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# Plant Biotechnology: Key to Advancing the Pre-Cocoon Sericulture

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**SUMMARY**

Biotechnology, a rapidly advancing branch of science, has significantly impacted various sectors of the textile industry. In particular, plant biotechnology has emerged as a critical driver of progress and innovation. It plays an essential role in the pre-cocoon sector of sericulture, especially in the bio-genetic improvement of host plants. At present our key objective is to harness its potential effectively and develop a clear strategic plan for future advancements.

## INTRODUCTION

Sericulture involves several key activities that are integral to the production of silk. First, it includes the cultivation of host plants, which serve as the primary source of leaves to feed the silkworms. Next, the silkworms are reared on these host plants, where they feed on the leaves and eventually spin cocoons. Finally, the cocoons are processed through a reeling procedure to extract the silk yarn, completing the transformation from raw material to usable silk (Narzary *et al*.,2022). Pre-cocoon sericulture primarily focuses on the propagation of improved mulberry varieties for establishing new plantations. The development of improved plant varieties leverages plant biotechnology, employing advanced techniques such as genome editing, micropropagation, and marker-assisted breeding. Host plants such as mulberry (*Morus spp.*), castor (*Ricinus communis*), som (*Machilus bombycina*), sualo (*Litsea polyantha*), arjun (*Terminalia arjuna*) and asan (*Terminalia tomentosa)* are susceptible to a range of diseases and pest infestations that can significantly impact their health and productivity. Plant biotechnology enables the management of diseases and pests through the development of climate-smart and resistant varieties.

### About pre-cocoon sericulture:

On the basis of consumption habit of silkworms, sericulture is classified into two major types: mulberry and non-mulberry silkworms. Mulberry silkworms (*Bombyx mori*) exclusively feed on mulberry leaves and generate the majority of commercial silk globally. Non-mulberry silk, commonly referred to as "Vanya" silk or wild silk, is produced by silkworms that feed on non-mulberry host plants found in forests and wild regions (Nandaniya *et al*., 2024).

In sericulture, host plat cultivation and silkworm rearing are included in the pre-cocoon stage, which includes all operations before the development of the silkworm cocoon. This stage is essential as it has a direct impact on the amount and quality of silk produced. The host plants are a key component of the sericulture industry. The availability of superior host plants and leaves is vital for silkworm rearing. The quality of these leaves has a considerable impact on silkworm health and silk output. On the other hand, Silkworm rearing refers to the process of cultivating silkworms for the production of silk. This involves nurturing the silkworms, providing them with proper nutrition to harvest quality silk from their cocoons.

### Silkworms and their major host plants:

There are more than 400 species are known to produce silk but majorly four are commercially exploited. India is the sole country in the world that produces all four varieties of silk. These are as follows-

| Sl.no | Silkworm common name | Silkworm scientific name | Major host plants |
|---|---|---|---|
| 1 | Mulberry Silkworm | *Bombyx mori* | Mulberry |
| 2 | Tasar silkworms | *Antheraea sp.* | Arjun, Asan, Sal, ber |
| 3 | Eri Silkworm | *Samia cynthia ricini* | Castor |
| 4 | Muga silkworm | *Antheraea assamensis* | Som, Champa and Moyankuri |

### Scope of Plant Biotechnology:

The field of plant biotechnology offers extensive and promising opportunities for improving silkworm host plants, which are vital for enhancing silk quality and productivity. Silkworms, particularly *Bombyx mori*, primarily feed on specific host plants, with mulberry (*Morus* species) being the most important. The quality of these host plants directly affects the growth, health, and silk yield of the silkworms. The following are important areas in which plant biotechnology may be beneficial:

**Improvement of silkworm host plants**

**Yield Improvement:** Plant biotechnology offers significant potential for enhancing the growth rate and biomass of mulberry plants, thereby increasing leaf production per unit area. Key strategies for achieving these improvements include the overexpression of growth-regulating genes, genetic modifications to strengthen and expand cell walls, optimization of photosynthetic pathways, modifications to root architecture for improved nutrient uptake, and enhancements to plant architecture that promote greater leaf production. For example, two triploid genotypes, TRI-10 and TRI-8 with higher leaf yield potential has been identified by scientists recently (SERI CSB 2022-23).

**Targeted Breeding:** Instead of waiting for the plant to exhibit desired features phenotypically, Marker-Assisted Selection (MAS) is a breeding method that uses molecular markers, or particular DNA sequences, to identify plants having those traits based on their genetic composition. It speeds up the breeding process and improves the accuracy of choosing for silkworm-friendly features. As an example, cultivar identification diagram using SSR marker has been developed under CSB (SERI CSB 2022-23).

**Omics Technologies**: The potent plant biotechnology tool known as omics may offer profound understanding of the genetic, transcriptional, and proteomic characteristics of mulberry plants. By identifying important genes that play a role in the interactions between the silkworm and its host plant, these technologies can open the door for focused genetic changes that will enhance sericulture.

**Synthetic Biology:** An effective method in plant biotechnology is the creation of synthetic pathways that result in new or improved characteristics in host plants, such as mulberries, which serve as the main host for silkworms. Researchers can create and introduce new biochemical pathways or alter existing ones in plants through the use of synthetic biology and metabolic engineering. This can improve plant features and make them more suitable for raising silkworms.

**Development of robust silkworm host plant varieties**

**Drought and Stress Tolerance:** Creating host plants in sericulture that can withstand abiotic stressors like salt, drought, and temperature changes is essential to guaranteeing steady leaf production for raising silkworms, particularly as climate change causes weather patterns to become more erratic. Farmers may maintain consistent leaf output by developing or choosing mulberry cultivars that are resistant to certain environmental challenges, which will eventually increase silk yield and sustainability in sericulture.

**Developing Pest and Disease Resistance:** The development of pest and disease resistance in silk moth host plants is significantly facilitated by plant biotechnology. Genes from *Bacillus thuringiensis*, a bacterium that generates proteins poisonous to certain pests like caterpillars, may be incorporated into silk moth host plants by genetic manipulation. The host plant becomes more resilient to pest assaults when these genes are included, which lessens the requirement for chemical pesticides. Additionally, certain genes that provide pest resistance can be modified or improved through the use of CRISPR technology. As a result, silk moth host plants may acquire naturally occurring pest-resistant characteristics, such the ability to produce protective compounds or structural elements that discourage insect feeding. For example, two candidate genes, MLO2, MLO6A, responsible for susceptibility to powdery mildew were identified by experts and manipulated to develop resistant against the pathogen (SERI CSB 2022-23).

**Improvement of Silkworm health and productivity**

**Improved Leaf Texture and Digestibility:** Mulberry leaves are the food source for silkworms, and the texture of the leaves can influence how readily the silkworms can eat and digest them. The physical characteristics of the leaf can be altered via biotechnology to make it more appealing to silkworms. For instance, silkworms' eating habit may be improved by softening or lowering the roughness of the leaves, which enables them to eat more leaves and absorb more nutrients. Additionally, plants can be modified to store or accumulate larger quantities of nutrients—such as proteins, amino acids, vitamins, and minerals—that are essential for silkworm growth by altering the texture of their leaves. Higher amounts of easily absorbed lipids, carbohydrates, and other vital substances for the best possible silkworm growth may also be encouraged by improved leaf texture.

**Reduce anti-nutritional factors:** Certain substances, such as tannins, phenols, and oxalates, are naturally present in silkworm host leaves and can hinder the silkworms' ability to absorb nutrition. These antinutritional elements may hinder silkworm growth and development and lessen the leaves' usefulness as a feeding source. Besides, to lessen the buildup of tannins or phenols in the leaves, genes that regulate their production can be targeted.

**Improved and sustainable Strategies of Cultivation practices**

**Biofertilizer Compatibility:** Plants can be improved using plant biotechnology to enhance symbiosis. For instance, mycorrhizal association-forming genes can be introduced or increased in host plants such as mulberries. More efficient and widespread mycorrhizal networks can result from increased expression of genes that support fungal colonization or root growth, which will improve the plant's capacity to take up nutrients from the soil without the need for artificial fertilizers.

**Reduced Water Usage:** By improving their water usage efficiency, drought resistance, and capacity to thrive in high temperatures, biotechnology can produce mulberry cultivars with reduced water needs. These plants can continue to generate silkworm-friendly leaves while using less water by undergoing genetic alterations that improve osmotic balance, root systems, and stomatal management. Adopting such sericulture types would help save valuable water resources, lessen the environmental effect of silk production, and increase the industry's resilience to climate change, all of which will contribute to the global promotion of sustainable silk production.

**Other scopes**

- Comprehensive mapping of the mulberry genome may reveal further genetic possibilities for better features.
- To diversify the feedstock, plant biotechnology may also be used to investigate and enhance other possible silkworm host plants.
- The use of nanotechnology into plant biotechnology has the potential to revolutionize nutrient delivery and pest management.
- Interdisciplinary research integrating plant biotechnology, sericulture, and environmental sciences can result in comprehensive breakthroughs.

## CONCLUSION

Plant biotechnology, as a branch of biology, has significantly advanced research and development across various industrial sectors. The silk production industry and sericulture have also greatly benefited from these advancements. However, there are still many challenges ahead, for which plant biotechnology will play a leading role in addressing. It is high time to apply the advanced tools and techniques of plant biotechnology to the sericulture sector in order to achieve optimal results in both the quality and quantity of production. This can be ensured by the abundant availability of high-quality host plants. For the time being, there is a need for greater focus from the stakeholders to accelerate research and development, ensuring that India maintains its position in the global silk industry.

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