

# Research in Pharmacy and Health Sciences

Review Article

## A review on *Madhuca longifolia*

Ashish Kumar\*

College of Pharmacy, Teerthanker Mahaveer University, Bagadpur, Delhi Road, Moradabad, UP-244001, India

<p><b>Abstract:</b></p> <p>Since the beginning of human civilization, medicinal plants have been used by mankind for its therapeutic value. <i>Madhuca longifolia</i> (Family: Sapotaceae), is an Indian tropical tree found largely in the central and north Indian plains and forests. Its common or trade name is Mahwa or Mahua. Various parts of <i>Madhuca longifolia</i> has been used traditionally for different ethnomedicinal purposes. This review enlists the contributions of various scientists on <i>Madhuca longifolia</i> under different sections like ethnomedicinal activity, pharmacological activity, toxicological activity, phytochemistry, insecticidal &amp; pesticidal activity, antimicrobial activity, ethnobotany, clinical studies, miscellaneous, pharmacognosy, analytical and processing techniques, biochemistry and agronomy. This review will provide a path to the researchers to explore the therapeutic potentials of <i>Madhuca lngifolia</i>.</p> <p><b>Keywords:</b> <i>Madhuca longifolia</i>, Sapotaceae, Mahua, Ethnomedicinal activity</p>	<p><b>Received:</b> 25-05- 2016</p> <p><b>Revised:</b> 30-05-2016</p> <p><b>Accepted:</b> 03-06-2016</p> <p><b>*Correspondence to:</b> Mr. Ashish Kumar, Email: ashish.pp17@gmail.com</p> <p><b>Funding:</b> Nil</p> <p><b>Competing Interests:</b> Nil</p>
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### INTRODUCTION:

Since the beginning of human civilization, medicinal plants have been used by mankind for its therapeutic value. Nature has been a source of medicinal agents for thousands of years and an impressive number of modern drugs have been isolated from natural sources. Many of these isolations were based on the uses of the agents in traditional medicine. The plant-based, traditional medicine systems continues to play an essential role in health care, with about 80% of the world's inhabitants relying mainly on traditional medicines for their primary health care.

### Distribution and Description

*Madhuca longifolia*, is an Indian tropical tree found largely in the central and north Indian plains and forests. It is a fast growing tree that grows to approximately 20 meters in height, possesses evergreen/semi-evergreen foliage.

### Taxonomical classification

The taxonomical classification of *Madhuca longifolia* is as follows: Kingdom: Plantae, Division: Magnoliophyta, Class: Magnoliopsida, Order: Ericales, Family: Sapotaceae, Genus: Madhuca, and Species: *longifolia*.

### Vernacular Names

It's common or trade name is Mahwa or Mahua. The common names of *Madhuca longifolia* in various languages are as follows: Hindi: Mohua, Mungli; Gujarati: Mahudo; Kannada: Doddippa, Halippa; Malayalam: Illuppa, Iruppapu; Marathi: Moha, Mhowra; Bengali: Mahula, Kochra; Oriya: Mohuka, Mohulo; Sanskrit: Atavimaduka; Tamil: Iluppai, Kattillupi; Telugu: Ippa, Madhukamu; Urdu: Mahuva

### Ethnomedicinal Uses

The oil (solid at ambient temperature) extracted from its seeds is used for the care of the skin, to manufacture soap or detergents, and as a vegetable butter. It can also be used as a fuel oil. The product is often used in sweets and chocolates. The seed cakes obtained after extraction of oil constitute very good fertilizer. The flowers are used to produce an alcoholic drink. Several parts of the tree, including the bark, are used for their medicinal properties. It is considered holy by many tribal communities because of its usefulness.<sup>[1]</sup>

### Literature review

#### Ethnomedicinal activity

Hiremath S G, *et al.*, 2007 has collected sixty indigenous medicinal plants including *Madhuca indica* (Sapotaceae), from Dharwad and its surroundings. The traditional uses of these plants were given after discussion with local healers.<sup>[2]</sup>

Pandey A K and Rout S D, 2006 has provided an account of ethnomedicinal uses of 42 plant species (including *Madhuca longifolia*) known among the tribals of Similipal Biosphere Reserve, Orissa.<sup>[3]</sup>

Sikarwar R L S, 2002 has reported that tribals of Madhya Pradesh use several plants to fulfill their basic requirements like food, medicine, shelter, etc. Among the plants used, Mahua (*Madhuca longifolia*) plays an important role in socio-economic life of tribal people. They use this plant for food, medicine, fodder, fuel, local drink and timber, etc.<sup>[4]</sup>

Amirthalingam M, 2000 has collected the ethnomedicobotanical data from the people during the study of Sacred Groves of Tamil Nadu, where four species of *Madhuca* viz; *Madhuca latifolia*, *Madhuca bourdillonii*, *Madhuca longifolia* and *Madhuca malabarica* are found. All the parts of plants are useful i.e. leaves control bleeding, bark

decoction useful in bleeding gum and ulcers, latex for cracked feet, fruit oil in skin diseases, etc. Other uses of plants have also been mentioned.<sup>[5]</sup>

Rao V N, *et al.*, 1997 has worked over the standardization of Ayurvedic formulation "Parthadhyarishta". The ingredients are Arjuna bark, Mridvika fruits and Madhuka flowers.<sup>[6]</sup>

Sharma S K, 1997 has reported the use of various plants including *Madhuca longifolia* as fish-poison by the tribals of southern Rajasthan.<sup>[7]</sup>

Singh C B, 1994 has reported the methods of natural conservation of six economic plants (including *Madhuca longifolia*) of ethnic value in the Santhal Parganas of Jharkhand.<sup>[8]</sup>

Singh J P, 1994 has recorded during ethnobotanical survey and field work, 270 plant species (including *Madhuca longifolia*) belonging to 214 genera and 78 families utilized by the kols for various purposes.<sup>[9]</sup>

Joshi A, 1993 has reported that the available sources of oil bearing materials in the country is fall under perennial oil seeds, annual oil seeds and minor oil seeds such as sal, neem, karanja, mahua, pisa, etc.<sup>[10]</sup>

Uniyal M R, 1993 has identified Drug plants from Kumaon hills used in the drug 'Madhuk Pushpi' of Ayurvedic text as *Aesandra butyracea*, *Bassia butyraceae*, and *Madhuca indica*.<sup>[11]</sup>

Uniyal M R, 1993 has reported the Determination of unknown "Madhukpushpi" of literature with "chura (*Aisandra butyracea*)" found in Kumaon forest division.<sup>[12]</sup>

Jain P and Sahu T R, 1993 has enumerated the ethnobotanical uses of forty five plant species belonging to thirty nine genera and twenty eight families. Various plants including *Madhuca longifolia* have been reported useful against scorpion sting and snake bite.<sup>[13]</sup>

Saxena R B, 1992 has studied the Physico-chemical parameters of the Kubja prasarini taila (oil), used for curing many ailments like vataroga, kubjata stimitata, etc. The ingredients used are from plant products including *Madhuca longifolia*.<sup>[14]</sup>

Sikarwar R L S, 1992 has reported a paper containing 20 plant species including *Madhuca longifolia*, of ethnomedicinal importance. These plant species are used by various tribal communities for curing certain diseases, in the North Surguja forest division in Madhya Pradesh.<sup>[15]</sup>

Lahankar M A, 1991 has reported the use of dental sticks from ten plants including *Madhuca* (Mahua), in different diseases of teeth and mouth.<sup>[16]</sup>

El-Gammal S Y, 1991 has found that many herbs possess antidiabetic activity and were used in many remote antiquity in folk traditional therapy. Sixty four plants have been identified and listed alongwith form of intake and different dosage.<sup>[17]</sup>

Iyengar MA, *et al.*, 1987 has made a survey of eleven medicinal plants (including *Madhuca longifolia*) of South Kanara, Karnataka.<sup>[18]</sup>

Chandra K, *et al.*, 1985 has listed the Medicinal properties of 69 Folklore medicinal plants of Dumka forest division, including *Madhuca longifolia*.<sup>[19]</sup>

Alam, *et al.*, 1984 has revealed the Microbiological screening of *Madhuca longifolia* flower. *Madhuca longifolia* flower harbours three types of non-fermenting bacteria and

yeast which is capable of producing 2.9 percent alcohol from honey.<sup>[20]</sup>

Alam M, *et al.* 1983 has made Studies on Mustakarishtha prepared according to textual and modified methods were carried out. *Madhuca longifolia* flowers caused fermentation but the amount of alcohol was less.<sup>[21]</sup>

### Pharmacological activity

Chaudhary A, *et al.*, 2011 have studied the antidiabetic activity of bark of *Madhuca indica*. Its methanolic extract was tested on normal and streptozotocin induced diabetic rats, and has shown a significant antidiabetic activity.<sup>[22]</sup>

Kumar K P, *et al.*, 2011 have performed the screening of *Madhuca indica* for antidiabetic activity. Its methanolic extract was tested on streptozotocin and streptozotocin nicotinamide induced diabetic rats, and has shown significant antidiabetic activity.<sup>[23]</sup>

Rahmatullah M, *et al.*, 2011 have performed the antihyperglycemic activity of *Madhuca indica* leaves and *Paederia foetida* L. stems in mice. Its methanolic extract has demonstrated significant antihyperglycemic activity.<sup>[24]</sup>

Dahake A P, *et al.*, 2010 studied the antihyperglycemic activity of bark of *Madhuca longifolia* in alloxan -induced diabetic rats. It was reported that, its methanolic extract is a potential antidiabetic agent.<sup>[25]</sup>

Dahake A P, *et al.*, 2010 studied the antioxidant activity of bark of *Madhuca longifolia*. It was reported that, its methanolic extract exhibited significant antioxidant activity.<sup>[26]</sup>

Prashanth S, *et al.*, 2010 studied the antihyperglycemic activity of bark of *Madhuca longifolia*. It was reported, its ethanolic extract has potential antidiabetic and antioxidant properties.<sup>[27]</sup>

Gaikwad R D, *et al.*, 2009 studied the anti-inflammatory activity of seeds of *Madhuca longifolia*. It was reported that *Madhuca longifolia* seed saponin mixture may exhibit a significant anti-inflammatory activity in cotton pellet granuloma.<sup>[28]</sup>

Ghosh R, *et al.*, 2009 studied the antihyperglycemic activity of leaves of *Madhuca longifolia* in alloxan -induced diabetic rats. It was reported that, its hydroethanolic extract of the leaves of *Madhuca longifolia* significantly lowered blood glucose levels, which indicates its antihyperglycemic activity.<sup>[29]</sup>

Pawar R S and Bhutani K K, 2004 have reported glycosides from *Madhuca indica*. These glycosides have inhibitory effect on free radical release from phagocytes.<sup>[30]</sup>

Shiva A, 1998 has described the use of various plant remedies including *Madhuca longifolia*, in the treatment of diabetes/glycosuria.<sup>[31]</sup>

Lanjewar RD, *et al.*, 1986 has reported the larvicidal and ovicidal properties of aqueous extracts of various plants including *Madhuca longifolia* oil cakes and two fungicides against *Meloidogyne incognita*.<sup>[32]</sup>

Banerji R, *et al.*, 1985 has reported *Madhuca longifolia* leaf saponin and its biological activity (moderate spasmolytic activity).<sup>[33]</sup>

Banerji R, *et al.*, 1982 has collected twelve saponin samples from seeds and leaves of *Madhuca longifolia*, showed moderate spasmolytic activity on isolated ileum of guinea pig.<sup>[34]</sup>

Banerji R, *et al.*, 1979 has isolated twelve steroid and triterpenoid saponins from different plant sources including *Madhuca longifolia* seed as spermicidal agents.<sup>[35]</sup>

#### Toxicological activity

Karim M R, 2007 has done the toxicological evaluation of the root and stem bark extracts of *Madhuca indica*. The results were discussed with reference to the indication of using the plant extracts as antimutagenic agent.<sup>[36]</sup>

Lalitha T, *et al.*, 1991 has studied oral toxicity of *Madhuca longifolia* saponins to albino rats.<sup>[37]</sup>

Polasa K, *et al.*, 1987 has tested eight unconventional oils for mutagenicity, on *Salmonella typhimurium* strains, by using Ames mutagenicity assay. No mutagenic activity was observed with mahua oil.<sup>[38]</sup>

Lalitha T, *et al.*, 1984 has made a toxicity evaluation on saponins of *Madhuca longifolia* on albino rats.<sup>[39]</sup>

#### Phytochemistry

Siddiqui B S, *et al.*, 2010 has isolated a new isoflavone, 3',4'-dihydroxy-5,2'-dimethoxy-6,7-methylenedioxy, from the fruit coatings of *Madhuca latifolia* (Sapotaceae).<sup>[40]</sup>

Vijayvargia R, *et al.*, 2009 has investigated biochemical estimation of primary metabolites such as protein, lipids, starch, phenol and sugar in different parts of *Madhuca indica* (Sapotaceae).<sup>[41]</sup>

Pawar R S and Bhutani K K, 2004 has established the structures of Madhucoisides A and B, as protobasic acid glycosides. These glycosides were isolated from the bark of *Madhuca indica*, and had shown significant inhibitory effect on superoxide release in a NBT reduction assay and hypochlorous acid generation in a chemiluminescence assay.<sup>[42]</sup>

Walia S, 2004 has studied Azadirachtin based neem biopesticides. Azadirachtin plus potassium salt of mahua oil fatty acids (3:1) combination was 2.4 times more active than azadirachtin concentrate.<sup>[43]</sup>

Yoshikawa K, *et al.*, 2000 has isolated four new oleannane type triterpene glycosides, madlongisides A-D, from *Madhuca longifolia* seeds. Structural elucidation of these glycosides were also performed. Known compounds like mimusopsin A, Mi-saponins A, B and C, and 3-O-beta-D-glucopyranosyl protobasic acid; were also obtained in this study.<sup>[44]</sup>

Nigam S K and Misra G, 1994 has discussed the chemistry of saponin, fat and protein, besides their uses of Mahua (*Madhuca longifolia*).<sup>[45]</sup>

Venkata Rao E, 1992 has presented an overview of chemical and biological aspects of selected polysaccharides from natural sources, and has reported the presence of galactomannans and mannogalactans in various plants, and polysaccharides in various plants including *Madhuca longifolia*.<sup>[46]</sup>

Nigam S K, 1992 has isolated two new triterpenoid saponins, butyrosides A and B, from *Madhuca butyracea* seeds, alongwith two known saponins, Mi-saponin A and 16 alpha-hydroxy Mi-saponin A.<sup>[47]</sup>

Yang CR, 1992 has investigated new glycosides from the medicinal plants including *Madhuca longifolia* in the west of China.<sup>[48]</sup>

Misra G, *et al.*, 1991 has isolated Butyraceol, a triterpenoid saponin from the seed saponin of *Madhuca longifolia*.<sup>[49]</sup>

Lalitha T, *et al.*, 1987 has reported the isolation and properties of saponins A and B from *Madhuca longifolia* seeds.<sup>[50]</sup>

Banerji R, *et al.*, 1985 has isolated Butyric acid, a new saponin from the leaves of *Madhuca longifolia*.<sup>[51]</sup>

Kiatagawa I, *et al.*, 1978 has established the structure of Mi-saponin C, a minor constituent of *Madhuca longifolia* seed kernels.<sup>[52]</sup>

#### Insecticidal and pesticidal activity

Mani C, *et al.*, 2003 has carried out a study to evaluate the efficacy of acaricides and botanical pesticides (neem oil, azadirachtin, mahua and pungum oil) against two spotted mite, *Tetranychus urticae* Koch on Okra crop.<sup>[53]</sup>

Pandey R, *et al.*, 2003 has evaluated the use of mahua cake, castor cake, neem cake, Mentha distillate, *Murraya koenigii* distillate, *Artemisia annua* marc in phytonematode control.<sup>[54]</sup>

Tripathi A K, Bartaria A M, 2002 has studied the management of stem gall of coriander by the use of oilseed cakes including Mahua (*Madhuca longifolia*).<sup>[55]</sup>

Raja N, *et al.*, 2002 has studied the use of *Madhuca longifolia* seed oil in controlling pulse beetle *Callosobruchus maculatus*.<sup>[56]</sup>

Anuradha V, *et al.*, 2000 has examined the effect of petroleum ether extract of seeds of six plants including *Madhuca longifolia*, against the fourth instar larvae of filarial vector *Culex quinquefasciatus*.<sup>[57]</sup>

Dharpure S R, 1998 has evaluated botanical insecticides like neem oil, Pongamia oil and Mahua oil at 0.1 percent against the pest *Citrus blackfly*, *Aleurocanthus woglumi* (ashby).<sup>[58]</sup>

Sebastian S, Gupta P, 1997 has reported that Carbosulfan, carbofuran and phorate caused mortality of *Pratylenchus thornei*. Groundnut, linseed, mahua, neem and mustard oil cakes extracts in various solvents resulted in 70-100 percent nematode mortality.<sup>[59]</sup>

Siddiqui M A and Alam M M, 1997 has reported that highest reduction in root-knot index was observed in the soil amended with leaves of *Aloe barbadensis* followed by *Madhuca indica* and some other non-conventional plant additives for the management of *Meloidogyne incognita* infecting tomato.<sup>[60]</sup>

Sankaranarayanan C and Sundarbabu R, 1997 has reported that Neem, mahua, groundnut and castor oil cakes gave higher biomass production than the nematicides and VAM fungus (*Glomus fasciculatum*) plus root-knot nematode (*Meloidogyne incognita*) treatments.<sup>[61]</sup>

Poornima K, *et al.*, 1997 has reported that higher concentrations of organic oils of karanj, neem, mahua and castor proved effective in preventing larval penetration and gall production of root-knot nematode, *Meloidogyne incognita* affecting the roots of tomato.<sup>[62]</sup>

Katole S R, 1996 has tested the efficacy of some non edible oils (including mahua oil) and insecticides against nymphs of citrus blackfly (*Aleurocanthus woglumi*).<sup>[63]</sup>

Devi S, Gupta P, 1995 has reported the inhibition of larval emergence from the egg-sacs of cyst nematodes, when they were dipped in various extracts of neem, mahua, mustard, linseed cakes and sawdust for 24 and 48 hrs.<sup>[64]</sup>

Johri P K, *et al.*, 1993 has reported the Flocculation of water pollutants through plant-origin materials (seeds) of various plants including *Madhuca longifolia*.<sup>[65]</sup>

Ratnoo R S, *et al.*, 1993 has studied the effect of straw, oil cakes (including Neem, Kusum and Mahuva cakes) on ashy gray stem blight *Macrophomia phaseolina* (Tassi) Goid of cowpea.<sup>[66]</sup>

Soundar Rajan K, *et al.*, 1993 has tested five plant products including Mahua oil and standard insecticides against five common temperate crop pests in the upper Palani hills.<sup>[67]</sup>

Padmanaban B, *et al.*, 1993 has conducted the bioassay of nonedible oil cake of *Azadirachta indica*, *Pongamia pinnata* and *Madhuca longifolia* against *Leucopholis lepidophora*.<sup>[68]</sup>

Alam M M, 1989 has reported control of root-knot and stunt nematodes with horn meal, bone meal and oilseed cakes of various plants including *Madhuca longifolia*.<sup>[69]</sup>

Jaitly N, *et al.*, 1989 has studied effect of certain saponins isolated from various plants including *Madhuca longifolia* on ustilospore germination.<sup>[70]</sup>

Parmar B S, *et al.*, 1987 has tested evaluation of some non-edible oils including mahua, as malathion synergists.<sup>[71]</sup>

Jadhav KB, *et al.*, 1984 has tested efficacy of some vegetable oils, plant extracts (including Mahua oil of *Madhuca longifolia*), and synthetic products as protectants from pulse beetle, *Callosobruchus maculatus* in stored grain.<sup>[72]</sup>

Ali SI, *et al.*, 1983 has reported the effectiveness of plant oils including mahua against pulse beetle *Callosobruchus chinensis*.<sup>[73]</sup>

#### Antimicrobial activity

Premnath Shenoy K R, 2009 has screened Kutajarista, an anti-diarrhoeal Ayurvedic formulation prepared in the laboratory using various plant materials including *Madhuca longifolia* (Sapotaceae), flowers, etc. for antimicrobial activity.<sup>[74]</sup>

Maurya S, *et al.*, 2004 has reported in vitro test on spore germination, extracts of *Azadirachta indica* bark (NBM) and *Cyperus rotundus*. It has shown inhibition of more than 80 percent of spore germination at 500ppm followed by extract of *Ocimum sanctum*, Cashew nut shell, *Zingiber officinale* rhizome and *Madhuca indica* leaves.<sup>[75]</sup>

Lalitha T, *et al.*, 1991 has reported antifungal activity and mode of action of saponins isolated as a byproduct from the defatted cake of *Madhuca longifolia* oil seed.<sup>[76]</sup>

#### Ethnobotany

Basu R, 2010 has made a series of investigations in 43 sacred groves of the tribal of Bankura district of West Bengal during 2006-08. One thirty nine plant species were recorded, dicots were 124, monocots 12. Among them, species of tree were 72 including *Madhuca longifolia* (Sapotaceae), shrubs 16, herbs 33, lianas 4, climbers 13, epiphytes 1.<sup>[77]</sup>

Meena S L, 2008 has studied the ethnobotany of Banaskantha District. Various ethnobotanical plants from the ethnobotanical study area include *Madhuca indica* (Sapotaceae), etc.<sup>[78]</sup>

Shukla A, *et al.*, 2007 has studied the phytodiversity and stratification pattern of kuwana forest at Balrapur

district, UP. Various plant species are found in this forest including *Madhuca indica* (Sapotaceae), etc.<sup>[79]</sup>

Paliwal S P, *et al.*, 2007 has investigated two tropical trees, viz. *Madhuca indica* (Sapotaceae), a deciduous and *Terminalia arjuna* (Combretaceae), an evergreen to find out size variations between cambial initials and their derivatives in the phloem and xylem.<sup>[80]</sup>

Verma R K, *et al.*, 2007 has studied diversity of leaf phenology of tree species including *Madhuca longifolia* in a mixed deciduous forest of Orchha, Madhya Pradesh.<sup>[81]</sup>

Thorat Sanjay B, 2005 has investigated flowering phenology, pollen production, and insect behavior in some red data listed medicinal plants including *Madhuca longifolia*.<sup>[82]</sup>

Sahu T R, 2002 has investigated the popular beverage in Abujhmaria tribal dominating in Abhujmarh region of Bastar district of Chhatisgarh. These tribes use various wild products as drink like Sulphi, Chind and wine of Mahua being main among them.<sup>[83]</sup>

Bishayee G C, 1992 has made a ecofloristic survey of selected biozones of Birbhum district, West Bengal and have recorded a total of 289 species (including Madhuca) belonging to 220 genera of 96 families of Angiosperms and Pteridophytes.<sup>[84]</sup>

#### Clinical studies

Sahasrabudhe S H, 2003 has investigated skin moisturizing effect of Mahua oil and it was proved that the mahua oil can be used as a good moisturizer.<sup>[85]</sup>

Dolui A K, *et al.*, 1988 have discussed Mahua fat in suppository bases.<sup>[86]</sup>

Dolui A K, *et al.*, 1988 have discussed Mahua fat in ointment bases.<sup>[87]</sup>

#### Miscellaneous

Chandra K, *et al.*, 1985 have studied the medicinal properties of 69 Folklore medicinal plants of Dumka forest division, including *Madhuca longifolia* have been listed.<sup>[88]</sup>

#### Pharmacognosy

Alam, *et al.*, 1984 has studied the microbiological screening of *Madhuca longifolia* flower, and revealed that it harbours three types of non-fermenting bacteria and yeast which is capable of producing 2.9 percent alcohol from honey.<sup>[89]</sup>

Iyengar MA, *et al.*, 1987 has made a survey of eleven medicinal plants of South Kanara, Karnataka, have been enumerated.<sup>[90]</sup>

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Rao V N, *et al.* 1997 has done the standardization of Ayurvedic formulation "Parthadhyarishta". The ingredients are Arjuna bark, Mridvika fruits and Madhuka flowers.<sup>[97]</sup>

Mandal S and Bhattacharya A, 2001 have investigated the flower morphology, anthesis, pollen production, foraging nature of flower visitors, pollination mechanism, *in vitro* and *in vivo* pollen germination, and stigma receptivity of ten medicinal plants including *Madhuca longifolia* growing in the lateritic belt of West Bengal.<sup>[98]</sup>

Thorat Sanjay B, 2005 has investigated the flowering phenology, pollen production, and insect behavior in some red data listed medicinal plants including *Madhuca longifolia*.<sup>[82]</sup>

Verma R K, *et al.* 2007 have studied the diversity of leaf phenology of tree species including *Madhuca longifolia* in a mixed deciduous forest of Orchha, Madhya Pradesh.<sup>[81]</sup>

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#### Analytical and processing techniques

Alam M, *et al.*, 1983 have carried out studies on Mustakarishtha prepared according to textual and modified methods. *Madhuca longifolia* flowers caused fermentation but the amount of alcohol was less.<sup>[99]</sup>

#### Biochemistry

Shanmugasundaram T, *et al.*, 1989 have determined the functional properties of defatted and detoxified *Madhuca longifolia* seed flours and compared with those of soybean flour.<sup>[100]</sup>

Mahajan R T, *et al.*, 1994 have exposed the organic and inorganic constituents of haemolymph of freshwater crab,

*Paratelphusa jacquemontii* (Ruthdum) to defatted oil cake of *Madhuca indica*.<sup>[101]</sup>

Rath S P, 1998 has analysed the bioaccumulation and bioconcentration of fluoride in environmental segments (including leaf samples of perennial trees, like *Ficus bengalensis*, *Azadirachta indica*, *Madhuca longifolia*, *Derris indica*, etc.) within 5 km radius of smelter plant of Indian Aluminium Company, Hirakud.<sup>[102]</sup>

#### Agronomy

Rout G R and Das P, 1993 have reported the micropropagation of *Madhuca longifolia*.<sup>[103]</sup>

Gupta S, *et al.*, 2003 have reported the development of nursery techniques of some important medicinal plants including *Madhuca indica* in Vindhyan and central plains of UP.<sup>[104]</sup>

Verma S K, *et al.*, 2010 have made a note on air layering in *Madhuca latifolia* (Sapotaceae).<sup>[105]</sup>

#### Conclusion

Although indigenous plants like *Madhuca longifolia* and their products (active, natural principles and crude extracts) have been used in the Indian traditional system of medicine, but still its pharmacological potential for various therapeutic activities have not been fully explored. This review is an exhaustive compilation of the research data on *Madhuca longifolia*. It will provide a path for further research to be carried out on *Madhuca longifolia* and to explore its therapeutic potentials. It will thus give a scientific basis for the further development of herbal drugs.

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