1. Introduction

From ayurvedic era, herbal medicines are considered as the backbone of traditional system of medicine, as they have potent pharmacological effect, and hence are considered to be potential source of new drug development[1]. More than 75% of the population in developing countries still depends on traditional medicines. It has been found from scientific intervention that plant derived compounds show broad spectrum of efficacy and safety with comparatively lesser side effect as compared to synthetic molecules. Thus there is a need to increase screening of plants having medicinal value[2,3].

*Madhuca longifolia* (*M. longifolia*) also termed as mahua or butter nut tree (Mahva, Mohva, Mohua, Erappe, Ippa, Iluppai, Madhukah, Irippa), belong to family sapotaceae[4]. These are medium evergreen deciduous tree, distributed widely across India, Nepal, and Sri Lanka. Various parts of *M. longifolia* is used in traditional and folklore system of medicine, due to its various pharmacological properties[5,6]. Therefore it is also termed as universal panacea of ayurvedic medicine[7]. Different parts of *M. longifolia* has shown efficacy in the treatment of epilepsy, diabetes, inflammation, bronchitis, ulcer and other diseases[8-10]. *Madhuca* oil extracted from seed is used as biofuel, edible fats and has shown good antioxidant and antimicrobial properties[10-12]. The flowers are well known for its reducing sugar content and have been used as cooling agent, astringent, demulcent and clinical study proves its activity in increasing the sperm count[13,14]. Leaves of *M. longifolia* are used in Cushing’s disease and bronchitis and have antioxidant properties[14,15]. The barks have shown remedy for itching, swelling, snake poisoning and diabetes[16,17].

2. Botanical description

*M. longifolia* trees are normally 15–16 m high, with clustered leaves at the end of branches. The barks are brownish to yellowish grey in colour. Elliptic flowers are small, cream coloured and are produced in clusters[16,17].

Its taxonomy and nomenclature are as follows: Plant name: *M. longifolia*; Kingdom: Plantae; Phylum: Tracheophyta; Order: Ericales; Family: Sapotaceae; Genus: Madhuca; Species: longifolia.
3. Traditional uses

In traditional and folklore medicine, *Madhuca* plays an immense role for the prevention and cure of many diseases. Different parts show versatile pharmacological activity. Flowers have been used for bronchitis, demulcent, diuretic, analgesic, as cooling agents and tonic. It is also used for treatment against helminths infestation as well as pharyngitis and also shows aphrodisiac activity. The bark also exhibits various pharmacological properties and is used for bronchitis, diabetes, rheumatism, bleeding, ulcer, tonsillitis, pharyngitis and spongy gums. It has also shown to be good remedy against swelling, snakebite poisoning, itching and fractures. Leaves of *Madhuca* have been used for the treatment of diabetes, Cushing’s disease, bronchitis, rheumatism, haemorrhoids, cephalalgia, intestinal diseases, and dermatopathy. The leaves are used as hepatoprotectants, for wound healing activity and as antioxidant. Seed fat has emulsant property, are used in hypoglycaemia, rheumatism, headache, in piles as a laxative, in skin disease and also as a galactogogue. *Madhuca* roots have shown its action against inflammation, and as antipyretic. The roots are also used in diarrhea, as antioxidant, and for the treatment of ptosis and scrofula[12,17,18].

4. Chemical constituents

The flowers mostly contain vitamin A and vitamin C[19,20]. Many phytoconstituents have been found in bark, which may be responsible for various activities[21,22]. It constitutes of oleic acids, α-spinasterol, α-amyricin acetate, erythrodiol monopcapryl betulinic acid, α-terpinenol, and sesquiterene alcohol[23,24]. Fruits of *Madhuca* chemically consists of quercetin, dihydroquercetin, β-sitosterol, as well as α and β amyrin acetates[25,26]. Main constituents of *M. longifolia* seeds are some amino acids like glycine, alanine, cysteine, leucine, and isoleucine. It also consists of arachidic, oleic, linoleic, myristic, palmitic and stearic acids[27-29]. Quercetin, Misaponin A and B are also found in seeds. Several bioactive constituents have been isolated and identified in the leaves of *Madhuca* like sitosterol, quercetin, 3-O-Lhamnoside, stigmastanol, n-hexacosanol, n-octacosanol, carotene, myricitin, erthrodiol, β D glucoside, β sitosterol, 3 β caproxylocan 12 en 28-ol, 3 galactoside, 3-O-arabinoside, and xanthophylls[28].

5. Scientific proven uses of *Madhuca* species

Several scientist substantiated the traditional observation, through various experimental procedures. The bark and leaves are the frequently used parts. The ease of availability of leaves and bark helps in extensive use in traditional system of medicine. The presence of different phytoconstituents like alkaloids, terpenoids, saponins, and flavonoids is proposed to be responsible for various pharmacological actions. Scientific evaluations and study authenticates the ethnomedicinal and novel pharmacological effects. Different pharmacological findings obtained from various parts of *M. longifolia* have been tabulated in Table 1.

### Table 1

| Plant parts | Pharmacological activity | Extract | Dose | Experimental model | References |
|-------------|--------------------------|---------|------|--------------------|------------|
| Bark        | Anti-ulcer               | Ethanolic extract | 400 mg/kg | in vivo    | [29] |
|             | Anti-diabetic            | Ethanolic extract; Methanolic extract | 100–200 mg/kg; 75 mg/kg | in vivo    | [16,30] |
|             | Wound healing            | Ethanolic extract | 5% w/w | in vivo    | [31] |
|             | Hepatoprotective         | Methanolic extract | 200–400 mg/kg | in vivo    | [32,33] |
|             | Antioxidant              | Ethanolic extract | 100–300 mg/kg | in vitro  | [27,28] |
|             | Anti-inflammatory        | Ethanolic extract | Data not available | in vivo    | [34] |
|             | Antimicrobial            | Acetone, chloroform, ethanolic extracts | 50–100 μg/mL | Bacteria (Staphylococcus aureus, Bacillus subtilis), fungi (Aspergillus oryzae) | [7,17] |
| Flower      | Analgesic                | Alcoholic extract | 64 mg/kg | Bacteria (Staphylococcus aureus, Bacillus subtilis), fungi (Aspergillus oryzae) | [35] |
|             | Hepatoprotective         | Methanolic extract | 100–200 mg/kg | in vivo    | [11] |
|             | Anti-ulcer               | Ethanolic extract | 100–300 mg/kg | in vivo    | [36] |
| Leaves      | Wound healing            | Ethanolic extract | 5% w/w | in vivo    | [31] |
|             | Cytotoxic                | Acetone, ethanolic extracts | 200 μg/mL | Ascites carcinoma cell lines | [37] |
|             | Anxiolytic               | Hydro alcoholic | 100 mg/kg | in vivo    | [38] |
|             | Anti-hyperglycaemic      | Hydroethanolic extract | 300 mg/kg | in vivo    | [39] |
|             | Antioxidant              | Ethanolic extract | 500 mg/kg | in vivo    | [14,29] |
|             | Nephro and hepatoprotective | Ethanolic extract | 500–750 mg/kg | in vivo    | [40] |
|             | Antimicrobial            | Acetone, chloroform, ethanolic extracts | 50–100 μg/mL | Bacteria (Staphylococcus aureus, Bacillus subtilis), fungi (Aspergillus oryzae) | [7,8] |
| Seed        | Anti-ulcer activity      | Aqueous extract | 100–400 mg/kg | in vivo    | [36] |
|             | Neuropharmacological     | Methanolic extract | 50 mg/kg | in vivo    | [38,42] |
|             | Anti-inflammatory        | Ethanolic extract | 10 mg/kg | in vivo    | [43] |
|             | Anti-fertility           | Crude | 10 mg/kg | in vivo    | [44,45] |
|             | Anticancer               | Ethanolic extract; Methanolic extract | 10 μg/mL | HeLa cell lines | [7,8] |
|             | Antioxidant              | Methanolic extract | 100–500 mg/kg | in vitro  | [18] |
|             | Alleviate pain           | Oil | 32 mg/kg | in vivo    | [43] |
5.1. Antioxidant activity

Many scientific works prove that free radicals including active nitrogen species and reactive oxygen species are the primary cause in initiation of cellular damage resulting pathological changes and many diseases. Studies of Roy et al. and Agrawal et al. had shown that the ethanolic extract of bark of Madhuca exhibits significant antioxidant potential[27,28]. The extract also averts the lipid peroxidation. Palani et al. studied the in-vitro free radical scavenging capacity of leaves and subsequently the in-vivo antioxidant assessment was carried out by glutathione and lipid peroxidation method is done for in-vitro assessment[40].

5.2. Anti-inflammatory activity

Inflammation is a complex response of a body to the external stimuli. Formation of inflammatory leukocytes in this process leads to the excess generation of free radicals which alters the cellular function and damages the organs by initiating and promoting the various diseases[46]. Several scientific studies on the ethanolic extract of Madhuca bark and seeds had proven anti-inflammatory activity. The crude ethanolic extract, saponin mixture and methanolic bark extract of M. longifolia extract has shown significant effect on inflammation induced by carrageenan as followed by the study of Agrawal et al. and Gaikwad et al. and there was size reduction in paw edema[34,43].

Similar research was carried out and has shown that the crude alkaloid extract of Madhuca species also exhibits potent anti-inflammatory activity. On the other hand, ethanolic extract and saponin mixture at dose of 10–15 mg/kg markedly reduces the rat paw oedema induced by formaldehyde, carrageenan and cotton pellet granuloma. However, a dose-dependent activity was found only on the carrageenan induced model[47]. The proposed mechanism of action was that constituents of Madhuca inhibit the prostaglandin synthesis as well as its mediators in synthesis. It may also act by reducing the intercellular cell adhesion molecule-1 expression which is induced by tumor necrosis factor α[47].

5.3. Analgesic activity

The drugs used to prevent algesia are termed to be analgesic. Studies suggest that analgesic activity of Madhuca is mediated by central or peripheral mechanism. Experimental works of Chandra have demonstrated the analgesic activity of Madhuca[35]. Study of Chandra states that the alcoholic extract of flowers has good analgesic activity against hot plate and tail flick method showing central analgesic activity in dose-dependent manner[35]. The dose of 4–64 mg/kg showed a marked increase in analgesic efficacy on all nociceptive methods. The methanolic extract at dose of 50–200 mg/kg i.p markedly reduces acetic acid induced pain in a dose-dependent manner showing that the extract possessed peripheral analgesic activity[47]. Madlongoside, an isolated compound obtained from the Madhuca bark, showed a significant central analgesic activity when assessed by hot plate method.

5.4. Antipyretic activity

Elevation of body temperature from normal is termed as pyrexia. Madhuca also exhibits febrifuge action. Methanol extract of aerial part showed significant dose-dependent inhibition on temperature elevation when evaluated by Brewer’s yeast induced pyrexia model[47].

5.5. Anti-ulcer activity

Peptic ulcer is chronic inflammatory condition referring to the sores and ulcer in the lining of stomach and duodenum[29]. Experimental works of Kalaivani and Jagadeesan had shown that ethanolic extract of bark possess significant antiulcer action[36]. Study of Mohod and Bodhankar had proven the antiulcer activity of aqueous extract of leaves. The crude ethanolic extract of seeds of Madhuca showed significant protective effect in pylorus ligation induced gastric ulcer model with a marked decrease in ulcer index as compared to vehicle[48]. This action may be due to its activity through prostaglandin.

5.6. Immunosuppression

A wide range of immunosuppressive drugs have now been adopted to control unwanted immune responses, particularly those giving autoimmune disease and transplant rejection[49]. The immunosuppressant activity of M. longifolia was also explored. Administration of methanolic extract of M. longifolia to murines was found to decrease the total WBC count and spleen leukocyte count significantly indicating that the extract could suppress the non-specific immune system. Moreover there was a decrement in the relative spleen weight and thymus weight which supports these findings[50,51].

5.7. Anti-hyperglycaemic activity

Diabetes mellitus is a metabolic disorder which is most prevailing problem and is increasing rapidly worldwide[52]. Investigation of Dahake et al. and Seshgiri et al. showed the efficacy of a methanolic extract of Madhuca bark on hyperglycemia[16,53]. Bark extract of M. longifolia has shown significant antidiabetic activity in rats indicating its potential role in diabetes treatment and management. The antidiabetic activity may be due to its effect on glucose utilization[16]. Prashanth et al. proved the dose-dependent anti-hyperglycaemic activity of ethanolic extract of bark at dose 100–200 mg/kg against streptozotocin-induced diabetes in rats[30]. A study by Ghosh et al. showed that the hydroethanolic extract of Madhuca leaves had significant anti-hyperglycaemic activity against alloxan-induced diabetic rats[39]. The methanolic and ethanolic extracts of Madhuca seeds also exhibited the antidiabetic activity as studied by Seshgiri et al.[53]. The authors postulated that these effects of phytoconstituents may be due to the altering of glucose utilization and insulin level. The in-vitro studies showed that extracts also effects the rat intestinal enzymes[54].

5.8. Neuropharmacological activity

Anticonvulsant effect of Madhuca has also been investigated. It is observed that at a dose of 400 mg/kg there is prolongation the onset of a seizure and also decrease in the seizure duration. It suggests that it may posses an active constituent entity having anticonvulsant nature which may help in the treatment or management of absence seizures. The in-vitro study proves the anti-convulsant potential of...
Madhuca and thus supports its traditional use as an anti-epileptic agent[38,42].

5.9. Madhuca as anti-neoplastic

Chemoprevention is prominence effect of natural or pharmacological agents on reversing, blocking or delaying the onset of cancer with least adverse effect serving in the reduction of cancer related mortality[55]. Few scientific investigations also showed the chemopreventive action of Madhuca on human cancer cell lines[56]. The M. longifolia has also shown the cytotoxic potential against the carcinoma cell. In-vitro cytotoxic assay of Madhuca against the Ehrlichascites, carcinoma cell lines proves its anticancer potential. The crude acetone and ethanolic extract of stem and leaves are used for in-vitro study at different dose and showed cytotoxic effect at dose 200 μg/mL. The ethanolic extract showed better potency as compared to acetone extract[37].

5.10. Antihelminthic activity

The antihelminthic activity of Madhuca was evaluated by incubating Ascardiagalli with the alcoholic leaf extract. An investigation by Akhil et al. showed that methanolic extracts of M. longifolia at a dose of 60 mg/mL showed significant anthelmintic activities when compared to standard drug (Piperazine)[41]. The proposed mechanism by scientist is that it inhibits the glucose uptake and lactic acid content and decreases the glycogen content. Loss of motility was also observed, which may be due to inhibition of energy metabolism or ATP production[57].

5.11. Hepatoprotective and nephroprotective activity

Hepatoprotective effects of the ethanolic extract of M. longifolia bark was studied based on D-galactosamine induced liver hepatitis. The hepatoprotective effect of M. longifolia has been shown in earlier studies. The rise in serum glutamic-oxaloacetic transaminase, serum glutamic pyruvic transaminase, alkaline phosphatase, and bilirubin levels induced by D-galactosamine administration was significantly reduced[32]. Its hepatoprotective activity might be due to its effect against cellular leakage and loss of functional integrity of the cell membrane in hepatocytes[27,32,33].

5.12. Wound healing

Investigation of Sharma et al. deduced the notable wound healing property of Madhuca as compared to standard betadine[31]. This activity may be due to the presence of constituents responsible for the promotion of wound healing. In this study, ether-benzene-95% crude ethanolic extract of leaves and bark of M. longifolia showed a marked reduction in wound healing time with respect to control in excision wound model. There was a significant increase in the rate of wound closure and epithelisation rate[31].

5.13. Anti-fertility activity

The crude seeds extract possess antifertility action when administration to male albino rats due to presence of bioactive entity. On administration of Madhuca seed extract to male albino rats, marked changes were observed proving its effectiveness. It caused weight decrease of testis, epididymis, seminal vesicle, vasa deferens and ventral prostate which may be due to low plasma level of testosterone. Studies showed that decrease in weight of accessory sex organs was also observed indicating the atrophy of glandular tissue and also reduction in secretory cells thus reflecting the decrease level of testosterone. Thus the seeds of Madhuca has antifertility potentials in male albino rats[44,45].

6. Toxicity

Toxicity is an important parameter that needs to be evaluated in order to minimize the risk aspect associated with any herbal product. Sometimes plants are used directly or along with the formulated drugs which make it mandatory to access the toxic behaviour of plants. On parenteral administration, saponins are extremely toxic with respect to oral route[58]. The median lethal dose LD₅₀ dose of saponin extracted from Madhuca was found to be 1 000 mg/kg in mice on oral administration. The ethanolic leaves extract of M. longifolia were administered at a dose of 175 mg/kg for 14 d to male Wistar rats and morphological and histopathological changes were observed. There were no toxicity effect on liver and kidney upto dose of 2 000 mg/kg. The nontoxic effect of methanolic extract of M. longifolia bark has also been reported. It was found that bark extract were safe upto the dose level of 2 000 mg/kg[58,59]. However excess dose of mahua oil may lead to antifertility effect as reported by European Food Safety Association. Its suggest that it causes testicular atrophy and degenerative changes in rats; whereas, no mutagenic or genetic toxicity has been reported in literature till date[60].

7. Non-medical and commercial uses

M. longifolia leaves are also proved as a useful adsorbent. Studies showed that M. longifolia leaves along with polyaniline adsorbs cadmium and lead from water thus, it can be used for purification. Some studies also reveals the anticorrosive nature of its leaves. It protects the mild steel in 1 mol/L HCl solution from the corrosion[61,62].

Leaves of M. longifolia are fed on moth Antracsa paphia, which produces Tassar silk, a wild silk used commercially[63]. Flowers are used for distilled liquor preparations[64]. Seeds kernel yields mahua oil which is utilized for cooking and fuel purposes[65].

8. M. longifolia in preclinical and clinical studies

An open clinical trial was performed on 40 subjects with oligospermia to study the efficacy and safety of Chandrakanthi chooram. Chandrakanthi chooram is a formulation consisting of 25 ingredients including flowers of M. longifolia. The primary outcome of this study was sperm count, its morphology and its motility[66]. Clinical studies and surveys on M. longifolia has also been performed for its anti-venom activity, dyslipidemia in Santhal tribes. The study suggest that regular consumption of Madhuca drink by Santhal tribes improves their blood sugar and lipid profile[67]. Different parts of M. longifolia have been tested preclinically for many pharmacological activities like hepatoprotective, anti-epileptic, antimicrobial,
analgesic, and anti-diabetic[6,8].

Kutajarista is one of the ayurvedic marketed products containing *Madhuca longifolia* which is used for the treatment of amoebiasis and bacterial dysentery, amoebic dysentery, and blood diarrhea[8]. Preclinical study of kutajarista was performed in male Sprague Dawley rats and the dose of 40 ml/kg was administered. From the experiment, it was deduced that it cannot be administered for chronic period at higher dose as it will alter the biochemical profile[69].

9. Conclusions

According to scientists, medicines obtained from medicinal plants are best alternative to combat the diseases, as they have immense potential to treat the diseases with least side effect and with high safety and efficacy. They are the strongest contender as alternative treatment and for the adjuvant therapy. *M. longifolia* is one of most versatile plants which has been used for medicinal as well as to household purposes. All parts of plants had been used in the prevention and treatment of diseases like diabetes and inflammation. Different extracts have been found possessing pharmacological activity. Therefore, it is also termed as “Universal panacea in ayurvedic medicine or Paradise tree for tribals”.

In this review, phytochemistry and pharmacological aspects of *Madhuca* has been highlighted. Further exhaustive work is required, because the literature shows limited research in several areas to understand and reveal the mode of its pharmacological activities. In addition, isolation, purification and identification of new entities from *Madhuca* species are required as it may help further to establish the application of isolated compound in treatment of various acute and chronic diseases and provide more assurance in application of isolated compounds.

**Conflict of interest statement**

We declare that we have no conflict of interest.

**References**

[1] Grover JK, Yadav S, Vats V. Medicinal plants of India with anti-diabetic potential. *J Ethnopharmacol* 2002; 81(1): 81-100.

[2] Grover JK, Yadav SP. Pharmacological actions and potential uses of *Momordica charantia*: A review. *J Ethnopharmacol* 2004; 93(1): 123-132.

[3] Dubey NK, Kumar R, Tripathi P. Global promotion of herbal medicine: India’s opportunity. *Current Sci* 2004; 86(1): 37-41.

[4] Banerji R, Mitra R, Mahua (*Madhuca* species): Uses and potential in *Appl Bot Abstract* 1996; 16: 260-277.

[5] Agarwal SS, Paridhavi M. *Herbal drug technology*. Hyderabad: University Press (India) Pvt. Ltd; 2000, p. 1-8.

[6] Panghal M, Arya V, Yadav S, Kumar S, Yadav JP. Indigenous knowledge of medicinal plants used by Saperas community of Khetawas, Hujjar District, Harayana. *J Ethnopharm Ethnomed* 2010; 4(4): 1-11.

[7] Mishra S, Padhan S. *Madhuca longifolia* (Sapotaceae): A Review of its traditional use and Nutritional properties. *Int J Soc Sci humanit invent* 2013; 2(5): 30-36.

[8] Akshath KN, Mahadeva Murthy S, Lakshmidevi N. Ethnomedical uses of *Madhuca longifolia*: A review. *Int J Life Sci Pharma Res* 2013; 3(1): 44-53.

[9] Puhan S, Vedarmanan N, Rambrahaham BV, Nagarajan G. Mahua (*Madhuca indica*) seed oil: A source of renewable energy in India. *J Sci Indus Res* 2005; 64(11): 890-896.

[10] Gupta A, Chaudhary R, Sharma S. Potential applications of mahua (*Madhuca indica*) biomass. *Waste Biomass Valor* 2012; 3(2): 175-189.

[11] Patel M, Naik SN. Flowers of *Madhuca indica* JF Gmel.: Present status and future perspectives. *Indian J Nat Prod Resour* 2010; 1(4): 438-443.

[12] Khare CP. *Encyclopedia of Indian medicinal plant*. New York: Springer Science & Business Media; 2000, p. 292.

[13] Sikarwar RL, Kumar V. Ethnoveterinary knowledge and practices prevalent among the tribals of central India. *J Nat Rem* 2005; 5(2): 147-452.

[14] Inanganal TS, Swamy PL. Evaluation of *in vitro* antioxidant activity of triterpene isolated from *Madhuca longifolia* leaves. *Int J Pharm Pharmaceutical Sci* 2013; 7(4): 389-391.

[15] Agrawal S, Kulkarni GT, Sharma VN. Antimicrobial and anti-inflammatory activities of bark of four plant species from Indian origin. *Wolrdmed Central Pharma* 2012; 3(10): 2-14.

[16] Dahake AP, Chiranant S, Chakma R, Bagherwal P. Antihyperglycemic activity of methanolic extract of *Madhuca longifolia* bark. *Diab Cro* 2010; 39(1): 1-8.

[17] Kirikar KR, Basu BD. *Indian medicinal plants. 2nd ed*. Allahabad: Lalit Mohan Basu; 1935, p. 1536.

[18] Sunita M, Sarojini P. *Madhuca longifolia* (Sapotaceae): A review of its traditional uses and nutritional properties. *Int J Humanities Soc Sci Inven* 2013; 2(5): 30-36.

[19] Fowler GJ, Behram GDE, Bhat SN, Hassan KH, Mehdihassan H, Inuganti NN. Biochemistry of Mahua flower. *J Indian Inst Sci* 1920; 3: 81.

[20] AwasthiYC, Mitra CR. *Madhuca butyracea*. Constituents of the fruit-pulp and the bark. *Phytochemistry* 1968; 7(4): 637-640.

[21] AwasthiYC, Mitra CR. *Madhuca latifolia*: Triterpenoid constituents of the trunk bark. *Phytochemistry* 1968; 7(8): 1433-1434.

[22] AwasthiYC, Bhatnagar SC, Mitra CR. Chemurgy of sapotaceous plants: *Madhuca* species of India. *Eco Bot* 1975; 29(4): 380-389.

[23] Siddiqui BS, Khan S, Kardar MN, Aslam H. Chemical constituents from the fruits of *Madhuca latifolia*. *Helv Chim Acta* 2004; 87(5): 1194-1201.

[24] Khaleque A, Miah MW, Huq MS, Khan NA. Investigations on *Madhuca latifolia* Roxb. (Beng. mahua) constituents of the seeds. *Sci Res* 1969; 6: 227-230.

[25] Bhatnagar SC, AwasthiYC, Mitra CR. Steroidal and other constituents of *Madhuca latifolia* leaves. *Phytochemistry* 1972; 11(4): 1533.

[26] Bhatnagar SC, AwasthiYC, Mitra CR. Constituents of *Madhuca longifolia* leaves. *Phytochemistry* 1972; 11(1): 465-467.

[27] Roy SP, Shirode D, Patel T, Shastry CS, Gheewala N, Sonara G, et al. Antioxidant and hepatoprotective activity of *Madhuca longifolia* (Koening) bark against CCl4-induced hepatic injury in rats. *Biomed Res* 2010; 1(1): 1-10.

[28] Agrawal S, Kulkarni GT, Sharma VN. A comparative study on the antioxidant activity of methanolic extracts of *Terminalia paniculata* and *Madhuca longifolia*. *Free Rad Antiox* 2011; 1(4): 62-68.

[29] Roy SP, Shirode D, Patel T, Prabhu K, Shetty SR, Rajendra SV. Antilucre activity of 70% ethanolic extract of bark of *Madhuca longifolia*: *Indian J Nat Prod Res* 2008; 24(4): 8-10.

[30] Prashanth S, Kumar AA, Madhu B, Kumar YP, Prashanth S. Antihyperglycemic and antioxidant activity of ethanolic extract of *Madhuca longifolia* bark. *Int J Pharm Sci Res* 2010; 5(3): 84-94.
Shekhawat N, Vijayvergia R. Investigation of anti-inflammatory activity of Madhuca longifolia seed extract on D-Galactosamine induced hepatotoxicity in rats. Biomed Res 2015; 26(2): 365-369.

Odili VU, Akpe AI, Arigbe-Osula ME, Iginaduwa PO. Antioxidant and hepatoprotective activity of Madhuca longifolia (koenig) bark against CCl4-induced hepatic injury in rats. In vitro and in vivo studies. Res J Pharm Biol Chem Sci 2010; 1(1): 1-10.

Agrawal S, Kulkarni GT, Sharma VN. Antimicrobial and anti-inflammatory activities of bark of four plant species from Indian origin. Webmed Central Pharma Sci 2012; 3(10): WMC00210

Chandra D. Analgesic effect of aqueous and alcoholic extracts of Madhuca longifolia (Koenig). Indian J Pharmacol 2001; 33(2): 108-111.

Kalaivani M, Jeganadeesam. Evaluation of antilucre activity of ethanolic extract of Madhuca longifolia flowers in experimental rats. Int J Sci Res Publication 2013; 3(6): 1-7.

Sangameswaran B, Saluja MS, Hura IS, Sharma A, Gupta SK, Chaturvedi M. Anticancer activity of ethanolic extract of Madhuca longifolia against Ehrlich Ascites Carcinoma. Med Clin Pharmacol 2012; 2: 12-19.

Patel S, Patel S, Patel V. Investigation into the mechanism of action of Madhuca longifolia for its anti-epileptic activity. Phcog Commn 2011; 1(2): 18-22.

Ghosh R, Dhande I, Kakade VM, Vohra RR, Kadam VJ, Mehra. Antihyperglycemic activity of Madhuca longifolia in alloxan-induced diabetic rats. Internet J Pharmacol 2009; 6(2): 1-2.

Patani S, Raja S, Karthi S, Archana S, Kumar BS. In vitro analysis of nephro&hepatoprotective effects and antioxidant activity of Madhuca longifolia against acetaminophen-induced toxicity & oxidative stress. J Pharm Res 2010; (1): 9-16.

Akhil M, Sarma DSK, PoonamchandraRao GVN, JyothiVS, Kumar DR, Kumar BR. Evaluation of anthelmintic activity of leaves of Madhuca indica. Int J Pharmachol Toxicol 2014; 4(2): 99-104.

Inganakal TS, Ahmed ML, Swamy P. Neuropharmacological potential of methanolic extract and a triterpene isolated from Madhuca longifolia leaves in mice. Indian J Exp Biol 2012; 50(12): 862.

Gaikwad RD, Ahmed ML, Khalid MS, Swamy P. Anti-inflammatory activity of Madhuca longifolia seed saponin mixture. Pharm Biol 2009; 47(7): 592-597.

Shivbasavaiah KR, Pavani T. Antifertility effects of Madhuca indica leaves in male Swiss albino rats. J Pharm Res 2011; 4(2): 323-326.

Gopalkrishnan B, Shimpni SN. Antifertility effect of Madhuca latifolia (ROXB.) macbride seed extract. Int J Appl Biol Pharm Tech 2011; 2(4): 49-53.

Hotamisligil GS. Inflammation and metabolic disorders. Nature 2006; 444(7121): 860-867.

Shekhwat N, Vijayvergia R. Investigation of anti-inflammatory, analgesic and antipyretic properties of Madhuca indica GMEL. Eur J Pharmacol 2010; 60(3): 165-171.

Mohod SM, Bodhankar SL. Evaluation of antilucre activity of methanolic extract of leaves of Madhuca indica JF Gmel in rats. Pharmacol online 2011; 3: 203-213.

Zdanowicz MM. The pharmacology of immunosuppression. Am J Pharma Educ 2009; 73(8): 144.

Mitra SK, Gupta M, Sarma DN. Immunomodulatory effect of IM-133. Phytother Res 1999; 13(4): 341-343.

Ganesh D, Shrinivas S. Study of the immunosuppressive activity of methanolic extract of Madhuca longifolia (Koenig). Orient Pharm Exp Med 2010; 10(3): 150-154.

World Health Organization. Prevalence of diabetes worldwide. 2010. [Online]. Available from: www. who. int/diabetes/facts/world_figures. Accessed on July 2, 2017

Seshagiri M, Gaikwad RD, Paramjyothi S, Jyothi KS, Ramchandra S. Anti-inflammatory, anti-ulcer and hypoglycemic activities of ethanolic and crude alkaid extract of Madhuca indica (Koenig) Gmelin seed cake. Orient Pharm Exp Med 2007; 7(2): 141-149.

Kumar KP, Vidyasagar G, Ramakrishna D, Reddy IM, Atym VSSSG RC. Screening of Madhuca indica for antidiabetic activity in streptozotocin and streptozotocin-nicotinamide induced diabetic rats. Int J Pharm Tech Res 2011; 3(2): 1073-1077.

Balachandran P, Govindarajan R. Cancer—an ayurvedic perspective. Pharmacol Res 2005; 51(1): 19-30.

Shaban A, Verma SK, Nantiyal R, Singh SK, Purohit R, Chimita ML. In vitro cytotoxicity of Madhuca indica against different human cancer cell lines. Int J Pharm Sci Res 2012; 3(5): 1385.

Shekhawat N, Vijayvergia R. Anthelmintic activity of extracts of some medicinal plants. Int J Compa Sci Math 2011; 3(2): 183-187.

Mulky MJ, Gandhi VM. Mowrah (Madhuca latifolia) seed saponin. Toxicological studies. J Chem Tech Biotech 1977; 27(6): 708-713.

Alexander J, Atli G, Bentord D. Saponin in the Madhuca longifolia as undesirable substance. Int J Pharm Bio Sci 2016; 7(4): 106-114.

Alexander J, Atli A, Benford D, Cockburn A, Cravedi J, Dogliotti E, et al. Scientific opinion on saponins in Madhuca longifolia L. as undesirable substances in animal feed. EFSA J 2009; 979: 1-36.

Sivakumar PR, Karuppasamy M, Perumal S, Elangovan A, Srikanth AP. Corrosion inhibitive effects of Madhuca longifolia (ML) on mild steel in 1N HCl solution. J Environ Nanotechnol 2015; 4(2): 31-36.

Karwal F, Rehman R, Rasul S. Adsorptive eradication of cadmium (II) from water using biocomposites of polyaniline with Madhuca longifolia and Eugenia jambolana leaves powder. Asian J Chem 2015; 27(2): 449.

Chavhan PR, Marginwar AS. Ethnobotanical survey of Markanda forest range of Gadchiroli district, Maharashtra, India. Br J Res 2015; 2(1): 55-62.

Swain MR, Kar S, Sahoo AK, Ray RC. Ethanol fermentation of mahua (Madhuca latifolia L.) flowers using free and immobilized yeast Saccharomyces cerevisiae. Microbiol Res 2007; 162(2): 93-98.

Puhun S, Vedaranam N, Ram BV, Sankaranarayan G, Jeychandran K. Mahua oil (Madhuca Indica seed oil) methyl ester as biodiesel-preparation and emission characteristics. Biomass Bioenergy 2005; 28(1): 87-93.

Dr Akila B. A clinical trial to study the safety and efficacy of Chandrakanti choornam in patients with low sperm count. [Online]. Available from: www.clinicalatrials.gov/ct/show/NCT02234206. Accessed on: July 3, 2017

Datta A, Pal A, Bandypadhyay A. A study on the effect of habitual consumption of Madhuca longifolia drinks on the prevalence of diabetes and dyslipidemia among Santhol tribals. Int J Basic Clin Pharmacol 2016; 5(3): 1108-1111.

Chandra SK, Sen PC, Joshi D. An experimental study of kutajarishta with special reference to ameobiasis. Anc Sci Life 1988; 8(2): 100.

Fatema K, Hasan MR, Mamun MM, Biswas PK, Kahali S, Chakma P, et al. Preclinical lipid profile studies of a classical Ayurvedic preparation “Kutajarista” after chronic administration to male Sprague-Dawley rats. J Pharm Bio Sci 2014; 9(4): 55-59.