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Neha A BadukaleIBSS's Dr. Rajendra Gode
College of Pharmacy, Amravati,
Maharashtra, India**Wrushali A Panchale**IBSS's Dr. Rajendra Gode
Institute of Pharmacy,
Amravati, Maharashtra, India**Jagdish V Manwar**IBSS's Dr. Rajendra Gode
College of Pharmacy, Amravati,
Maharashtra, India**Bhushan R Gudalwar**IBSS's Dr. Rajendra Gode
College of Pharmacy, Amravati,
Maharashtra, India**Ravindra L Bakal**IBSS's Dr. Rajendra Gode
Institute of Pharmacy,
Amravati, Maharashtra, India

Phytochemistry, pharmacology and botanical aspects of *Madhuca indica*: A review

Neha A Badukale, Wrushali A Panchale, Jagdish V Manwar, Bhushan R Gudalwar and Ravindra L Bakal

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Abstract

Medicinal plants have been used for prophylaxis, mitigation and treatment of various diseases and disorders. *Madhuca indica*, a plant commonly also known as Mahua, is found throughout in India. The tree is highly nutritious tree as well as used as a herbal medicine for treatment of various diseases. Various parts of plant are used by tribal people and as a folk medicine for the treatment of number of ailments. Plants shows the numbers of pharmacological and nutraceutical values. Flowers of the tree are used for induction of alcohol generation during preparation of ayurvedic formulations such as *asavas* and *arishtas*. Plant shows numerous pharmacological activities such as antidiabetic, antiulcer, hepatoprotective, antipyretic, etc. It is hidden from the eyes of researchers and other botanist. This will help in confirmation of traditional use along with value-added utility of mahua, eventually leading to higher revenues from the plant.

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

1. Introduction

Medicinal plants have a long history of natural remedy in traditional medicine. Ethno-botanical information on medicinal plants and their usage by indigenous cultures is useful in the conservation of traditional cultures, biodiversity, to promote health care and drug development. The world health organization (WHO) is now focusing attention towards the developing countries to encourage them to use herbal medicine, which they have been traditionally, used for centuries [1-3]. *Madhuca* is an important medicinal plant belonging to the Sapotaceae family (Table 1). There are number of species of the tree such as *M. indica*, *M. latifolia*, *M. longifolia* and *M butyracea*, etc. [4-7] (For taxonomy, see Table 1).

Table 1: Taxonomy of the plant

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

M. indica is one of the versatile forest tree species that provide an answer for the three major F's i.e., food, fodder and fuel. In India this species is generally found in Andhra Pradesh, Orissa, Gujarat, Madhya Pradesh, Bihar and UP as well. Flowers and fruits of mahua are edible with high nutritious value. It is highly regarded as a universal panacea in the tribal people's medicine and large evergreen tree distributed in India.

There is a misconception about *Mahua* tree that is used as liquor and harmful for health but this is what after the fermentation process but the aim of this review is to create an awareness for further investigations of the discovered phytochemical and pharmacological properties of this plant to promote research [8-9]. The plant is known to peoples by various names in various parts of India (for local names, see Table 2).

Corresponding Author:**Jagdish V Manwar**IBSS's Dr. Rajendra Gode
College of Pharmacy, Amravati,
Maharashtra, India

Table 2: Local names of plant across India

Language	Local name
English	Indian butter tree
Hindi	Mahua, Mohwa, mauwa
Bengali	Mahwa, Maul, Mahwla
Marathi	Mahwa, Mohwra
Guajarati	Madhuda, Telgu (Ippa),
Tamil	Illupei, Ewpa
Kenned	Tuppe
Oriya	Mahula, moha, Madgn

1.1 Plant Description

Mahua is a medium sized to large growing deciduous shady tree that grows about 16-20 meters tall. The plant is found mostly growing widely under dry tropical and sub-tropical climatic conditions. The plant grows well on rocky, gravely, saline and sodic soils, even in pockets of soil between crevices of barren rock. The plant has deep, strong taproot and short, stout trunk, 80 cm in diameter. The crown is rounded with multiple branches. The bark posses yellowish grey to dark brown color vertically cracked and wrinkled; exfoliating in thin scales and has milky substance inside. Leaves are thick, leathery having 10-30 cm length, lanceolate, narrowed at both ends, glabrous distinctly nerved and clustered at the end of the branches. It excludes a milky sap when broken. Young leaves are pinkish and wooly underneath (Fig. 1) [9-12].

**Fig. 1:** Various parts of the plant (www.google.com/images)

1.2 Flower & Fruit

Flowers are small and fleshy, dull or pale white in color. Corolla posses tubular, freshly, pale yellow aromatic and caduceus. Flowering normally occurs from March to June. Flowers are followed by fleshy berries that are 2-6 cm long, ovoid shape having 1-4 seeds that are brown to black colored. They are greenish when young and adopt pinkish yellow color when ripe. Mahua seeds are economically important as they are good source of edible fats. Flowers of mahua have been traditionally used as cooling agent, tonic, aphrodisiac, and astringent, demulcent and for the treatment of helminthes, acute and chronic tonsillitis as well as bronchitis. Leaves have expectorant activity and also used for chronic bronchitis and Cushing's disease. Tribal peoples used distilled juice of the flower is as a tonic, both nutritional and cooling preparation and also in treatment of helminthes, acute and chronic tonsillitis, as well as bronchitis. The flowers of the plants are reported to contain yeast *Sachharomyces cerevisiae* which can use to induce fermentation process for generation of alcohol [13-18].

Table 3: Microscopical Character

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

1.3 Geographical distribution

The *Madhuca indica* commonly known as Mahua. Economically as well as nutritionally it is an important tree, growing throughout the subtropical region of the indo-Pakistan subcontinent. Largely Mahua trees are found in the Indian states such as Uttar Pradesh, Madhya Pradesh, Orissa, Chhattisgarh, Jharkhand, Gujarat, Andhra Pradesh, Maharashtra, Bihar, West Bengal, North Circars, Deccan and Karnataka [19-20].

1.4 Useful parts of the plants

Following the parts and products thereof are wholly or in a part are used for various purposes for human diseases or disorders or for other problems (Table 4).

Table 4: Medicinal property/uses of plant's parts/products

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

1.5 Utilization of plant

Nutritional and Medicinal Use: The Mahua tree is having lots of nutritional value which are very beneficial for human health. It produces fruits which are valued for its seed which yield high quantity of fat. Commercially it is known as Mahua butter or mowrah butter, many edible and medicinal applications and it is also used as a biodiesel. This fat has

been used as substitute for cocoa butter and ghee. It is one of the rare largest sources of natural hard fat. The fat which is thus obtained from Mahua fruit oil is used mostly in cooking, frying and manufacturing chocolates. The seed fat has emulsion property because of that it mostly used as emulsifying agents in few pharmaceutical industries. It is

generally applied as massage oil in many part of the country because; it has a very good moisturizing effect [21-22].

Mahua has edible and medicinal uses as well as it has industrial application as it can be utilized in the manufacturing of laundry soaps and lubricants. Moreover, the seed cake is investigated to have insecticidal and pesticide property and used as organic manure in crops like rice, sugarcane etc. The medicinal properties for which we can use this plant are stimulant, demulcent, emollient, healing skin disease, rheumatism, headache, laxative, piles, and sometimes as galactagogue astringent and many more [23-25].

Traditional use: Mahua tree is easily found in the several part of India but it is not used as a food material. Mahua flower occupy an important position in the life of the tribal peoples in many parts of India. Small quantity of flowers is consumed in a raw, cooked or fried formed in different parts of India. Mostly flowers are used in the preparation of the distilled liquors. The freshly prepared liquor has a strong and smoky odor, which disappear on ageing. It is also studied that the pest of the Mahua tree bark is used to cure the fracture of bone. The interested thing about the Mahua tree is that it has two fruits in different seasons; the seed oil is extracted from it and used in the several different purposes. The wood of Mahua tree is utilized in the house hold utility like door and window making [26-27].

Sugar syrup: There are several studies on preparation of sugar syrup from dry Mahua flowers, as its sweet property is utilized in the fermentation process. The water extract of dried flowers are decolorized by using different de-colorizing agent like slacked lime and activated charcoal before concentrating it to the desired concentration. Best quality of mahua sugar

syrup can be prepared by using activated charcoal in concentration of 3.5-5%. The syrup thus obtained from the flower of Mahua is employed in the different purpose, either in the manufacturing of chocolate or as a sweetening agent in different food materials [28-29].

Flower is a natural substrate, which contains nearly 60% of sugar, and it additionally contains organic acids, which are essential for copolymer synthesis. In PHA production medium, nearly 50% of the cost is due to carbon sources such as sugar and organic acids. This can be economized by using industrial by products or natural substrates. Next to molasses, flowers can be considered as a cheaper source of carbon for the synthesis of PHA copolymers [31-32].

1.6 Phytochemical

The therapeutic value of any plant depends on the active constituents present inside the different part of the plant, which may be present in small or large quantity. The secondary metabolites are the important substance responsible for the main medicinal properties in the crude drugs. The leaves of Mahua tree contain saponin, an alkaloid, and glycoside. Saprogenic and other basic acid are found in the seeds. Various Phytochemical studies on Mahua include characterization of Sapogenin, triterpenoids, steroids, saponin, flavonoids and glycosides. In view of the aides and attributed medicinal properties, new components including madhucic acid (penta cyclic triterpenoids), madhushazone, four new oleanane type triterpene glycosides and madhucosides A and B. The fresh flowers contains 2- acetyl-1- pyrroline, the aroma molecule. They also contain polysaccharide which on hydrolysis gives D-galactose, D-glucose, L-arabinose, L-rhamose, D-xylose and D-glucuronic acid (Fig. 2) [30-40].

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

Part/product	Chemical constituents
Bark	Flavonoids, triterpene, sterol
Latex	Soluble resin, insoluble resin
Leaf	Moisture, organic matter, minerals, potash (k ₂ o) phosphoric acid (p ₂ o ₅) silica, alkaloids, flavonoids, protobasic acid.
Flower	Carotene, ascorbic acid, thiamine, riboflavin, niacin, folic acid, biotin, inositol.
Ripe Fruit	Moisture, protein, fat, carbohydrates, minerals, calcium, phosphorus, iron, carotene, ascorbic acid, tannins.

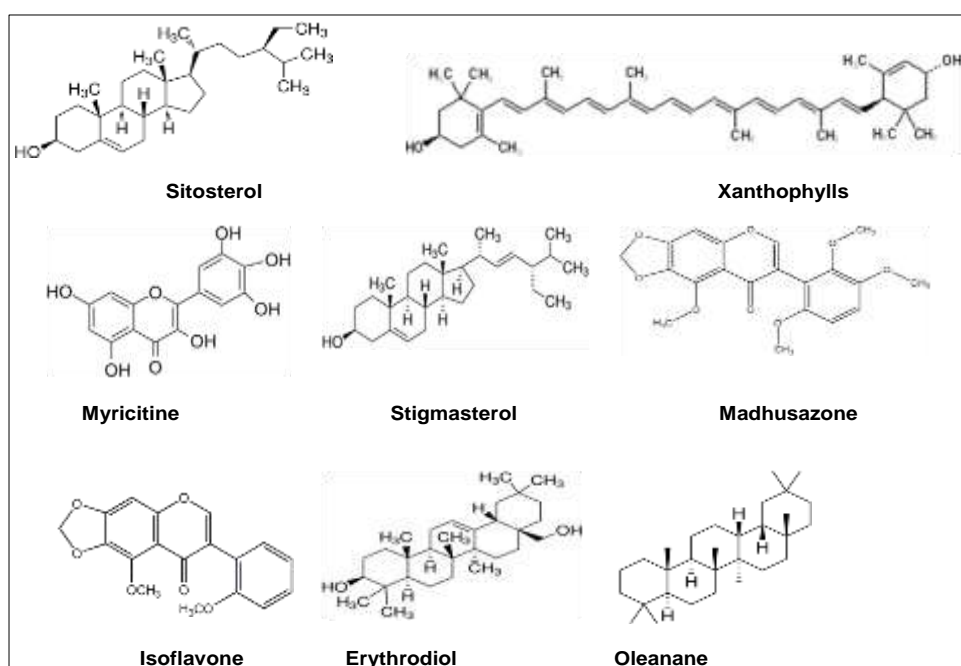


Fig 2: Chemical structures of important constituents

1.7 Health Benefits of *Madhua indica*

Oil extracted from the seeds of the Mahua plant is applied over the area affected with skin diseases and body pain. Oil is available in the market under different brands (Fig. 3). Nasal administration of the fresh juice of the flowers of Mahua is used in diseases of vitiated pitta dosha like headache, burning sensation of the eyes etc. Dried flowers of Mahua is boiled in milk and administered in a dose of 40-50 ml to treat weakness of the nerves and diseases of the neuromuscular system. Decoction prepared from the bark of the tree is given in dose of 30-40 ml to treat Irritable bowel syndrome and diarrhea. Fresh juice of the flowers is given in a dose of 20-25 ml to treat hypertension, hiccups and dry cough^[41].



Fig 3: *Madhuca indica* carrier oil

Flowers of Mahua plant is boiled in milk and added with sugar candy and given in a dose of 40-50 ml to treat less sperm count, premature ejaculation and production of less milk in postpartum periods. Cold infusion prepared from the flowers or bark of the plant is given in dose of 30-40 ml to treat burning maturation, fever and burning sensation of the body. Cold infusion or milk boiled with flowers of the plant is beneficial to patients suffering from general debility. For rheumatism, decoction of bark prepared by boiling bark in water is taken internally and the seed oil is applied externally on the affected areas^[42].

Bark decoction is given for managing diabetes. Leaves are used in treatment of eczema. The leaves are coated with Sesame oil and heated. This is applied externally on affected area to get relief from eczema. For spongy and bleeding gums, 4 ml of the liquid bark extract is mixed with 300 ml of water is used as a gargle. Gargling with bark extract is also useful in acute tonsillitis (inflamed tonsils) and pharyngitis. A cup of infusion of bark is taken orally twice a day to cure Diarrhoea. Seed oil massage is very effective remedy for reducing pain. Stem bark powder, mixed with Gular latex is given in dose of five grams twice a day, with warm water for respiratory illness. Roots are ground and applied on ulcers. Mahua flowers are very nutritive and taken as a general tonic. For this purpose, the dried flower powder is eaten with ghee and honey^[43].

1.8 Pharmacological reports

Madhuca indica, belonging to the family Sapotaceae, is an important economic tree growing throughout India. Traditionally, *M. indica* bark has been used against diabetes, rheumatism, ulcers, bleeding and tonsillitis. The flowers, seeds and seed oil of *M. indica* have great medicinal value.

Externally, the seed oil massage is very effective to alleviate pain. In skin diseases, the juice of flowers is rubbed for foliation. It is also beneficial as a nasya (nasal drops) in diseases of the head due to pitta, like sinusitis. The Mahua have several pharmacological potency and it is being used from the tradition. Few of its Pharmacological use are as follows:

1.8.1 Anti-inflammatory activity

Inflammation is the immune system's natural response to injury or illness. Inflammation is a defensive mechanism of the body. The *Madhuca indica* is found to be a good remedy for treatment of the inflammation. The aerial parts are utilized for the treatment of inflammation. The plant material (50 g) was extracted with 100 ml of methanol for 24 hrs using soxhlet apparatus. Thus, extract were filtered and concentrated under vacuum sounding apparatus for 30 min. when this solution was given to the male vistar rat which was already having inflammation showed a satisfactory result^[44-46].

1.8.2 Analgesic activity

Analgesics are the agents that relieve the sensation of pain without disturbing consciousness or altering other activities. The methanolic extract of *M. indica* was given orally to the group of 6 animals. The number of writhing during the following 30 min. period was observed after acetic acid injection. If the analgesic drug works the abdominal contraction will be the less in numbers. The analgesic activity of the *M. indica* can also be evaluated by the using other method of evaluation like tail flick method or hot plate method in rats. Significant reduction either in the reaction time hot plate, tail flick, gradient heat, abdominal constriction compared with vehicle treated animals was consider as anti nociceptive response^[47-48].

1.8.3 Antipyretic activity

M. indica is used to treat the fever in individual, as it is experimented in animals. About 5 groups of 6 rats each were injected subcutaneously with 10 ml kg⁻¹ body weight. Firstly the animal are forced to fever by injecting the suspension of the yeast suspension, this will increase the body temperature of the experimental animal. After measuring the basal rectal temperature of each animal by a help of thermometer, about 19 Hr. after yeast injection, the rectal temperature was recorded again and animal showing a rise in temperature of <0.6oc were discarded. Rectal temperature was then recorded at 20-24 hr after yeast injection. After some time interval it is found in the reduction in the rectal temperature of rat, which shows the antipyretic effect of *M. indica*^[49].

1.8.4 Anti-hyperglycemic Activity

The significant hypo-glycemic effects of *Madhuca indica* bark in diabetic rats indicate that this effect can be mediated by stimulation of glucose utilization by peripheral tissues. The results of the present study clearly indicated the ethanolic extract of *Madhuca indica* bark to have a hypoglycemic effect on STZ induced diabetic rats. In all groups except for glibenclamide, at 30 min of initiating glucose tolerance test, blood glucose concentration was higher than at zero time but decreased significantly from 30 min to 120 min. Methanolic extracts were enhancing glucose utilization, thus the blood glucose level was significantly decreased in glucose loaded rats^[50-53].

1.8.5 Anti-ulcer activity

Gastro intestinal ulcer is a common disorder of gastrointestinal tract. Ulcer is a result of the imbalance between the defensive and attacking factors in the GIT. An ulcer is a local defect or excavation of the upper part that is called surface of an organ or the tissue.

Anti ulcer activity has been proved in *M. indica* plant while it is tested in the male vistar rat. To evaluate the anti ulcer activity of the Mahua tree, firstly the animal is forced to produce the ulcer by any of suitable method like stress induced ulcer or carrageen induced ulcer, and then the same is treated with the extract of the tested plant materials.^[50]

1.8.6 Antioxidant Activity

Oxidative stress is a phenomenon caused by an imbalance between production and accumulation of oxygen reactive species (ROS) in cells and tissues and the ability of a biological system to detoxify these reactive products the reducing property of ethanolic bark extract of *Madhuca indica* implies that it is capable of donating hydrogen atom in a dose dependent manner.

The high content of phenolic compounds in the extract may be a contributing factor towards antioxidant activity because the phenol compounds are known to have direct antioxidant property due to the presence of hydroxyl groups, which can function as hydrogen donor. The reducing capacity of a compound may serve as a significant indicator of its potential antioxidant activity. The anti oxidant potency of any drug depends upon the two mechanism, first to prevent the oxidation by oxidizing itself or second by creating a layer of protection over the material^[54].

1.8.7 Anti fertility activity

The percentage of fertile male mice and the number of pregnancies were significantly reduced in atropine induced mice from control mice in present case there was complete reduction of fertility in male rat, number of pregnant females and number of litters in plant extract treated group. Among the plant based contraceptives, inhibition of male fertility after administration of natural substances has been related to decrease spermatozoa density. Also for male contraception, it is not necessary to stop spermatogenesis, but rather to eliminate the fertilizing ability of the spermatozoa by causing changes in the morphology or in the function of the sperm. The decrease in sperm count and the high number of morphologically abnormal sperms indicate interference with testicular spermatogenesis^[55].

1.8.8 Dermatological use

The decoction of the bark is useful in itching and ulceration, the oil is obtained from the seed, which is useful in the several allergic disorders. It is also used as laxatives^[56].

1.8.9 Hepatoprotective activity

The methanol extracts of *Madhuca indica* bark shows hepatoprotective activity against albino rats with liver damage induced by carbon tetrachloride (CCl₄). It was found that the methanol extract of *Madhuca indica* bark at a dose of 300 mg/kg body weight exhibited moderate protective effect by lowering the serum levels of Glutamate Pyruvate Transaminase (SGPT), Serum Glutamate Oxaloacetate Transaminase (SGOT), Serum bilirubin and Serum alkaline phosphate (SALP) to a significant extent. Present finding demonstrated the methanolic bark extract of *Madhuca indica*

could afford significant dose- dependent protection against CCl₄ induced hepato cellular injury^[57].

1.9.0 Antibacterial Activity

The flower has an antibacterial activity against the *Escherichia coli* and resist against rice pest disease^[58].

1.8.10 Antiepileptic Activity

The anticonvulsant activity of the methanol extract of heart wood of *M. indica* was assessed in pentylenetetrazole (PTZ) - induced convulsion in mice with benzodiazepine as standard drug. *Madhuca indica* at the dose of 400 mg/kg prolonged the onset time of seizure and decreased the duration of seizures compared to saline group^[58].

1.8.11 Anticancer Activity

In Ayurvedic system of medicine it is stated that the bark of *Madhuca indica* is useful in the treatment of cancer at the local application^[60].

1.8.12 Toxicity

The essence of toxicity testing is not just to check how safe a test substance is; but to characterize the possible toxic effects it can produce. A mixture of saponin isolated from *Madhuca indica* seed did not reveal any cholinergic activity, although it produced at a higher concentration. The saponin is extremely toxic when administered parentally. L.D. 50 by IP route was one of the same orders as that by the IV route, being 50 to 70 times higher than oral route. In the root of *M. Indica*, maximum amount of phenol was observed i.e. 46.0 mg/gdw. These compounds play an important role in the precursor of toxic substance and role in the growth regulation and development of plants. It is also reported to have toxic chemical aflatoxine in *M. indica* seed oil. The quality control of herbal medicine should be strictly followed to avoid any harmful effect^[61-64].

Formulations Available In the Market

Bark of mahua tree 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 bark, ginger extract, *M. indica* 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). Its dose is 10-15 g. Therapeutic uses of these formulations are Svasa, Daha, Ksaya, Trsna, Srama^[65]. Various marketed products of the plants are discussed bellow.

- (i) *Madhukasava*: It is a liquid ayurvedic formulation which is used in the cure of various disorders like bleeding disorder, emaciation, skin diseases and tiredness.
- (ii) *Abhayarishhta*: It is a liquid ayurvedic formulation which is used in the cure of constipation and piles.
- (iii) *Chandanāsava*: It is a liquid ayurvedic formulation which is used in the cure of burning sensation, burning micturition and also spermatorrhoea.
- (iv) *Nyagrodhadi churna*: It is a powder ayurvedic formulation which is used in the cure of diabetes and urinary disorders.
- (v) *Lakshmanarishhta*: It is a liquid ayurvedic formulation which is used in the cure of various gynecological disorders like menorrhagia, heavy and irregular periods.

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

2. Conclusion

According to scientists as well as Ayurveda, 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 challenger as alternative treatment and for the adjuvant therapy. *M. Indica* is one of most versatile plants which has been used for medicinal as well as in 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 arcadia tree for tribal". In this review, phytochemistry and pharmacological aspects of *Madhuca indica* has been highlighted. Further exhaustive work is required, because the literature shows limited research in several areas to understand and disclose 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.

3. References

- Evans WC. Trease and Evans Pharmacognosy. Saunders Publication, Edition 16, 2009, 03-04.
- Rangari VD. Traditional Drug of India, Pharmacognosy and Phytochemistry, career publication, Nasik, Edition 2 2009;II:01-04.
- Manwar JV, Mahadik KR, Sathiyarayanan L, Paradkar AR, Patil SV. Comparative antioxidant potential of *Withania somnifera* based herbal formulation prepared by traditional and non-traditional fermentation processes. *Integr Med Res* 2013;2:56-61. <http://dx.doi.org/10.1016/j.imr.2013.04.002>
- Chaudhary A, Bhandari A, Pandurangan A. Antioxidant potential and total phenolic content of methanolic bark extract of *Madhuca indica* (koenig) Gmelin. *Anc Sci Life* 2012;31(3):132-136. doi:10.4103/0257-7941.103197
- Ramadan MF, Mohdaly AA, Assiri AM, Tadros M, Niemeyer B. Functional characteristics, nutritional value and industrial applications of *Madhuca longifolia* seeds: an overview. *J Food Sci Technol* 2016;53(5):2149-2157. doi:10.1007/s13197-015-2095-6
- Pawar RS, Bhutani KK. Madhucoisides A and B, protobassic acid glycosides from *Madhuca indica* with inhibitory activity on free radical release from phagocytes. *J Nat Prod* 2004;67(4):668-71. Doi: 10.1021/np0301792. PMID: 15104500.
- Yoshikawa K, Tanaka M, Arihara S, Pal BC, Roy SK, Matsumura E, et al. New oleanene triterpenoid saponins from *Madhuca longifolia*. *J Nat Prod* 2000;63(12):1679-81. Doi: 10.1021/np000351r. PMID: 11141115.
- Kokate CK, Putohit AP, Ghokhle SB. Pharmacognosy, Nirali Prakashan, Fourty First Edition, 2008.
- Behl PN, Sriwasrawa GS. Herbs Useful In Dermatological Therapy, CBS Publishers and Distributors, New Delhi, Edition 2, 2002, 94-95.
- Sidhu OP, Chandra Harish, Behl HM. Occurrence of Aflatoxins in Mahua (*Madhuca indica* Gmel.) seeds:

Synergic Effect of Plant Extract on Inhibition of *Aspergillus Flavus* Growth and Aflatoxin Production. *Food And Chemical Toxicology* 2009;47:774-777.

- Shivabasavaiah, Ram Krishna. Anti fertility Effect of *Madhuca indica* Leaves in Male Swiss Albino Rats. *Journal of Pharmacy Research*, 2011, 4:323-326. Das BK, Choudhary BK: Quantitative Estimation of Changes in Biochemical Constituents of Mahua Flower during Post Harvest Storage. *Journal of Food Processing and Preservation* 2010;34:831-844.
- Tagbota S, Townson S. Antiparasitic properties of medicinal and other naturally occurring products. *Adv Parasitol* 2001, 199-205.
- Yosiokal I, Inada A, Kitagawal I. Structure of genuine spogenol protobasic acid and prosapogenol of seed kernel of *Madhuca indica*. *Tetrahedron* 1974;30:707-14.
- Yosiokal I, Inada A, Kitagawal I. Structure of genuine spogenol protobasic acid and prosapogenol of seed kernel of *Madhuca indica*. *Tetrahedron* 1974;30:707-14.
- Ramadan MF, Mohdaly AAA, Assiri AMA, Tadros M, Niemeyer B. Functional characteristics, nutritional value and industrial applications of *Madhuca longifolia* seeds: an overview. *Journal of Food Science & Technology*. 2016;53:2149e2157.
- Abhyankar VS, Narayana N. Reports on preparation of sugar syrup from dry mahua flowers which can be further use as a sweetening preliminary note on the preparation of syrup from mahua flowers. *Poona Agric Coll Mage* 1942;33:168-172.
- Manmode R, Manwar J, Vohra M, Padgilwar S, Bhajipale N. Effect of preparation method on antioxidant activity of ayurvedic formulation kumaryasava. *J Homeop Ayurv Med* 2012;1:114. doi:10.4172/2167-1206.1000114.
- Swain MR, Kar S, Sahoo AK, Ray RC. Ethanol fermentation of mahula (*Madhuca latifolia* L.) flowers using free and immobilized yeast *Saccharomyces cerevisiae*. *Microbiological Research* 2007;162(2):93-98. <https://doi.org/10.1016/j.micres.2006.01.009>.
- The Wealth of India. A dictionary of Indian raw materials and industrial products- raw materials publications and information, Directorate Council of Scientific and Industrial Research, New Delhi, India, 1962, 207-215.
- Sidhu OP, Chandra H, Behl HM. Occurrence of aflatoxins in mahua (*Madhuca indica* Gmel.) seeds: synergistic effect of plant extracts on inhibition of *Aspergillus flavus* growth and aflatoxin production. *Food Chem Toxicol* 2009;47(4):774-7. doi: 10.1016/j.fct.2009.01.001 PMID: 19167450.
- Singh A, Singh IS. Chemical evaluation of mahua (*Madhuca indica*) seed. *Food Chemistry* 1991;40:221e228.
- Gupta A, Chaudhary R, Sharma S. Potential applications of mahua (*Madhuca indica*) biomass. *Waste Biomass Valorization* 2012;3:175e189.
- Gupta A, Kumar A, Sharma S, Vijay VK. Comparative evaluation of raw and detoxified mahua seed cake for biogas production. *Applied Energy* 2013;102:1514e1521.
- Sharma S, Tyagi H, Kumar N, Yadav V. Comparative tribological investigation of mahua oil and its chemically modified derivatives. *SAE Int. J. Fuels Lubr* 2014;7(2). doi:10.4271/2014-01-0956.
- Rath SC, Nayak KC, Mohanty TK, et al. Evaluation of mahua oil cake (*Bassia latifolia* Roxb.) as a non-conventional feed ingredient for *Labeo rohita* (Ham.) fingerlings. *Indian Journal of Fisheries* 2017;64(2):33-39.

26. Product profile, Mahuwa, Trifed, Ministry of Tribal Affairs, Government of India. Trifed.nic.in. Archived from the original on 2009-06-19. Retrieved 2013-11-21.
27. Benerji DSN, Rajini K, Rao SB. 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* 2010;2:46-50.
28. Parrotta JA. *Healing Plants of Peninsular India*, CABI Publishing, United Kingdom, First Edition 2001.
29. Shrivastava RK, Sawarkar SK, Bhutey PG. Decolourization and deodorizations studies on mahua extract. *Res India* 1970;15:114-117.
30. The wealth of India, Raw material, Council of scientific and industrial research, New Delhi, 2007, 6.
31. Patel Madhumita, Naik SN. Flowers of *Madhuca indica* J.F. Gmel: Present Status and Future Perspectives. *Indian Journal of Natural Products and Resources* 2010;1:438-443.
32. Bina Siddiqui S, Shazia Khan, Nadeem Kardar M. A New Isoflavone from the *Madhuca latifolia*. *Natural Product Research* 2010;24:76-80.
33. Bhattacharya A, Saini V, Gupta A. Novel application of Mahua (*Madhuca* sp.) flowers for augmented protease production from *Aeromonas* sp. S1. *Nat Prod Commun* 2012;7(10):1359-62. PMID: 23157010.
34. Awasthi YC, Mitra CR. *Madhuca latifolia*: Constituents of fruit pulp and nut shell. *Phytochemistry* 1967;6:121-5.
35. Khaleque A, Wahed Miah MA, Huq MS, Khan NA. *Madhuca latifolia* I. Constituents of the seeds. *Sci. Res* 1969;6:227-8.
36. Hilditch TP, Ichaporia MB. The fatty acids and glycerides of solid seed fats. III. The seed fat of *Madhuca (Bassia latifolia)* (mowrah fat) *J. Soc. Chem. Ind.* 1938;57:44.
37. Awasthi YC, Mitra CR. *Madhuca latifolia*: Triterpenoid constituents of the trunk bark. *Phytochemistry* 1968;7:1433-4.
38. Bhatnagar SC, Awasthi YC, Mitra CR. Steroidal and other constituents of *Madhuca latifolia* leaves. *Phytochemistry* 1972;11:1533.
39. Banerji R, Mishra G, Nigam SK. *Madhuca indica* leaf saponin and its biological activity. *Fitoterapia* 1985;56:186-8.
40. Subramanian SS, Nair AG. Myricetin and myricetin-3-O-Lrhamnoside from the leaves of *Madhuca indica* and *Achras sapota*. *Phytochemistry* 1972;11:3090-1.
41. https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=505956#null.
42. <https://davesgarden.com/guides/pf/go/191053>
43. <https://npgsweb.ars-grin.gov/gringlobal/taxonomydetail.aspx?id=23083>
44. Waugh Anne, Grant Allison, Ross, Wilson. *Anatomy and Physiology in Health and Illness*, Churchill Livingstone, London, Edition 9, 2001, 375-377.
45. Tortora Gerards. Grabowski Sandra Reynolds: *Principles of Anatomy and Physiology*, John Wiley and Sons, Edition 10, 2003, 777.
46. Tripathi KD. *Essential of Medical Pharmacology*, Jaypee Brother's Medical Publishers. New Delhi, Edition 6, 2008, 185.
47. Shekhawat Neha, Vijayvergia Rekha. Investigation of Anti inflammatory, Analgesic and Anti Pyretic properties of *Madhuca indica* GMEL. *International Journal of Molecular Medicine and Advance Sciences* 2010;6:26-30.
48. Chandra Dinesh. Analgesic Effect of Aqueous and Alcohol Extract of *Madhuca indica* Longifolia. *Indian Journal of Pharmacology* 2001;33:108-111.
49. Shekhawat Neha, Vijayvergia Rekha. Investigation of Anti inflammatory, Analgesic and Anti Pyretic properties of *Madhuca indica* GMEL. *International Journal of Molecular Medicine and Advance Sciences* 2010;6:26-30.
50. Seshagiri M, Gaikwad RD. Anti Inflammatory, Anti ulcer And Hypoglycemic Activities of Ethanolic And Crudealkaloid Extracts of *Madhuca indica* Gmein Seed Cake: *Oriental Pharmacy And Experimental Medicine* 2007;7:141-149.
51. Dahake Ashok P, Chiratan S. Antihyperglycemic Activity of Methanolic Extract of *Madhuka Lonifolia* Bark. *Diabetologia Croatica* 2010;39:3-8.
52. Srirangam Prashanth, Annsmpelli Anil Kumar. Anti hyperglycemic and Antioxidant Activity of Ethanolic Extract of *Madhuca indica* Bark, *International Journal of Pharmaceutical Science Review and Research* 2010;5:89-94.
53. Khan Salehin, Zahan Dilara. Anti hyperglycemic Activity Studies With Methanol Extract of *Madhuca indica* J.F. Gmel. Leaves and *Paederia Foetida* L. Stems in Mice. *Advance in Natural and Applied science* 2011;5:122-126.
54. Chaudhary A, Bhandari A, Pandurangan A. Antioxidant potential and total phenolic content of methanolic bark extract of *Madhuca indica* (koenig) Gmelin. *Anc Sci Life* 2012;31(3):132-136. doi:10.4103/0257-7941.103197.
55. Shivabasavaiah, Ram Krishna. Anti fertility Effect of *Madhuca indica* Leaves in Male Swiss Albino Rats. *Journal of Pharmacy Research* 2011;4:323-326.
56. Behl PN, Sriwasrawa GS. *Herbs useful in dermatological therapy*. CBS Publishers and Distributors, New Delhi 2002;2:94-95.
57. Chaudhary A, Bhandari A. Hepatoprotective Activity of a Methanolic Extract of *Madhuca indica* on carbon tetrachloride induced hepato toxicity in rat. *Pharmacology online* 2011;1:873-880.
58. Das BK, Choudhary BK. Quantitative Estimation of Changes in Biochemical Constituents of Mahua Flower during Post Harvest Storage. *Journal of Food Processing and Preservation* 2010;34:831-844.
59. Patel Sandip, Patel Sandeep, Patel Veena. Investigation into The Mechanism of Action of *Madhuca longifolia* for its Anti Epilepsy Activity. *Pharmacognosy Communication* 2011;1:18-22.
60. Balachandran P, Govindarajan R. Cancer an Ayurvedic Perspective. *Pharmacological Research* 2005;5:19-30.
61. Mills Simon, Bone Kerry. *The Essential Guide to Herbal Safety*, Elsevier Churchill Livingstone.
62. Alexander Jan, Atli Guojon, Bentord Diana. Saponin in the *Madhuca Longifolia* as Undesirable Substance in Animal Feed. *Europien Food Safety Authority* 2009;979:1-36.
63. Sidhu OP, Chandra Harish, Behl HM. Occurrence of Aflatoxins in Mahua (*Madhuca indica* Gmel) seeds: Synergic Effect of Plant Extract on Inhibition of *Aspergillus Flavus* Growth and Aflatoxin Production. *Food And Chemical Toxicology* 2009;47:774-777.
64. Liang Yi-Zeng, Xiepeishan Chan Kelvin. Quality Control of Herbal Medicine. *Journal of Chromatography* 2004;812:53-70.
65. *Ayurvedic Formulary of India*. Ministry of Health and Family Planning, Government of India. The Controller of Publications: New Delhi 2001.