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Mahua (*Madhuca longifolia*): Review on Processing and Biological properties

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Mahua (*Madhuca longifolia*) is an economically vital, drought-resistant tree heavily ingrained in the culture and economy of Central India, including the regions of Chhattisgarh, Odisha, and Madhya Pradesh. Scientific research focuses on the cultivation, medicinal properties, and value-added processing of both its flowers and seed oil.

Mahua Cultivation and Processing

The botanical properties, propagation, and industrial applications of Mahua:

- **Processing and Biological Properties:** The harvesting practices and value addition of Mahua flowers. It highlights that the fleshy corollas are rich in natural sugars (glucose, fructose, sucrose) and details post-harvest processing methods like drying and sugar extraction.
- **Bioactive Compounds and Pharmacology:** The bioactive compounds in Mahua. It covers the tree's ecology (thriving in 550-1500 mm rainfall and sandy soils) and its medicinal properties, including antioxidant, anti-inflammatory, and antimicrobial traits.
- **Mahua in Food Technology:** Detailing how dried and powdered Mahua flowers can be used to develop value-added food products like fortified laddoos, candies, cookies, and squashes.
- **Socio-Economic Significance:** The cultural and economic importance of the Mahua tree for tribal communities. It emphasizes the importance of sustainable harvesting and decentralized governance for community empowerment.
- **Industrial Processing Guidelines:** For entrepreneurs, the National Institute of Food Technology Entrepreneurship and Management outlines standardized processing operations for both Mahua flowers (for fermentation and sugars) and seeds (for oil extraction).

Traditional vs. Modern Processing

A shift from traditional open-air sun drying and fermentation to controlled, modernized processing:

1. **Harvesting & Drying:** Flowers are collected at dawn and typically spread out in clean areas to dry in direct sunlight for 3-4 days. Modern processing often incorporates hot air ovens at temperatures around 60° C to prevent post-harvest spoilage and maintain nutritional quality.
2. **Value Addition:** Rather than just alcoholic fermentation, modern food science utilizes dried Mahua powder as a natural sweetener and ingredient in bakery and confectionery products, minimizing the reliance on refined sugars.

- **Food Product Development (Baking, Confectionery & Laddoos)**

Food scientists focus on exploiting the high reducing-sugar content (predominantly glucose and fructose) and mineral density of Mahua flowers to create nutritious, shelf-stable, and sugar-free added foods.

Flour & Powder Processing

Before inclusion into recipes, fresh flowers undergo multi-stage drying to drop moisture levels to roughly 3.15%. They are then pulverized into a fine, hygroscopic powder. This acts as both a flavoring agent and a complete replacement for refined cane sugar.

Nutri-Cereal & Wheat Laddoos

Studies focused on vulnerable demographics (like lactating women or children with malnutrition) show that composite formulations yield highly acceptable results.

- **Standardized Formulations**: In research conducted using a Composite Rotatable Experimental Design (CRD), wheat flour and finger millet (*Ragi*) are blended with dried Mahua flower powder.
- **Nutritional Gains**: A 100g serving of optimized Mahua laddoos provides excellent caloric density (≈ 429.64 kcal). It successfully meets roughly one-third of the Recommended Dietary Allowance (RDA) for iron and protein. Combining sesame seeds (*til*) or groundnuts into the formulation significantly optimizes the amino acid profile and total fat content (≈ 13.88%).

- **Bakery Applications (Cakes, Cookies & Bread)**
  - **Sugar Replacement**: Dried Mahua powder can substitute sucrose up to **40–50%** in cookies and cakes without compromising the elastic properties of dough.
  - **Maillard Reaction**: Due to its high concentration of reducing sugars, Mahua-infused baked goods achieve a deep caramel crust faster, requiring precise oven temperatures (≈ 160–175°C) to prevent bitter over-browning.

- **Medicinal Extracts & Phytochemical Profiling**

Pharmaceutical research prioritizes the isolation of secondary metabolites from Mahua flowers, bark, and leaves using polar and non-polar solvents.

Solvents and Extraction Yields

Sequential extraction experiments show varying yields based on compound polarity:

- **Petroleum ether / Chloroform**: Low yield (≈ 1.3% - 3.85%), isolates non-polar fatty acids and sterols.
- **Methanol / Ethanol**: High yield (≈ 20.25% - 30.1%), successfully extracts bioactive polyphenols, flavonoids, and glycosides.

- **Key Bioactive Compounds Identified**

Advanced analytical profiles via UPLC-Q-TOF-MS (Ultra-Performance Liquid Chromatography-Quadrupole Time-of-Flight Mass Spectrometry) reveal an abundance of therapeutic agents in the dry flower and bark:

- **Flavonoids & Phenolics**: Highly enriched with quercetin, myricetin, and gallic acid, which drive major radical scavenging properties.
- **Saponins & Triterpenoids**: Found primarily in the bark and seeds, contributing to anti-inflammatory activity.

Validated Pharmacological Actions

- **Antimicrobial & Antibiofilm**: Recent studies confirm that methanolic extracts of dried flowers exhibit extremely low Minimum Inhibitory Concentrations (MIC) against hazardous ESKAPE pathogens, notably *Enterococcus faecalis* and *Staphylococcus aureus*. They actively inhibit bacterial biofilm formation.
- **Antioxidant Efficacy**: Standardized DPPH and ABTS assays reveal that Mahua liquid concentrate exhibits antioxidant defence superior to commercial maple syrup and comparable to high-grade raw honey.
- **Traditional Therapeutics**: Extracts are clinically screened for their traditional validation as a demulcent, analgesic, and anti-diabetic agent (mediated via alpha-glucosidase enzyme inhibition by bark polyphenols).

Comparative Overview: Food Science vs. Medical Application

Attribute	**Food Product Development (Laddoos/Bakery)**	**Medicinal Extract Formulations**
Primary Part Used	Fleshy Corollas (Flowers)	Bark, Leaves, and Dried Flowers
Target Components	Glucose, Fructose, Calcium, Iron, Phosphorus	Quercetin, Gallic Acid, Saponins, Tannins
Processing Goal	Elimination of moisture, sensory score retention	Maximum recovery of bioactive yield via solvents
Key Benefit	High energy density, sugar substitute, combats anaemia	Antibacterial, anti-biofilm, anti-inflammatory

References-

Adhikari, S. and Adhikari, J. (1989), "Sal olein and Mahua olein for direct edible use", Journal of the American Oil Chemists' Society, Vol. 66 No. 11, pp. 1625-1630.

Akshatha, K.N., Mahadeva Murthy, S. and Lakshmi Devi, N. (2013), "Ethnomedical uses of madhuca longifolia-a review", International Journal of Life Science and Pharma Research, Vol. 3 No. 1, p. 44.

Amia, E. and Ekka, N. (2014), "Madhuca longifolia var. latifolia: an important medicinal plant used by tribes of North-East part of Chhattisgarh", Online International Interdisciplinary Research Journal, Vol. 4, pp. 227-231.

Bakhara, C.K., Bal, L.M., Pal, U.S., Sahoo, N.R. and Panda, M.K. (2016), "Post-harvest practices and value addition of Mahua (madhuca longifolia) flower in Odisha", Agricultural Engineering Today, Vol. 40 No. 4, pp. 22-28.

Behera, S., Mohanty, R.C. and Ray, R.C. (2012), "Biochemistry of post-harvest spoilage of mahula (madhuca latifolia L.) flowers: changes in total sugar, ascorbic acid, phenol and phenylalanine ammonia-lyase activity", Archives of Phytopathology and Plant Protection, Vol. 45 No. 7, pp. 846-855.

Chandel, P.K., Prajapati, R.K. and Dhurwe, R.K. (2018), "Documentation of post-harvest methods and value addition of different NTFPs in Dhamtari forest area", Journal of Pharmacognosy and Phytochemistry, Vol. 7 No. 1, pp. 1518-1523.

Chandra, D. (2001), "Analgesic effect of aqueous and alcoholic extracts of madhuka longifolia (koeing)", Indian Journal of Pharmacology, Vol. 33 No. 2, pp. 108-111.

Singh, V., Kumar, S., Singh, J. and Rai, A.K. (2018), "Fuzzy logic sensory evaluation of cupcakes developed from the Mahua flower (madhuca longifolia)", International Journal of Emerging Technologies and Innovative Research, Vol. 5 No. 1, pp. 411-421.

Sinha, J., Singh, V., Singh, J. and Rai, A.K. (2017), "Phytochemistry, ethnomedical uses and future prospects of Mahua (madhuca longifolia) as a food: a review", Journal. Nutr. Food Science, Vol.7, p.573.