

## **Sustainable textile fibers for 2020**

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### **INTRODUCTION**

Waste is unavoidable. Industrial revolution to the globalisation theories of the recent past, has tapped the natural resources to a great extent that can now be deployed leading to various adverse effects to eco-system. Fibers from new sources from nature in the form of plants, tree barks, microorganisms are tapped and processed to get fibers. The processing like dyeing and printing of textiles are greatly dependant on water. Researches that work in minimising the need for water during processing (dyeing and printing) and further washing (removal of extra chemicals) result in toxic effluent (waste water from fabric coloring industries). Further creating GM cotton, Bt cotton, organic cotton and even coloured cotton are some of the major initiatives taken to reduce the carbon foot prints in the industry

Fiber is the basic raw material to make a fabric. Conventional sources include natural and man-made fibers. Cotton, silk, wool, hemp, linen, asbestos are natural whereas nylon, polyester, aramids are made from petroleum based derivatives. The old fibers are still used but is doubtful to serve the growing population needs. Since clothing forms the basic requirement for humans, exploration of new sources to be made into fiber is significant.

#### **Bio-mass fibers for future :**

##### ***Milk fiber:***

History unveils that milk was mixed with paint and when applied to churches heled in maintaining whiteness factor which made the walls be unfaded and bright till now [1]. Invented in the 1930's, to replace wool in mens clothing line; this fiber was certified with Oeko-tex standard 100 green certification in 2004. The process is done in skimmed milk, which is mixed with a liquid and further solidified to isolate the milk protein casein. Wet spinning technique is involved in the production of milk fiber which has fifteen different types of amino acids and bacteriostatic action upto eighty per cent proving its sanitarian property. It is important to know that the milk casein is used, instead the fresh milk. Since graft polymerisation is employed it is eco-friendly. Dyeability of such fibers are excellent. During drying of the fiber, zinc oxide produced gives natural anti-microbial property. Even 20% of the milk fiber blended with conventional fibers are proved to be effective [2].

Milk and its nourishing properties are known since time immemorial. This does not have

formaldehyde in its production and made used graft polymerisation technique, this fiber is eco-friendly. This regenerated protein fiber has been compared with wool and silk for its hygroscopic nature, moisture transmission, pH to that of skin, blend-ability, supreme lustre, dyeability, comfort properties and degradable properties. Acid, cationic or reactive dyes works best.

Even the prepared fiber is proved to have anti-ageing properties and anti-microbial action This is bio-degradable. Compared to cotton it uses less water for its production. Blends of milk protein with silk, cotton, ramie, wool, bamboo, cashmere as cool/ warm fabrics, high end inner wear, health care and home textiles. The functionality of this fiber is so high that it is used for cancer patients (Qmilk). Azlon is one of the popular brand that manufactures fiber from milk. Some of the other popular brands that sell milk fibers are Aralac, Lanatil and Merinova. Qmilch (Q-quality; milch-milk) GmbH. Germany manufactures fiber from milk in 5 minutes using less than two litres of water [3-13].

### **Soy silk:**

Henry ford explored soya bio-mass potential to be made into a textile material. He made fashion suite for him and a neck tie. The car interiors of Ford were then made using this fiber. World war and its after effects made this fiber get volatile and move out of market until the 20<sup>th</sup> century [14].

Costlier than cotton and hemp, this is derived from tofu waste, hence eco-friendly. This vegetable cashmere fiber, is available in two shades white and natural tone. The isolated soy protein is made into a liquid, then solidified and cut into staple fibers of required length [15]. Since the fiber has huge amount of protein, the dyeability property is good. This enable the application of natural dyes and creating a series of end uses. The drape and softness (requires less ironing) are two very appreciable properties of soy fiber. The Luxurious look of this fiber, exceptional dyeing property, outstanding comfort are some of the amazing factors [16].

This is manufactured by breaking the protein of soya beans and further alkali treatment. It is made by upcycling the tofu and soya oil industry wastes not textile fibers. Soy fabrics are cool, warmer than polyester and does not wrinkle easily [17]. It is very durable and drapes well. There are issues that claim this to possible carcinogen as it made from soya that are genetically modified (GMOs). Xylem (USA) manufactures this fiber on large scale.

The fiber is often blended with silk, wool, cashmere and cotton. It moisture absorbency and breathability made it an ideal fiber for knits and inner wear. In home textiles, the application of soy fiber is huge [18]. The UV protection property is higher than cotton, silk and viscose. Soya fiber, spandex and organic cotton are ideal for sports textiles. Its breaking strength is higher than cotton, silk and wool. The colour fastness property is much appreciated by industrialists. The plant needs water and pesticides for its growth, which is the only point to think when talking about sustainability of this fiber. The solution is using organically grown soya plant and process it further [19, 20].

### **Corn fiber / PLA (Poly lactic acid) :**

First cultivated ten thousand years ago, this cereal grain has huge potential to be used as textile material [21]. Fermentation, distillation and polymerisation of corn enable to get the fibers. Fermentation of natural available sugars from corn will result in fibers. It is available as both short and long staple filaments and fabrics of light weight to micro deniers can be made using this fiber. This is bio-degradable, strength and resilience properties are very good [22, 23]. The excellent moisture management properties are making this popular for apparel and sport textiles. Lustre and

draped is so appealing that makes it popular as fashion clothing. It is a very good alternative to nylon and polyester in active wear apparels. Studies suggest that the soil release property is good. Quick drying and wash properties are very much appreciated in apparel, home textile, non-woven and industrial textiles [24].

These have low flammability and also release less smoke generating compared to cotton or PET fibers. High melting point, crystallisation and strength are the merits of corn fiber. Dye uptake is very appreciable that also affects the longevity, making the fibers to hold dye for a long time (good colour fastness property) [25]. The fabrics made are considered ethical. It uses 40% less fossil fuels than conventional fiber production. The fiber has UV protection better than polyester. It is also hypoallergenic. The stain resistance is appreciable and it doesn't absorb odour which makes it very suitable for sport textiles. The only disadvantage is the rigidity of the same, which is also seen as beneficial by many manufacturers by comparing it with plastics. Corn is often used as bio-plastics. Corn fiber and Amara are common brands of corn fiber. Cargill down polymers have developed huge variations in corn fiber for commercial exploitation. Ingeo is the common brand name for corn fiber [26].

#### **Spider silk :**

Mei Wei, UConn professor in materials and a biomedical engineer, has isolated a protein called fibroin from the silk that was spun from spiders and moth. This protein fiber is known for its toughness, tensile strength, bio-degradable properties. The composite was made of silk fibers and polylactic acid, coated with bio-ceramic hydroxyapatite. The fibers are then stuck on a thick composite bar. This is reported to be the best bioresorbable material, with excellent strength and flexibility, that has huge potential to be used in orthopaedics [27].

Spider silk is made using coax bacteria, to produce fibrin, to resemble the excrete from spider. This fiber is stronger than steel, more flexible than nylon, three times stronger than Kevlar. This incredible fiber is light weight and super strong find it very much suitable to perform as bio-compatible material. Golden Orb spider is grown in a controlled condition and the fibers are collected which is made into the largest cape gown made till date [28, 29].

The recent innovation is use of spider web for air purification. Stabilimentum is a face mask that has a face mask and a bag like design that has three cups attached. Each box has seven spiders in it. The fibers made by the spider are used in face mask to combat pollution [30].

#### **Pine:**

The Philippines mastered the craft of making Pina fiber, from the leaves of the Pineapple fruit. Excavations from Hispanic times prove woven textiles made from pina. It was very commonly used in Greece and Africa. They have been a very active producer of pineapple and in order to enforce sustainability, they started making textiles from the waste pineapple leaves. Thus, Pina fiber evolved into apparels.

Over 1500 varieties are found in this fruit. India has this fruit widely distributed and thus making production easy and cost effective. The famous and very popular fiber in the recent times with huge application in apparels are pina fiber. The leaves of pineapple are collected, scrapped manually using tools like porcelain plate, coconut shell, plastic comb and seashells and finally retting is done. The fibers tend to break easily so the process is done slowly. The traditional embroidered (calado) garment of Philippines was made from pina. Apart from this mat, fan, gown, bridal wear, handkerchief, table linen was also made using pina. The production is time consuming.

The fibers are lustrous, lightweight, soft, glossy and transparent. It is usually blended with silk and linen.

SITRA, the South Indian Textile Research Association has done innumerable researches in extraction of fiber and developing garments made from this fiber. It is interesting to know this luxury fiber is compared with silk and often found as blend with banana fiber [31].

The plant bast fibers are extracted by retting and hand decortication. This is similar to ramie fiber. The fiber is known to have lustre, good absorbency, strength, light in weight and also biodegradable. It was used for making mats, ropes and now as apparel and home textiles [32]. Ananakit is the commercial brand that sells banana fiber as apparel and was recently awarded for using 25 natural fibers to make a sari [33]. India and Sri Lanka has been largest producers of this plant but only 10% of the disposed fiber is recycled into fiber. The bast fibers of banana is used in high end luxury clothing. It is also used in making paper that can last for a century. This technique was first invented by Chinese in the thirteenth century. It is used in the traditional Japanese garment called kimono and kamishimo from 16<sup>th</sup> to 18<sup>th</sup> century.

The retail stores around the world have been selling this fiber based apparel in the last decade and has set a potential market now. This fiber has low density, appreciable drapability and degradable properties. Its light in weight, with good moisture management capacity and extremely fine, lustre and strong fiber [34]. TNAU and NGO based in Pune has developed extraction. Processing and product development using banana fiber. Five to six plants are used to make one kilogram of fiber. The residue is vermicompost and the obtained manure is used in cultivation of banana or other crops. The products from banana started from ropes, mats to apparel, home furnishings like cushion cover, curtain, bag and rugs [35].

### **Bamboo:**

The bamboo varieties offer good potential end uses in various application of textiles. There are many varieties in bamboo, which are tapped for textiles. The collected bamboo plants are cut into strips and then subjected to steaming, crushing and decomposing. The fibers are carded to be made into a fabric. It is also called black diamond and often available as blends with rayon and carbon. This age-old plant gained its popularity in 2004. Before this period it was used in making papers. TENCEL is the commonly seen brand for bamboo fibers. Now it is seen as non-wovens, intimate apparels and health care textiles [36].

The plant that grows extremely fast and available plenty in nature is used in textiles for its cooling, anti-microbial properties, resistance to mould, hypoallergic and thermal properties. It can be compared with wool and silk. Without the use of any chemicals the bamboo plant can be crushed and using natural enzymes to break the mass and extract the fibers [37]. Bleaching is not essential and is also ignored when required to make organic bamboo fiber. The fibers are then spun into yarns. These are later spun into yarns. This is similar to rayon which is regenerated cellulose, and both are not organic but eco-friendly. Bamboo fiber can block up to 94% of sun's ray. It can be made without using chemicals. This is on the top row of eco-chic fashion and compared to that of cashmere wool [38].

### **Hemp:**

This plant fiber is referred as the best eco-friendly fiber since it does not use chemicals and grows also leaving the soil condition for future crop rotations. The long fibers of hemp make textile forming very easy. UV resistant, breathable, insulating and absorbent property along with increase

in quality over washing has made the fiber being explored by many categories [39].

#### **Nettle fabric:**

This was mainly This fiber is stronger than cotton, finer and glossier than linen. It was a very popular fiber in the middle ages and lost its popularity due to cotton available at a much cheaper rate. STING plus is the brand that makes the nettle fabric. This is naturally fire-retardant textile fiber, strong and soft comfort properties. When blended with wool this is used very much in upholstery textiles.

This is derived from Brennessel plant which has natural resistance to small insects and pests. It requires no fertilisers in cultivation. During fiber formation retting and sun drying technique is employed, after which bales are formed. This is usually blended with organic cotton and made into a yarn. This is made from nettle or Allo of Himalaya. This was very popular once but lost its supremacy to cotton. It is mostly compared with linen. The softness and long staple length makes them very desirable for interiors. It is quite popular in Nepal where various end uses are developed using this fiber for home, clothing and packaging textiles.

#### **Aloe Vera :**

Micro-encapsulated particles of Aloe-vera are used in health care and beauty textiles. These fabrics made of aloe vera can replace the moisturisers and lotions that are applied from bottles and enable application through wipes that are infused with microencapsulated particles of aloe-vera.

#### **Sisal :**

The major application of sisal fiber is buffing cloth that is used to polish iron. The reinforcement properties are very good. That makes it suitable for dart board, composite making. Automobile, boat making, furniture making, water tank and pipe making. This fiber is mixed with cement to do cost reduction and also to replace asbestos in roofing and also in the pads of brakes. This fiber has high folding endurance property. It is used in cigarette paper and in tea bags. The fifteen million tonnes of biomass from sisal production is also used in bio-manure production, bio-gas, pharmaceutical and building [40].

#### **Lyocell:**

This fiber is processed from wood pulp of trees without the use of any chemicals. The process effluent is recycled and used many number of times and since it does not use any harmful chemicals it is eco-friendly. The advantages of these fibers are that the effluent is recycled many number of times that suggest less pollution percentage. Also, such products find their application in the emerging non-woven sector especially in disposal wipes, considering its regenerative property. Wipes made from these fibers can be readily disposed in the flush without the worry of drainage blocking like conventional polyester yarns. Viloft non-woven made from regenerated wood pulp is softer and also facilitate quicker disintegration of fiber in the fluids which makes it a popular flushable wipes brand. Extremely intensive works are also going in creating compostable baby diapers, a sector that needs utmost care. The common brand includes Seacell pure and smartcell clima.

#### **Seacell:**

This is a combination of lyocell and seaweed. This is made by a combination of wood pulp with microscopic particles of seaweed this fabric is known for its miracle in cellular regeneration.

The algae works in the fabric that enable it to be a very nourishing medium for medical textiles. It is anti-inflammatory and also works in stimulating metabolism. Hempcel is another variation that is a combination of lyocell and hemp. This range of fibers will degrade in 12 weeks when disposed off in soil. The fact serves as a major reason for extending the product category.

### **Lenpur:**

This is derived from white pine trees and are reported to have beneficial qualities of silk, wool, and linen. This is supposedly the bestest of cellulosic fibers ever made. They having excellent softness, absorption, ability to release dampness and keeps the wearer cool in summer and warm in winter [41]. Thermo regulation and anti-stress are properties mainly highlighted.

### **Conclusion:**

Everyday there is a news highlight on a new raw material for making fibers. Recently, headlines of an American newspaper, highlighting Hagfish slime as a new thread that can be possibly made into a yarn for textiles. This is believed to be giving a competition for spider silk. Such bio-materials are a huge trend. Another study shows the use of brown sea weed is exploited to extract Alginate that has very good wound healing properties due to high iodine content. The human hair is no exception and designers who are working on sustainability have found this interesting. The human hair is now collected and used into fashion accessory as a neck tie and earring [42-44].

The twitter and other cites that help in networking and connecting people are also making recycling and sustainability issues as a trend. Recently, Zara was bombarded by many social activists (Green peace), suggesting that the company should not be selling clothes at very less cost, which initiate more purchase, which in turn make more waste clothing to end up in landfill. Reports portray Zara alone churns out 850 million clothing items a year. This was an information to deeply think and act.

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