

Chapter 13

Revolutionizing Sericulture: From Mulberry to Market with Technology

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Abstract

Mulberry, a deciduous woody perennial tree, is native to the northern and southern hemispheres. It is found at altitudes ranging from sea level to 4000 meters. However, mulberry is facing challenges as a result of global warming, industrialization, and urbanization. To carry on cultivating and provide income for rural people, contemporary biotechnological methods must be exploited to generate novel varieties with increased productivity and adaptability. This chapter discusses mulberry origins, distribution, taxonomic position, genetic resource characterization, growing strategies, biotechnology advancements, and molecular biology applications. Mulberry, a plant with numerous sustainable attributes, is cultivated for its economic value and sustainability. It is primarily used in the sericulture industry for silkworm feeding, enhancing the manufacturing of raw silk for commercial use. To ensure environmental safety, mulberry is also used in the food, beverage, cosmetic, and pharmaceutical industries. Mulberry continues to be a crucial crop plant for economic growth and a sustainable future despite its many advantages, making it an essential resource for rural economies. Silk reeling machines are used throughout Africa, Europe, Central Asia, and the Near East to manufacture raw silk and handcrafted goods. These machines include standard wheel machines, enhanced two-end reeling machines, direct multi-end reeling machines, and multi-end reeling machines with compact reels. Some primitive machines need a lot of effort and may be replaced with contemporary ones that are specifically built for the cottage industry without a large expenditure. This study investigates the feasibility of vertical farming techniques such as hydroponic, aero-ponic, and aqua-ponic systems for mulberry propagation in controlled conditions. These techniques can boost protein content in meals and extract physiologically beneficial components for phyto-therapy. However, these approaches need the availability of space and irrigation, both of which vertical farming systems can readily provide. The objective of this article is to assess their application to sustainable and safer agriculture methods.

Keywords

Mulberry, Commercial Raw Silk, Genetic Engineering, Soil-Mulberry-Silkworm System, Medicinal Plant, Black Mulberry, White Mulberry Fruit

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I. Introduction

Mulberry, a perennial, resilient plant, is grown around the world in temperate, tropical, and subtropical climates. Traditional breeding can increase leaf output and quality, which has a direct influence on cocoon production and economy. In sericulture practices, traditional breeding. Techniques have shown promising results in creating superior mulberry cultivars that are more resilient to drought, low temperatures, salinity, soil alkalinity, and pests and diseases, and that have higher leaf yields and better leaf quality ^[1]. A hardy, woody tree species, mulberry is mostly planted for the sericulture industry, which boosts rural economies. Its leaves are used to make raw silk for commercial purposes and to feed silkworms. For commercial uses, the quality and quantity of mulberry crops have significantly risen thanks to modern biotechnology techniques. Using technologies such as micro-propagation, in vitro tissue culture, callus culture, protoplast integration, marker-assisted selection, and genetic engineering, stress-tolerant mulberry varieties have been created, which have led to optimal leaf production and an excellent financial reward ^[2]. Mulberry, a plant with several advantages, has established itself as an important asset in a range of sectors, including sericulture, food production, pharmaceuticals, and preservation of the environment. Its unused elements can be utilized for nutrition, phytotherapy, and the extraction of physiologically active chemicals. However, the plant's distinct characteristics necessitate availability of space and water supply, which can be readily fulfilled by vertical farming technologies such as hydroponic, aeroponic, and aquaponic systems. These strategies will assist the plant overcome its limitations and maximize its potential for growth ^[3]. A nursery is a controlled environment for juvenile cuttings until they are ready to be transplanted into the field. The primary purpose is to generate enough high-quality seedlings to fulfill consumer demands. Using both conventional and new strategies for mulberry sapling development, including Mini clonal Technology, has shown economically viable, with Mini clonal Technology outperforming traditional propagation methods ^[4]. Silkworm rearing and mulberry cultivation are essential elements of Asian agriculture that support long-term development, economic expansion, and cultural preservation. In addressing heavy metal (HM) contamination, the soil-mulberry-silkworm system (SMSS) has social, environmental, and economic ramifications. HM tolerance is determined by development phases and contamination levels in mulberry and silkworm products ^[5]. Mulberry trees are critical for raising the silkworm *Bombyx mori*, giving employment and foreign cash in nations including Asian country. Mulberry trees have greatly increased crop quality and leaf output because of their high heterozygosity, which results from their out-breeding reproductive system. Conventional breeding has greatly advanced, whereas modern biotechnology technologies have not advanced as much ^[6]. Mulberry is a hardy perennial plant of to the genus *Morus* and family *Moraceae*. It is reasonably resistant to environmental stresses such heavy metals, waterlogging, and drought. *Bombyx mori*, the silkworm that makes silk thread, is fed mulberry leaves. Mulberry trees have greatly increased crop quality and leaf output because of their high heterozygosity, which results from their out-breeding reproductive system. Conventional breeding has greatly advanced, whereas modern biotechnology technologies have not advanced as much ^[6]. Mulberry is a hardy perennial plant of to the genus *Morus* and family *Moraceae*. It is reasonably resistant to environmental stresses such heavy metals, waterlogging, and drought. *Bombyx mori*, the silkworm that makes silk thread, is fed mulberry leaves. Mulberry trees can thrive in a variety of climates and soil conditions, and their significance in mitigating desertification, preserving water and soil, and managing salty land has rekindled attention ^[7]. Silk is a luxury material used in a variety of items, including robes, bedding, and gowns. Mulberry silk, which comes from the Mulberry silkworm, is the costliest silk. Silk production costs have grown as a result of the advent of synthetic textures like as polyester. Silk-noils, a type of short fiber, are generated

by carding, combing, and spinning. Rotor spinning now provides considerable economic advantages for producing mulberry silk-noil, cotton, and polyester blended fibers [8].

2. From Mulberry to Market with Technology

The businesses aims to identify high-quality fruit mulberry varieties by gathering resources, developing gardens, and evaluating their characteristics. They intend to develop a mulberry material basis based on green food standards while also researching high-output green farming technologies. They prefer to utilize mulberry fruit to make industrial goods including juice, wine, sauce, and pigment. Mulberry industrialization is the outcome of their plan to combine production, sales, processing, and cultivation into an organic whole. [9]. Over the last decade, there has been an increase in interest in herbal or plant-based diabetic treatment options. Mulberry, a medicinal plant, has been examined for its anti-diabetic potential. In experimental animals and people, several sections of the plant, including as the leaf, root, fruit, and branches, have demonstrated substantial hypoglycemic and antidiabetic properties. The sequencing of the mulberry genome is expected to increase our understanding of the gene architectures and metabolic pathways involved in the mulberry's antidiabetic components [10]. Growing silkworms, feeding animals, and producing delicious fruit that is full of health-promoting components like sugar, carbohydrates, alkaloids, vitamins, lipids, minerals, amino acids, carotenoids, flavonoids, and antioxidants are all made possible by mulberries, a valuable economic resource. The bark of the root and stem has a high phenolic content and is astringent, anthelmintic, and purgative. Mulberries can be cultivated as trees, tall bushes, and short bushes in environments that receive rain and irrigation. They can also be reproduced through grafting, seedlings, stem cuttings, saplings, and seedlings. [11]. **Figure 1** below demonstrates the path of the silk from seed to market. Mulberry, recognized for its medicinal benefits, is extremely perishable due to its high moisture content. This raises sustainability concerns, like food waste and an increased carbon impact. Mulberry vinegar is a biotechnological solution that converts a perishable raw material into a stable product by fermenting it with a mixture of acids, sugar, and crushed mulberries. However, heat-intensive processing, which results in energy and environmental inefficiencies, is occasionally a part of older approaches [12]. Because mulberry leaves are pleasant and easy for ruminants to digest, they can also be used as a feed ingredient for non-ruminants. They provide 15-35% protein, depending on the species, and are used as supplements for dairy cattle, goats, sheep, rabbits, and pigs. Mulberry fodder has more protein than Napier grass hasn't been able to boost milk production. Whereas ruminant production uses cottonseed and canola meal, non-ruminant production uses fishmeal and soybean meal [13]. Since ancient times, black mulberry (*Morus nigra*) has been utilized as a traditional remedy because of its high nutritional value and physiologically active ingredients. Its components include vitamins, proteins, minerals, anthocyanin, polysaccharides, and quercetin. Extracts from these fruits have shown to be antibacterial, anti-Alzheimer's, anti-tumor, and anticancer. However, research on the therapeutic properties of this fruit is minimal, needing more research to determine its possible health benefits [14]. The white mulberry fruit is renowned for its health advantages and nutritional importance. It is a healthy snack that may be eaten either fresh or dry. This fruit's classification is inconsistent, nevertheless. A machine vision system that blends artificial intelligence and image processing was developed to address this. The system uses support vector machine classifiers and artificial neural networks to categorize data as either high or low quality. This novel technique may tremendously benefit stakeholders in the mulberry business [15]. Mulberry fruits are high in glucose, phenols, flavonoids, organic acids, tannins, vitamins, iron, potassium, and calcium. They are utilized as a medicinal plant to promote human health by extracting biologically active substances from its leaves,

stems, and roots. To retain mulberry's beneficial characteristics in confiture manufacture, each technical process is examined step by step, with crucial control points dictated by temperature regimes and variations in soluble solid content [16]. The demand for health-promoting items has grown as people become more aware of the benefits of a healthy lifestyle. Ohmic heating, a new sterilizing method, is being used to sterilize indigenous berry-like fruits in Indonesia, including mulberry, bignay, and jambolana. These fruits have a high potential as raw materials for juice companies. A fixed ohmic heating system was constructed and tested on these fruit juices to determine their suitability [17].

Figure 1. Path of Silk from Mulberry to Market

3. Recommendations

Based on our thorough literature review, we propose the following recommendations for the future of the various Mulberry market domains.

- To accomplish the Sustainable Development Goals for global food security, innovative technologies and techniques to strengthen sericulture are required. It might be beneficial to switch from traditional sericulture to alternative systems that are less impacted by climate, pesticides, and water consumption, such as indoor hydroponics, aquaponics, and aeroponics.
- Black mulberry, which is high in nutraceutical components, has a variety of pharmacological qualities, including antibacterial, anti-tumor, anti-diabetic, brain damage prevention, anticancer, and Alzheimer's activity. Additionally, it has therapeutic and preventive benefits on the kidneys, liver, gastrointestinal tract, and central nervous system.
- Mulberry should be utilized in a variety of industries, including environmental safety, medicines, cosmetics, and food & beverage. To enhance genetics, it is critical to acquire and capitalize on un-adapted species, applying modern genomic tools like transgenic technology, and integrate traditional breeding approaches.
- Mulberries have an ecological influence that preserves soil and water, prevents desertification, manages salty and alkaline terrain, and protects sand forests. with a focus on recovering heavy metals in soil because to its widespread distribution, high biomass, established root system, and adaptability.
- Environmental impact assessments can encourage environmentally friendly activities by concentrating on energy efficiency and waste reduction. Microbial dynamics research can improve safety standards for non-thermal fermentation, and researching synergistic combinations of non-thermal methods can result in considerable efficiency and quality advantages.
- By computing the benefit-cost ratio and net revenue, the study ascertains the financial sustainability and feasibility of mulberry nurseries. demonstrating that commercial nurseries using mini clonal technology are extremely lucrative after the second harvest.


Conclusion

The Catalytic Development Programme (CDP), which the Indian government has suggested, aims to establish sericulture clusters in rural and tribal areas. The goal of providing quality mulberry seedlings at a cheaper cost. The program's goal is to give self-employment possibilities to entrepreneurs and jobless adolescents. The study assesses the feasibility of mulberry nursery operations by comparing net

revenue and benefit cost ratios for nurseries employing traditional and innovative sapling production methods. An SVM and ANN classifier-based machine vision method was created to evaluate the quality of dried white mulberry samples. The samples' high and low quality were determined by precisely grading them. ANN classifier performed better than the other two. The creation of an opto-electromechanical system for industrial and real-time use should be the focus of future research, allowing for the automated grading of mulberry or comparable fruits based on appearance, soundness, and maturity. Mulberry is an important medicinal plant with bioactive qualities, and many researchers have discovered mulberry-based products with favorable biological benefits. Oxidative stress is a key cause of heart disease and cancer. Mulberry's high antioxidant activity may aid in the treatment of various disorders. It also inhibits lipid build-up in hyper-lipidemia-related disorders by promoting lipolysis and inhibiting lipid synthesis. Mulberry is also a unique food source for *B. mori*, making it ideal for year-round cultivation in locations with restricted resources owing to cold weather, soil, or land. Mulberry is therefore an effective preventive medication for fatty liver conditions.

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