The actual staple length depends upon the helix angle of the cutter blade. The blade roller width is usually about 25 mm to 38 mm. The space between the cutting edges is lined with synthetic rubber to prevent lateral movement of the filaments

during cutting.
Different rollers are required to produce different fiber lengths. In this way, the filaments are sheared at an acute angle without disturbing the parallel arrangements of the filaments. Schematic diagram of a tow to staple fiber conversion by the cutting method. This method does not alter fiber characteristics such as strength, elasticity, extensibility or shrinkage characteristics. Also, the staple length and fiber length distribution are controlled positively. Also by redesigning the arrangement of the projected helical blades on the cutting roller, staple fibers having a varied staple length can be produced for fancy yam. On the other hand, the cutting method is not very effective for the fibers finer than. 2 deniers. The pacific converter converts all types of man-made fiber tows into a staple.

11.10 Abrasion Method

In this method, the filament tow is ruptured against an abrasive surface. This method is not popular and has only limited application because of the following reasons:
(a) It cannot be applied to fibers having higher abrasion resistance characteristics.
(b) There is no control over the fiber length. The length is generally varied from 1 cm to 25 cm.
(c) The presence of short fibers reduces the mechanical properties of the ultimate product.

The process is generally used to regenerated fibers and/or light tows and to a very special purpose.

11.11 Stretch Breaking Method

The stretch-breaking method can be utilized for any filament of any thickness. The system is based on the principle that if a filament is held between the nips of two sets of rollers, then under suitable conditions, the filament will be stretched and broken. The two sets of rollers are usually running at different speeds.

The delivery roller is always faster than the feeding roller. Depending upon the speed of the rollers and deformability of the fiber, the fiber will first be stretched and then will be broken. The break takes place at the weakest point of the fiber which may be anywhere along its length.

The stretch breaking process gives a reasonably nap-free product. The load-elongation characteristics of the fiber after breakage differs in comparison with that of the same fibers before breakage. Mostly stretch breaking enhances tenacity and lowers the extensibility of the fiber. Simultaneously the filament is reduced and finer filaments are produced after stretch breaking. There are several machines available in stretch-breaking principle, like Seydel stretch-breaking machine, Porlock machine, Turbo stapler.

11.12 Flow Chart of the Staple Fiber Production Process

Each man-made fiber is manufactured in different principles and with different processing conditions. Accordingly, their processing also differs and they undergo a series of purifying and finishing stages after fiber formation. These post spinning treatment operations for staple fiber production are not the same for all the fibers. This section highlighted the post spinning treatment of individual staple fibers

11.13 Production and post-treatment of viscose staple fiber

Spinning → Drawing-- Stapling- Pre-opening Drying- Conditioning- Washing- - Intermediate opening Drying - Fleece formation - Fine opening - Packing

TABLE 1. Viscose fiber is blended in different stages of production process:

Blending type	Process stage
Bale mixing	Before the blowroom
Flock blending	Within the blowroom
Fiber blending	In the blow room at the card or the OE
Web blending	At the ribbon lap machine

Sliver blending	At the draw frame or at the sliver lap machine
Roving blending	At the ring spinning machine

12. CONCLUSION:

In this study we analysed the inherent antimicrobial property of plant fibre especially fibre extracted from bamboo. And the morphology and chemical composition of bamboo fibre is discussed along with their physical property. And in further investigation we analysed the various production methods through which the bamboo fibre can be converted into bamboo yarn along with maximum possible retainment of it's natural property especially antimicrobial property. Through which we like to conclude that the yarn produced from the jute spinning method is coarser and not suitable to be converted into a textile product and then bamboo yarn produced through a ring spinning system could result as yarn with more imperfection and the antimicrobial property of bamboo fibre could not be completely retained. Where in case of regenerated fibre production method that is bamboo viscose beside the retainment of the antimicrobial property this process would enhance the properties of bamboo fibre.

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