Soyabean protein fiber: A sustainable alternative to silk

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ABSTRACT

Natural silk has an abundance of properties like soft texture, lightweight, good strength, absorbency, and drapability which makes it a lucrative fabric for apparel production. But at the same time, its manufacturing presents certain challenges. Soyabean protein fiber (SPF), therefore, offers a great alternative without compromising the advantages that natural silk provides. It is a regenerated vegetable protein fiber from soyabean (*Glycine max*). Soyabean has 18 amino acids of which aspartic acid and glutamic acid form the major part. It also contains the maximum portion (90%) of salt-soluble globulins which are very important for textile fibers. The fiber is obtained from soyabean cake after extraction of oils and other fatty substances, which are further, blended with polyvinyl alcohol (PVA) and spun by the wet spinning method. SPF has excellent absorbency and breathability which makes it comfortable to wear. Similar to natural silk, it has a smooth surface, fine appearance, drapility, and good dyeing ability. SPF has higher breaking strength and elongation, high melting point, excellent alkali resistance and good UV resistance as compared to silk. Thus, it is also being popularized as soy silk. The blending of SPF has also yielded good results. Soyabean fiber is also ideal for clothing which is worn close to the skin. SPF is also resistant to *Staphylococcus aureus* and has excellent antimicrobial activity. Due to the low sensitivity of soyabean protein fibers to pH, they can be dyed using reactive dyes and are stable against washing at high temperatures. In light of all the properties, it is not wrong to say that soyabean fiber provides all the advantages of natural silk and is more economical and sustainable at the same time thus making it an efficient alternative to natural silk. The cost of production of silk is also higher than soy protein fiber which supports the environmental as well as economic sustainability of soy protein fiber (SPF).

Keywords: Breathability, cost-effective, drapability, soy, unethical, silk

INTRODUCTION:

The textile industry presents a wide range of products to its customers, from a large number of fibers to different classes of yarns and then a variety of fabrics made through varied construction techniques. A combination of these raw materials and processes has

presented us with numerous fabrics and textile materials. Natural fibers provide a wide variety of characteristics which include soft texture, shiny lustre, bright colours, and above all the environment-friendly processing. Natural fibers are favoured for apparel purposes because of their pliability and comfort. Amongst the natural fibers, silk is the most delicate yet the strongest fiber. It is produced by a silkworm (*Bombyx mori*) and it is the only natural filament fiber. Silk is a natural protein fiber. The protein of silk is known as fibroin which is constituted of 16 amino acids with glycine, alanine, and tyrosine being the chief constituents (Kaplan *et al* 1991, Sashina *et al* 2006).

Silk is of four types namely mulberry, tasar, eri, and muga. India produces all four types of silk and ranks second in the world after China, contributing to 18% of the total raw silk production. Silkworm feeding on mulberry leaves produces a fibrous substance to envelope itself to form a cocoon. The cocoons are then boiled and fiber is reeled. The majority of the world's silk is produced by this method but this process kills the silkworm inside the cocoon and hence, it disturbs the natural lifecycle of the silkworm. It is therefore not wrong to say that silk production is unethical. The high cost of silk also restricts its usage amongst all sections of society. This has given rise to peace or *ahimsa* silk where the silkworm can complete its life cycle. The silk is reeled after complete maturation of cocoon and after the moth leaves the cocoon, hence, each moth completes its life cycle. But, this process ruins the silk filament. The short-staple silk fibres are then woven to produce silk fabric. The peace silk has different properties as compared to natural silk and loses its shine and strength which give the original identity to the queen of fibres- the silk (Datta and Nanavaty 2005).

Figure 1: Mulberry Silk Fiber

In light of the above facts, researches are being undertaken to find out cheaper substitutes of silk which have similar properties and uses ethical production processes. Soybean protein fiber is one such development in the field of green textiles. Soybean fibre is a kind of reproducible plant protein fibre. The soybean protein fibre is fine, has low specific gravity, high tensile elongation, and good acidic and alkali resistance. It is similar to natural fibres such as cotton, wool, hemp, silk, etc. As regards its moisture absorption and discharge performance, permeability performance, heat-retaining performance, and spinning performance, people in textile industry refer to it as "a healthy and comfortable fibre in the 21st century" (Yi-you 2004).

OBJECTIVES OF THE STUDY:

1. To compare the properties and cost of silk and soyabean fibre.
2. To explore the potential of soyabean fibre as an alternative to silk.

METHODOLOGY

The information about silk and soyabean was taken from secondary sources like books, research papers, journals, encyclopedias, magazines, and newspapers.

FINDINGS

Every textile fibre has some desirable properties and few limitations which not only determine its end uses but also point out its acceptability and cost-effectiveness. These properties are due to the inherent nature of fibres and the method of their processing and production.

Production of Soyabean Fibre:

The process involves the extraction of polymer from the residual soyabean cake, preparation of the spinning solution and finally spinning of the filament fiber by the wet spinning method. It is evident from the processing that 100 kilograms of residual soyabean cake produce 40 kilograms of protein. The cost of the extracted protein is only one-third of silk and just one-fifteenth of cashmere. Hence, soyabean protein fiber is cheaper than both pure silk and cashmere (Yi-you 2004).

Figure 2: Soy protein Fiber (SPF)

Table 1: Comparative Analysis of properties of silk and soyabean

Properties		**Silk**	**Soy protein fiber**
Diameter (μm)		13-18	20
Length		Filament	Filament
Breaking strength (CN/dtex)	Dry	2.6-3.5	3.8-4.0
	Wet	1.9-2.5	2.5-3.0
Initial modulus (kg/mm^{-2})		650-1250	700-1300
Moisture regain (%)		11.0	8.6
Density (g/cm^{-3})		1.34-1.38	1.29
Alkali resistance		Good	General
Acid resistance		Excellent	Excellent
Ultraviolet resistance		Bad	Good
Antistatic property (mass-specific resistance)		9.8	10.33

Source: Swicofil (2011)

From the table, it is evident that the physicochemical and mechanical properties of soy protein fiber are similar to that of silk. Also, soy silk is lighter than silk and has good ultraviolet resistance and antistatic property.

Cost evaluation of silk and soyabean protein fiber (SPF)

The process of rearing silkworms for silk production is termed as sericulture. Sericulture includes preparation of mulberry plantation, facilitation of infrastructure for

silkworm breeding, and the processing of silk fibers. Since the process of silk cultivation is labor-intensive, hence the cost of production of silk is higher. Secondly, the yield of silk is very low as compared to the investment i.e. 3000 silkworms feed on 104 kg mulberry leaves to produce one kilogram of silk (Fritz and Cant, 1986).

For the production of soy protein fiber (SPF), major raw materials come from natural soybean cake, which can be derived from soy residue after processing of soy products like tofu. The quantity of raw material is large and can be readily regenerated. Furthermore, it does not produce any waste. Additionally, the garments made from soy silk can be easily composted after they have worn out (Edwards, 2017). Soy silk is usually manufactured on a closed-loop system i.e. the chemicals can be reused for the processing. Because the auxiliary and additional agents and materials used in the production of soybean fibre are not poisonous, the semi-finished fibres can be recovered of most additional agents and used again, and the residue left after purification of protein can be used as a foodstuff. Therefore, its production course does not cause pollution to the environment and complies completely with environmental protection requirements.

Soybean proteins contain 18 different amino acids. There are about 23% of acidic amino acids (glutamic acid and aspartic acid), about 25% of alkaline amino acids (serine, arginine, lysine, tyrosine, threonine, tryptophan) and about 30% of neutral amino acids (leucine, phenylalanine, valine, alanine, isoleucine, proline, glycine). Sulphur containing amino acids are present also in soy proteins: about 1.0% of cysteine and 0.35% of methionine. Soybean proteins consist of various groups of polypeptides with a broad range of molecular size: about 90% are salt-soluble globulins (soluble in dilute salt solutions) and the remainder is water-soluble albumins (Zhang, 2003).

Soybean protein fibres (SPF) are manufactured fibres, produced from regenerated soya (*Glycine max)* soybean proteins in combination with synthetic polymer (polyvinyl alcohol) as a predominant component. According to textile fibre labelling (FTC, 2010), textiles from SPF can be marked as azlons from soybean. Azlons are manufactured fibres in which the fibre forming substance is composed of regenerated naturally occurring proteins (FTC, 2011).

Potential of soyabean as a silk substitute

Soy Protein Fiber (SPF) is the only protein fiber made from soybean cake. Their physical properties are the same as that of synthetic fiber. It gives tremendous change in properties like smoothness/luster/comfort/absorbency/strength/shrinkage when mixed with other fibers. For example; when soybean fibers mix with cashmere, it gives smooth quality

with an enhancement of easy-care properties. As a wool/soy protein fiber, it reduces shrinkage and increases ease of care. As a silk blend, it improves the properties of silk with the prevention of the fabric from sticking to the skin when wet.

Soybean has a gentle drape, a soft and smooth structure luster appearance, as well as anti-bacterial and anti-ultraviolet properties. SPF is the only renewable botanic protein fiber. Its 16 amino acids are healthy and nutritional to people's skin. It is a kind of active fiber that shows the superiorities of many natural fibers and a synthesized one. Soy fiber is soft and comparable to silk in the way it drapes. It is also very durable and lends itself well to many different types of garments or home textiles like sheets. Thick soy fabric has even been proven to be warmer than wool. Soy fabric is also easy to care for, doesn't wrinkle easily and is often more durable than natural fabrics of the same grade. SPF has better UV resistance and anti-bacterial properties (Zupin and Dimitrovski 2010). SPF is resistant to *Staphylococcus aureuses, Coli bacillus,* and *Candica albicans* thus providing easy-care properties than silk (Swicofil 2011).

CONCLUSION

The successful manufacture of the soyabean protein fibre is a breakthrough and follows the developmental direction of world-wide fibres. The physical, chemical and mechanical properties of soy protein fiber (SPF) are at par with silk and hence, can be suggested as a substitute for silk escaping the unethical production and high cost of silk fiber. On the contrary, SPF utilizes residue and fewer chemicals. The cost of production of SPF is also less as compared to natural silk. As a contribution to sustainability, soy silk can be put forth as an eco-friendly and economical substitute for silk.

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