

Morphological, Medicinal and Technological Evolution of Mulberry

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Mulberry is a deciduous tree belonging to the genus *Morus*. Cultivated globally across tropical, temperate, and subtropical regions for over 4,000 years, it is historically famous for driving the sericulture industry as the primary food source for silkworms (*Bombyx mori* L.). Beyond its agricultural value, the plant plays a crucial role in traditional Chinese and Indian medicine, as well as modern sustainable ecology. Locally known as *shahtoot* (meaning "King's Berries") in Hindi and Urdu.



Botanical name: *Morus alba*

Family: Moraceae

Origin: North America

Types and Characteristics

- **White Mulberry (*Morus alba*):** Native to Asia; its leaves are the primary food source for silkworms (*Bombyx mori*) in sericulture.
- **Black Mulberry (*Morus nigra*):** Native to southwestern Asia; known for producing deep purple-black, juicy, and flavorful berries.
- **Red Mulberry (*Morus rubra*):** Native to North America; the largest species in the genus with dark purple fruits.

Morphology

- **Growth Habit:** Fast-growing deciduous trees or shrubs reaching up to 10–20 meters in height with much-branched stems.
- **Bark & Stem:** The color of the stem varies from dark grey with rough textures to dull orange-tinged.
- **Leaves:** Simple, alternate, thick, rough, dark green, broadly ovate, petiolate, and frequently irregularly lobed.
- **Flowers:** Unisexual spikes; plants can be monoecious or dioecious. Female flowers form in short, erect, cylindrical capitate spikes, while male flowers grow in catkin-like spikes.

- **Fruit:** Botanically a collective fruit called a **sorosis** (often mistaken for a berry) that turns from green/red to deep purple, black, or white when ripe, measuring 2–8.5 cm long.

Chemical Composition

Mulberries are highly nutritious and host a dense matrix of primary and secondary metabolites across the fruit, leaves, bark, and roots:

- **Primary Nutrients:** The fruit possesses a high-water content (>70%), along with 7.8–9% carbohydrates (neutral sugars like glucose and fructose), 0.5–1.4% protein (rich in glutamate, glycine, and aspartate), low fat (mainly linoleic and oleic acids), and crude fiber. It is also high in Vitamin C, A, E, K, and B-complex vitamins, alongside minerals like iron, potassium, calcium, and selenium.
- **Bioactive Secondary Metabolites:**
 - ✓ Polyphenols & Flavonoids: Rich in anthocyanins (predominantly *cyanidin-3-glucoside*, giving black mulberries their deep color), rutin, quercetin, and kaempferol.
 - ✓ Phenolic Acids: Abundant in chlorogenic acid (the primary phenolic acid in leaves).
 - ✓ Alkaloids: Contains 1-deoxynojirimycin (DNJ), a specialized iminosugar primarily concentrated in the leaves.
 - ✓ Stilbenoids: The roots and twigs are rich in prenylated flavonoids and hydroxystilbenes like resveratrol and oxyresveratrol.

Medicinal Value

- **Anti-Diabetic Effects:** DNJ in the leaves and active compounds in the fruit inhibit intestinal alpha-glucosidase, helping suppress postprandial blood glucose spikes.
- **Antioxidant and Anti-Aging:** High concentrations of anthocyanins and polyphenols scavenge free radicals, lowering systemic oxidative stress.
- **Cardiovascular & Lipid Control:** Helps reduce LDL cholesterol and triglycerides while supporting healthy blood pressure and vascular function.
- **Anti-Inflammatory & Neuroprotective:** Extracts have the ability to shield neurons from amyloid-beta toxicity (in Alzheimer's-related models) and decrease inflammatory indicators (e.g., through NF-κB pathways).
- **Dermatological & Skin Whitening:** Root and twig extracts act as natural tyrosinase inhibitors, reducing melanin synthesis for cosmetic applications.

Value Addition

Because fresh mulberry fruits have a high water content and thin skin, they are highly perishable and prone to postharvest loss. Value-added processing extends shelf life and unlocks commercial viability:

- **Foods and Beverages:** Raw fruits are industrially processed into long-lasting consumer goods like functional juices, jams, jellies, vinegars, syrups, squashes, and fermented wines.
- **Nutraceuticals and Dietary Supplements:** Mulberry leaf extracts are commercialized into anti-diabetic teas, capsules, and health powders.
- **Natural Food Colorants:** The high anthocyanin content makes the fruit extract an ideal clean-label red/purple colorant for industries.
- **Advanced Industrial Uses:** Beyond food, components are increasingly researched for cosmetics (whitening creams) and biomaterials (such as eco-friendly packaging and targeted drug-delivery systems).

Conclusion

Consumers are increasingly more attentive of their eating habits as the link between health and nutrition is well known. The creation of functional, nutraceuticals and Pharma foods, which now dominate the global nutrition market, emerged from the investigation of these links. *Morus* spp. and their bioactive phytochemicals have been shown to have a wide range of biological activities, including antioxidant, antidiabetic properties.