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Madhuca longifolia (Mahua): A comprehensive ethno pharmacological review

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Abstract
Madhuca longifolia is cultivated as well as found in wild and considered as boon for the forest dwellers for its medicinal property. It is an economic plant grows mainly in subtropical region of India and Pakistan. It is commonly known as Mahua and known for its antimicrobial, antioxidant, antipyretic, anti-inflammatory, antiulcer, cardioprotective, anti-carcinogenic, immuno-modulant, anti-rheumatic, oxytocic, anti-estrogenic, uterotonic, antiepileptic, demulcents and many other useful pharmacological activities. Its chemical ingedients include terpenoids, proteins, starch, anthraquinone glycosides, phenolic compounds, mucilage, cardiac glycosides, tannins, flavonoids and saponins. This article gives a brief description of *Madhuca longifolia* regarding its identification, phytochemical properties, traditional uses including anti-inflammatory, antipyretic, antihyperglycemic, antifertility, antiulcer activities. The outcome of this review will further expand the existing knowledge about Mahua and provide a convincing support to its future clinical use in modern veterinary and human medicine.

Keywords: *Madhuca longifolia*, Mahua, pharmacology, anti-ulcer, anti-pyretic

Introduction
Madhuca longifolia is the botanical name of *Mahua* tree which belongs to family-Sapotaceae (Banerji *et al.*, 1996; Devi and Sangeeta, 2016; Khare *et al.*, 2018) [1, 8, 11]. Medium to large sized deciduous tree, spreading branches and a large rounded crown. Leaves are clustered at the end of branches, elliptic, obovate. Flowers are small, cream-coloured and produced in clusters at end of branches (Verma *et al.*, 2014) [32]. Fruit, a green egg-shaped fleshy berry. Seeds arc either double convex or flattened on one or two sides. The Honey tree (English name) has many medicinal uses. Almost all parts of this tree are medicinally very important. Tribals in Central India worship this tree for its medicinal values and also for its relevance in their rituals. Mahua is a large deciduous tree growing widely under dry tropical and sub tropical climatic conditions (Verma *et al.*, 2014; Khare *et al.*, 2018) [32, 11]. *Madhuca longifolia* is distributed in Andhra Pradesh, Gujarat, Madhya Pradesh, Odisha, Chhatisgarh, Jharkhand, Bihar, Uttar Pradesh. It is an important tree for poor, greatly valued for its flowers and its seeds known as tora. The tree has religious and aesthetic value in the tribal culture. The trees with best girth in forest are often Mahua trees as it is protected and cared by forest dwellers. Mahuatree can be found in forests, revenue, and private land (Khare *et al.*, 2018) [11]. The early settlers had rights to specific Mahuatrees occurring near the village in private, revenue and forestlands. Some trees may even be located at long distance from the village but are recognized as being associated to a family. These rights are only for harvesting (lowers but not for fruits and have been practiced. These rights have passed from generation to generation. When father divides the property among his sons, he also divides Mahuatree between them but keeps some for himself till the end, as it becomes an easy source of income. In absence of sons, harvesting rights are given to daughters when they get married. Sometimes villagers of one region, in dearth of Mahua, visit relatives who have trees in abundance (Mishra and Padhan *et al.*, 2013) [14]. In most agricultural communities people rely on seasonal crop production. For many rural people, and especially for the poor, these cycles entail periods of food shortage. It is at these critical periods that the importance of forest foods is greatest. Of course, forests and fallow lands provide food resources in most seasons, in the form of edible leaves, fruits, wild vegetables, roots and tubers (Verma *et al.*, 2014) [32].

Madhuca longifolia

Botanical names	*Madhuca longifolia*
English name	Indian Butter tree, Honey tree
Hindi name	Mahua
Type (vegetation)	Deciduous tree
Part used	Fresh or dried whole fruit

Botanical Description and Identification Features

A medium sized to large deciduous tree, usually with a short, hole and large rounded crown found throughout the green forest part of India up to an altitude of 1,200 meter and of 12 to 15 meter height, hark thick dark colored cracked, inner hark dark red, milk, trunk short, branches numerous (Behl *et al*., 2002) [3]. Leaves are 10-30 centimeters long, thick and leathery, most of leaves pointed at the tip and bred near end of branches, epileptic or elliptic oblong 7.5 to 23 cm into 3.8 to 11.5 cm (Khare *et al.*, 2018) [11]. Flowers are small and fleshy, dull or pale while in color and in define fascicles near end of branches. Fruits are 2-6 cm long, fleshy and greenish. Bark dark color, cracked (Variers *et al*., 1995) [31].

Useful parts of plant: Every part of ally plant possess sonic medicinal properties, either in small of large proportion. Different parts of a plant often contain different active ingredients, so that one part may be toxic and another one quite harmless (Wyk *et al.*, 2004) [33]. The plant consists of several parts, they may he classified according to the function. They are root, bark, leaves, flowers, fruits, seeds, oil.

Table 1: Parts of Madhuca and its medicinal properties

Parts of Madhuca	Medicinal Properties Wealth of India 2007 (Seshagiri *et al.*, 2007) [28, 20]
Leaf	Eczema, Wound Healing, Anti Burns,
Oil	Fracture Emollient, Skin Disease, Rheumatism, Headache, laxative, Piles, Hemorrhoids, Emetics, Anti Earthworm.
Fruit	Sweet, Refrigerant, Aphrodisic, Tonic, Dipsica, Bronchitis, Astringent, Antiulcer, Acute and Chronic Tonsillitis, Pharyngitis
Bark	Rheumatism, Ulcer, Inflammation, Bleeding, Spongy Gums, Tonsillitis, Diabetic, Stomach Ache, Anti Snake Poisoning, Astringent, Emollient, Fracture, Itching
Flower	Hepatoprotective, Refrigerant, Gastropathy Liquor, Jelly, Sweet Syrup, Expectorant, Increase the production of milk in woman, Stimulant, Diuretics, Anthelmentic, Verminosis

Phytochemical Property

The therapeutic value of the plant depends on the active constituents present inside the different part of the plant, which may be present in the small or large quantity (Sardana *et al.*, 1995; Devi and Sangeeta, 2016; Khare *et al.*, 2018) [19, 8, 11]. The secondary metabolites are the important substance responsible for the main medicinal properties in the crude drugs (Sengar *et al.*, 2009) [22]. The leaves of Mahua tree contain saponin, an alkaloid, and glucoside. Sapogenin and other basic acid are found in the seeds. Various Photochemical studies on Mahua include characterization of Sapogenin, triterpenoids, steroids, saponin, flavonoids and glycosides. In view of the aides and attributed medicinal properties new components including madhucic acid (pentacyclic triterpenoids), madhushazone, triterpene glycosides and madhucosides A and B20. The fresh flower of Mahua contains 2 acetyl pyrroline, the aroma molecule. They also contain polysaccharide which on hydrolysis give D-galactose, D-glucose, L-araninose, L-rhamose, D-xylose and D-glucuronic acid (Miller *et al*., 2005; Khare *et al.*, 2018) [13, 11]. The chemical composition of mahua flower reveals its high nutritional value. Apart from being a rich sours of sugar and protein, the flowers also contain essential minerals like Ca, P, Fe, and K. Calcium is a major component of the hone and assists in teeth development (Brody *et al.*, 1994; Patel *et al.*, 2010) [4, 16]. Phosphorus is next in importance to calcium as utilization of Ca is closely related to it. Most of the Calcium in the body is deposited as the calcium Phosphate (Gopalan *et al*., 2004) [9].

Table 2: Parts of Madhuca and its chemical composition

Part	Phytoconstituents
Bark	Flavonids, Triterpene, Sterol
Latex	Soluble Resin, Insoluble Resin
Leaf	Moisture, Organic Matter, Minerals, Potas (K_2O) Phosphoric Acid (P_2O_5) Silica, Alkaloids, Flavnoids, Protobasic Acid.
Flower	Carotene, Ascobic Acid, Thiamine, Riboflavine, Niacine, Folic Acid, Biotine, Inositole.
Fruit	Moisture, Protein, Fat, Carbohydrates, Minerals, Calcium, Phosphorus, Iron, Carotene, Ascorbic acid, Tannins

Nutritional and Medicinal Use

The Mahua tree is having lots of nutritional value in it. It produces fruit which is valued for its seed which yield high quantity of fat commercially known as Mahua butter or mowrah butter, many edible and medicinal applications and it is also used as a biodiesel (Singh *et al.*, 1991; Devi and Sangeeta, 2016; Khare *et al.*, 2018) [27, 8, 11]. Its fat has been used as substitute for cocoa butter and ghee. It is one of the single largest sources of natural hard fat (Bringi *et al.*, 1987) [5]. The fat which is thus obtained from Mahua fruit oil is used in cooking, frying and manufacturing chocolates. The seed fat has emulsion property so it mostly used as an emulsifying agents in few pharmaceutical industries. It is generally applied as massage oil in many part of the country, as it is very good to moisturize skin. Besides edible and medicinal uses, Mahua has industrial application as it can be utilized in the manufacture of laundry soaps and lubricants (Parrota *et al.*, 2001; Verma *et al.*, 2014) [15, 32]. Moreover, the seed cake is reported to have insecticidal and pesticide property and used as organic manure in crops like rice, sugarcane etc. The medicinal properties which are seen in this plant are stimulant, demulcent, emollient, healing skin diseases, rheumatism, headache, laxative, piles, and sometime as galactogogue, astringent and many more (Pinakin *et al*., 2018) [17].

The chemical composition of mahua flower reveals its high nutritional value. Apart from being a rich source of sugar and protein, the flowers also contain essential minerals like Ca, P, Fe, and K. Calcium is a major component of the bone and assists in teeth development (Pinakin *et al*., 2018) [17].

Traditional use

Although Mahua tree is easily found in the several part of India, it is not used as a food material. Mahua flower occupy an important position in the life of the tribal in many parts of India (Das *et al*., 2001) [7]. Only a small quantity of flowers is consumed in a raw, cooked or fried formed in different parts of India. Major quantity of flowers is used in the preparation of the distilled liquors. The freshly prepared liquor has a strong, smoky fetid odor, which disappear on ageing (The wealth of India *et al*., 2010; Verma *et al.*, 2014) [32]. It is also seen that the pest of the Mahua tree bark is used to cure the fracture of bone. The most interested thing about the Mahua tree is that it has two fruits in different seasons; the seed oil is extracted from it and used in the several different purposes. The wood of mahua tree is also used in the house hold utility like door and window making. The tribal people use it for the development of halwa, meethi puri, barfi, mahua daru or mahuli (Pinakin *et al*., 2018) [17].

Sugar syrup

There are several reports on preparation of sugar syrup from dry Mahua flowers, as its sweet property is utilized in the fermentation process (Shriwastava *et al.*, 1970; Benerji, 2010) [24, 2]. The water extract of dried flower is decolorized with different decolorizing agent like slacked lime and activated charcoal before concentrating it to the desired concentration. Activated charcoal at a concentration of 3.5-5% was found to be the best agent for the preparation of the Mahua sugar syrup (Patel *et al*., 2010) [16]. The syrup thus obtained from the flower of Mahua is employed in the different purpose, either in the manufacturing of chocolate or as a sweetening agent (The wealth of India *et al.*, 2010).

Pharmacological profile

Madhuca longifolia, belonging to the family Sapotaceae, is an important economic tree growing throughout India. Traditionally, *Madhuca longifolia* bark has been used against diabetes, rheumatism, ulcers, bleeding and tonsillitis (Khare *et al*., 2000; Khare *et al.*, 2018) [10, 11]. The flowers, seeds and seed oil of *Madhuca longifolia* have great medicinal value. Externally, the seed oil massage is very effective to alleviate pain. In skin diseases, the juice of flowers is rubbed for oleation. It is also beneficial as a nasya (nasal drops) in diseases of the head due to pitta, like sinusitis (Dahake *et al.*, 2010) [6]. The Mahua have several pharmacological potency and it is being used from the tradition. Few of its Pharmacological use are as follows:

Anti-inflammatory Activity

The reason of the emergence of the swelling or inflammation is release of the various chemical mediators from the damaged cell like histamine and serotonin. Inflammation is a defensive mechanism of the body (Tortoro *et al.*, 2003) [30]. The most important mechanism of anti-inflammatory drugs is considered to be inhibition of Prostaglandins synthesis at the site of injury. The anti-inflammatory potency of drugs hampers PG synthesis.

Anti-pyretic activity

Madhuca indica, is used to treat the fever in individual, as it is experimented in animals. About 5 groups of 6 rats each were injected subcutaneously with 10 ml kg^{-1} body weight. Firstly, the animals are forced to fever by injecting the suspension of the yeast suspension, this will increase the body temperature of the experimental animal. After measuring the basal rectal temperature of each animal by a help of thermometer, about 19 Hr. after yeast injection, the rectal temperature was recorded again and animal showing a rise in temperature of $<0.6^{o}$ C were discarded. Rectal temperature was then recorded at 20-24 hours after yeast injection. After sometime interval it is found in the reduction in the rectal temperature of rat, which shows the antipyretic effect of *Madhuca longifolia* (Shekhawat *et al*., 2010) [23].

Anti-hyperglycemic Activity

The significant hyper-glycemic effects of *Madhuca longifolia* bark in diabetic rats indicate that this effect can he mediated by stimulation of glucose utilization by peripheral tissues. The results of the present study clearly indicated the ethanotic extract of *Madhuca longifolia* bark to have a hypoglycemic effect on STZ induced diabetic rats (Srirangam *et al*., 2010) [26]. In all groups except *for* glibencyl amide, at 30 min of initiating glucose tolerance test, blood glucose concentration was higher than at zero time but decreased significantly from 30 min to 120 min. Methanolic extracts were enhancing glucose utilization, thus the blood glucose level was signiticantly decreased in glucose loaded rats (Seshagiri 2007; Dahake *et al.*, 2010) [20, 6].

Anti-fertility activity

The percentage of fertile male mice and the number of pregnancies were significantly reduced in atropine induced mice from control mice. There was complete reduction of fertility in male rat, number of pregnant females and number of litters in plant extract treated group. Among the plant based contraceptives, inhibition of male fertility after administration of natural substances has been related to decrease spermatozoa density. Also for male contraception, it is not necessary to stop spermatogenesis, but rather to eliminate the fertilizing ability of the spermatozoa by causing changes in the morphology or in the function of the sperm. The decrease in sperm count and the high number of morphologically abnormal sperms indicate interference with testicular spermatogenesis (Saif *et al*., 2018) [18].

Analgesic activity

Analgesics are the agents that relieve the sensation of pain without disturbing consciousness or altering other afferent inputs temperature of rat, which shows the antipyretic effect of *Madhuca longifolia* (Shekhawat *et al*., 2010) [23].

Analgesic activity was evaluated on the acetic acid induced writhing. The methanolic extract of *Madhuca longifolia* was given orally to the group of 6 animals. The number of writhing during the following 30 min. period was observed after acetic acid injection. Anti-analgesia is expressed as the reduction of the number of abdominal constriction between control animal and mice pretreated with the extract (Shekhawat *et al.*, 2010) [23]. In otherwords, if the analgesic drug works, the abdominal contraction will be less in numbers. The analgesic activity of the *Madhuca longifolia* can also be evaluated by the using other method of evaluation like tail flick method.

Anti-ulcer Activity

Gastro-intestinal ulcer is a common disorder of gastrointestinal tract. It is now considered that gastrointestinal ulcer is a disease of multi factorial origin but its detailed etiology is still not clear (Maity *et al.*, 2009) [12].

Ulcer is a result of the imbalance between the defensive and attacking factors in the GIT. An ulcer is a local defect or

excavation of the tipper part that is called surface of an organ or the tissue (Seth *et al*., 1999) [21]. Anti ulcer activity has been proved in *Madhuca Indica* plant while it is tested in the male wistar rat (Simon *et al.,* 2019) [25]. To evaluate the anti ulcer activity of the Mahua tree, firstly the animal is forced to produce the ulcer by any of suitable method like stress induced ulcer or carrageen induced ulcer, and then the same is treated with the extract.

Conclusion

Madhuca longifolia, commonly known as mahua, is very well known for its medicinal properties and other industrial use. Its therapeutic potential is of great importance but is not fully utilized. Mahua seeds are rich source of edible fats making it economically more important. Mahua possess a lot of ethnic values among the tribal people for the development of various fermented and non-fermented food products, and improve the livelihood of the tribal people with the increase chances of the employment.

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