Chemical processing of silk

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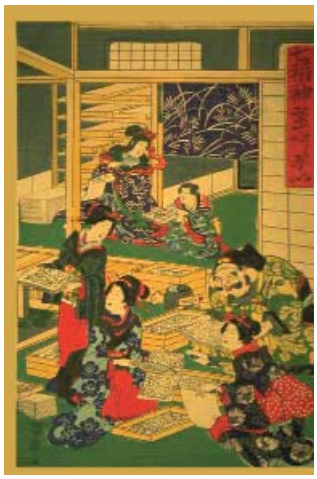
Silk is known as the Queen of all textile fibres because of its sheen and luster. It is one of the most beautiful and precious fibres[1] given to us by nature and has been very much overshadowed over the past few decades by the other natural fibres and more particularly by synthetics. Recently, its importance has again increased, partly due to the current preference for natural products and the resultant increase in demand for natural fibres. Silk has optimum properties in terms of comfort and wearability and eco-friendly nature and the shimmering appearance comes from the fibers' triangular prism-like structure which allows silk cloth to refract incoming light at different angles. Certainly silk will never become a mass produced fibre, but it will continue to occupy its special position as a fibre for exceptionally high quality garments. The silk is gaining increasing importance day by day because of its exclusive qualities which are rarely found in any other fibres. Silk is one of the prestigious fibres and worn mostly by people as a symbol of royalty. The of silk processing requires great care so as to preserve its classic feel, scroopy handle and shimmering appearance. This article entails chemical processing of silk, bleaching, optical whitening, dyeing, printing and finishing of silk fabrics.



Introduction

Silk is a natural protein fiber, some forms of which can be woven into textiles. Silk is the only natural filament that man does not have to spin, before it can be used for textile fabrics.The cultivation of silk is known as Sericulture.The natural silk spun by silk worms in the form of cocoons is utilized only to 50% of its production because of lack in right way of processing and deficiency in sericulture.

Silk is broadly divided into two kinds: domestic silk or mulberry silk and wild silk. The wild silk has three varieties: (a) Eri (b) Muga and (c) Tussar silk. Eri is the staple fibre and other two are filaments. All these species rear in the forests and known as VANYA SILKS. The best-known type of silk is obtained from cocoons made by the larvae of the mulberry silkworm Bombyx mori reared in captivity (sericulture). Whereas, "Wild silks" are produced by caterpillars other than the mulberry silkworm and can be artificially cultivated. Over 30 countries produce silk worldwide.

A variety of wild silks have been known and used in China, India, South Asia, and Europe since early times, but the scale of production was always far smaller than that of cultivated silks. They differ from the domesticated varieties in color and texture, and cocoons gathered in the wild, usually have been damaged by the emerging moth, before the cocoons are gathered, so the silk thread that makes up the cocoon has been torn into shorter lengths.

Commercially reared silkworm pupae are killed by dipping them in boiling water before the adult moths emerge, or by piercing them with a needle, allowing the whole cocoon to be unraveled as one continuous thread. This permits a much stronger cloth to be woven from the silk. Wild silks also tend to be more difficult to dye than silk from the cultivated silkworm.

Silks are produced by several other insects, but only the silk of moth caterpillars has been used for textile manufacture. There has been some research into other silks, which differ at the molecular level. Silks are mainly produced by the larvae of insects that complete metamorphosis, and also by some adult insects such as web-spinners

Chemical processing of silk[2]

Silk is one of the strongest natural fibers but loses up to 20% of its strength when wet. It has a good moisture regain of 11%. Its elasticity is moderate to poor, if elongated even a small amount it remains stretched. It can be weakened if exposed to too much sunlight. It may also be attacked by insects, especially if left dirty. Silk is a poor conductor of electricity and thus susceptible to static cling. Unwashed silk may shrink up to 8% due to a relaxation of the fiber macrostructure, therefore, silk should either be pre-washed prior to garment construction, or dry cleaned. Dry cleaning may still shrink the material up to 4%. Occasionally, this shrinkage can be reversed by a gentle steaming with a press cloth. There is almost no gradual shrinkage or shrinkage due to molecular-level deformation. Chemical processing of silk is carried out in stages of degumming, bleaching, dyeing and finishing.

Degumming of silk

The compositon of raw silk is given as under:

Fibroin	70-80%
Sericin	20-30%
Waxy matter	0.4-0.8%
Moisture	10-11%
Carbohydrates and Starches:	1.2-1.6%
Inorganic matter	0.7%
Pigment	0.2%

Under chemical examination, silk fibre consists of two elements, i.e. inner layer called silk fibroin which forms the core of the fibre. It is insoluble even when boiled in hot water.

The outer layer of silk filament is a form of gum, or silk glue, called sericin. These two elements are present in the fibre in the proportion of about 75 parts fibroin to 25 parts Sericin. Outside Sericin is also a thin layer of Albumen and on the extreme outer surface is a coat of gelatine.

The process of eliminating ' gum ' from raw silk is known as Degumming of silk.It is synonymous to the scouring process used for purification of cotton and wool. The different ways of degumming silk are as follows:

a. Soap as a degumming agent

Soap is a good degumming agent and grey fabrics can be completely degummed by treating with soap solution at close to boiling point for 1-2 hours. Neutral synthetic agents have no degumming properties. After degumming the silk is thoroughly washed with water, with weak solutions of ammonium chloride or soda ash at 40 -500^{0}C for 20 minutes.

b. Enzymatic degumming

Proteolytic enzymes like Trypsin and Papain may be used for degumming. All the sericin is not removed by this treatment, hence a subsequent treatment with soap solution is necessary. The enzymes preferably hydrolyze peptide bonds formed by carboxyl groups of Lysine and Arginine of silk to form low molecular weight water soluble products which can be easily washed out.

c. Extraction with water

In order to remove sericin from raw silk the yarns must be autoclaved for long periods with water at temperature over 1000^{0}C. The degradation of silk is minimum. There might be some modification of the protein molecule.

d. Treatment with alkalis

Alkalis have severe destructive effect on proteins. Severity of the treatment required to remove sericin from a given sample depends on the type of silk. Degumming with soaps in the presence of alkalis is in practice since a long time. Here soap acts as the degumming agent and the alkalis aid the process.

Bleaching of silk

Natural coloring matters present in silk are associated mainly with sericin and hence are eliminatedduring degumming. However, the residual pigments are adsorbed by fibroin and hence silk fabrics made from yellow raw silk after degumming are not white but have a cream colour.

The natural colouring matter of silk can be roughly divided into yellow, green and brown pigments.

The bleaching process may be based on reducing agents or oxidizing agents. But material bleached with reducing agents tends to reoxidise and the original color may be restored. Hence oxidizing bleaching is most preferred.

Predominant reducing agents used are sulphur dioxide, sodium hydrosulphite and sodium or zinc sulphoxylate formaldehyde. While the oxidizing agents used are potassium permanganate, sodium perborate, sodium peroxide or Hydrogen peroxide. The hydrogen peroxide is the most preferred bleaching agent. The Chlorine based bleaching agents are bleaching powder, sodium hypochlorite and sodium chlorite which are generally not used since these agents tend to chlorinate the fibroin.

Optical Whitening

In order to enhance the whiteness of a fabric treatment is carried out with an optical brightening agent. The optical brightening agent may be applied along with bleaching agent during processing of silk.

Dyeing of silk

Since silk is a natural polyamide fibre it can be dyed with various dyes as acid, basic, direct, reactive, metal-complex and solubilised vat dyes. The pH of the dyebath and the temperature of dyeing should be adjusted so that slow and even adsorption of the dye takes place from the start.

Printing of silk

Silk is mainly printed by handblock printing and screen printing methods.The handblock method is a slow process.The different styles of printing are direct, discharge and resist style. Hardly any other fibre can be printed with so many different classes of dyes as silk. The some classes of dyes that can be used to print silk include acid, metal-complex, direct, reactive, basic, vat and indigosols.This wide variety is due to the fact that a high proportion of silk in the market is always creedited to discharge printing.

Finishing of silk

Silk being a noble fibre, care must be taken during its finishing so as not to affect its classic feel, scroopy handle and shimmering appearance. During finishing silk is treated for following properties:

- Crease resistance.
- Antistatic effect.
- Spot resistance(water and oil drops).
- Flame retardancy.
- Dimensional stability (with hand washing).
- Wash and wear properties.

Conclusion

Thus it is concluded that silk a lustrous, precious natural fibre is popular for its highest position among all fibres as Queen of fibres and requires careful processing so as not to affect its feel and appearance. Silk processed well with great care will fetch a great deal of exports earnings.

References

1. Sandoz Colour Chronicle (Jan/Mar 1990).
2. Gulrajani,M.L. Chemical Processing of Silk, pg 70 (1992).

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