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Madhuca Indica As A Medicinal Plant: A Review Of Its Phytochemistry, Pharmacological Activities, And Botanical Attributes

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ABSTRACT

Many illnesses and problems have been prevented, mitigated, and treated with medicinal herbs. Known by many as Mahua, Madhuca indica is a plant that grows all throughout India. In addition to being a very nourishing tree, the tree is used as a herbal remedy to cure a number of illnesses. Tribal people cure a variety of diseases with different plant parts and as a kind of traditional medicine. The pharmacological and neutraceutical benefits of plants are many. When preparing ayurvedic formulations like asavas and arishtas, the tree's flowers are utilized to induce the production of alcohol. Many pharmacological properties, including antidiabetic, antiulcer, hepatoprotective, and antipyretic properties, are displayed by plants. It is not visible to researchers or other botanists. It is not visible to researchers or other botanists. Mahua's value-added usefulness and traditional usage will be confirmed thanks to this, which will ultimately increase plant profits.

Keywords: Mahua indica, nutraceutical, phytochemical, pharmacological properties.

INTRODUCTION

Traditional medicine has a long history of using medicinal plants as natural remedies. Health care and medication development, biodiversity preservation, and the preservation of traditional cultures can all benefit from ethnobotanical knowledge about medicinal plants and how indigenous societies use them. As herbal therapy has been utilized for centuries, the World Health Organization (WHO) is now directing its attention on poorer nations to encourage their usage [1–3]. Madhuca, a significant medicinal plant in the Sapotaceae family, is shown in Table 1. Many species of the tree exist, including M. indica, M. latifola, M. longifolia, M. butyracea, and others [4–7]. Table 1 shows the taxonomy.

Table 1: Taxonomy of the plant

Classification	Name
Botanical Name	Madhuca indica
Family	Sapotaceae
Subfamily	Caesalpinioideae
Tribes	Caesalpinieae
Genus	Madhuca
Species	Indica
Order	Ericaleae

Among the many forest tree species, M. indica offers a solution for the three main Fs: food, fodder, and fuel. Andhra Pradesh, Orissa, Gujarat, Madhya Pradesh, Bihar, and Uttar Pradesh are the states in India where this species is most commonly found. Mahua's fruits and flowers are highly healthy and tasty. It is a huge evergreen tree that is found across India and is widely valued as a universal cure in the medicine of tribal people.

There is a common misperception that the Mahua tree is used to make alcohol and is unhealthy, but this is actually what happens after the fermentation process. The purpose of this review is to raise awareness of the phytochemical and pharmacological properties of this plant that have been found in order to encourage more research [8–9]. People in different areas of India refer to the plant by different names (see Table 2 for local names).

Table 2: Local names of plant across India

Language	Local Name
English	Indian butter tree
Hindi	Mahua, Mohwa, Mauwa
Bengali	Mahwa, Maul, Mahwla
Marathi	Mahwa, Mohwra
Guajarati	Madhula, Telgu (Ippa)
Tamil	Illuoei, Ewpa
Kenned	Tuppe
Oriya	Mahua, Moha, Madgn

1.1 Plant Description

A medium- to large-sized, shaded, deciduous tree, Mahua reaches a height of 16 to 20 meters. Typically, the plant grows extensively in arid tropical and subtropical climates. The plant thrives in rocky, gravely, saline, and sodic soils, even in soil pockets that are situated between bare rock fissures. The plant has an 80 cm diameter, short, robust stem and a deep, robust taproot. There are several branches on a circular crown. The vertically cracked and wrinkled bark is yellowish-gray to dark brown in color, flaking in thin scales and containing a milky material. The thick, leathery leaves are 10–30 cm long, lanceolate, narrower at both ends, glabrous, clearly nerved, and grouped at the branches' tips. A milky sap is not produced when it breaks. Young leaves have a wooly underside and are pink (Fig. 1) [9–12].

Fig. 1 : Various part of the plant

1.2 Flower & Fruit

The plump, tiny flowers are either dull or light white in hue. Corolla has caduceus and tubular, newly harvested, pale yellow, fragrant flowers. Typically, flowers bloom from March to June. The meaty berries, which are 2–6 cm long and oval in form with 1-4 brown–black seeds, follow the flowers. while they are ripe, they turn pinkish yellow, but while they are young, they are greenish. Because mahua seeds are an excellent source of edible lipids, they are significant commercially. Traditional uses for mahua flowers include cooling, tonic, aphrodisiac, astringent, and demulcent properties. They are also used to cure helminthes, acute and chronic tonsillitis, and bronchitis. The leaves are used to treat Cushing's disease and chronic bronchitis because of their expectorant properties. The distilled juice of the flower was utilized by tribal peoples as a cooling and nourishing tonic, as well as to cure bronchitis, acute and chronic tonsillitis, and helminthes. Sachharomyces cerevisiae, a yeast that may be used to trigger fermentation and produce alcohol, is said to be present in plant blossoms [13–18].

Table 3: Microscopical character

Part	Microscopical character
Stem	Stems of Madhuca indica consists thin layered cell cork, cortex, epidermis, xylem, phloem, pith.
Petiole	Petiole consist vascular bundle, xylem, phloem, endodermis, pericycle and pith
Leaf	Leaf T.S. consists cork, upper and lower epidermis, xylem, phloem and pith.
Trichomes	Leaves consists uniseriate type of trichomes and covering trichomes
Stomata	Both lower and upper surface consist paracytic stomata

1.3 Geographical distribution

Mahua is a popular name for Madhuca indica. Growing throughout the subtropical region of the Indo-Pakistan subcontinent, it is a significant tree both economically and nutritionally. Indian states including Uttar Pradesh, Madhya Pradesh, Orissa, Chhattisgarh, Jharkhand, Gujarat, Andhra Pradesh, Maharashtra, Bihar, West Bengal, North Circars, Deccan, and Karnataka are home to a large number of Mahua trees [19–20].

1.4 Useful parts of the plants

The following components and byproducts are used entirely or in part to treat human illnesses, pathologies, and other issues (Table 4).

Table 4: Medicinal property/uses of plants part

Parts/product	Medicinal property
Leaves	Enzymes, wound healing, anti burns, bone fracture
Bark	Rheumatism, ulcer, inflammation, bleeding, spongy gums, tonsillitis, diabetic, stomach ache, anti snake poisoning, astringent, emollient, fracture, itching
Flower	Refrigerant, liquor, jelly, sweet syrup, expectorant, increase the production of milk in woman, stimulant, diuretics, anthelmentic.
Fruits	Sweet, refrigerant, aphrodisiac, tonic, dipsica, bronchitis, astringent, anti ulcer, acute and chronic tonsillitis, pharyngitis.
Oil	Emollient, skin disease, rheumatism, headache, laxative, piles, hemorrhoids, emetics, anti earth worm.

1.5 Utilization of plant

Nutritional and Medicinal Use: Numerous nutrients found in mahua trees are highly advantageous to human health. It yields fruits with high fat content that are prized for their seeds. Commercially, it is referred to as Mahua butter or mowrah butter. It has several culinary and therapeutic uses in addition to being utilized as biodiesel. Ghee and cocoa butter have both been replaced with this fat. It is among the few biggest sources of hard fat that occurs naturally. The fat that is thus extracted from Mahua fruit oil is mostly utilized in chocolate production, cooking, and frying. A small number of pharmaceutical enterprises primarily employ seed fat as an emulsifying ingredient due to its emulsion properties. Due to its excellent moisturizing properties, it is frequently used as massage oil throughout the nation [21–22]. Mahua has industrial use since it may be used to make lubricants and laundry soaps, in addition to its culinary and therapeutic benefits. Additionally, the seed cake is being utilized as organic manure for crops like rice, sugarcane, and others and is being researched for its insecticidal and insecticide qualities. This plant

has a variety of therapeutic uses, including stimulant, demulcent, emollient, treating skin illness, rheumatism, headache, laxative, piles, and occasionally as an astringent galactogogue [23–25].

Traditional use: Although mahua trees are widely distributed throughout India, they are not used as food. In various regions of India, mahua flowers play a significant role in the lives of the indigenous peoples. In several regions of India, a small amount of flowers are eaten raw, boiled, or fried. The majority of the time, flowers are utilized to make distilled liquor. The pungent, smokey smell of newly made booze goes away as it ages. Research has also shown that the bark of the Mahua tree may be utilized to treat bone fractures. The Mahua tree is interesting because it bears two fruits in separate seasons, and the seed oil is collected and utilized for a variety of uses. The Mahua tree's wood is used for household tasks like constructing windows and doors [26–27].

Sugar syrup: Since the fermentation process uses the sweet quality of dried Mahua flowers, there have been several experiments on the production of sugar syrup from these flowers. Before being concentrated to the appropriate concentration, the aqueous extract of dried flowers is decolored using various decolorizing agents, such as slacked lime and activated charcoal. Activated charcoal may be used to make the highest-quality mahua sugar syrup at concentrations of 3.5–5%. The syrup that is thus extracted from the Mahua flower is used for a variety of purposes, such as making chocolate or adding sweetness to various foods [28–29].

Flower is a naturally occurring substrate that has around 60% sugar and organic acids, both of which are necessary for the production of copolymers. Carbon sources like sugar and organic acids are responsible for about half of the cost of the PHA manufacturing medium. Natural substrates or industrial byproducts can be used to reduce this. Flowers are a less expensive carbon source for the production of PHA copolymers, second only to molasses [31–32].

1.6 Phytochemical

The active ingredients that are present in each plant portion, whether in tiny or big amounts, determine the plant's medicinal efficacy. The key ingredient in crude medicines that gives them their primary therapeutic effects are the secondary metabolites. The Mahua tree's leaves contain glycoside, an alkaloid, and saponin. The seeds contain saprogenic acid and other basic acids. The characterisation of sapogenin, triterpenoids, steroids, flavonoids, and glycosides are among the many phytochemical investigations conducted on Mahua. novel components such as madhucic acid (penta cyclic triterpenoids), madhushazone, four novel oleanane type triterpene glycosides, and madhucosides A and B were added in light of the aids and associated therapeutic qualities. The fragrance molecule, 2-acetyl-l-1 pyrroline, is present in fresh flowers. Additionally, they include polysaccharide, which results in D-galactose, D-glucose, L-arabininose, Lrhamose, D-xylose, and D-glucuronic acid upon hydrolysis. [30–40].

Table 2.1: Active constituents present in different part of Madhuca indica

Parts	**Chemical constituents**
Bark	Flavonoids, triterpene, sterol
Latex	Soluble resin, insoluble resin
Leaf	Moisture, organic matter, minerals, potash (k2o) phosphoric acid (p205) silica, alkaloids, flavonoids, protobasic acid.
Flower	Carotene, ascorbic acid, thiamine, riboflavin, niacin, folic acid, biotin, inositole.
Ripe Fruits	Moisture, protein, fat, carbohydrates, minerals, calcium, phosphorus, iron, carotene, ascorbic acid, tannins.

1.7 Health Benefits of Madhua indica

The region afflicted with skin conditions and bodily aches is treated using oil that is derived from the Mahua plant's seeds. Several brands of oil are available in stores (Fig. 3). Fresh juice from Mahua flowers is administered via the nose to treat vitiated pitta dosha conditions including headaches and eye burning. To treat nerve weakness and disorders of the neuromuscular system, dried Mahua flowers are cooked in milk and given in doses of 40–50 ml. To treat diarrhea and irritable bowel syndrome, a decoction made from the tree's bark is administered in doses of 30 to 40 milliliters. Fresh juice of the flowers is given in a dose of 20-25 ml to treat hypertension, hiccups and dry cough [41].

Fig. 2: Madhuca indica carrier oil

To treat low sperm counts, early ejaculation, and decreased milk supply during the postpartum phase, the flowers of the Mahua plant are cooked in milk, mixed with sugar candy, and administered in doses of 40–50 ml. To cure fever, burning sensations, and burning maturation, a 30–40 ml dosage of a cold infusion made from the plant's blossoms or bark is used. For individuals with overall debility, a cold infusion or milk cooked with the plant's blossoms is helpful. For rheumatism, the bark decoction made by boiling the bark in water is consumed orally, and the resulting seed oil is used topically to the afflicted regions [42].

A decoction of bark is used to treat diabetes. The leaves are used to cure eczema. After being cooked, the leaves are covered with sesame oil. This is used externally to the eczema-affected region to provide relief. Four milliliters of the liquid bark extract are combined with three hundred milliliters of water and gargled for spongy and bleeding gums. Additionally, pharyngitis and acute tonsillitis (inflamed tonsils) might benefit from gargling with bark extract. Twice daily, a cup of bark infusion is used orally to treat diarrhea. A seed oil massage is a really good way to ease discomfort. For respiratory ailments, a five-gram dosage of stem bark powder combined with Gular latex is administered twice daily with warm water. Ground roots are used to ulcers. Mahua flowers are used as a general tonic and are particularly nutrient-dense. Ghee and honey are consumed with the dried flower powder for this purpose [43].

1.8 Pharmacological reports

A significant economic tree that grows all throughout India is Madhuca indica, a member of the Sapotaceae family. The bark of M. indica has long been used to treat tonsillitis, ulcers, diabetes, rheumatism, and bleeding. M. indica's seeds, flowers, and seed oil are all very valuable medicinally. The seed oil massage

works wonders for relieving discomfort on the outside. Flower juice is used topically to treat skin conditions. It also works well as a nasya (nasal drops) for pitta-related head conditions including sinusitis. The Mahua has been utilized for centuries and has a variety of medicinal properties. Here are a few examples of its pharmacological applications:

1.8.1 Anti-inflammatory activity

The immune system's normal reaction to disease or injury is inflammation. The body uses inflammation as a defense mechanism. Madhuca indica has been proven to be an effective therapy for inflammation. The purpose of the aerial sections is to reduce inflammation. Using a Soxhlet system, 50 g of plant material was extracted for 24 hours using 100 ml of methanol. As a consequence, extract was filtered and concentrated for 30 minutes using a vacuum sounding device. The male Vistar rat, which was already exhibiting inflammation, responded satisfactorily to this solution [44–46].

1.8.2 Analgesic activity

The substances known as analgesics reduce pain without impairing awareness or changing other bodily functions. The six animals in the group were administered the methanolic extract of M. indica orally. The amount of writhing that occurred during the next half hour following the injection of acetic acid was noted. There will be less abdominal contractions if the analgesic medication is effective. Other assessment techniques, such as the tail flick method or the hot plate method in rats, can also be used to assess the analgesic effect of M. indica. Antinociceptive response was defined as a significant decrease in either the hot plate reaction time, tail flick, gradient heat, or abdominal constriction as compared to animals given with a vehicle [47–48].

1.8.3 Antipyretic activity

M. indica is used to treat fever in humans after being tested on animals. Five groups of six rats each received subcutaneous injections of 10 ml kg-1 body weight. The experimental animal's body temperature is raised by first forcing the animal to have a fever by injecting the yeast solution. About 19 hours following the yeast injection, each animal's basal rectal temperature was measured with a thermometer. The rectal temperature was then recorded once more, and any animals that showed a temperature increase of less than 0.6 °C were eliminated. After the yeast injection, the rectal temperature was then measured 20–24 hours later. After a while, the rat's rectal temperature drops, demonstrating M. indica's antipyretic properties [49].

1.8.4 Anti-hyperglycemic Activity

Madhuca indica bark's notable hypoglycemic effects in diabetic rats suggest that peripheral tissues' promotion of glucose consumption may be the mechanism behind this action. The current study's findings unequivocally showed that Madhuca indica bark ethanolic extract had a hypoglycemic impact on rats with STZ-induced diabetes. Blood glucose levels in all groups, with the exception of glibenclamide, were greater at 30 minutes after the glucose tolerance test began than at zero time, but they sharply dropped between 30 and 120 minutes. In rats given glucose, the blood glucose level was considerably lowered because methanolic extracts improved glucose consumption [50–53].

1.8.5 Anti-ulcer activity

One frequent gastrointestinal tract condition is a gastro intestinal ulcer. An imbalance between the GIT's attacking and defense components leads to ulcers. An ulcer is a localized flaw or excavation of the upper portion of a tissue or organ known as the surface. The M. indica plant has demonstrated anti-ulcer properties when tested on male Vistar rats. The animal is first made to develop an ulcer using any appropriate technique, such as stress-induced ulceration or carrageen-induced ulceration, in order to assess the Mahua tree's anti-ulcer efficacy. The animal is then given an extract of the tested plant material. [50]

1.8.6 Antioxidant Activity

An imbalance between the generation and buildup of oxygen reactive species (ROS) in cells and tissues and the biological system's capacity to detoxify these reactive products results in oxidative stress. Madhuca indica's ethanolic bark extract's reducing property suggests that it has the ability to donate hydrogen atoms in a dose-dependent way. Because phenolic compounds are known to have direct antioxidant properties because they include hydroxyl groups that can act as hydrogen donors, the extract's high phenolic compound concentration may be a contributing factor to antioxidant activity. One important predictor of a compound's possible antioxidant action is its reducing capacity. Any drug's antioxidant efficacy is dependent on two mechanisms: either it oxidizes itself to stop oxidation or it forms a protective layer over the substance [54].

1.8.7 Anti fertility activity

In the current instance, there was a total decrease in male rat fertility, the number of pregnant females, and the number of litters in the group treated with plant extract. The percentage of fertile male mice and the number of pregnancies were considerably lower in atropine-induced mice compared to control mice. Reduced spermatozoa density has been linked to the suppression of male fertility following the administration of natural chemicals in plant-based contraceptives. Additionally, for male contraception, it is not essential to halt spermatogenesis; rather, it is sufficient to alter the sperm's shape or function in order to prevent the spermatozoa from fertilizing. Interference with testicular spermatogenesis is indicated by the decline in sperm count and the large proportion of sperm with aberrant morphology [55].

1.8.8 Dermatological use

The bark may be decocted to help with itching and ulcers, while the seed oil can help with a number of allergy conditions. Laxatives are another usage for it [56].

1.8.9 Hepatoprotective activity

Albino rats with carbon tetrachloride (CCl4)-induced liver injury exhibit hepatoprotective effect when exposed to methanol extracts of Madhuca indica bark. A moderate protective effect was observed by the methanol extract of Madhuca indica bark at a dose of 300 mg/kg body weight, which significantly reduced the serum levels of glutamate pyruvate transaminase (SGPT), glutamate oxidaloacetate transaminase (SGOT), serum bilirubin, and serum alkaline phosphate (SALP). The current research showed that Madhuca indica's methanolic bark extract may provide notable dose-dependent protection against hepatocellular damage brought on by CCL4 [57].

1.9.0 Antibacterial Activity

Resistant to rice pest illness, the blossom possesses antibacterial properties against Escherichia coli [58].

1.8.10 Antiepileptic Activity

Pentylenetetrazole (PTZ)-induced convulsion in mice treated with benzodiazepines as a standard medication was used to test the anticonvulsant properties of the methanol extract of M. indica heart wood. When compared to the saline group, Madhuca indica at a dosage of 400 mg/kg extended the time it took for seizures to start and shortened their length [58].

1.8.11 Anticancer Activity

There is a claim in the Ayurvedic medical system that Madhuca indica bark may be used locally to cure cancer [60].

1.8.12 Toxicity

The goal of toxicity testing is to describe the potential harmful consequences that a test material may have, not merely to determine how safe it is. Despite producing at a greater concentration, a combination of saponins extracted from Madhuca indica seeds did not exhibit any cholinergic action. When given to parents, the saponin is highly harmful. The IP route's L.D. 50 was 50–70 times greater than the oral route, which was on par with the IV route's. The highest concentration of phenol, 46.0 mg/gdw, was found in M. indica root. These substances are crucial for the development and growth control of plants as well as for the precursor of hazardous substances. Additionally, M. indica seed oil is said to contain the hazardous chemical aflatoxine. To prevent any negative effects, herbal medicine quality control procedures should be closely adhered to [61–64].

1.9 Formulations Available In the Market

Mahua tree bark was utilized to make a herbal hand wash that was safer, more effective, and nontoxic. Using the disc diffusion technique, the antibacterial activity of this herbal hand wash was evaluated and contrasted with that of a hand wash that is sold commercially. This hand wash was said to be efficient and to have no negative side effects. Bark, ginger, M. indica, and lemon grass extracts are all used in the herbal hand wash recipe. 4 ml of the suspended water extract (1.25 g/4 ml w/v) was combined with 3 g of sodium lauryl sulphate (SLS) to create the herbal hand wash. The dosage is 10–15 g. These formulations are used therapeutically as Svasa, Daha, Kasya, Trsna, and Srama [65]. Various marketed products of the plants are discussed bellow.

i. Lakshmanarishta: It is a liquid ayurvedic formulation which is used in the cure of various gynecological disorders like menorrhagia, heavy and irregular periods.
ii. Madhukasava: It is a liquid ayurvedic formulation which is used in the cure of various disorders like bleeding disorder, emaciation, skin diseases and tiredness.
iii. Nyagrodhadi churna: It is a powder ayurvedic formulation which is used in the cure of diabetes and urinary disorders.
iv. Abhayarishta: It is a liquid ayurvedic formulation which is used in the cure of constipation and piles.
v. Chandanasava: It is a liquid ayurvedic formulation which is used in the cure of burning sensation, burning micturition and also spermatorrhoea.
vi. Stanyajanana rasayana: It is an ayurvedic formulation which is used for post natal care as it enhances the milk production and provides strength to the lactating mother.
vii. Pancha saara panaka: It is a cool drink which is used in the treatment of burning micturition, burning sensation of the body and thirst.

2. Conclusion

Scientists and Ayurveda agree that medications made from medicinal plants are the greatest way to fight against illnesses since they have a great deal of potential to treat illnesses with little side effects and with high safety and effectiveness. They pose the biggest threat to adjuvant therapy and alternative treatment. One of the most adaptable plants, M. indica has been utilized both medicinally and domestically. All plant parts have been utilized to cure and prevent conditions including inflammation and diabetes. It has been discovered that several extracts have pharmacological action. As a result, it is also known as the "arcadia tree for tribal people or universal panacea in ayurvedic medicine." The pharmacological and phytochemical properties of Madhuca indica have been emphasized in this review. Because the literature reveals little study in a number of areas to comprehend and reveal the method of its pharmacological actions, more thorough work is needed. Furthermore, it is necessary to extract, purify, and identify novel entities from Madhuca species since this might further establish the use of isolated chemicals in the treatment of a variety of acute and chronic illnesses and increase the assurance of their application.

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