



Eatable Materials into Feasible Textile Fibres – A Detailed Review

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ABSTRACT

Textile industry is the second largest industry in world where the food industry still remains first. The waste produced from both the industries are huge in volume and most of it are dumped in soil as a landfill waste. When the production rate increases, disposal amount of waste also increases to create the environment pollution. To avoid this, the disposed natural waste are collected, treated and converted into a useful products that serves as a raw material for needed industries, especially in textile sector. Fruit waste or consumable part of the plants are converted into textile fibres to provide excellent properties of fabrics and create high demand in the textile market. These renewable natural fibres used for medical purpose as well as fashion, apparel and technical textile products. In this article, method of application of fruit/natural waste as raw material and its uses are discussed in a detailed manner.

KEYWORDS: fruit fibres, textile, sustainability, eco-friendly.

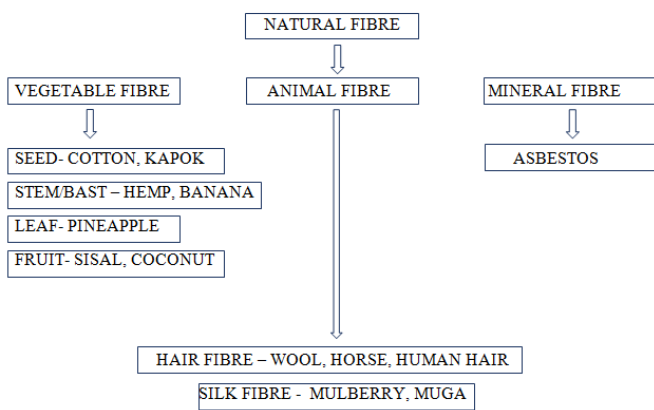
INTRODUCTION

New generation natural fibres are mostly extracted from the natural waste or by-products of the natural resources especially from the eatable materials. Basically natural fibres are categorized as vegetable fibre, animal fibre and mineral fibre. In that vegetable fibres are classified as seed, stem/bast, leaf, fruit, root fibres and animal fibres are classified as keratin type protein fibre and non-keratin type protein fibre and finally for mineral fibres, asbestos is the best example. Among this, vegetable fibres are popularly known for the vast production of textile materials. Now-a-days emerging natural fibres are extracted from the natural

waste or non-consumable parts of the plants which doesn't need any special sort of plantation or cultivation techniques. These fibres are sometimes obtain from the food waste or agricultural waste or by directly extracted from the plant. Some of those emerging fibres are discussed widely in the topics below.

CLASSIFICATION OF NATURAL FIBRES

Natural fibres are classified as vegetable fibre, animal fibre and mineral fibres. The subcategories of vegetable fibre, animal fibre and mineral fibres are listed in the below flow chart.



2. SOME OF THE EATABLE BASED MATERIALS INTO TEXTILE FIBRES

- Banana fibre:** The top most fruit based fibre is banana fibre. It is one of the strongest natural fibre. The stem portion of banana tree is used to extract fibres. The approximate fineness of banana fibre is 2380Nm and the fibre length is 60mm. Fibre contains cellulose, lignin and hemi cellulose. For the extraction of one kg of banana fibre it needs thirty seven kgs of raw material which quite low in volume when compared to the cotton fabric. It is similar to the bamboo fibre in appearance but the smoothness is far better than that.^[1] Banana fibre has natural sheen, which acts as a good substitute for real silk.^[3] The thickness of banana fibre is based on the types of textile product. Due to its soft and lustrous quality, it works as an alternative option to cotton and silk and it is blended with cotton and polyester to produce excellent quality of fabrics.^[6]
- Pineapple fibre:** In pineapple fibre, fibres are extracted from the leaves of pineapple tree not from the fruits. The fibres extracted from the leaves are either done by manually retting the leaves or by the mechanical method. Fibre contains high amount of lignin and cellulose.^[1] these pineapple fibres are ivory in colour. These pineapple fibres are soft and sheen with high lustrous translucent texture. Mostly these pineapple fibres are used to create vegan leather.^[3] the fabric made on pineapple fibre are with the characteristics of water resistance, breathable and have high tensile strength.^[4] It is an innovative fibre naturally desired form of tissue made out of pineapple leaves, a waste generated from pineapple fruit harvest and it providing better alternatives to leather.^[5]

- Orange fibre:** orange fibre is the first patented material extracted from citrus fruit by-products. It is similar to other fibres like banana fibres but it undergoes various process to convert the fruit fibre into usable textile material. Orange fibres are light in weight, soft, sheen, lustrous like silk and it is bio-degradable as vegan in nature.^[9] To extract an orange fibre, first the by-product are obtained from the individualized orange juice to extract the citrus cellulose then it is processed and spun into yarn. Its ability of shine and opaque level is tuned by the designers based on their desired look.^[10] It has good drapability, anti-wrinkle property and it comes in a wide variety of fabrics like crepe, satin, cotton etc. Orange fibres are rich in vitamin A, vitamin C, vitamin E, the fabric made through the orange fibres contain these vitamins which are directly in contact and absorbed by the skin. These vitamins are locked for the entire lifetime of the fabric with the help of nano technology. These new vitamin enriched textile represents a brand new opportunity for high quality textiles and fashion in textile industry. Orange fibres are the new innovation which is perfectly suitable as per the market trends and also serves sustainability and eco-friendly in nature.^[9]
- Coconut fibre:** coconut fibre is commonly known as a coir it is extracted from the husks of coconut. Usually these fibres are coarse in nature, mostly in dark brown in colour. Coconut fibres are short of 0.5-1mm length and thick walled with irregular lumen its surface covered with pores. Fibres are found between the husk and outer shell of the coconut. Individual fibres are hollow and narrow with thick wall made of cellulose. They are pale in colour when immature and it turns hardened and yellow in colour as layer of lignin is deposited on their walls when it attains a mature level of growth. There are two types of coir to extract, one is white coir and other is brown coir. White coir are harvested before the coconuts turn ripe. So it is smoother and finer but also weaker. Brown coir is harvested from totally ripened coconuts so it is strong, thick and high abrasion resistance.^[11] The coir fibre has relatively quick dry compared to cotton. And it is long lasting and durable than cotton and bamboo. It is wrinkle resistant, water

proof and also provides sun protection. Approximately ten kgs of coconut fibre is extracted from thousand pieces of coconuts.^[2]

- **Sugarcane fibre:** Fibre is extracted from the cane stalk of the fruit, which it is also known as bagasse. It is an abundant waste fibrous material of sugarcane which is used initially as fuel for mill boilers, animal fodder, paper raw material etc. Lyocell is a sugarcane fibre produced from the bagasse having huge potential application in medical sector^[1] and also used for the production of rayon fibres like viscose, modal etc. It contains approximately 25 percent of hemi cellulose and lignin, 50 percent of cellulose content. Now a days it is step forward to applied in apparel industry as raw material. These sugarcane fibres are extracted by both mechanical separation and chemical extraction. These fibres are usually seems long that more that 6 to 12mm. It is glossier and seems silk like appearance than wood pulp rayon.^[12]
- **Coffee ground fibre:** coffee ground fibres are the new innovation in textile industry, that the coffee waste are collected from the industries and recycled, processed to produce yarn. It is similar to the bamboo, viscose like material. It is a combined formation of coffee waste and recycled polyester. Coffee fibre is similar to the nylon and polyester when it is blended with other fibres. Approximately one cup of coffee can be possible to make a set of T-shirts. These are used to make both woven and knitted fabrics. It is suitable for active wear and sportswear garment.^[13] coffee fibres are in excellent natural anti-odour qualities, UV protection, quick drying time and eco-friendly. Coffee fibre stands an excellent example for the recycled fibres which are environment friendly in nature.^[4]



Orange fibre



Coconut fibre



Sugarcane fibre



Coffee ground fibre

3. MANUFACTURING PROCESS

- **Banana fibre:** Banana fibres are comes under the category of stem fibres. In the manufacturing of banana fibres, extraction of fibres are done by mechanical shredding or by chemical reaction.^[6] Fibres are extracted from the centre portion of the stem by removing two to three outer sheaths to avoid coarse, brittle and innermost layer to avoid a pulpy substance. After the extraction process, it is soaked in the alkaline solution make it softer and separate them. Then the fibres are dried, spun and the fabric is prepared by the loom.^[15] though it is a laborious process of cultivation, fibre extraction, sorting and processing, it provides excellent property of fabrics and acts as a sustainable fibre which supports the eco-friendly trend.^[7]
- **Pineapple fibre:** pineapple fibres are extracted by the process of decortication that the fibres are extracted from the leaves of pineapple tree.^[15] Usually pineapple leaves are long and its surface is coated with wax. These leaves are properly washed, cleaned and involved in decortication process. This is done manually or by decortication machine. It is the process of removing the outermost layer of the leaf or scraping. In this process, fibres get exposed as a gummy substance which it is cleaned and separated by the retting process. The extracted ,fibres are then collected and dried to prepare for spinning.^[8] The process of cutting and peel, extraction, separation and drying are undergoes the process of fibre preparation. The staple fibre of this plant varies from 0.5-1m. Also these pineapple



Banana fibre



Pineapple fibre

fibres are majorly used to prepare a vegan leather. It also undergoes the industrial process to become a non-woven textile materials.^[8]

- **Orange fibre:** orange fibre is extracted from the peels of orange fruit. The peels which are separated from the fruit for juice making process by the juice industry get collected and then processed with some sort of patented method to extract the cellulose matter that is treated and spun into yarn.^[9] With the treatment of chemical reagents, cellulose can turn into yarn which is processed, dyed to blend with other fibres to produce excellent properties of fibres.^[14] These cellulose in the citrus peel can produce a light weight cellulose yarn with soft, silky nature.^[4]
- **Coconut fibre:** Fibres are extracted from the intermediate portion of the husk of the coconut. The fibrous husk are immersed in the pits or in the nets with water, that is slowly swell and soften the fibres. The long brittle, strong fibres are separated from the short, weaker fibre matter by the process known as wet-milling. The fibres with good quality and strength are separated and dried under sunlight. After drying of fibres it is packed into bundles. These coir fibres are elastic enough in nature to twist without getting break and it holds the twist as through permanently waved. The long bristle fibres are washed in clean water and dried before packed into the bundles or husks. These bristle fibres are get bleached and dyed to obtain hanks of different colours which it is needed for the apparel production.^[11]
- **Sugarcane fibre:** sugarcane fibre which is known as bagasse is extracted from the stalk of the plant. Bagasse is shredded from the stalk and broken down with the eco-friendly chemicals or other chemicals to make it in a liquid form which it is forced with high pressure through tiny holes in the spinneret. Through this process, long strands of fibres are obtained to solidified and spun into yarn. With this procedure, bagasse is used to produce textile rayon materials like viscose, modal and lyocell. The extraction of bagasse fibres from sugarcane stalk is done with two steps they are mechanical separation and chemical extraction. The length of fibre to be produced is depends on the method of extraction process and extraction time.

These fibres are also involved in spinning and weaving process.^[12]

- **Coffee ground fibre:** coffee grounds are obtained to create the yarn are extracted and recycled from some of the world's largest coffee vendors.^[4] The process of extracting the coffee fibre by transforming the coffee ground into yarn through a temperature of 160°C for carbonisation. Mixing of coffee waste with recycle plastic bottle which is re-polymerising to masterbatch. After that it is spined as a coffee yarn. For this process, coffee grounds and recycled polyester is used as a raw materials. This process followed to prepare a coffee fibre as technical composite fibre which is used to produce both woven and non-woven materials.^[13]

4. CHARACTERISTICS AND APPLICATIONS

Name of the fibre	Characteristics	Applications
Banana fibre	Soft, lustrous, durable, high tensile strength, tear resistant, flexibility, moisture absorption ^[6]	Ropes, mats, woven fabrics, vegan wallets, handmade papers, hand bags, accessories ^[15]
Pineapple fibre	Strong, moisture regaining, breathable, flexible, versatile, less resistance dyes. ^[5]	Upholstery, furnishings, conveyor belts, ropes, bags, mats, linens, leather apparels and seating, paper manufacturing, home tech, agro tech etc ^[8]
Orange fibre	Soft, silky, light weight, anti-wrinkle, drapable, high tensile strength ^[9]	Lace silk, shirts, dresses, foulards and wearable body creams. ^[14]
Coconut fibre	Thick, high tensile strength, abrasion resistance, water proof, resistance to microbes, high absorption ^[11]	Apparels, sportswear, activewear, geo-textiles, door mats, brushes, sacking, ropes, fishing nets etc. ^[11]
Sugarcane fibre	Glossier, soft, high tensile strength ^[12]	Apparel, auto mobile industry,

		construction materials, paper manufacturing, animal fodders, mill boilers etc. ^[12]
Coffee ground fibre	Fast drying, anti-odour, UV protection etc ^[13]	Sports bra, sportswear, active wear, T-shirts, shirts, home furnishing etc ^[13]

5. LIST OF SOME TEXTILE BRANDS BASED ON FRUIT FIBRES

- **Banana fibre:** Bananatex^R is a three-way development between Swins Backpack brand QWSTION, a Taiwanese yarn specialist and a weaving partner in Taiwan, that the fabric is invented in 2008. They spent three years in research and develop the world's first water proof, durable fabric made fully from Abaca banana plants.
- **Pineapple fibre:** Pinatex^R was founded and developed by Dr.Carmen Hijosa in 2017. To give a better alternative to the chemical composition and tanning process involved for mass leather production. He developed this fabric which is purely 100% vegan and bio-degradable.
- **Orange fibre:** orange fibre was developed by Adriano Santanocito and Enrica Arena in 2014 at first and later it is developed by the fashion company named Salvatore Ferragamo in 2017.
- **Coffee ground fibre:** Signtex, Taiwanese company introduced the coffee ground fibre in the year 2008, which works as a sustainable vegan fibre with excellent fibre performance properties.^[2]

6. CONCLUSION

Usually waste materials disposed from the industries of both food and textile are huge in volume which it is dumped as a landfill waste to create environmental pollution and the treatment of waste disposal needs a large procedure. These can be eliminated vastly by using the fruit/food waste disposed from the food industry or from agricultural land are collected and recycled or reprocessed to produce as a textile raw materials. By the result of this, waste disposals are minimised and doesn't need any specific preparation of plantation and cultivation and also serves with excellent textile properties with affecting the environment as

these are purely bio degradable and sustainable in nature. To avoid the environmental pollution and increasing of ability of the textile products, these recycled natural waste fibres are welcomed and involved to produce various innovations in textile materials.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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