

**Review Article****Medicinal uses, Phytochemistry and Pharmacological profile of *Madhuca longifolia***Pragati Khare<sup>1\*</sup>, Kamal Kishore<sup>2</sup>, Dinesh Kumar Sharma<sup>3</sup><sup>1</sup>Department of Pharmacy, Bhagwant University, Rajasthan, India<sup>2</sup>Department of Pharmacy, M.J.P. Rohilkhand University, Bareilly, U.P., India<sup>3</sup>Department of Pharmacy, Devsthal Vidyapeeth College of Pharmacy, Rudrapur, U.K., India

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**Abstract**

*Madhuca longifolia* is also called Mahua or butternut tree, belonging to sapotaceae family. It is about 17m in height. *Madhuca longifolia* is an evergreen tree. It is mostly found in India, Sri Lanka and Nepal. It is gifted with many chemical ingredients which are responsible for various medicinal properties. It consists of terpenoids, proteins, starch, anthraquinone glycosides, phenolic compounds, mucilage, cardiac glycosides, tannins and saponins. Leaves are also contained quercetin,  $\beta$ -carotene, erthrodol, palmitic acid, myricetin, 3-O-arabionoside, 3-O-L-rhamnoside, quercetin, 3-galactoside, xanthophylls. The timber is used in construction of houses, cartwheels, doors. It is a good source for nitrogen fixation. Various parts of the tree are used as fodder for cattles, as fertilizer as intercrop. Leaves of mahua are used in the treatment of eczema, wound healing, antiburns, bone fracture, anthelmintic, emollient, skin disease, rheumatism and headache. The flowers are utilized as tonic, analgesic and diuretic; bark for rheumatism, chronic bronchitis and diabetes mellitus and leaves as expectorant and for chronic bronchitis and Cushing's disease. In this review we make a compilation focused on the synonyms, botanical description, phytochemicals, pharmacological activity and medicinal uses of Mahua.

**Keywords:** Mahua, Sapotaceae, *Madhuca longifolia*, antioxidant, swelling and liquor

**Introduction**

Madhuca is also called Mahua or butternut tree, belonging to sapotaceae family. It is about 17m in height. It is gifted with many chemical ingredients which are responsible for various medicinal properties. It consists of terpenoids, proteins, starch, anthraquinone glycosides, phenolic compounds, mucilage, cardiac glycosides, tannins and saponins. The bark can be used for phlegm, itching, swelling, fractures, snake-bite, diarrhoea, chronic tonsillitis, leprosy and fever and rheumatism. It has been reported that mahua possesses wound healing, antimicrobial, antioxidant, anti-inflammatory, anticancer activity and anti-diabetic activities (Sharma et al., 2016).

Mahua is found mainly in Asian and Australian forests, deciduous forests of West Bengal, Orissa, Madhya Pradesh, Uttar Pradesh, Bihar, Punjab and sub mountainous region of the Himalaya. Its flowers have the property of tonic, aphrodisiac,

astrigent and cooling. It can be used to cure acute and chronic tonsillitis, helminthes, pharyngitis as well bronchitis. Its leaves can be used as expectorant, cushing's disease and chronic bronchitis and can be used to cure eczema in the form of poultice. Inflammation can be cured by the use of aerial parts of the plant. The stem bark powder can be used for strengthening gums in form of tooth powder. The bark infusion can be used for the treatment of diarrhoea (Sharma et al., 2013).

*Madhuca indica* is been gifted with the antioxidant activity which is necessary to combat the oxidative stress due to free radicals. The free radicals are responsible to damage chemical species making the other molecules unstable like superoxide anion (Reactive oxygen species) (Sharma et al., 2013).

*Madhuca longifolia* is a medium to large sized deciduous tree with a large top, distributed in Nepal, India and Sri Lanka. Leaves: Clustered at end of the branches; coriaceous, elliptic, shortly acuminate, base cuneate.

Flower: numerous, near the ends of branches, drooping on pedicels. Calyx: coriaceous, densely clothed rusty

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tomentum. Corolla: yellowish-white, tube, fleshy. Stamens: 20-30, usually 24 or 26, anthers hispidat the back with stiff hairs. Fruits: berries, ovoid, fleshy and green, seeds. The flowers are used as cooling agent, aphrodisiac, astringent, demulcent, tonsillitis, helminthes, pharyngitis, bronchitis, impotency, inflammation, eczema. Flowers are used in the cure of eye diseases. Flower juice is beneficial for the treatment of skin disease. The bark is useful for the treatment of itching, swelling, fractures and snake-bite poisoning (Bhaumik et al., 2014).



**Figure 1.**(a) Tree of *Madhuca longifolia* (b) Flowers of *Madhuca longifolia*

All the parts of *Madhuca longifolia* (Honey tree) possess medicinal properties. This tree is worshipped by the tribals of Central India for its religious and medicinal value. It grows well in dry tropical climate and is a deciduous tree.

The states of India where Mahua is widely distributed are Gujarat, Odisha, Andhra Pradesh, Bihar, Jharkhand, Madhya Pradesh, Uttar Pradesh and Chhattisgarh. Mahua tree is grown on private land, revenue and forest lands (Ekka et al., 2014).

#### Taxonomical classification

The taxonomical classification of *Madhuca longifolia* is as follows:

<b>Kingdom</b>	Plantae
<b>Division</b>	Magnoliophyta
<b>Class</b>	Magnoliopsida
<b>Order</b>	Ericales
<b>Family</b>	Sapotaceae
<b>Genus</b>	<i>Madhuca</i>
<b>Species</b>	<i>Longifolia</i>

#### Vernacular Names

*Madhuca longifolia* is known by different names in different languages like Atavimaduka in Sanskrit; Mohua, Mungli in hindi; Ippa, Madhukamu in telugu; Iluppai, Kattillupi in tamil; Mohuka, Mohulo in odia; Illuppa, Iruppapu in Malayalam; Doddippa, Halippa in kannada; Mahuva in urdu; Moha, Mhowra in Marathi; Mahudo in gujarati; Mahula, Kochra in Bengali (Kumar et al., 2016).

#### Different Species of Madhuca

The genus *Madhuca* belongs to the family Sapotaceae. This genus has various species (The Plant List, 2013); some of it are listed below:

1. *Madhuca alpinia*
2. *Madhuca aristulata*
3. *Madhuca aspera*
4. *Madhuca barbata*
5. *Madhuca bejaudii*
6. *Madhuca betis*
7. *Madhuca burckiana*
8. *Madhuca calcicola*
9. *Madhuca cheogiana*
10. *Madhuca clavata*
11. *Madhuca coriacea*
12. *Madhuca costulata*
13. *Madhuca crassipes*
14. *Madhuca cuneata*
15. *Madhuca cuprea*
16. *Madhuca curtisii*
17. *Madhuca daemonica*
18. *Madhuca decipiens*
19. *Madhuca diplostemon*
20. *Madhuca dongnaiensis*
21. *Madhuca dubardii*
22. *Madhuca elliptica*
23. *Madhuca elmeri*
24. *Madhuca endertii*
25. *Madhuca engleri*
26. *Madhuca erythrophylla*
27. *Madhuca esculenta*
28. *Madhuca firma*
29. *Madhuca floribunda*
30. *Madhuca fulva*
31. *Madhuca fusca*
32. *Madhuca glabrascens*
33. *Madhuca hainanensis*
34. *Madhuca heynei*
35. *Madhuca hirtiflora*
36. *Madhuca insignis*
37. *Madhuca kingiana*
38. *Madhuca klackenbergtii*
39. *Madhuca korthalsii*
40. *Madhuca krabiensis*
41. *Madhuca kuchingensis*
42. *Madhuca kunstleri*
43. *Madhuca lanceolata*
44. *Madhuca lancifolia*
45. *Madhuca lanuginose*
46. *Madhuca laurifolia*

47. *Madhuca lecomtei*
48. *Madhuca leucodermis*
49. *Madhuca ligulata*
50. *Madhuca lobbii*
51. *Madhuca longifolia*
52. *Madhuca longistyla*
53. *Madhuca macrophylla*
54. *Madhuca magnifolia*
55. *Madhuca malaccensis*
56. *Madhuca microphylla*
57. *Madhuca mindanaiensis*
58. *Madhuca mirandae*
59. *Madhuca montana*
60. *Madhuca monticola*
61. *Madhuca moonii*
62. *Madhuca motleyana*
63. *Madhuca multiflora*
64. *Madhuca multinervia*
65. *Madhuca neriifolia*
66. *Madhuca oblongifolia*
67. *Madhuca obovatifolia*
68. *Madhuca obtusifolia*
69. *Madhuca ochracea*
70. *Madhuca orientalis*
71. *Madhuca ovate*
72. *Madhuca pachyphylla*
73. *Madhuca palembanica*
74. *Madhuca pallida*
75. *Madhuca pasqueiri*
76. *Madhuca penangiana*
77. *Madhuca penicillata*
78. *Madhuca pierrei*
79. *Madhuca platyphylla*
80. *Madhuca primoplagensis*
81. *Madhuca proluxa*
82. *Madhuca pubicalyx*
83. *Madhuca punctata*
84. *Madhuca ridieyi*
85. *Madhuca rufa*
86. *Madhuca sandakanensis*
87. *Madhuca sarawakensis*
88. *Madhuca sepilokensis*
89. *Madhuca stipulacea*
90. *Madhuca stylosa*
91. *Madhuca sessliiflora*
92. *Madhuca sessilis*
93. *Madhuca silamensis*
94. *Madhuca spectabilis*
95. *Madhuca stipulaceae*
96. *Madhuca takensis*

97. *Madhuca thorelii*
98. *Madhuca tomentosa*
99. *Madhuca tubulosa*
100. *Madhuca utilis*
101. *Madhuca vulcania*
102. *Madhuca vulpina*
103. *Madhuca woodii*

### Historical background

Since long ago, mahua tree has been a source for various edible products and also in medicinal purposes. Mahua has been worshipped by tribals because its all parts are used for the well-being of humans. The flower of *Madhuca longifolia* is used as a flavoring agent in dishes and rice. Pickles are also made from mahua flower. It is also used as feed for the cattle. Mahua is used by the lactating mothers as it increases the milk production (Shrivastava, 2018).

Tribals believe in conserving mahua as it is sacred for them and the mahua drink comes in the culture of tribals (Verma, 2014).

### Cultivation and collection

In India, 0.12 million tones Mahua seeds are produced which are used for extraction of the oil. Mahua flowers production in India is about 1 million tons. State government of India motivates mahua seeds and flowers collection as it is a source of employment for many people. Mahua can be planted or it can be self sown. Flowering occurs in March to April (Patel et al., 2012).

The collection of mahua seeds is generally performed in the months of May, June and July. In this period the flowering is more than the seed production. The fruits are collected in the morning by the villagers by hand-picking method or bamboo sticks. In the peak time about 15 kg of tori could be collected in one day. From 1 kg of seed, approximately 250 ml of oil can be extracted which is mostly used in household purposes. The seeds are parted out from the fruits; from which the pulp obtained is consumed as food. For oil expelling, the indigenous methods could be used. The gully oil obtained could be sold after vacuum purification to the soap industries. The gully oil can be preserved from not being destroyed by fungus by storing in airtight earthen pot/basket (Kulkarni et al., 2013).

The desired dose of mahua is 10-15 g (The Ayurvedic Pharmacopoeia of India).

### Macroscopic characteristics

*Corolla*: Fleshy, erect, tubular, 7-14 lobes, short (0.5-2 cm long), ovate lanceolate and reddish-brown in colour. *Stamen*: Epipetalous and about 20-30 in number.

**Anther:** Epipetalous, lanceolate, sub-sessile, basifixed. It hairs on it back and is pointed at the tip. It has a sweet taste and dark brown strand.

### Microscopic characteristics

**Corolla:** There is a single layer of epidermis in the petal. Beneath the epidermis lie irregularly shaped and thin-walled parenchyma cells. In the parenchymatous tissues lie the scattered vascular bundles. **Androecium:** 4 pollen chambers are present inside the anther and in the centre of these pollen chambers lies cells of connective tissue. The epidermis of androecium is single layered and has a thin cuticle. **Endothecium:** It has oval, radially elongated lignified cells.

Tapetum is not distinct.

**Pollen grains:** These are single or found in groups, spherical in shape, with clear exine and intine walls scattered in the pollen sac, a few cells of the vascular bundles are observed inside the connective tissues.

**Powder:** The powder is dark brown in color. Fragments of epidermal cells and unicellular hairs are observed. Round-shaped, brown pollen grains are observed with clear exine and intine walls.

### Distribution and Habitat

*Madhuca longifolia* is widely distributed in Burma and India (North and central parts). Mahua is found in dry teak forests, mixed deciduous and dry forests. Mahua grows well on sandy soil. It can grow on a variety of soils like clayey, shallow, calcareous soils. The favorable conditions for growth of *Madhuca longifolia* are as follows:

- Temperature: 28-50°C (max); 2-12°C (min)
- Altitude: 1200 m
- Annual rainfall: 550-1500 mm

It needs strong light and is resistant to drought conditions (Sinha et al., 2017).

### Medicinal and other uses

Mahua plant used by tribals of north-east Chhattisgarh

**Mahua flower:** The flowers are dried in sun, followed by boiling them with *Tamarindus indicus* seeds and *Shorea robusta* seeds. Mostly the poor people store this as a grain substitute. The flowers fermented and used for preparing alcoholic drinks. Halua (food) can be prepared from dried flower powder. Eye diseases, impotency can be cured by using mahua flowers. The flowers are good analgesic, diuretic, aphrodisiac, demulcent, astringent and cooling. Mahua flower juice is a good cure for skin diseases. According to tribal beliefs, the marriage of unmarried girls and boys may get soon by dancing around the tree.

**Mahua fruits:** The inner portion of the fruit is used for preparing

cakes, whereas the outer portion is consumed in the raw form. The fruits are used as astringent, lotion for chronic ulcer, in treatment of tonsillitis. The mahua oil is consumed in cooking, for preparing margarine, hair oil, soap, burning lamps.

**Mahua Stem barks:** Diabetes mellitus can be cured by using decoction of stem bark. Its paste can be used as antidote for scorpion sting. It is also used for the treatment of ulcer, tonsillitis (Prashanth et al., 2010).

The timber is used in construction of houses, cartwheels, doors. It is a good source for nitrogen fixation. Various parts of the tree are used as fodder for cattles, as fertilizer as intercrop. *Madhuca longifolia* holds the soil together, hence it controls soil erosion and also in nitrogen fixation (Ekka et al., 2014).

*Madhuca longifolia* (Mahua) flowers have been used as cooling agent, aphrodisiac, astringent, tonic, demulcent and for the treatment of acute and chronic tonsillitis, pharyngitis bronchitis. LATA is prepared in Bihar to relieve pain in arthritis by Mahua flowers and roasted maize grain (Chandra, 2001).

The stems of mahua are used for the treatment of debility, diabetes, snake-bite, arthritis, tuberculosis, cholera, paralysis, low semen count, tonsillitis, influenza, piles and sinusitis. Flowers are efficient tonic and cooling agent. Leaves help to cure chronic bronchitis, Cushing's disease and eczema. Mahua bark is used to cure itching, inflammation, diabetes and also as an antidote I snake-bite poisoning and as blood purifier (Shrivastava et al., 2014).

### Chemical constituents

It has been reported that Mahua consists of phenols, flavonoids like quercetin (Krishnaveni et al., 2013).

Leaves are composed of quercetin,  $\beta$ -carotene, erthrodiol, palmitic acid, myricetin, 3-O-arabionoside, 3-O-L-rhamnoside, quercetin, 3-galactoside, xanthophylls, 3  $\beta$ -palmitoxy-olean-12-en-28-ol, oleanolic acid,  $\beta$ -sitosterol, stigmasterol,  $\beta$ -sitosterol, n-octacosanol (Banerji et al., 2010; Shrivastava et al., 1970; Shashikant et al., 2005; Puhan et al., 2005; Khare, 2000; Chakma, et al., 2011).

Bark is composed of ethylcinnamate, sesquiterpene alcohol,  $\alpha$  and  $\beta$ -amyryn acetates, 3  $\beta$ -monocaprylic ester of erythrodiol and 3  $\beta$ -capryloxy oleanolic acid,  $\alpha$ -tocopherol (Rajagopal et al., 2013; Alexander et al., 2009; Liang et al., 2004; Puhan et al., 2005; Banerji et al., 2010; Yadav et al., 2012; Akshatha et al., 2013; Shirode et al., 2008).

Seeds are composed of quercetin, oleic, linoleic, arachidic, stearic and palmitic acids, aspartic acid, isoleucine, leucine, cystine,  $\alpha$ -alanine, proline, threonine, Mi-saponin A and B

and myricetin (Ramadan et al., 2015; Sengupta et al., 1978; Agarwal et al., 2000; Mishra et al., 2013).

Fruits are composed of quercetin,  $\alpha$  and  $\beta$ -amyirin acetates,  $\beta$ -sitosterol and its 3 $\beta$ -D-glucoside, n-hexacosanol and dihydroquercetin.

### Leaves

Mahua leaves are composed of  $\beta$ -carotene, xanthophylls, sitosterol, D-glucoside, stigmasterol, erthrodiol, palmitic acid, myricetin, quercetin, 3-O-arabinoside, oleanolic acid,  $\beta$ -sitosterol, 3 $\beta$ -caproxyolcan-12-en-28-ol,  $\beta$ -carotene, quercetin,  $\beta$ -sitosterol- $\beta$ -Dglucoside, n-hexacosanol, n-octacosanol, 3-O-L-rhamnoside, 3-galactoside; 3 $\beta$ -caproxy and 3 $\beta$ -palmitoxy-olean-12-en-28-ol and 3-O- $\beta$ -D-glucoside (Benerji, et al., 2010; Shriwastae, et al., 2010; Shashikant et al., 2008; Puhan et al., 2005; Khare, 2000; Chakma, 2011). The leaves of mahua are composed of quercetin and its 3-galactoside,  $\beta$ -carotene, myricetin and its 3-O-arabinoside,

xanthophylls, 3-O-L-rhamnoside, n-octacosanol, 3 $\beta$ -caproxyolcan-12-en-28-ol,  $\beta$ -sitosterol and its 3-O- $\beta$ -D-glucoside and sitosterol (Khare, 2007).

### Barks

The bark of mahua consists of  $\alpha$ - and  $\beta$ -amyirin acetates, 3 $\beta$ -monocaprylic ester of erythrodiol and 3 $\beta$ -capryloxy oleanolic acid, Ethylcinnamate,  $\alpha$ -terpeneol and sesquiterene alcohol (Alexander et al., 2009; Liang et al., 2004; Puhan et al., 2005; Benerji et al., 2010).

### Seeds

The seeds are composed of arachidic acid, oleic acid, linoleic acid, aspartic acid, lysine, Myricic, palmitic and stearic acids, isoleucine, cystine,  $\alpha$ -alanine, glycine, and leucine, methionine, proline, threonine, myricetin, serine, quercetin, Mi-saponin A and saponin B (Prajapati, et al., 2003; Shashikant et al., 2003; Sengupta et al., 1978; Agarwal et al., 2007).

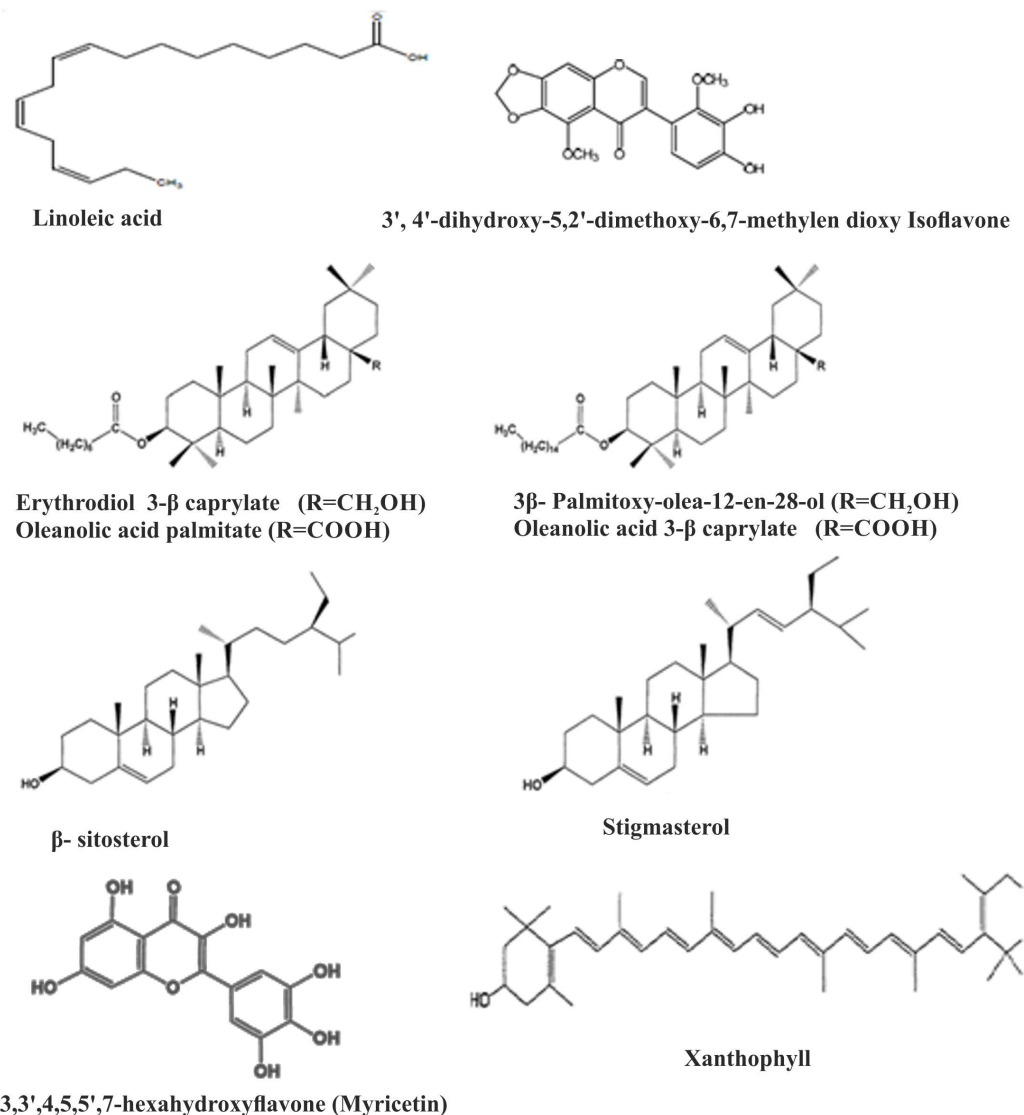


Figure 2. Chemical constituents of *Madhuca indica*

## Fruits

Mahua fruit consist of *n*-hexacosanol,  $\beta$ -sitosterol and its 3 $\beta$ -D-glucoside, quercetin, dihydroquercetin and  $\alpha$ - and  $\beta$ - amyrin acetates (Saikia, 2006; Panghal, et al., 2010; Dubey et al., 2004; Vohra et al., 2011).

## Flowers

Vitamins like A & C are found in Mahua flowers (Hoffman et al., 1996). The major chemical components present in Mahua are quercetin,  $\beta$ -amyrin decanate, betullic acid, tannins,  $\beta$ -amyrin,  $\beta$ -amyrin acetate, stigma sterol and  $\beta$ -amyrin cinamate (Sharma et al., 2013).

## Pharmacological activities

### Antihyperglycemic activity

*Madhuca indica* is been gifted with the antioxidant activity which is necessary to combat the oxidative stress due to free radicals. The free radicals are responsible to damage chemical species making the other molecules unstable like superoxide anion (Reactive oxygen species) (Sharma et al., 2013). The hydroethanolic extract of the leaves of mahua possessed a significant antihyperglycemic activity as it reduced the blood glucose levels. The methanolic extract of leaves of mahua and stems of *Paederia foetida* possessed significant antihyperglycemic activity (Rahmatullah et al., 2011). Dahake et al., 2010 reported that the methanolic extract of mahua bark showed a significant antihyperglycemic activity against alloxan-induced diabetic rats (Dahake et al., 2010).

### Anti-inflammatory activity

The flowers are used as cooling agent, aphrodisiac, astringent, demulcent, tonsillitis, helminthes, pharyngitis, bronchitis, impotency, inflammation, eczema. Flowers are used in the cure of eye diseases (Bhaumik et al., 2014). The seeds of mahua possessed good anti-inflammatory activity against cotton pellet granuloma (Gaikwad et al., 2009). Ramchandra et al., 2009 reported that the ethanolic extract of mahua and saponins extracted from mahua were efficient anti-inflammatory agent against carrageenan induced edema and cotton pellet granuloma (Ramchandra et al., 2009).

### Larvicidal and Ovicidal activity

All the parts of *Madhuca longifolia* (Honey tree) possess medicinal properties. This tree is worshipped by the tribals of Central India for its religious and medicinal value. It grows well in dry tropical climate and is a deciduous tree (Ekka et al., 2014). The aqueous extract of mahua oil cakes possessed significant larvicidal and ovicidal activities against *Meloidogyne incognita* (Lanjewar et al., 1986). The mahua cakes were active against the larval growth from the egg-sacs of cyst nematodes (Devi et al., 1995).

### Antidiabetic activity

Mahua is found mainly in Asian and Australian forests,

deciduous forests of West Bengal, Orissa, Madhya Pradesh, Uttar Pradesh, Bihar, Punjab and sub mountainous region of the Himalaya. Its flowers have the property of tonic, aphrodisiac, astringent and cooling (Sharma et al., 2013). Shiva, (1998) reported the utilization of many medicinal plants for the cure of diabetes/glycosuria which also include *Madhuca longifolia* (Shiva A., 1998).

### Spasmolytic activity

*Madhuca longifolia* is widely distributed in Burma and India (North and central parts). Mahua is found in dry teak forests, mixed deciduous and dry forests. Mahua grows well on sandy soil. It can grow on a variety of soils like clayey, shallow, calcareous soils (Sinha et al., 2017). The saponins extracted from mahua leaves possessed a significant spasmolytic activity (Banerji et al., 1985). The saponins present in the leaves and seeds of *Madhuca longifolia* possessed spasmolytic property on isolated guinea pig ileum (Banerji et al., 1982).

### Spermicidal activity

The flowers fermented and used for preparing alcoholic drinks. Halua (food) can be prepared from dried flower powder. Eye diseases, impotency can be cured by using mahua flowers (Prashantha et al., 2010). The steroid and triterpenoid saponins present in the seeds of *Madhuca longifolia* possessed marked spermicidal activity (Banerji et al., 1979).

### Insecticidal and pesticidal activity

Diabetes mellitus can be cured by using decoction of stem bark. Its paste can be used as antidote for scorpion sting. It is also used for the treatment of ulcer, tonsillitis (Prashanth et al., 2010). Mahua cake possessed a significant insecticidal and pesticidal activity against phytonematode (Pandey et al., 2003). Mahua has a good pesticidal activity against *Tetranychus urticae* (Mani et al., 2003).

### Antimicrobial activity

The timber is used in construction of houses, cartwheels, doors. It is a good source for nitrogen fixation. Various parts of the tree are used as fodder for cattles, as fertilizer as intercrop. *Madhuca longifolia* holds the soil together, hence it controls soil erosion and also in nitrogen fixation (Ekka et al., 2014). Methanolic extract of mahua was prepared, followed by concentrating it to semisolid state. Agar well diffusion method was used to perform the antimicrobial activity against 3 bacterial strains *E. coli*, *Pseudomonas*, *S. aureus* and 3 fungal strains *Aspergillus niger*, *Penicillium spp.*, *Scytalidium spp.* Its activity was more potent against *S. aureus* followed by *E. coli*. The results were negative in case of *A. niger* and *Penicillium spp.* *Scytalidium spp.* Showed positive results at a concentration of 40% i.e.

0.5cm followed by 60% and 80% (Sarwey et al., 2013).

An inhibition of greater than 80% of spore germination was observed on spore germination of *Erycipse pisi* by the action of *Cyperus rotundus* and *Azadirachta indica* bark at 500 ppm. After this it was treated with *Ocimum sanctum*, *Zingiber officinale* rhizome, *Madhuca indica* leaves and Cashew nut shell. *Cyperus rotundus* and *Azadirachta indica* reported a decrease in disease intensity at 500 ppm, whereas *Ocimum sanctum*, *Zingiber officinale* rhizome, *Madhuca indica* leaves and Cashew nut shell showed a reduction in disease intensity at 2000 ppm (Maurya et al., 2004).

Kutajarista is an ayurvedic formulation used for the treatment of diarrhoea. It consists of *Holarrhena antidysenterica* stem bark, *Madhuca longifolia* flowers, *Vitits vinifera* raisins, *Gmelina arborea* stem bark and *Woodfordia fruticosa*. The antibacterial activity of Kutajarista was estimated against various microorganisms like *Staphylococcus aureus*, *Salmonella typhi*, *Bacillus pumilus*, *Proteus vulgaris*, *Escherichia coli*, *Bacillus subtilis*, *Candida albicans*, *Pseudomonas aeruginosa* and *Micrococcus luteus* (Shenoy et al., 2009).

#### Antibacterial activity

*Madhuca longifolia* (Mahua) flowers have been used as cooling agent, aphrodisiac, astringent, tonic, demulcent and for the treatment of acute and chronic tonsillitis, pharyngitis bronchitis. LATTA is prepared in Bihar to relieve pain in arthritis by Mahua flowers and roasted maize grain (Chandra, 2001). The dried bark of Mahua possessed significant antibacterial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Escherichia coli* by the disc diffusion technique. It was also reported that the methanolic extract proved to be good antibacterial activity (Nimbekar et al., 2012).

#### Antifungal activity

The stems of mahua are used for the treatment of debility, diabetes, snake-bite, arthritis, tuberculosis, cholera, paralysis, low semen count, tonsillitis, influenza, piles and sinusitis (Shrivastava et al., 2014).

A byproduct is obtained by defatting cake of Mahua oil seeds which possess saponins and these saponins are responsible to elicit antifungal activity. A range of 500 to 2000 ppm was observed as the inhibitory concentrations for plant pathogenic fungi. The mechanism of action of saponins was by causing leakage of cell contents thereby damaging the *Trichoderma viride* fungus (Lalitha et al., 1991).

#### Antioxidant activity

Flowers are efficient tonic and cooling agent. Leaves help to cure chronic bronchitis, Cushing's disease and eczema. Mahua bark is used to cure itching, inflammation, diabetes and also as an antidote for snake-bite poisoning and as blood purifier

(Shrivastava et al., 2014). The methanolic extract of mahua leaves possess antioxidant activity. The antioxidant activity of mahua leaves was found to be comparable with butylated hydroxyl anisole. The antioxidant activity was investigated by Reducing power assay, Super oxide radical scavenging activity, Hydroxyl radical scavenging activity. Madhucic acid was the active constituent responsible for the antioxidant activity of mahua (Inganakal et al., 2013). The reducing power and free radical (hydroxyl and superoxide) scavenging models (*invitro*) were used to analyze the antioxidant activity of ethanolic extract (70%) of mahua. The levels of GSH and lipid peroxidation levels were estimated to analyze *in-vivo* antioxidant activity. In the study, the CCl<sub>4</sub> treated rats were given 70% of ethanolic mahua extract (200 and 400 mg/kg) and silymarin (100mg/kg). In the rats with CCl<sub>4</sub> induced hepatotoxicity, the responses of 70% of ethanolic mahua extract and silymarin were measured on wet liver weight, liver volume, serum biomarkers like SGPT, SGOT, ALP, direct and total Bilirubin (Roy et al., 2010).

#### Wound healing activity

The inner portion of the fruit is used for preparing cakes, whereas the outer portion is consumed in the raw form. The fruits are used as astringent, lotion for chronic ulcer, in treatment of tonsillitis. The mahua oil is consumed in cooking, for preparing margarine, hair oil, soap, burning lamps (Prashanth et al., 2010). The ethanolic extract of bark and leaves of *Madhuca longifolia* possessed significant wound healing activity as it showed a decrease in period of epithelization and wound area. 5%w/w ointment of the ethanolic extract of bark and leaves of Mahua was formulated and used in the excision wound created on the dorsal side of experimental animals. Its wound healing activity was comparable with the standard drug Betadine (5%w/w) (Sharma et al., 2010).

#### Antipyretic activity

The flowers are good analgesic, diuretic, aphrodisiac, demulcent, astringent and cooling. Mahua flower juice is a good cure for skin diseases. According to tribal beliefs, the marriage of unmarried girls and boys may get soon by dancing around the tree (Prashantha et al., 2010). The methanolic extracts of mahua (50, 100, 200 mg/kg body weight) were investigated for anti-inflammatory, analgesic and antipyretic activities in male wistar rats. The brewer's yeast induced pyrexia was used for the study. The extract showed the presence of flavonoids, tannins, terpenes, steroids, saponins and cardiac glycosides. The increased body temperature due to brewer's yeast was minimized by 50 and 100mg/kg body weight of the extract after 60 mins and 30 min for 200 mg/kg body weight (Shekhawat et al., 2010).

### Anticancer activity

The flowers are good analgesic, diuretic, aphrodisiac, demulcent, astringent and cooling. Mahua flower juice is a good cure for skin diseases. According to tribal beliefs, the marriage of unmarried girls and boys may get soon by dancing around the tree (Prashantha et al., 2010). The ethanolic extract of leaves of mahua possess anticancer activity. It was proved to be effective against Ehrlich Ascites Carcinoma (EAC) in mice. In the study it was reported that the mahua leaves extract caused a significant decrease in tumor volume, tumor weight, tumor cell count and enhanced the mean survival time. Its activity was comparable with 5-Flourouracil (standard drug) (Sangameswaran et al., 2012).

### Anti-epileptic activity

The stems of mahua are used for the treatment of debility, diabetes, snake-bite, arthritis, tuberculosis, cholera, paralysis, low semen count, tonsillitis, influenza, piles and sinusitis (Shrivastava et al., 2014). *Madhuca longifolia* possess significant anti-epileptic activity as it increased the onset time of seizure and reduced duration of seizures. It was reported that Mahua could cure absence seizures in a dose of 400 mg/Kg (Sandip et al., 2011).

### Immunomodulatory activity

Mahua is found mainly in Asian and Australian forests, deciduous forests of West Bengal, Orissa, Madhya Pradesh, Uttar Pradesh, Bihar, Punjab and sub mountainous region of the Himalaya. Its flowers have the property of tonic, aphrodisiac, astringent and cooling (Sharma et al., 2013). The ethanolic extract of mahua (100 and 200mg/kg body weight) possess significant immunomodulatory activity. Its activity was tested by cyclophosphomide induced myelosuppression in mice. The mahua extract enhanced the DTH response and antibody titre value and also caused the restoration of Total Leukocyte Count (TLC) and Differential Leukocyte Count (DLC) (Shrivastava et al., 2014).

### Anthelmintic activity

Madhuca is also called Mahua or butternut tree, belonging to sapotaceae family. It is about 17m in height. It is gifted with many chemical ingredients which are responsible for various medicinal properties. It consists of terpenoids, proteins, starch, anthraquinone glycosides, phenolic compounds, mucilage, cardiac glycosides, tannins and saponins (Sharma et al., 2016). The anthelmintic activity of mahua leaf extract against adult Indian earthworm (*Pheritima posthuma*). It was noticed that aqueous and methanolic extracts (60 mg/ml of each) of mahua leaves were potent anthelmintic agents comparable to standard Albendazole (60 mg/ml) (Akhil et al., 2014).

### Hepatoprotective activity

The flowers are used as cooling agent, aphrodisiac, astringent,

demulcent, tonsillitis, helminthes, pharyngitis, bronchitis, impotency, inflammation, eczema. Flowers are used in the cure of eye diseases (Bhaumik et al., 2014). The methanolic extract of mahua flowers (100, 200 mg/kg) possessed significant hepatoprotective activity against paracetamol-induced liver toxicity. The methanolic extract of mahua proved to be effective in lowering serum levels of serum glutamic oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), serum alkaline phosphatase (ALKP) and total bilirubin. It enhanced the levels of total protein and albumin (Umadevi et al., 2011).

### Anticonvulsant activity

The states of India where Mahua is widely distributed are Gujarat, Odisha, Andhra Pradesh, Bihar, Jharkhand, Madhya Pradesh, Uttar Pradesh and Chhattisgarh. Mahua tree is grown on private land, revenue and forest lands (Ekka et al., 2014). It was revealed from the study that mahua extract protect animals from seizures and decreased the duration of tonic hind leg extension in comparison to phenytoin. Phenytoin inhibits tonic hind leg extension. The fruit-seeds of mahua (200 mg/kg) possess anticonvulsant activity and was comparable with the standard drug phenytoin. Mahua fruit-seeds extract was proved to be protective against MES induced seizures. Phenytoin showed 100% protection from seizures, whereas mahua shows 95.85% protection from seizures (Boddupally et al., 2015).

### Nephroprotective activity

Mahua tree has been a source for various edible products and also in medicinal purposes. Mahua has been worshipped by tribals because it's all parts are used for the well-being of humans. The flower of *Madhuca longifolia* is used as a flavoring agent in dishes and rice (Shrivastava, 2018). The ethanolic extract of mahua possess nephroprotective activity (500 mg/kg & 750 mg/kg B/W) against acetaminophen-induced nephrotoxicity. It was also reported mahua extract caused an increase in the levels of serum urea, hemoglobin (Hb), total leukocyte count, creatinine, packed cell volume, DLC, mean corpuscular volume and raised body weight along with reduced levels of neutrophils, mean corpuscular Hb content, mean corpuscular hematocrit, granulocytes, uric acid, and platelet concentrations (Palani et al., 2010).

### Antinociceptive and Antidiarrhoeal activities

In India, 0.12 million tones Mahua seeds are produced which are used for extraction of the oil. Mahua flowers production in India is about 1 million tons. State government of India motivates mahua seeds and flowers collection as it is a source of employment for many people.



Mahua can be planted or it can be self sown. Flowering occurs in March to April (Patel et al., 2012). The ethanolic extract of mahua bark possessed antinociceptive and antidiarrhoeal activities in mice. Mahua bark extract proved to be efficient in controlling writhing reflex induced by acetic acid at a dose of 250 and 500 mg/kg of body weight by oral route. Its response was comparable to the standard drug Diclofenac sodium (25 mg/kg of body weight) (Rahman et al., 2011).

#### Formulations available in the market

Mahua bark was used to prepare herbal hand wash which was nontoxic, effective and safer to use. The antimicrobial activity of this herbal hand wash was tested by Disc diffusion method and compared with the commercially available hand wash. It was reported that this hand wash was effective and no side effects were observed. The formula of herbal hand wash contains extracts of *Madhuca indica* bark, ginger extract and extract of lemon grass. The herbal hand wash was made by stirring 4 ml of the suspended water extract (1.25g /4 ml w/v) to 3 g of sodium lauryl sulphate (SLS) (Sharma et al., 2016). Its dose is 10-15 g. Therapeutic uses of these formulations are Svasa, Daha, Ksaya, Trsna, Srama (The Ayurvedic Pharmacopoeia of India).

*Madhukasava*: It is a liquid ayurvedic formulation which is used in the cure of various disorders like bleeding disorder, emaciation, skin diseases and tiredness.

*Abhayarishta*: It is a liquid ayurvedic formulation which is used in the cure of constipation and piles.

*Chandanayasa*: It is a liquid ayurvedic formulation which is used in the cure of burning sensation, burning micturition and also spermatorrhoea.

*Nyagrodhadi churna*: It is a powder ayurvedic formulation which is used in the cure of diabetes and urinary disorders.

*Lakshmanarishta*: It is a liquid ayurvedic formulation which is used in the cure of various gynecological disorders like metrorrhagia, menorrhagia, heavy and irregular periods.

*Pancha saara panaka*: It is a cool drink which is used in the treatment of burning micturition, burning sensation of the body and thirst.

*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 (Prashanth, 2016).

#### Conclusion and future perspective

*Madhuca longifolia* is one of the widely used medicinal plants in India. We have discussed about the pharmacological activities, traditional, medicinal uses, cultivation, collection, chemical constituents and history of *Madhuca longifolia*. The important chemical constituents present in it are flavonoids, glycosides, alkaloids, tannins and terpenoids which are responsible for different pharmacological properties of *Madhuca longifolia* Linn. *Madhuca longifolia* Linn. act as anti-diabetic,

antihyperglycemic, anti-inflammatory, larvicidal, ovicidal, spasmolytic, spermicidal, insecticidal, pesticidal, antimicrobial, antibacterial, antifungal, antioxidant, wound healing, antipyretic, anti-epileptic, immunomodulatory and antipsychotic activity. There is much more to explore about the benefits of this herbal medicinal plant by clinical and pharmacological screening at molecular level. So, investigations should be done for the standardization of different extracts of *Madhuca longifolia* for preparing herbal formulations, analyzing the possible mode of action of isolated active constituents.

#### Conflicts of interest

There are no conflicts of interest.

#### References

- Akhil M, Sarma SK, Rao PGVN, Jyothi Ch VS, Kumar RD, Kumar RS. 2014. Evaluation of anthelmintic activity of leaves of *Madhuca longifolia*. International Journal of Pharmacology & Toxicology, 4(2):99-104.
- Akshatha KN, Murthy SM, Lakshmidhevi N. 2013. Ethnomedical uses of *Madhuca longifolia* – A review. International Journal of Life Science and Pharma Research, 3(1):44-53.
- Alexander J, Atli G, Bentord D. 2009. Saponin in the *Madhuca longifolia* as undesirable substance in animal feed. European Food Safety Authority, 979:1-36.
- Baky HM, Kamal AM, Elgindi MR, Haggag EG. 2016. A Review on Phenolic Compounds from Family Sapotaceae. Journal of Pharmacognosy and Phytochemistry, 5(2):280-7.
- Banerji R, Misra G, Nigam SK. 1985. *Madhuca indica* leaf saponin and its biological activity. Fitoterapia, 56(3):186-8.
- Banerji R, Prakash D, Patnaik GK, Nigam SK. 1982. Spasmolytic activity of saponins. Indian Drugs, 20(2):51-4.
- Banerji R, Srivastava AK, Misra G, Nigam SK, Singh S, Nigam SC, Saxena RC. 1979. Steroid and triterpenoid saponins as spermicidal agents. Indian Drugs 17(1): 6-8.
- Benerji DSN, Rajini K, Rao SB. 2010. Studies on Physico-Chemical and Nutritional Parameter for the production of ethanol from mahua Flower Using *Saccharomyces Cerevisiae*- 3090 through Submerged Fermentation. Journal of Microbial and Biochemical Technology, 2:46-50.
- Bhaumik A, Kumar MU, Khan KA, Srinivas Ch. 2014. The Bioactive Compounds Obtained from the Fruit-Seeds of *Madhuca longifolia* (L) Act as Potential Anticancer

- Agents. Scholars Journal of Applied Medical Sciences, 2(4A):1235-8.
- Boddupally M, Bhaumik A, Reddy CGV, Das P, Das S. 2015. The biomolecules present in the fruit-seeds of *Madhuca longifolia* against MES- induced rats. International Journal of Current Medical and Pharmaceutical Research, 1(7):96-8.
- Chakma CS. 2011. Pharmacological Screening of Isolated Compound from *Madhuca longifolia* seeds gives significant analgesic effect. International Research Journal of Pharmacy, 2:43-5.
- Chandra D. 2001. Analgesic effect of aqueous and alcoholic extracts of *Madhuca longifolia* (Koeing). Indian Journal of Pharmacology, 33:108-11.
- Dahake AP, Chakma CS, Chakma RC, Bagherwal P. 2010. Antihyperglycemic activity of methanolic extract of *Madhuca longifolia* bark. Diabetologia Croatica, 39(1):3-8.
- Devi S, Gupta P. 1995. Larval emergence from egg sacs of *Heterodera cajani* in extracts of cakes in various media and their effect on cowpea. Indian Journal of Nematology, 25(2):190-3.
- Dubey NK, Kumar R, Tripathi P. 2004. Global promotion of herbal medicine: India's opportunity. Current Science, 86(1):37-41.
- Ekka A, Ekka NS. 2014. *Madhuca longifolia* var. *latifolia*: An Important Medicinal Plant used by tribes of North-East part of Chhattisgarh. Online International Interdisciplinary Research Journal, 4:227-31.
- Gaikwad RD, Ahmed ML, Khalid MS, Swamy P. 2009. Anti-inflammatory activity of *Madhuca longifolia* seed saponin mixture. Pharmaceutical Biology, 47(7):592-7.
- Ghosh R, Dhande I, Kakade VM, Vohra RR, Kadam VJ, Mehra S. 2009. Antihyperglycemic activity of *Madhuca longifolia* in alloxan-induced diabetic rats. International Journal of Pharmacology, 6(2):354-8.
- Hoffman FA, Leaders FE. 1996. Botanical (herbal) Medicine in Health Care. Regulatory Perspective Pharm New, 1:23-5.
- Inganakal TS, Swamy PL. 2012. Evaluation of *in vitro* antioxidant activity of a triterpene isolated from *madhuca longifolia* l leaves. International Journal of Pharmacy and Pharmaceutical Sciences, 5(4):389-91.
- Khare CP, 2000. Rational Western Therapy, Ayurvedic and Other Traditional Usage. Encyclopedia of Indian medicinal plant. Botany Springer: 292.
- Khare P, Kishore K, Sharma DK. 2017. A study on the standardization parameters of *Madhuca longifolia*. Asian Journal of Pharmaceutical and Clinical Research, 10(7):318-21.
- Krishnaveni M, Amsavalli L, Chandrasekar R, Madhaiyan P, Durairaj S. 2013. Antioxidant activity of Plants at Govt. College of Engineering Campus, Salem, Tamil Nadu, India. International Journal of Pharmaceutical Sciences Review and Research, 21(1): 160-3.
- Kulkarni PS, Dr. Sharanappa G, Dr. Ramesh MR. 2013. Mahua (*Madhuca indica*) as a source of Biodiesel in India. International Journal of Scientific & Engineering Research, 4(7).
- Kumar A. 2016. A review on *Madhuca longifolia*. Research in Pharmacy and Health Sciences, 2(3):187-95.
- Lalitha T, Venkatraman LV. 1991. Antifungal activity and mode of action of saponins from *Madhuca butyraceae* Macb. Indian Journal of Experimental Biology, 29(6):558-62.
- Lanjewar RD, Shukla V. 1986. Vulnerability of larvae and eggs of *Meloidogyne incognita* to some oil cakes and fungicides. Indian Journal of Nematology, 16(1):69-73.
- Liang YZ, Xiepeishan CK. 2004. Quality control of herbal medicine. Journal of Chromatography, 812:53-70.
- Mani C, Kumar S, Singh RN. 2003. Efficacy of acaricides and botanicals against two spotted mite, *Tetranychus urticae* Koch on okra. Annals of Plant Protection Sciences, 11(1):153-4.
- Marikkar JM, Ghazali HM, Long K. 2010. Composition and thermal characteristics of *Madhuca longifolia* seed fat and its solid and liquid fractions. Journal of Oleo Science, 59:7-14.
- Maurya S, Singh DP, Srivastava JS, Singh UP. 2004. Effect of some plant extract on pea powdery mildew (*Erysiphe pisi*). Annals of Plant protection Sciences, 12(2):296-300.
- Mishra S, Padhan S. 2013. *Madhuca longifolia* (Sapotaceae): A Review of its traditional use and Nutritional properties. International Journal of Humanities and Social Science Invention, 2(5):30-6.
- Nimbekar T, Bais Y, Katolkar P, Wanjari B, Chaudhari S. 2012. Antibacterial Activity of the Dried Inner Bark of *Madhuca indica* J.F. GMEL. Bulletin of Environment, Pharmacology & Life Sciences, 1(2):26-29.
- Palani S, Raja S, Karth S, Archana S, Kumar, SB. 2010. *In vivo* analysis of nephro and hepato protective effects and antioxidant activity of *Madhuca longifolia* against acetaminophen-induced toxicity and oxidative stress. Journal of Pharma Research, 3:9-16.
- Pandey R, Kalra A, Gupta ML, Sharma P. 2003. Phytonematodes: Major pest of MAPs. Proceedings of First National Interactive Meet on Medicinal & Aromatic Plants (edited by Mathur et al.), CIMAP,

- Lucknow, India: 188-97.
- Panghal M, Arya V, Yadav S, Kumar S, Yadav JP. 2010. Indigenous knowledge of medicinal plants used by Saperas community of Khetawas, Jhajjar District, Haryana. *Journal of Ethnobiology and Ethnomedicine*, 6(4):1-11.
- Patel PK, Prajapati NK, Dubey BK. 2012. *Madhuca indica*: A review of its medicinal property. *International Journal of Pharmaceutical Sciences and Research*, 3(5):1285-93.
- P r a s h a n t h B K . 2 0 1 6 .  
Hrrps://easyayurveda.com/2016/11/11/Madhuca-longifolia-butter-tree/
- Prashanth S, Kumar AA, Madhub B, Kumar YP. 2010. Antihyperglycemic and antioxidant activity of ethanolic extract of *Madhuca longifolia* bark. *International Journal of Pharmaceutical Sciences Review and Research*, 5(3):89-94.
- Puhan S, Vedaraman N. 2005. Mahua Oil (*Madhuca indica* seed oil) Methyl Ester as biodiesel preparation and emission Characteristics. *Biomass and Bioenergy*, 28:87-93.
- Rahman MA, Haque ME, Solaiman M, Saifuzzaman M. 2011. Antinociceptive and Antidiarrhoeal activities of *Madhuca indica* J.F. GMEL. *Pharmacologyonline*, 1:473-80.
- Rahmatullah M. 2011. Antihyperglycemic activity studies with methanol extract of *Madhuca indica* J.F. Gmel. leaves and *Paederia foetida* L. stems in mice. *Advances in Natural and Applied Sciences*, 5(2):122-6.
- Rajagopal PL, Dhilna KK, Kumar SPN, John J. 2013. Herbs in Inflammation-A Review. *International Journal of Ayurvedic and Herbal Medicine*, 3(4):1289-307.
- Ramadan MF, Mohdaly AAA, Assiri AMA, Tadros M, Niemeyer B. 2015. Functional characteristics, nutritional value and industrial Applications of *Madhuca longifolia* seeds: an overview. *Journal of Food Science and Technology*, 53(5):2149-57.
- Ramchandra D, Gaikwad MD, Liyaqat A, Saifuddin K, Paramjyoti S. 2009. Antiinflammatory activity of *Madhuca longifolia* seeds saponin mixture. *Pharmal Biol.* 47:592- 7.
- Roy SP, Shirode D, Tushar P, Shastry CS, Gheewala N, Goutam S, Ramachandra S, Rajendra SV. 2010. Antioxidant and hepatoprotective activity of *Madhuca longifolia* (Koenig) bark against CCl<sub>4</sub> - induced hepatic injury in rats: *In vitro* and *In vivo* studies. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 1:1-10.
- Saikia B. 2006. Ethnomedicinal plants from Gohpur of Sonitpur District, Assam. *Indian Journal of Traditional Knowledge*, 5(4):529-30.
- Sandip P, Patel S, Patel V. 2011. Investigation into the Mechanism of action of *Madhuca longifolia* for its anti-epileptic activity. *Pharmacognosy Communications* 1:18-22.
- Sangameswaran B, Saluja MS, Sharma A. 2012. Anticancer activity of ethanol extract of *Madhuca longifolia* against Ehrlich Ascites Carcinoma. *Molecular and Clinical Pharmacology*, 2:12-9.
- Sarma DSK, Reddy AST, Akhil M, Sankar CHS. 2013. Phytochemical and antimicrobial activity of whole plant of *Madhuca indica*. *International Journal of Research in Pharmacy and Chemistry*, 3(1):15-9.
- Sarwey U, Pandey B, Deshpande B. 2013. Estimation of elemental contents of *Madhuca longifolia* and its antimicrobial activity against various pathogenic microorganisms. *Indian Journal of Scientific Research and Technology*, 1(3):10-7.
- Sengupta SK, Roychoudhury. 1978. Triglyceride composition of *Madhuca butyracea* seed fat. *Journal of the American Oil Chemists' Society*, 55:621-4.
- Sharma A, Yadav R, Guha V, Soni UN, Patel JR. 2016. Formulation and evaluation of herbal hand wash. *World Journal of Pharmacy and Pharmaceutical Sciences*, 5(3):675-83.
- Sharma P, Chaturvedi N, Upadhyay M, Varma S. 2013. Quantitative determination of total phenolic content in stem bark and leaves extracts of *Madhuca longifolia*. *International Journal of PharmTech Research*, 5(3):1150-4.
- Sharma S, Sharma MC, Kohli DV. 2010. Wound healing activity and formulation of ether-benzene-95% ethanol extract of herbal drug *Madhuca longifolia* leaves in albino rats. *Journal of Optoelectronics and Biomedical Materials*, 1(1):13-5.
- Shashikant VG, Raheman H. 2008. Biodiesel Production from Mahua Oil Having High Free Fatty Acid. *Biomass and Bioenergy*, 28:601-5.
- Shekhawat N, Vijayvergia R. 2010. Investigation of antiinflammatory, analgesic and antipyretic properties of *Madhuca indica* GMEL. *Int J Mol Med Adv Sci.* 6: 26-30.
- Shenoy PKR, Yoganarasimhan SN. 2009. Antibacterial activity of Kutajarista- an ayurvedic preparation. *Indian Journal of Traditional Knowledge*, 8(3):362-3.
- Shirode D, Patel T, Roy SP, Setty RS, Rajendra SV. 2008. Antiinflammatory activity of 70% ethanolic extract of *albizzialebeck* leaves and *Madhuca longifolia* bark. *International Journal of Pharmacy and Biological Sciences*, 2(3):127-30.
- Shiva A. 1998. First aid remedies: Their sources and methods of uses. XVI<sup>th</sup> series: (A1 Anaemia (B))

- Diabetes/Glycosuria (sugar in the urine). MFP News 8(1):8-9.
- Shrivastava A. 2018. A study on promotion/branding of Mahua (*Madhuka longifolia*) in Chhattisgarh state. IJARIT, 103:332-6.
- Shrivastava M, Dhingra N, Dwivedi LK. 2014. Immunomodulatory activity of ethanolic extract of *Madhuca longifolia* in mice. International Journal of Pharmacy and Technology, 5(4):6094-103.
- Shrivastava RK, Sawarkar SK, Bhutey PG. 1970. Decolourization and Deodorizations studies on mahua extract. Research and Education - RESindia, 15:114-7.
- Sinha J, Singh V, Singh J, Rai AK. 2017. Phytochemistry, Ethnomedical uses and future prospects of Mahua (*Madhuca longifolia*) as a food: A Review. Journal of Nutrition & Food Sciences, 7(1):1-7.
- The Ayurvedic Pharmacopoeia of India. Government of India Ministry of Health and Family Welfare, Department of Ayush, Part-1, vol.2: 109-10.
- Umadevi M, Maheswari C, Jothi R, Kishore PS, Reddy YS, Venkata NR. 2011. Hepatoprotective activity of flowers of *Madhuca longifolia* (Koen.) Macbr. Against paracetamol-induced hepatotoxicity. Research Journal of Pharmacy and Technology, 4(2):259-62.
- Verma N, Jha KK, Kumar U, Kanad D, Singh NK, Singh AK, Sharma R. 2014. Phytochemistry and Traditional Uses of Mahua (*Madhuca longifolia*): A Review. International Journal of Advance Research and Innovation Biological Properties, 2(3):630-8.
- Vohra A, Kaur H. 2011. Chemical investigation of medicinal plant *Ajuga bracteosa*. Journal of Natural Products and Plants Resources 1(1): 37-45.
- Yadav P, Singh D, Mallik A, Nayak S. 2012. *Madhuca longifolia* (Sapotaceae): A review of its traditional uses, phytochemistry and pharmacology. International Journal of Biomedical Research, 3(7):291-305.