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Mahua (*Madhuca longifolia*) flower and its application in food industry: A review

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Abstract

Mahua is a tropical tree mostly seen widely in the central and north Indian plane forest. It is known as the warehouse of no of phytochemicals and mostly used by the tribal people. It has numerous benefits in pharmaceutical and food industry. In Ayurveda the flowers have application in medicines with cooling properties. Mahua flowers are edible and consumed by the tribal mostly. It is rich in antioxidant and antimicrobial properties and used as food in tribal area. It is also used as an exchange of buying goods. The fruits of mahua are utilized as vegetable and mostly prepared curries by rural tribal peoples. However, the mahua tree is considered as medicinal tree and very useful for curing diseases like piles, skin diseases, headache, ulcer, constipation and many more. Mahua flower is not only used for the production of liquor but also used as an ingredient for the making of biscuit, cake, jam, jelly and sauces etc. The tree is considered as gold in forest dwellers and measured as fortunate thing for tribal. Oil is extracted from the flower used in cosmetic industry as well as for the purpose of cooking. Mahua tree is considered as a cultural heritage for the tribal people.

Keywords: mahua, flower, tribal, antioxidant, vitamin C

1. Introduction

Mahua is one of Central India's most significant trees. Although many of the mahua trees' roots are shallow, they have a huge spreading root system. The sapwood is thick, and the wood is tough to extremely tough. Hardwood has a reddish- brown color. It's a tall, slender deciduous tree with a rounded crown and a short bole. Mahua has a unique place among NTFPs since it is related to tribal subsistence systems in a variety of ways. It is a major source of seasonal revenue in addition to fulfilling food and other needs. Its blossoms are used to make a country whiskey that is particularly popular in the country's tribal communities. In tribal culture, the tree has religious and aesthetic significance. Mahua flowers and seeds are gathered and dried for their medicinal and nutritional qualities. A single mature tree may provide around Rs. 1500 in revenue from its blooms and seeds, as well as a variety of other physical and intangible advantages (Kulkarni *et al.*, 2013). *Madhuca longifolia* (*Madhuca indica*; Sapotaceae) is a tree endemic to the Indian subcontinent. It is a deciduous tree endemic to the Indian states of Jharkhand, Bihar, Chhattisgarh, Bihar, Madhya Pradesh as well as portions of Maharashtra, Andhra Pradesh, Jaipur, and Tamil Nadu. It's known by a variety of names, including Mahua and Mowarh (North). It is an essential tree for the impoverished, and its blooms and tora seeds are highly prized. In tribal culture, the tree has religious and aesthetic significance. Mahua trees have the best girth in the forest because they are maintained and cared for by forest residents. This is used as a grain replacement by tribal and poor people. The fruit pulp may be used to create sugar, while the dry husk can be used to brew alcoholic beverages. Oil is abundant in seeds (Singh *et al*, 2005). Mahua is the name given to a tree that yields tasty blooms and fruit. The high reducing sugar and nutritional content of mahua flowers and well known. The plant's flowers are tasty. The corolla, also known as mahua blossoms, is a sugar-rich flower that also contains a significant number of vitamins and minerals (Singh and Singh, 2005). The flowers are also used to make distilled spirits, portable spirits, vinegar, and cattle feed (Adhikary and Adhikary, 2001). According to Midya & Brahmachary, Zacetylpyrroline (2AP), the chemical responsible for the pleasant aroma of basmati and other scented rice, is present in fresh blooms of Mahua (*B. latifolia* Roxb). Due to a lack of adequate scientific research and post-harvest processing technologies before storage, they are picked and put to open yard sun drying until about 80% moisture is gone (Patel and Naik, 2008). This technique results in a high microbial burden,

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which reduces the food value of the product. Because of their hygroscopic nature, the flowers are readily ruined by absorbing air moisture. Indigenous peoples are forced to sell their collections as soon as possible, with little or no added value. Only a little number of Mahua blossoms are consumed fresh, boiled, or fried in various areas of the nation (Bakhara *et al.*, 2016) [13]. Spoilage or rotting is the most prevalent kind of post-harvest loss in mahua flowers, accounting for 20–25 percent of total post-harvest losses.

2. Morphological Analysis

Mahua (*Madhuca longifolia*) is an evergreen tree that grows up to 70 feet tall. The tree grows and begins yielding fruit at the age of 8-15 years, and it can bear fruit for up to 60 years. A medium-sized to the big deciduous tree with a short, holed, rounded, and shaded crown found across India's green forest region up to an altitude of 1,200 meters and a height of 12 to 15 meters. Rough, thick, dark-colored bark with fractures and fissures. The inner bark, on the other hand, is dark crimson and oozes a milky white sap when sliced. Behl and Sriwasrawa (2002) describe a small trunk with many branches. The leaves are elliptical in shape, leathery on the underside with a hairy underside, and 10-30 cm long, with pointy ends with strong nerves. Furthermore, leaves are epileptic or elliptic-oblong 7.5 to 23 cm into 3.8 to 11.5 cm with entire but waxy margins, fluorescent laboured near branch ends, (Verma *et al.*, 2010). Flowers are tiny, fragrant, and fleshy, with a dull or light white hue and arranged in distinct fascicles towards the branches' ends. Fruits are oval in shape, 2 to 6 cm long, fleshy, and greenish in color. The seeds, on the other hand, are elongated, measuring 2 cm in length, brown, and gleaming (Erik and Michael, 2004). Flowers that are small, plump, and creamy white. Fruits are fleshy, oblong, and 2-6 cm long. When completely ripe, the fruit develops a greenish-yellow color. Sugars, vitamin A, ascorbic acid, thiamine, riboflavin, calcium, phosphorus, iron, magnesium, copper, anthocyanin, betaines, malic and succinic acid salts, calcium, phosphorus, iron, magnesium, copper, anthocyanin, betaines, anthocyanin, betaines, and malic and succinic acid salts are all abundant in flowers. Rheumatism, ulcers, itches, bleeding, and spongy gums are treated with bark, which contains 17 percent tannins. Inflammations, sprains, and pruritus can all benefit from the bark. Mahua

seeds are valuable economically because they provide a good source of edible lipids.

2.1. Taxonomic

Mahua's Botanical Profile (*Madhuca longifolia*).

Botanical Name: *Madhuca longifolia*

Family: Sapotaceae

Subfamily: Caesalpinioideae

Tribes: Caesalpinieae

Genus: Madhuca

Species: longifolia

Order: Ericaleae

2.1.1. Area and Production

Mahua is a forest-resistant plant native to India's dry tropical and subtropical forests, where it can reach altitudes of 1200-1800 m. It requires a mean annual temperature of 2-46°C, 550-1500 mm of annual rainfall, and 40-90 percent mean annual humidity. Mahua trees can be found in India, as well as other Asian countries like the Philippines, Pakistan, and Sri Lanka, as well as Australia. It may be found in semi-evergreen woods and on river banks in central India's grazing areas. Mahua trees are abundant in the Indian states of Uttar Pradesh, Madhya Pradesh, Orissa, Jharkhand, Chhattisgarh, Andhra Pradesh, Maharashtra, Bihar, West Bengal, Karnataka, Gujarat, and Rajasthan, with an estimated annual yield of 45000 million tonnes of mahua flowers. The output of mahua flowers ranges between 80 and 320 kg per tree. With an average trade volume of 5,730 metric tonnes and a value of roughly 8.4 million Indian rupees, Madhya Pradesh is the most astounding mahua developing state.

2.1.2. Flower Composition

Mahua flowers are high in sugars, which gives them a sweet flavor, and they may be used to produce traditional or modern alcoholic drinks. Mahua flowers are high in Vitamin C, which is responsible for their antioxidant properties. Carotene, a precursor to Vitamin A, is found in mahua flowers. Flowers are also high in minerals such as calcium and phosphorus. Mahua flowers also contain a little number of proteins and lipids. Nutritional analysis of mahua flower was explain in

Table 1: Mahua Flower Composition

Sr.no	Constituents	Fresh Flower	Dry Flower
I	Moisture	73.6-76.82(%dry basis)	11.61-19.8(%wet basis)
II.	Ph.	4.6	-----
III.	Starch(g/100g)	0.94	-----
IV.	Ash%	1.5	1.4-4.36
V.	Total sugar(g/100g)	47.35-54.06	41.62
VI.	Total invert%	54.24	-----
VII.	Cane sugar%	3.43	-----
VIII	Reducing sugar(g/100g)	36.3-50.62	28.12
IX	Protein%	6.05-6.37	5.62
X	Fat%	1.6	0.09-0.06
XI	Fibre%	10.8	-----
XII	Calcium(mg/100g)	45	0.14-8
XIII	Phosphorus(mg/100g)	22	0.14-2
XIV	Carotene(mg/100g)	307	-----
XV	vitamin C(mg/100g)	40	7

[Source: Gopalan *et al.*, (2007); Swain *et al.*, (2007); Hiwale, (2015) [8]; Patel *et al.*, (2011)]

3. Applications of Mahua

3.1. Plant

- Fodder: For goats and sheep, leaves, flowers, and fruits are trimmed. Cattle are also given seed cake.
- Timber: The heartwood is reddish-brown in color, strong, solid, and long-lasting; it is exceptionally thick (929 kg/cu. m) and takes a fine finish. It's used to make homes, cartwheel naves and felloes, and door and window frames.
- Erosion control: Mahua has a broad spreading superficial root system that helps to retain soil together.
- Shade or shelter: Animals can find shade thanks to the crown's vast distribution. Reclamation: Mahua is grown in a wasteland in India with hard lateritic soils.
- Nitrogen fixation: Mahua has been shown to exhibit vesicular-arbuscularmycorrhizal connections as well as root colonization.
- Fertilizer: The seed cake was utilized as fertilizer.
- Decorative: Mahua is sometimes planted as an avenue tree.
- Boundary, barrier, or support: It is grown along field borders.
- Intercropping: *M. latifolia* can be grown in conjunction with Agricultural crops.

4. Health benefits of mahua plant

4.1 Some of the health benefits of consuming mahua flower

- **Bronchitis:** Madhuca flowers are used to treat the symptoms of chronic bronchitis. Coughs can also be relieved with flowers.
- **Orchitis (Testis inflammation):** Boiling madhuca leaves is used to treat orchitis.
- **Rheumatism:** A decoction is produced by boiling bark in water and eaten internally to alleviate rheumatism. Seed oil can be used to treat and damaged areas as well.
- **Diabetes:** A bark decoction has been shown to be beneficial in the treatment of diabetes.
- **Piles:** Seed oil has laxative effects, which can aid with chronic constipation and piles.
- **Eczema:** Eczema can be effectively treated using Madhuca leaves. To gain relief from eczema, sesame oil-coated leaves are cooked over a fire, and then applied and to the damaged area.
- **Gums:** To obtain respite from spongy and bleeding gums, Gargle with 4 ml of the liquid extract obtained from the bark and 300 ml of water.
- **Tonsillitis:** The above-mentioned preparation is also used to treat chronic and acute tonsillitis, as well as pharyngitis.
- **Burns:** Scalds and burns are treated with a mixture of ash from the leaves and ghee. Bark paste is applied to the affected area to relieve itching.
- **Lactation:** Madhuca flowers are used to help feeding mothers produce more milk. Seeds have the same feature as well.

5. Pharmacological properties of mahua flower

To evaluate the validity of folk and traditional claims for the plant's medicinal advantages, the plant's capacity to treat a variety of ailments should be scientifically validated. Mahua flowers have a long history of being used to prevent and treat a range of illnesses. Flowers offer a variety of bioactivities and ethno-medicinal applications, according to reports

5.1 Anthelmintic activity

In Pheretimaposthuma, Katiyar *et al* (2011). investigated the anthelmintic activity of ethanol and methanol extracts of *Madhuca longifolia* J. F. Gmel (Sapotaceae) flowers (Indian Earth Worm).

5.2 Antioxidant activity

The ethanolic extract of *M. Sylvestris*bark (70%). The antioxidant properties of longifolia were investigated. *In vitro*, the ethanolic extract's antioxidant activity was assessed using reducing power and free radical (hydroxyl and superoxide) scavenging models; *in vivo*, tissue GSH and lipid peroxidation levels were measured. *M. sylvestris* bark ethanolic extract The antioxidant activity of longifolia may be seen. To evaluate the bark's antioxidant capabilities, free radical scavenging activity using 1, 1-diphenyl-2-picryl hydrazine (BPPH), reducing power test, and superoxide scavenging activity were employed. The findings of the experiment were then compared to ascorbic acid, a naturally occurring antioxidant. *M. sylvestris* leaves, ethanolic extract Longifolia has antioxidant effect against acetaminophen-induced toxicity in rats at doses of 500 mg kg-1 and 750 mg kg-1 body weight.

5.3 Anticancer activity

Acetone and ethanol extracts of *Madhuca longifolia* leaves exhibit cytotoxic activity against Ehrlich Ascites Carcinoma cell lines in numerous In-vitro cytotoxic assays at 200g/ml. Both extracts had significant cytotoxic action, although the ethanol extract had a higher level of cytotoxic activity.

5.4 Analgesic activity

The analgesic effects of aqueous and alcoholic extracts of *M. sylvestris* flowers were tested using nociceptive methods such as tail-flick, hot plate, and chemical writhing. *Maduca longifolia*, as well as graded doses of *Madhuca longifolia* and alcoholic extracts in all of the studies conducted in rats or mice, *longifolia* had a dose-dependent analgesic effect. The aerial component of *M. indica's* crude methanolic extract has analgesic efficacy, which was tested using an acetic acid-induced nociception response.

5.5 Cytotoxic activity

Brine shrimp lethality was used to assess the cytotoxic properties of crude extracts of *Madhuca longifolia*, with vincristine sulfate as a reference and an LC50 of 8.84g/ml. The crude extracts of leaves and barks showed significant cytotoxicity, with LC50 values of 17.09 g/ml and 45.96 g/ml, respectively.

5.6 Antiulcer activity

Methanolic extracts of *M. sylvestris* in various dosages (100, 200, and 400 mg/kg, p.o.) Using the pylorus ligation, ethanol-induced, and naproxen-induced stomach ulcer models, the antiulcer efficacy of indica was studied in rats. Experiments have revealed that a methanolic extract of *M. indica* leaves has potent antiulcer properties, which can be attributed to its ability to increase the protective layer of mucin while decreasing the damaging and potentially digesting effects of pepsin and acid. The antiulcer effect of an ethanolic extract of *M. longifolia* flowers was tested in pylorus ligated ulceration in rats.

5.7 Anti-inflammatory activity

Carrageenan-induced oedema in the right hind paw volume was used to assess the anti-inflammatory efficacy of *Madhuca*

indica (Sapotaceae) crude methanol extract. The findings show that *M. indica* methanol extract could be useful in the treatment of inflammation, discomfort, and fever. The anti-inflammatory efficacy of *Madhuca longifolia* methanol extracts was investigated using a carrageenan-induced rat hind paw oedema model.

6. Commercialization of mahua flower

Mahua flower is largely harvested by indigenous peoples, and it provides a significant portion of their income. They perform very little value addition after collecting. The dried mahua flower is primarily sold to small traders (kutchia), who then provide it to brewing facilities via dealers and commission agents, or to a bovine feed facility for processing into chow. For the first time, the central government plans to introduce a mahua-based alcoholic beverage, mahua nutri-beverage, to the market. The beverage will be available in six fruit-based flavors and will cost 700 for a 750 ml bottle. This is the first time the tribal affairs ministry has gotten involved in the bottling and sale of alcoholic beverages. The beverage is excellent in nutritional value and contains very little alcohol (5%). It was created in conjunction with the tribal cooperative marketing development Federation of India by the Indian Institute of Technology, Delhi. The most important element impacting mahua flower quality PINAKIN *et al.* 2008. For them and their food product, poor post-harvest storage and a lack of modern equipment for mahua flower value addition are a concern. Poor tribal people and small local enterprises are facing a plethora of economic challenges as a result of the low earnings market for mahua flowers and their goods.

7. Traditional uses mahua flower

Although the mahua tree is found in many parts of India, it is not used as a food source. In various regions of India, the mahua flower plays a significant role in tribal life (Das *et al.*, 2001). Only a little number of flowers are consumed fresh, boiled, or fried in various parts of India. Flowers are utilised in large quantities in the production of distilled spirits. The stench of newly made whiskey is pungent, smokey, and foetid, which fades with age (The wealth of India *et al.*, 2010; Verma *et al.*, 2014). It's also been observed that the pest of mahua tree bark is useful to treat bone fractures. The most intriguing aspect of the mahua tree is that it produces two fruits in separate seasons; the seed oil is collected and utilized in a variety of applications. The mahua tree's wood is also utilized to make household items such as doors and windows. It is used by indigenous people to make halva, methipuri, barfi, mahudaru, and mahuli (Pinakin *et al.*, 2018) ^[20].

8. Modern utilization of mahua flower

Mahua's flowers, fruits, and leaves are all edible. In India and other Southern Asian nations, they are used as vegetables in a variety of dishes. Because of its high sugar content, mahua flowers are used to sweeten a range of local and traditional dishes like halva, methipuri, kheer, and burfi (sucrose, glucose, fructose, arabinose, and a small amount of maltose and rhamnose) Tribal people create a cake from mahua flowers and some grains (rice, ragi, jowar) or root crops (sweet potato), according to Behera *et al.* (2016). When it comes to fermented products, flowers are also used as a raw material for the manufacturing of alcohol and alcoholic drinks. Locals in North-West India gathered and dried mahua flowers for the manufacturing of "mahua daaru," which contains 20-40 percent alcohol. Mahua blossoms are put in a dish with water and allowed to ferment for a few days.

Throughout the fermenting process, navshar (ammonium chloride) and jaggery are added. Black pepper is occasionally used to give a spiciness to the dish. The mixture is maintained in a typical distillation container after fermentation. This process produces 300-400 ml of daaru from a kilogram of dried flowers, according to reports. During times of scarcity, Mahua flowers and sal seeds are combined and boiled to provide a grain-free replacement. To extract oil, mahua seeds are used. It's a significant oil producer. Its seeds produce anywhere from 35 to 50 pounds of fruit per pound of seed.

9. Value added products of mahua flower

The production of value-added products based on indigenous knowledge has immense potential for supporting long-term livelihoods. The indigenous wisdom of tribal tribes, which is historically tied to Indian customs in general, is extremely visible in these products. Such items not only add to our understanding of forest-based traditional Indian culture but also illustrate its historical evolution (Somnath Ghosal 2012). Technical expertise is a vital component for value addition.

Mahua flower was used to make a variety of value-added food products such as dried flower, ready-to-serve (RTS) beverage, squash, jam, bar, candied flower, glazed flower, laddu, and cake. In the sensory test, consumers liked the prepared value-added goods made from mahua flowers.

Recently, the candy, cake, RTS, toffee, squash, and laddoo were produced by the Orissa University of Agriculture and Technology in Bhubaneswar, Odisha using dry mahua flowers. The Mahua RTS beverage was made with a blend of ginger and fennel extracts, and the storage trials were positive (Mishra *et al.*, 2013) ^[18]. An antioxidant-rich, sugar-free (no added sugar) beverage was created using mahua flower juice concentrate and amla juice with excellent antioxidant activity has been produced (Patel *et al.*, 2016). Soni and Dey (2013) ^[17] produced a mahua Guava fermented Nutra-beverage that exhibited a greater level of protection against lipid peroxidation. Candied flowers, glazed flower, and mahua bars are examples of value-added goods made from dried mahua.

9.1. Sugar syrup

There have been multiple reports on the production of sugar syrup from dry mahua flowers, as the sweet quality of the blossoms is used in the fermenting process (Shriwastava *et al.*, 1970; Benerji, 2010). Before concentrating the dried flower water extract to the appropriate concentration, it is decolorized with various decolorizing agents such as slacked lime and activated charcoal. The optimal agent for the manufacture of Mahua sugar syrup was discovered to be activated charcoal at a concentration of 3.5-5 percent (Patel *et al.*, 2010) ^[11]. The syrup derived from the Mahua flower is used for a variety of purposes, including the production of chocolate and as a sweetening agent (The wealth of India *et al.*, 2010).

9.2. Jam, jelly, marmalade, and pickle

With the addition of citric acid, mature (but still unripe) fruits are transformed into jam, according to Reuther, Webber, and Batcher. The pulp is also turned into marmalade or syrup, which are both edible. To hide the astringent flavor, jelly can be made from the pulp alone or in conjunction with guava. Patel *et al.* 2010 ^[11] produced the mahua jam and jelly with fresh flowers. The generated items were assessed for color, flavor, taste, texture, and overall acceptability using a hedonic test. All of the Mahua goods created were judged to be very acceptable based on the findings of the hedonic test.

9.3. Bakery and confectionary

The mahua concentrate was utilized in the manufacture of sweets, biscuits, and cake as a liquid sweetener. Patel et al. 2008 used fresh flowers, smashing them into puree and turning them into a sauce (after personally removing the stamens).

9.4. Fermented product

Dried mahua flowers have high sugar content, making them an appealing source of fermented goods. It has also been stated that mahua wine may be made from fresh flowers. According to Malavade and Jadhav 2000, dried mahua flowers have generated a variety of products including alcohol, brandy, acetone, ethanol, lactic acid, and other fermented compounds.

10. Industrial uses

Instead of using traditional techniques, the flowers may be utilized to produce distillate liquor, portable spirits, vinegar, and other cane sugar-based items (Adhikari and Adhikari 1989; Awasthi *et al.*, 1975). Alcohol, brandy, acetone, ethanol, lactic acid, and other fermented drinks have all been made from dry mahua flowers (Malavade and Jadhav, 2000). It was recently reported that mahua flowers were used to produce poly (hydroxyl butyrate-cohydroxy valerate) by bacteria. In 1930, Fowler and Gilbert created organic manure by mixing discarded organic materials with mahua flowers. According to Saha and Singh *et al.* 1991 research, a novel antibacterial mahua flower agar medium has been developed. Cattle feed made from wasted flowers (formed after fermentation and distillation)

11. Conclusion

According to a study of the literature, mahua (*Madhuca longifolia*) is a nutrient-dense tree having antibacterial, anticancer, hepato protective, anti hyperglycemic, and analgesic properties, among others. Although much research has been done on mahua's flower, fruit, and seed to emphasize its medicinal advantages, there has been relatively little experimental research on utilizing it as a food or food additive. The flower's qualitative qualities are deteriorating as a result of the infractions used by the tribal people to preserve it. To address these issues, advanced technologies for the development of a variety of valuable food products and their year-round availability, as well as the commercialization of this flower, are needed, which will undoubtedly aid in the upliftment of tribal people's economies and long-term development. This very nutritious and valuable tree is deemed underused due to a lack of adequate information and processing techniques. So now is the time to divert mahua blossoms for commercial usage in a variety of culinary goods and fruits; the seed will also be utilized in the manufacture of medications. This end over has the potential to improve the nation's employment and money production capabilities.

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