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An Overview of Madhuca Longifolia's Biological Characteristics and Phytochemicals

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ABSTRACT

A member of the Sapotaceae family, Madhuca longifolia (mahua) is also referred to as the honey tree and butter-nut tree. Growing throughout the subtropical regions of India, Nepal, Australia, and Sri Lanka is the economically valuable plant known as mahua. Growing to a height of roughly 17 meters, it is both wild and commercially grown by villagers, who do so because it provides many jobs. Mahua is rich in sugar, vitamins, protein, glycosides, alkaloids, tannins, flavonoids, steroids, terpenoids, saponins, and phenolic compounds, according to a phytochemical analysis. These compounds are responsible for a variety of pharmacological properties, including anti-inflammatory, antioxidant, analgesic, antihyperglycemic, spasmolytic, hepatoprotective, anticonvulsant, anticancer, anthelmintic, antiulcer, antitumor, neuropharmacological, and dermatological effects Mahua flowers are used extensively in the production of various food items and liquor. This could boost employment and the country's potential revenue stream. The commercial use of mahua flowers in various food products has the potential to boost employment and create new revenue streams for the country. The traditional uses of different plant parts, phytochemical constituents and their chemical structures, and documented pharmacological activities are the primary topics of this review.

KEYWORDS: *Madhuca longifolia, traditional uses, phytochemistry, pharmacological profile, marketed formulation.*

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INTRODUCTION

The Mahua tree, a member of the Sapotaceae family, is botanically known as Madhuca longifolia. Every part of the plant has a specific medicinal purpose and is therefore grown for that purpose. The Honey Tree is the English synonym for Mahua. Tribal people also worship it, and it is relevant to their customs and norms (Saif et al., 2020). Mahua is also known as a butternut tree and has numerous other names in different languages, such as Atavimaduka in Sanskrit, Moha, Mungli in Hindi, Ippa, Madhukamu in Telugu, Iluppai, Kattilupi in Tamil, Mohuka, Mohulo in Odia, Illuppa, Iruppapu in Malayalam, Doddippa, Halippa in Kannada, Mahuva in Urdu, Moha, Mhowra in Marathi, Mahudo in Gujarati, and Mahula, Kochra in Bengali (Jha and Mazumder, 2018; Khare Its primary habitats are forests in Asia, Australia, Sri Lanka, and Burma. It is extensively found in India's sub-mountainous Himalayan region as well as the deciduous forests of West Bengal, Orissa, Punjab, Madhya Pradesh, Uttar Pradesh, and Bihar. The northern regions of India also grow it. The tree can withstand drought, but it needs a lot of light and does not do well in areas with shade. Although it can grow in a variety of soil types, including shallow, boulder, clay, and calcareous soil, the tree thrives in sandy soil. With an average annual maximum temperature of 28 to 50°C and rainfall ranging from 550 to 1500 mm, it is typically found up to 1200 m above sea level (Singh et al., 2017).The Mahua tree is a medium- to large-sized deciduous tree with rusty-tomentose, cracked bark, and a bunchy top that offers plenty of shade. According to Bhaumik et al. (2014) and Singh et al. (2014), it can reach a height of 17–18 meters. The leaves are coriaceous, elliptic, shortly acuminate, band base cuneate, and appear in bunches at the tips of branches (Bhaumik et al., 2014). Their

thick texture and pointed tips are accompanied by a hairy underside and powerful nerves (Singh et al., 2017; Yadav et al., 2011).

The tree is a powerful medicine because it has been endowed with numerous chemical constituents. Additionally, it offers a range of edible products (Khare et al., 2018). The tree is valuable to humanity because of its oil-bearing seeds and flowers, which are also used to make alcoholic beverages. Mahua seeds are valuable economically because they are a good source of edible fats (Gaikwad et al., 2009). The Mahua tree blooms between March and April. Villagers typically gather seeds in May, June, and July by hand-picking them or using bamboo sticks. Indigenous techniques could be employed for oil expelling (Khare et al., 2018). Mahua trees have a lot of secondary metabolites that can help prevent and treat a lot of chronic illnesses. They also have pharmacological responses that are antimicrobial, cardioprotective, antifungal, antiulcer, antiparasitic, antiviral, anti-allergic, anticancer, antispasmodic, antihyperglycemic, anti-inflammatory, and immunomodulatory (Gaikwad et al., 2009).

Traditional uses:-

Since ancient times, people have utilized Madhuca longifolia to meet their needs as food, medicine, additives, and animal feed. Mahua leaves are used as an expectorant and to treat Cushing's disease and chronic bronchitis. The tree's bark is used to treat diabetes mellitus, snakebite poisoning, fractures, and itching. Chronic bronchitis and eye conditions can be treated with flowers; impotence and general weakness can be treated with a flower and milk mixture. Additionally, flower juice is used as a nourishing tonic and to treat a variety of skin conditions (Bhaumik et al., 2014).

It can be used as a nasal drop and relieves pitta-related discomfort (Dahake et al., 2010). Oil, which is abundant in Mahua seeds, is typically used as a laxative and to treat skin infections and inflammation. Since ancient times, Mahua flowers have been used as a cooling agent, tonic, aphrodisiac, astringent, and demulcent. According to Singh et al. (2014), the tree's bark is used as a remedy to treat tonsillitis, ulcers, and rheumatism. Several parts of the mahua plant can treat a variety of illnesses, including rheumatoid arthritis, cholera, influenza, paralysis, piles, arthritic pain, helminthiasis, low semen count, headaches, cholera, flatulence, and debility. Additionally, it serves as a blood purifier and a poison counteractant (Sangeetha and Devi, 2016). Madhuca leaves are boiled and used to treat orchitis, which is an inflammation of the testicles. Diabetes can be effectively treated with the bark decoction. Mahua seed oil is a laxative that can help with persistent constipation and piles. Mahua leaves can also be used to treat eczema by applying sesame oil to the leaves, heating them over a flame, and then applying the oil to the area that is afflicted.

Nutritional properties of Mahua:-

A. Nutritional aspects of flowers of Madhuca;- According to Misra and Pradhan (2013), Mahua flowers have 50.6% reducing sugars, 3.43% cane sugar, 6.37% protein, 8% calcium, and 2% phosphorous.

B. One of the many plants with both nutritional and medicinal uses is Madhuca longifolia (Mishra and Pradhan, 2013; Marikkar and Yanty, 2012).

C. Table No. 1 lists the numerous nutritional components found in Madhuca seed oil. The refractive index of Madhuca seed oil is approximately 1.452-1.462, the saponification value is 187-197, the iodine value is 55-70, and the unsaponifiable matter (%) is 1-35. C 16:0 palmitic acid (%) Stearic Acid C 18:0 (%) 24.56 Oleic Acid C 18:0 (%), 22.77 Linolic Acid C 18:2 (%) 37.08 14.3.

Table 1. Nutritional aspects of *Madhuca longifolia* seed oil

S. No.	Parameters	Value
1.	Refractive index	1.452-1.462
2.	Iodine value	55-70
3.	Saponification value	187-197
4.	Unsaponifiable matter (%)	1-35
5.	Palmitic Acid C 16:0 (%)	24.56
6.	Stearic Acid C 18:0 (%)	22.77
7.	Oleic Acid C C18:0 (%)	37.08
8.	Linolic Acid C18:2 (%)	14.3

Table 2. Chemical constituents and uses of *Madhuca longifolia*

Plant Parts	Chemical Constituents	Uses	Ref.
Leaves	B-carotene, xanthophylls, D-glucosides, erthrodiol, palmitic acid, Protobassic acid, myricetin, quercetin, oleanolic acid, n-hexacosanol, 3-O-L-rhamnoside, 3β-caproxy and 3β-palmitoxy- olean-12-en- 28-ol, 3-O-β-D-glucoside, quercetin and its3-galactoside, myricetin and its 3-O-arabinoside, n-octacosanol, β-sitosterol and its 3-O-β-D-glucoside	Orchitis, Eczema, Chronic Bronchitis, Cushing's Diseases	Khare et al., 2018; Singh et al., 2014
Bark	α- and β- amyrin acetates, Ethylcinnamate, Betulinic acid, α-terpineol and sesquiterpene alcohol, 3β- monocaprylic ester of erythrodiol and 3β-capryloxy oleanolic acid.	Used to cure bleeding spongy gums, ulcer, and tonsillitis, skin diseases, epilepsy,rheumatism, pneumonia, and piles	Khare et al., 2018; Sangeetha and devi, 2016.
Flowers	Vitamins like A & C, quercetin, β- amyrindecanate, betulinic acid, tannins, β-amyrin acetate, stigmasterol andβ -amyrin cinnamate	Used as tonic,analgesic, (aphrodisiac, demulcent)and diuretic	Singh et al., 2017; Mishra et al., 2013.
Seeds	Arachidic acid, oleic acid, linolenic acid, aspartic acid, Protobassic acid, lysine, Myristic, palmitic and stearic acids, isoleucine, cysteine, α-alanine, glycine, and leucine, methionine, proline, threonine, myricetin, serine, quercetin, Mi-saponin A and saponin B, Madlongiside A, B, C, D	Fat obtained from seeds is used to treat skin diseases, rheumatism, headache, laxative, piles, Galactagogue etc.	Yadav et al., 2012.
Fruits	n-hexacosanol, β-sitosterol, and its 3β-D- glucoside, quercetin, dihydroquercetin, and α- and β- amyrin acetates	Used in Tonsillitis, as an astringent, and in pharyngitis	Kumar et al., 2015.

Chemical constituents:-

The Mahua tree is a powerful medicine because of its abundance of chemical constituents. Tables No. 2 and No. 3 list the chemical components and their corresponding chemical structures along with the corresponding plant parts.

Pharmacological activities

Anti-hyperglycemic activity

The anti-diabetic activity by may be Madhuca longifolia reported due to the differences in glucose utilization (Jha and Mazumder, 2018). Diabetes mellitus involves a group of metabolic diseases that are characterized by hyperglycemia, hypertriglyceridemia, and hypercholesterolemia which may be either a result of insulin action or secretion or at times both. Recently bark of is used to treat diabetes, Madhuca longifolia arthritis, ulcers, bleeding, and tonsillitis. Diabetes can be grouped into two types which have greater possibilities of morbidity and mortality which are of the following two types of Insulin-dependent diabetes mellitus (IDDM) and Non-insulin dependent diabetes mellitus (NIDDM). The present studies indicate that the methanolic extract of the bark of Madhuca longifolia exhibits hypoglycemic activity when tested on STZ induced diabetic rats, Hence, can be supposed to be a potent antihyperglycemic agent (Dahake et al., 2010; Mishra and Pradhan, 2013). Significant hypoglycemic activity exhibited by the bark of in diabetic rats depicts that this Madhuca longifolia pharmacological effect can be administered by stimulation of glucose utilization with the medium of peripheral tissues (Srirangam et al., 2010). Hydroalcoholic leaf extracts also showed the Anti-hyperglycemic activity against diabetic rats induced with Alloxan, oral administration of a single dose of ethanolic bark extract of caused Madhuca longifoliaa significant decrease in serum glucose level in normal rats only (Jha and Mazumder, 2018; Ghosh et al., 2009).

Table 3. Chemical Structures of active ingredients of *Madhuca longifolia*

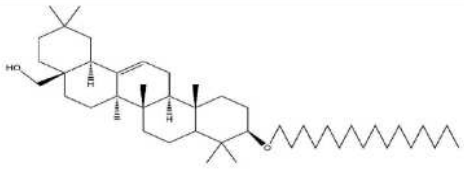
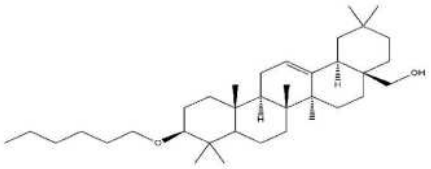
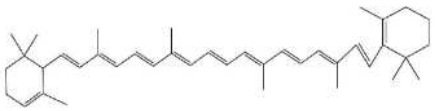
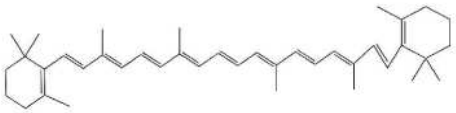
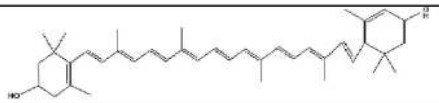
No	Name	Chemical Structure	Plant part
1.	3-beta- palmitoxy-olean-12-en-28-ol		Leaves
2.	3-beta-caproxy-olean-12-en-28-ol		Leaves
3.	Alpha-carotene		Leaves
4.	Beta-carotene		Leaves
5.	Xanthophyll		Leaves
6.	Palmitic acid		Leaves, Seeds

Table 4. Various Pharmacological properties of *Madhuca longifolia* Linn.

Sr. No	Activities	Plant Parts	Solvents	References
1.	Anti-hyperglycemic	Bark	Methanol	Dahake et al., 2010
		Leaves	Hydro-ethanol	Ghosh et al., 2009
2.	Anti-inflammatory	Bark	Ethanol	Jha, 2018
		Seed	Ethanol	Jha, 2018
		Overall plant	Acetone	Chakma, 2011
3.	Larvicidal and Ovicidal	Seed cakes	Aqueous	Verma et al., 2014; Lanjewar 1986
4.	Spasmolytic activity	Leaves	Crude Extract	Khare et al., 2018
		Seeds	Crude Extract	
5.	Insecticidal and Pesticidal activity	Seeds	Crude Extract	Khare et al., 2018
6.	Antimicrobial activity	flowers, leaves, stem and stem bark	Ethanol, Acetone, Water	Singh et al., 2018; Jagram, 2016
7.	Antibacterial	Bark,stem,flowers,leaves	Alcoholic	Khare et al., 2018
8.	Antifungal	Leaves, Flowers	Alcoholic	Kalaivani, 2013
9.	Analgesic	(Flowers, Leaves)	Methanol	Verma et al., 2014
10.	Hepatoprotective	Flowers	Methanol	Singh et al., 2017.
11.	Anti-oxidant	Bark	Ethanol	Verma et al., 2014
		Leaves	Ethanol	Khare, 2018
12.	Dermatological uses	Leaves	Ethanol	Khare et al., 2018
		Bark	Ethanol	
13.	Anti-convulsant/ Anti-epileptic	Bark	Methanol	Palani et al., 2010
		Leaves	Ethanol	
14.	Anti-cancer	Leaves	Ethanol	Jagram, 2016
15.	Anthelmintic	Flowers	Ethanol	Singh et al., 2017
			Methanol	
16.	Anti-Ulcer	Flowers	Alcohol	Kalaivani, 2013.
		seed	Ethanol	Seshagiri et al., 2007
17.	Anti-tumor	Leaves	Acetone	Sangameswaran et al., 2012.
18.	Neuropharmacological Response	Leaves	Methanol	Ingankal, 2012

Anti-bacterial activity

Using the disc diffusion technique, dried mahua bark demonstrated strong antibacterial activity against a number of species, including E. coli, B. subtilis, Staphylococcus, and Epidermidis. Madhuca flowers are resistant to rice pest disease and have antibacterial properties against Escherichia coli (Verma et al., 2014). Research revealed that biological substances such as 2,3-dihydrofuran methanol, 4H pyran 4-one, and Alcoholic extracts of mahua leaves and flowers exhibited antibacterial activity due to 3,5-dihydroxy-6-me t hy l, Th iop h en e, 2-F ur a nc a rb o xy a lde hy d e-5-(hydroxymethyl), and 1,4-tetradecanediol (Kalaivani and Jegadeesan, 2013). Mahua flower extract was used to create silver nanoparticles, which demonstrated possible antibacterial activity against both Gram-positive and Gram-negative bacteria (Maheshkumar et al., 2018).

Anti-fungal activity

Saponins were responsible to exhibit the anti-fungal activity against plant pathogenic fungi. The remnant seed cake is used for its anti-fungal property which was generally collected after defatting of mahua seeds (Khare et al., 2018). Antifungal activity of alcoholic extracts of leaves and flowers of Madhuca longifolia was reported due to the presence of biological compounds like 2-Furan methanol, 4H pyran 4-one, 2,3-dihydro 3,5-dihydroxy-6-methyl, Thiophene, 2-Furancarboxyaldehyde5-(hydroxymethyl), and 1,4-tetradecanediol (Kalaivani and Jegadeesan, 2013).

Anti-pyretic effect

An increase in body temperature that is higher than normal is called pyrexia, and M. longifolia is known to exhibit febrifuge activity (Mishra, 2019). Mahua can be used as an antipyretic agent because it has been shown to have an antipyretic effect in mice based on rectal temperature measurements and is therefore important in lowering body temperature (Chandra, 2001).

Table 5. Marketed formulations of *Madhuca longifolia* (Khare et al., 2018; Mishra, 2019)

Name of the formulation	Dosage form	Cures
Madhukasava	liquid	Bleeding, Emaciation, Tiredness, Diseases of skin
Abhayarishta	liquid	Constipation, Piles
Chandanasava	liquid	Burning sensation, Burning micturition, Spermatorrhoea
NyagrodhadiChurna	powder	Diabetes, Urinary disorders
Lakshmanarishta	liquid	Gynecological disorders like:Heavy and irregular periods Metrorrhagia, Menorrhagia
PanchaSaarapanaka	liquid	Burning sensation, Burning micturition, Thirst
StanyajananaRasayana	powder	Enhances milk production, provides strength to lactating mothers
Kutajarishta	Liquid	Amoebiasis, Bacterial dysentery, Amoebic dysentery, Blood diarrhea

Conclusion and future perspective

The local heritage of medicinal plants is significant on a global scale. One of those multifunctional forest tree species, Madhuca longifolia, has both medicinal and food, fodder, and fuel qualities. Therefore, future commercial cultivation should receive more attention. Additionally, Madhuca longifolia is looking into an increasing number of bioactive ingredients that are used to treat different illnesses, and the current global pharmaceutical market requires proper validation of their safety and efficacy testing.

In order to better understand the mahua plant and increase its current therapeutic potential, we have covered its traditional uses, morphology, geographical origin, collection and cultivation, phytoconstituents, and various pharmacological activities in this review. This will offer compelling evidence in favor of Madhuca longifolia's potential pharmacotherapeutic application in a clinical setting.

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