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Mulberry Silk Production and Processing of Cocoon

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Introduction:

Silk is a fiber naturally occurring made up of a protein named fibroin; this is salivary gland secretion of some insect's feeds on some plants like mulberry, oak etc. Insect secrete this to form cocoons. Silk fiber is adorned with "Queen of Textiles". Silk has high affinity for dyes, light weight, very soft and high durability over the other naturally occurring fibers. The Indian way of life and culture has been influenced by silk. India's history with silk manufacturing and trading, which dates back to the 15th century, is extensive and complicated. In India, the sericulture sector employs about 8.7 million people in rural and semi-urban areas. A sizable portion of these employees are drawn from the economically underprivileged groups of society, including women. India's local market, which is rooted in tradition and culture and boasts an incredible variety of clothing made of silk that reflect regional distinctiveness, has contributed to the nation's success in the silk sector.

Sericulture: Sericulture, the practise of producing raw silk by rearing caterpillars (larvae), particularly those of the domesticated silkworm (Bombyx mori).China is considered the origin of sericulture. In India the cultivation dates back to 15th century.

Type of Silk: There are five major types of silk of commercial importance, obtained from different species of silkworms which in turn feed on a number of food plants: Except mulberry, other varieties of silks are generally termed as non-mulberry silks. India has the unique distinction of producing all these commercial varieties of silk.

Mulberry Silk: The species accounts for the majority of the commercial silk produced

Figure 1: Mulberry Crop

worldwide, and when people mention silk, they typically mean mulberry silk. Mulberry silk is produced by the silkworm (*Bombyx mori* L), which feeds on mulberry plant (*Morus alba*). These silkworms are raised indoors and are entirely domesticated. The five states of Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu, and Jammu & Kashmir produce the majority of the country's mulberry raw silk, accounting for 92% of total output.

Tasar (Tussah): It is a copper-colored silk that is mostly used for interior decoration and furniture. It has a different feel and appeal than mulberry silk while being less shiny. Tasar silk is produced from larvae of several species of silkworms belonging to the moth genus *Antheraea*. that mostly feeds on the food plants Asan and Arjun. Tussar silk is considered more textured than cultivated *Bombyx* or "mulberry" silk, but it has shorter fibers, which makes it less durable. As most of the cocoons are collected from the forest, it is considered by many as a forest product.. For many tribal communities in India, tasar silk is their main source of income.

Oak Tasar: It is a finer kind of tasar produced by the silkworm (*Antheraea proyeli* J.), which is abundant in the sub-Himalayan area of India, which includes the states of Manipur, Himachal Pradesh, Uttar Pradesh, Assam, Meghalaya, and Jammu & Kashmir. The silkworm feeds on natural food plants of oak. A different silkworm known as *Antheraea pernyi* is the source of oak tasar, which is primarily produced in China.

Eri silk: is the product of the domesticated silkworm *Samia ricini*, found mainly in North East India and some part of China and Japan. This silkworm feeds on castor plants. Eri silk is also known as **endi** or **errandi** in India. Eri silk is a staple fiber, unlike other silks, which are continuous filament. It is processed without killing the silkworm. Moths leave the cocoon and then the cocoons are harvested to be spun. The eri silkworm is the only completely domesticated silkworm other than *Bombyx mori*.

Muga silk: India is the rightful owner of this silk, which represents the state of Assam's pride. It is produced by *Antheraea assamensis*, a semi-domesticated multivoltine silkworm. These silkworms are raised on trees resembling tasar and fed on the fragrant leaves of Som and Soalu plants. Muga culture is unique to the state of Assam and is deeply ingrained in its heritage and culture. High-end items like sarees, mekhalas, chaddars, etc. are made from muga silk.

Silk production in India: India is only country in the wirld producing all these five types of silk namely, mulberry, tropical tasar, oak tasar, eri and muga in which muga with its

distinctive golden yellow shining is only found in India.

Mulberry sericulture is mainly practiced in states such as Karnataka, Andhra Pradesh, Assam, West Bengal, Jharkhand and Tamil Nadu who are the major silk producing states in the country. North East has the unique distinction of being the only region producing four varieties of silk viz., Mulberry, Oak Tasar, Muga and Eri. Overall NE region contributes 18% of India's total silk production. India is the second largest producer of silk in the world. Among the four varieties of silk produced in 2020-21, Mulberry accounted for 70.72% (23,860 MT), Tasar 8.02% (2,705 MT), Eri 20.55% (6,935 MT) and Muga 0.71% (239 MT) of the total raw silk production of 33,739 MT (Provisional).

Figure 2: Mulberry cuttings (A) Nursery raising (B)

Mulberry plant is most widely cultivated for silk production in India. Over 20 species of mulberry, the most common species are *Moras alba*, M. *indica*, M. *serrate*, and M. *latifolia.* Mulberry is propagated through seeds, root-grafts and stem cuttings, but the most popular propagating material is stem cutting. The cutting should be 22 to 23 cm long bearing at least 3-4 buds. These are directly planted in the nurseries and later transplanted in the field. After transplanting and sufficient growth of mulberry plants pruning is practiced routinely to induce growth and development of new shoots and leaves.

There are three methods for gathering leaves for larvae feeding: leaf plucking, branch cutting, and top shoot gathering. In leaf picking, each leaf is manually selected. The entire branch with leaves is cut in half and given to the third-instar larva in the branch cutting procedure. The tops of the shoots are cut off during top shoot harvesting and delivered to the 4th and 5th instars. The

agronomic techniques used to cultivate mulberry trees, such as irrigation, fertilizer application, etc., determine the leaf yield and quality. Under ideal circumstances, 20,000 to 25,000 kg of leaves can be gathered annually per hectare. According to estimates, 600-650 kg of leaves is needed for spring upbringing and 500-550 kg of leaves are needed for summer rearing to raise one box of 20,000 eggs.

Rearing of Mulberry Silkworm:

Procurement of quality seeds:

First step in silkworm rearing is procurement of quality seed free from diseases. Cocoons are placed in well ventilated rooms; temperature should be 23 to 25 0C and humidity 70 to 80 per cent. Rooms should be kept dark and light be provided on day of emergence of moth. These moths are mated to produce seed eggs. Female moths are allowed to lay eggs on paper sheet coated with gummy substance. These seeds are disinfected with 2% formalin and then washed with water to loosen the eggs. These egg bearing sheets are again washed with salt solution 1.06 to 1.10 specific gravity to separate unfertilized eggs.

Brushing:

Transfer of eggs on rearing tray is called as brushing. Eggs are then exposed to diffused light for hatching. Hatched larvae are then placed on new rearing tray having chopped mulberry leaves spread on fine net. Worms start feeding and after feed the net with worms transferred on rearing tray.

Preparation of feed bed and feeding:

Feed bed is prepared in tray by uniformly distributed chopped leaves over net. First and second instar larvae are fed and proper humidity is maintained in beds by water-soaked foam rubber strips sandwiched in between two sheets of paraffin paper. The first and second instar larvae are called as chawki worms are fed in these trays.

The 4^{th} and 5^{th} instar larvae are reared on wooden trays. Each age of the silk worms could be divided into seven stages *ie*., First feeding stage, sparse eating stage, moderate eating stage, active eating stage, premoulting stage, last feeding stage, moulting stage. The larvae have a robust appetite during the early phases of feeding but have relatively poor appetites during the sparse and moderate eating stages. During the active period and the final feeding stage, they consume voraciously before stopping.

Bed Cleaning: Bed cleaning is done by spreading the net loaded with chopped leaves on the tray the worms come on the net and then transfer the net on a new tray. In these way excreta is removed. This is essential for healthy development of worms

Spacing: As the worms get bigger they need more space. From one instar to the next instar larvae the space needed is just double or triple. So it is important to multiply the space by two to three in the fourth instar and by two in the fifth instar. Thus, from the time of brushing to the time of worm development, the rearing space multiplies by up to a hundred.

Mounting: Mounting is the process of transferring adult fifth instar larvae to mountages. When a larva reaches full maturity, it becomes translucent, stops feeding, and looking for a spot to attach itself so that it can spin a cocoon and pupate. They are taken by the hand and mounted. The worms begin weaving the cocoon after attaching to the mountages' spirals. Silk fluid is continuously released from the head in tiny amounts, where it solidifies to form a long, continuous filament. The silkworm initially creates the framework for the cocoon structure by spinning a temporary web that gives the larva foot hold to build the compact cocoon shell. The silk filament is deposited in a succession of brief waves that create the figure of eight as a result of the head's distinctive movements. In this manner, layers are constructed and combined to create the little cocoon shell. After the formation of compact shell of the cocoon, the shrinking larva wraps itself and detaches from the shell and becomes pupa or chrysalis. The spinning completes within 2-3 days in multi-voltine varieties and 3-4 days in uni- and bi-voltine.

Harvesting of Cocoons

Inside the cocoon, the larva goes through a transformation process to become a pupa. Pupal skin is brittle and prone to rupture in its early stages. Therefore, early harvest may cause pupa damage, which may harm the silk thread. Therefore, it is essential to harvest cocoons at the right moment. Cocoons are manually gathered. The cocoons are sorted after harvesting. After being cleaned by eliminating faeces and silk wool, the desirable cocoons are then sold.

Figure 3: Larvae feeding on mulberry leaves

Post Cocoon Processing: It includes all processes to obtain silk thread from cocoon.

Stifling: Stifling is the process of destroying pupa inside the cocoon. 8–10 day old, healthy cocoons are chosen for further processing. By exposing the cocoon to hot water, steam, dry heat, sunlight, or fumigation, the cocoon is stifled.


Figure 4: Silkworm feeding tray (A) Cocoons (B)

Reeling: Reeling is the process of extracting the threads from a dead cocoon. To soften and adhesion of silk threads to one another, release the threads so they may separate freely, and make it easier to unbind silk threads. The cocoons are first cooked in boiling water at 95–97°C for 10-15 minutes. The sericin protein softens during cooking, facilitating uninterrupted relaxation of thread. Then, with the aid of an appropriate machine, the cocoons are reeled in hot water. The free ends of four or five cocoon threads are threaded through eyelets and guides, twisted into one thread, and then coiled around a large wheel. By using croissure, the twisting is accomplished. Finally, the silk is put to spools; the silk that results from this process is known as raw silk or reeled silk. The raw silk is then boiled, stretched, and cleansed by acid or by fermentation to bring the luster. Raw Silk or Reeled Silk is finished in the form of skein and book for trading.

The demand for superior quality silk is increasing in India for domestic consumption as well as value added silk products for the export market. The Ministry of Textiles Government of India and Departments of Sericulture in various states provide technical and financial assistance for enhancing the bivoltine silk production. GI tags are granted to some Indian silk products are given below:

Geographical Indications of Indian silk:

1. Baluchari Saree - West Bengal
2. Salem Silk - Tamil Nadu
3. Arani Silk - Tamil Nadu
4. Molakalmuru Sarees - Karnataka
5. Ilkal Sarees - Karnataka
6. Muga Silk - Assam
7. Orissa Ikat - Odisha
8. Kancheepuram Silk - Tamil nadu
9. Mysore Silk - Karnataka
10. Chanderi Fabric - Madya Pradesh

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