

## Lotus Fiber: A Eco Friendly Textile Fiber

**Sangita Tomar, Nirmal Yadav**

Department of Textile and Apparel Designing

I.C. College of Home Science, CCS HAU, Hisar, Haryana, India

Email: Sangitatomar95@gmail.com

### ABSTRACT

*Lotus fiber (Nelumbo nucifera), (Nelumbo lutea) extracted from the stems of lotus which grow naturally on Burma lakes, especially on Lake-Inle. Almost all parts of lotus, i.e., leaves, flowers, seeds, and stems can be used for edible and medical purposes as well as clothing purpose. This is only the fiber that is the nano-fiber from natural fiber that is why it is called eco friendly fiber. It is antibacterial and self cleaning as well as super-hydrophobic quality containing plant. That lotus fiber is consist of cellulose, hemicellulose, fat waxy, lignin, ash, pectin, amino acids and so on, (cellulose is the main ingredient). Stems of the lotus plants are collected from the lake for the fiber making process. After than take the stems bunches and mark a slight cut around them by the help of knife. After doing the slight cut around the stems they are pulled and broken in to the parts. Twisted to expose fibers and windup on a role in the form of yarn. A spinner can produce up to 250 meters of thread a day. The material made by this fiber is light in weight and breathable. It can be dyed by both dyes (natural dyes and chemical dyes). The resulting fabric has the appearance of antique linen or raw silk, it is soft, exceptionally breathable and crease-resistant. Due to the hand holding process it is more expensive, that's why it is not so popular in world. Around 30 kg of stems is needed to produce 250 meters of thread. The development of this fiber will give the people, to work in the original environments. It will become the means to support future generations, thus allowing this art to survive and increase their family income status.*

**Keywords-** lotus fiber, properties, structure, environment, eco-friendly

Received 14.04.2019

Revised 19.04.2019

Accepted 21.05.2019

### CITATION OF THIS ARTICLE

Sangita Tomar, Nirmal Yadav. Lotus Fiber: A Eco Friendly Textile Fiber. Int. Arch. App. Sci. Technol; Vol 10 [2] June 2019: 209-215

### INTRODUCTION

Lotus (*Nelumbo nucifera*) is one of the most ancient angiosperms originally planted in south america and now grown in semitropical and temperate zones such as western asia, middle asia, north america, india, china, japan, etc.

- Other name of lotus are - ambal, thamarai, padma, ambuja, pankaja, bean of india etc.
- Lotus fibre obtained from stems of lotus plant and it is a eco-friendly fiber.
- This is only the fiber that is the nano-fiber from natural fiber.
- National flower of india, symbol of purity, holiness and immortality that is why it is called luxury textile fiber. A unique fabric from the lotus plant fibers is produced in myanmar. It is antibacterial and self-cleaning as well as super-hydrophobic quality containing plant. Lotus plants are pure by virtue, and they radiate this purity through their fibers. By wearing lotus fiber fabrics, one feels calm, peaceful and meditative. It also cures the wearer from headaches, heart ailments, asthma, and lung issues. The fabrics are 100 % organic.

Elizabeth govert, a textile engineer studies lotus for the first time and what she discovered is a real surprise; lotus is a micro fiber. A micro fiber is a micrometric-fiber which diameter

is very small, close from the micron. A micro fiber can be 10 times smaller than a hair. The lotus is the only natural microfiber known , the other are all synthetic.

#### AGROCLIMATIC CONDITION

- Temperature above 20°C
- 10 – 12 kg seeds per hectare
- Fill the pools with clay soil @ 3:1 to a depth of 45-50 cm
- Water should not be less than 30cm
- Open and sunny situation
- Sunlight at least 6 hours a day
- Best time for planting is april

#### STRUCTURE:

- Lotus fibre is multi-filament (fineness of each monofilament-4µm, space between- 3µm to 5µm).
- Cross section of fibre- round or oval.

Cheng *et.al* [1, 9] conducted a research on extraction of lotus fibres from lotus stems under microwave irradiation. Lotus fibres prepared a kind of hollow fibres which are composed of a superfine fibre and an external shell. The effect of the treatment time with hydrogen peroxide under microwave irradiation on the property of lotus fiber components, whiteness, moisture regain, removal rate of impurities, fineness, tensile strength and breaking elongation of lotus fibres was investigated. The results showed that the cellulose content in lotus fibres increases with in treatment time. Whiteness and moisture regain of lotus fibres increase with in treatment time with hydrogen peroxide. The removal rate of impurities and the fineness of lotus fibres are improved after they are treated with hydrogen peroxide. Microwave irradiation is supposed to be an efficient method for producing lotus fibres.

Chen, *et. Al.* [2] conducted a research on structure and properties of lotus fiber. They stated that lotus fiber is consist of cellulose, hemicellulose, fat waxy, lignin, ash, pectin, amino acids and so on, (cellulose is the main ingredient). The lotus fiber, showing ribbon spiral revolving structure vertically, has clearly imperceptible cross striation, and is bundle fiber composed of many monofils. Then, the cross-sectional of lotus monofil is circular or similar to circular. Lotus fiber is typical cellulose structure with 48% crystallinity and 60% orientation. The density, fineness and moisture regain of lotus fiber is respectively 1.1848 g/cm<sup>3</sup>, 1.55 dtex, 12.32%. Lotus fiber is high strength and low stretch fiber with initial modulus 146.81 cn/dtex, breaking strength 3.44 cn/dtex and breaking elongation 2.75%.

#### Species

Two important species:

- ***Nelumbo lutea***: new world (North America)
- ***Nelumbo nucifera***: old world (Asia and Australia)

Other species:

- ***N. flavescens***- strongly scented lemon yellow
- ***N. alba*** - bold and beautiful

#### History of the fiber

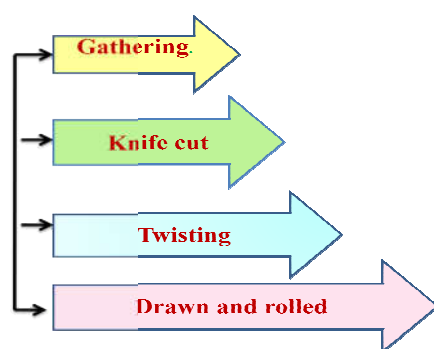
Lotus has a long planting history and abound resources in china and Myanmar. Lotus is a kind of special crop with unique research value. Almost all parts of lotus, i.e., leaves, flowers, seeds, and stems can be used for edible and medical purposes as well as clothing purpose . Extracting fibers from lotus stems have been in practiced since 1910. Later during the 1990s designers of Japan setup workshops to create a foreign market for their fabric. But due to low demand in Japan, lotus fiber fabric remained a rare and handmade textile. Dawsa u saw thin fibres trailing from the end of the lotus stem and was inspired to create a thread from the fibers, and from those threads she wove the first lotus robe, which she offered to a venerable Buddhist monk from golden peacock hill. In return, the monk renamed her dawkyar u (madam lotus egg) and she continued to create lotus robes throughout her life. Lotus weaving was conceived nearly a century ago by the dawkyar u'. Kyaing khan (kyaingkhan) and in paw khon (in pawkhon) are two main village where dawkyar u's work is carried on today by the grandchildren of her friends who operate aungsakkyar lotus robe cooperative ltd. Along with monastic robes, aungsakkyar produces a variety of pure lotus scarves for both local and foreign customers.

Hall stated *et al* [5] that the Italian fashion designer Ioropiana developed a line of lotus clothing and introduced it at the Parisian design fair maison et objet 2012. His 100% lotus double-breasted sport jacket valued at around €4,000 (\$5,600) made waves in the luxury fashion world (and the waters of Inle Lake). Japanese buyers have also shown great interest in the lotus fabric.

Dr. Koslin stated in 2015, that the online retailer devoted to lotus weaving is 'kyar chi lotus threads' run by Samadhimarr, an Australian who has lived and worked in Myanmar since 2008. Over 10% of its profits are donated to self-help groups and charity causes around the country. In 2009, introduced the art of robes made from lotus fibers worn by Burmese monks during an annual celebration.

### Process of fiber making

#### PROCESS OF FIBERMAKING



#### Gathering

Stems of the lotus plants are collected from the lake for the fiber making process. Ideally, the lotus flower should be in full bloom when the stems are picked, and the deep pink flowers contain the best lotus fibers.

#### Knife cut

Take the stems bunches and mark a slight cut around them by the help of knife.

#### Twisting

After doing the slight cut around the stems they are pulled and broken in to the parts.

#### Drawn and rolled

Twist to expose fibers and windup on a role in the form of yarn.

#### Yarn preparation:

- Placing skeins on bamboo spinning frame.
- Transferring the thread onto winders for warping process.
- To avoid tangling, yarn for warp is coiled into plastic bags.
- Yarn for weft is wound onto small bamboo bobbins.
- Raw lotus threads are a neutral creamy color, mainly natural dyes are often used to color the fabric.

#### Weaving:

- Type of loom- Cambodian loom (no warp beam).
- Width of the cloth- 24”(60-75cm).
- Fabric is woven in- 100yds (90m) batches.
- Fibres from 120,000 lotus stems are needed to weave the fabric for a costume.
- Dye - chemical or natural dyes.
- A spinner can produce up to 250 meters of thread a day.
- Around 30 kg of stems is needed to produce 250 meters of thread.
- A experimented weaver can weave 1 meter of lotus fabric a day.

#### Properties:

According to a test report realized in 2016 by ifth (the french textile and clothing institute)

- Finest aquatic fibre
- Breathable & comfortable
- Soft & irregular weft

- Crease resistance
- Under small stress,
- Lotus fibre has good elasticity
- Piling resistance
- Appearance of linen or raw silk
- Colour of lotus fibre-milky yellow
- Wrinkle free
- Cellulosic fibre
- Cool, stiff & neat
- Moisture absorption
- Antibacterial
- Self cleaning
- Environmental friendly as it is organic and natural fibre.
- Cool in summer and warm in winter, lotus fabric is highly breathable and wearable year-round. With a texture similar to raw silk and linen, lotus fabric is lightweight. Tearing and tensile strength make it perfectly suited to make dresses, jackets, tunics or scarves, weight: 130 grams/meter.

Zhao *et al.* [11] investigated the characteristics of lotus fiber length and fineness to provide theoretical basis for developing lotus fiber products, 1500 fibers were extracted by physical method from tip part, middle part and bottom part of lotus stalks (500 fibers for each part) and measured. The analysis showed that the length range of lotus fiber was about 31-50 mm, generally, fibers from tip part are longer, fibers from bottom part are shorter, and fibers from middle part were average in normal distribution. The fineness range of single fiber was 3.963-4.516  $\mu\text{m}$  (less than 5  $\mu\text{m}$ , belongs to microfiber), and the finest fiber was from tip part, with smallest coefficient of variation. The ratio of lotus fiber length to fineness was about 104, which can meet the textile processing requirement.

Jiangang *et al.* [4] stated that the density of lotus fiber is (1.184 8)  $\text{g/cm}^3$ , much less than that of cotton, ramie and wool fibers, but similar to that of silk and acrylic. The linear density of lotus fiber is 1.55 dtex, finer than ramie and silk fibers and similar to cotton and cotton type chemical fibers. It indicates that the lotus fiber is very fine and is beneficial to resultant yarn strength and yarn evenness. It can spin high count yarns. The moisture regain of lotus fiber is 12.32%, larger than that of cotton and silk and less than that of wool and viscose, but similar to that of ramie fiber. It shows that the lotus fiber has very good absorbent quality

Mahapatra *et al.* [8] stated that the united nations general assembly declared the international year of the natural fiber; a year long initiative focused on the global awareness about a natural fibres with the specific focus on increasing demand to help ensure the long term sustainability for farmers who rely heavily on their production. The lotus fibre production is very good for the same. It is eco-friendly as well as having silk and linen property in itself. The lotus fiber is smooth than the sisal fibre, but both thermal properties are same.

#### **Comparison of properties with other fibres**

- Initial modulus is 146.81 cn/dtex-superior to cotton, wool, silk and close to ramie.
- Breaking tenacity is 3.44 cn/dtex-superior to wool, close to cotton, silk and next to ramie.
- Elongation at break is 2.75%-close to ramie and smaller than cotton, wool & silk.

#### **Blending with other fibres**

- Can mixed with other fiber.
- Blending of 15% lotus fibre and 85% cotton can be used for upholstery and draperies.
- Blending of 80%lotus fiber and 20% silk, 50% lotus and 50% silk both used in the fashion garments.

Awendelavel in 2012, (samatoa) stated that the property of the lotus fibres is enhanced and gave better results when blended with the other fibres such as silk kapok and banana in different proportions .

Wu, *et al.* [10] Stated that the growing global environmental problems, demands for environmental friendly, fully biodegradable sustainable composites have substantially increased across various industries. Inspired by the composite structure of cocoon silk,

they fabricated a fully green composite fiber (gcf) that is based on the lotus fiber (lf) and a biodegradable polymer, namely poly vinyl alcohol (pva). After the formation of cross-linkages between the lf and pva, the mechanical properties of this bioinspired gcf had substantially improved. In particular, the specific mechanical properties are superior to those of cocoon silk and other natural fibers. Findings of study suggested that lfs may be used as reinforcement materials for the fabrication of bulk green materials for various industries, such as the textile, medical, automobile, and aerospace industries.

Cheng et. al, [3] studied the lotus fibers were prepared from lotus stems through being treated with sodium hydroxide. The lotus fibers were characterized by scanning electron microscopy (sem), fourier transform infrared spectrometry (ftir), x-ray diffraction (xrd) and thermal analysis (tg and dta). The results indicate that the length of lotus fibers ranges from 3.52 cm to 5.80 cm and the width of lotus fibers ranges from 50  $\mu\text{m}$  to 90  $\mu\text{m}$ . Lotus fibers belong to celluloses fiber with cellulose structure and the crystallinity of lotus fibers is 48.50 %. The lotus fibers consist of cellulose, lignin, hemicellulose, pectin, lipid and water-soluble substances. The effect of concentration of sodium hydroxide, time and temperature of treatment on removal of impurities, fineness and breaking strength of lotus fibers were investigated. The results suggested that the removal of impurities and breaking strength increase with the rise of concentration of the sodium hydroxide, time and temperature of treatment, respectively. However, the fineness of lotus fibers decreases with an increase in concentration of the sodium hydroxide, time and temperature of treatment.

Ling, *et al.* [7]. Analyzed the spinnability of lotus fibre with other fibres. The results showed that the lotus fiber's spinning performance between cotton fiber and ramie fiber blended with lotus fiber; the trial product of lotus/cotton blending of 20/80 with yarn fineness 28 tex were obtained.

#### **Dyes**

Using dyes made from jackfruit, bark, seeds, lotus leaves and other natural materials. The lotus leaf provides a rich green dye. Although most lotus accessories are sold in their natural earthy color, natural dyes are used to create four additional colors:

- Mango tree bark produces a dark reddish color
- Jackfruit bark deepens the natural brown color
- Backwater tree bark, also known as the inle lake tree, produces a dark gray color.

#### **Brands using lotus fibre:**

- Kyar chi (scarf and sacred fabric)
- Italian fashion company- lorapiana
- Mr. Loropiana says, he hopes to be selling 300 lotus jackets annually.

#### **SOMATOA LOTUS TEXTILE**

Luxury yarns textiles are produced in Cambodia. Its office is located in siemreap, in 2003 samatoa established the foundations of a solid fabric composed of the best experts in bio-textiles and ethical fashion. Lotus fabric can be sourced from delavel's eco-textile label samatoa. Hence, samatoa is a social textile enterprise focusing on the values of fair trade and sustainable development. Awendelavel in 2012, samatoa submitted a sarong, made from unique lotus textiles, to the unesco handicrafts program and received their seal of excellence. The 'seal of excellence' is a quality label, awarded to project proposals submitted for funding under horizon 2020 the eu's framework programme for research and innovation. Awendelavel for 10 years, experimented natural fibers: lotus, pineapple, banana, water lily, kapok, palm, silk, coconut, and rice leaves. They also developed a fantastic team of expert spinners, weavers, seamstresses, and designers. Finally, this gives them a unique texture and properties that is now in high demand worldwide and currently unavailable elsewhere on the planet.

#### **Advantages of lotus fabric**

- A waste (lotus stems) transformed into a quality textile
- No chemical or toxic product
- No use of polluting energy
- Hand spun,
- Hand woven, following traditional Cambodian methods.

#### **Care of lotus fabric**

- Hand wash

- Do not bleach
- Dry flat in the shade
- Do not require iron
- Dry-clean: petroleum solvent only

**Disadvantages:**

- Raw material collection to yarn spinning and weaving is completely handmade.
- Time consuming and expensive.
- The lotus fabric must be weaved within 24 hours to prevent the deterioration of fibre.
- The process is labor intensive.
- One of the most expensive textiles in the world.

The head office of lotus fabric at Mumbai, others branch offices in other parts of India, in ankaleshwar and vizag situated in vasai, Mumbai where the project work is going on for its bright future in india , this project is lead by mr. Suresh gupta.

**Future of lotus fibre**

- Through cooperation with the local population, this material can be introduced to appreciated by enthusiasts of extreme quality and nature.
- The development of this fiber will give the people, to work in the original environments.
- It will become the means to support future generations, thus allowing this art to survive and increase their family income status.

Le, *et. al* [6] stated the special wettability of lotus fiber has attracted a lot of interest and attention in both academia and industry. Such special wettability textile surfaces are demonstrated with self-cleaning, oil/water separation, self-healing, uv-blocking, anti-bacterial, and flame-retardant performances.

**CONCLUSION**

lotus fiber (*Nelumbo nucifera*), extracted from the stems of lotus which grow naturally on Burma lakes, especially on lake inle. It is one of the finest aquatic fibres ever weaved. The material made by this fiber is light in weight. It can be dyed by both dyes (natural dyes and chemical dyes ). The resulting fabric has the appearance of antique linen or raw silk, it is soft, exceptionally breathable and crease-resistant. It can be blend with the silk, kapok and banana fibre which enhance the property of resulting fabric , by this luxurious and eco friendly fabric, can make the different types of garments. Due to the hand holding process it is more expensive, that's why it is not so popular in world .

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