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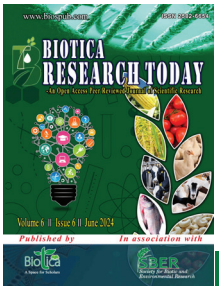

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Silk Spinning Process: An Overview

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Abstract

Greater than 400 million years of natural selection acting throughout the arthropod has resulted in highly specialized and potentially efficient processes to create a protein-based fiber with adequate properties that are a source of inspiration for all. Silk spinning has been observed in various organism including spiders and insects. It exhibits a notable biological source of inspiration for advanced polymer fabrications. Silk spinning has offers a potential significance in polymer and synthetics manufacturing. With the passage of times advancement achieves in various steps of process in sericulture areas and produced good quality of silk.

Keywords: Arthropods, Insects, Silk, Spinning

Introduction

The practice of producing silk through the raising of silkworms and post-cocoon activities that result in the manufacturing of silk yarn is known as sericulture. India is among the nations with the greatest biological and cultural diversity in the world. In india only the state Assam is producer of four natural silk varieties, *viz.*, Eri, Muga, Mulberry and Tasar. It can be produced due to its unique environmental conditions (Das, 2023). Several natural materials offer outstanding features and unusual uses that the industrial world has not yet attempted to duplicate. One such biomaterial is silk. Silkworms, spiders, and aquatic insects are among the many living things whose silk glands manufacture this amazing, progressively arranged protein fiber.

The process for making a single yarn from the different discontinuous filament of silkworm cocoon is known as Spinning. A bundle of fibers or filaments that is relatively durable yet malleable is called a yarn. It is a vital product that sits in between fabrics and fibers. Due to the eri silkworm's lack of Filippi's gland, typical mulberry, muga and tasar silk are made by boiling the cocoons before the adult emerges from them. This results in the recovery of continuous filament yarn. *Samia ricini* or open-ended cocoons are produced when silk fibers break off abruptly from the spinneret. These cocoons are not reelable due to their large variability in single fiber length and comparatively lesser continuity of filament length. Because of discontinuous fibers eri cocoon can only be used for spinning purpose. Apart from this, different kinds of silk waste are generated in rearing of mulberry and non-mulberry silkworms commonly called as cocoon waste and in conversion of cocoon into yarn called as reeling waste.

Spinning Process

Yarn spinning is super important when making clothes. It turns short fibers long yarn for weaving and knitting. One way to make silk yarn is by degumming cocoons. There are two proteins in silk: fibroin and sericin. Sericin acts like glue to stick fibroin together in silkworm cocoons (Figure 1). Degumming removes the sericin, leaving soft silk threads. This step is crucial for silk cocoons. By breaking down sericin's peptide bonds, we get rid of the gum using different methods like enzymes or chemicals. In the traditional way, eri cocoons are crushed by hand, which takes lots of time. Then yarn is made by hand with a takli or a CSTRI spinning machine (Sanapapamma and Naik, 2008). The yarn produced is usually uneven and coarser. The market's

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diversification forces yarn makers to provide higher-quality yarn. As a result, traditional hand spinning processes have been superseded by contemporary spinning techniques (Islam, 2019). The gummed cocoons are processed through a number of phases in order to produce good quality yarn utilizing the mill spinning method and the Amber Charkha set of spinning machinery. The cozy cocoon has lots of knots. To get rid of these knots, machines called cocoon openers and lap openers are used. These machines slowly break down the fibers into small bundles. The cocoon opener creates fluffy silk wrapping fibers that are then fed into the wrapping opener for further opening. The fabric is pulled from this machine and used for cutting staples. The staple cutter cuts the fibers to the correct length. For arranging the cut fibers neatly, they are carded and combed. Carding a method used to separate individual fibers in textile-making. It involves splitting and redividing the fibers multiple times, which makes many of the strands lie parallel to one another and eliminates the majority of residual contaminants. Spun yarn, commonly referred to as staple yarn, is a type of yarn composed of finite and generally short fibers called staples. Small and lengthy staples are the two categories into which staple fibers can be separated. Fibers less than approximately 50 mm are referred to as short staple, whereas fibers longer than approximately 50 mm inches are referred to as a lengthy staple. The last stage involves utilizing looms to weave silk fabric from the silk strands (handlooms and power looms). The wide range of silk textiles available today are created by a variety of weavers using different methods of retaining both warp and weft yarns in them and weaving techniques. The following stage, known as gilling, offers additional mixing, straightening and aligning of the fibers to provide a tiny bit of the necessary linear density and evenness. The produced sliver is then fed into drawing machine. Drawing is the process of thinning a loose fiber composite, also known as a sliver, through a series of rollers. The individual fibers are straightened out and aligned more parallel. In the drawing assembly, each pair of rollers spins faster than the previous one. Sliver, once a mushy mass of fiber, is converted to a rigid homogeneous strand of useable size. The twisted yarn is singed to remove any protruding strands and add luster to the finished silk yarn. The resulting yarn is subsequently wound into the desired container for use or marketing.

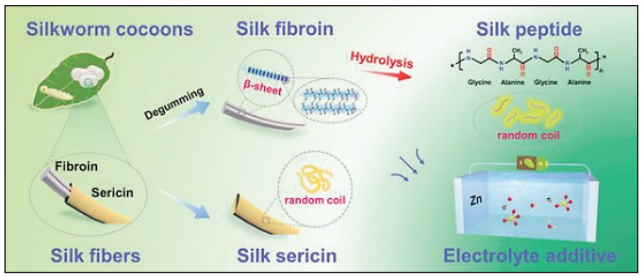

Figure 1: Schematic illustration of the relationship among sericin, fibroin and peptide molecules with electrolyte application (Source: Wang *et al*., 2022)

Precautions Followed during Spinning Process

The worms require monitoring while spinning cocoons because the quality of cocoons is heavily influenced by the ambient circumstances prevailing when the worms are on mountages. Dry weather is generally conducive to spinning. In general, worms require a little more intense temperature during spinning than during rearing; nevertheless, too high a temperature should be avoided because it will force the worms to spin quickly, resulting in a waste of silk. Worms that are in a rush to begin spinning waste a lot of silk. Too high a temperature causes the filament to be thicker than its typical size, while too low a temperature causes it to be thinner. If the temperature fluctuates violently throughout the spinning process, it results in ununiformity between the thread spun and a flaccid cocoon, which causes major problems in the cocoon reeling and wastes silk. A temperature nearby range of 24 °C is to be ideal for the spinning process. Humidity also plays crucial role the quality of cocoons spun. Generally 60-70% humidity is good for spinning process to make it efficiently.

Conclusion

One of the best textile materials is spun silk and its textile products have a high added value that meets consumer demand. The primary raw material used in the spun silk business is eri silkworm cocoons and silk waste from mulberries and non-mulberries. The market's variety forces yarn makers to provide high-quality yarn. As a result, traditional hand spinning methods have been supplanted by contemporary spinning techniques. Mill spinning is done in order to produce fine count silk yarn, requiring more advanced techniques and equipment. There aren't many specialized commercial machines available for use as sole silk spinning units. Thus, there is a great deal of room for research in this area.

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