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Mahua miracles: Exploring medicinal marvels and value-added innovation for health and wellness

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Abstract
The state of Chhattisgarh is regarded as the nation's heart as it is situated in the centre of the country. This state is widely recognized for its mineral resources and agricultural industry. In addition to these specializations, the state is renowned for its indigenous people's way of life, culture, and traditions. Within the borders of Chhattisgarh lies a little known culture that is considered unusual. Many regional and international scholars are still interested in learning more about their way of life and culture. The availability of certain potential minerals and trees with pharmaceutical and nutraceutical benefits, from which indigenous people were accustomed to gathering beneficial parts, is one factor that significantly impacts their quality of life. For example, Mahua (*Madhuca indica*), one of the most significant trees, yields a variety of non-medicinal and medicinal products that are essential to their well-being and prosperity. We have covered both medicinal (such as hepatoprotectivity, antibacterial, wound healing, skin protectively, and bone joining potentials) and non-medicinal (such as nutraceutical, alcohol fermentation, food, soap, oil, and candy manufacturing) qualities in this review. In summary, while few characteristics of these plants have been determined, a variety of them have not yet been put to use.

Keywords: Mahua miracles, medicinal marvels, health, wellness

Introduction
Madhya Pradesh state was divided into and the state of Chhattisgarh on November 1, 2000. There were several tasks on this state's to-do list when it was divided, but it managed to overcome these challenges in a rather comfortable manner. There are simply two primary aspects that need to be addressed if we are to determine why this state has emerged as one that is developing quickly: (16) The state's natural structure, which offers ideal agricultural conditions as well as abundant mineral resources that aid in the manufacture of several metals, including aluminium, steel, iron, tin, and so on (25). The customs and culture of the residents of Chhattisgarh's remote rural areas. One of the most widespread plants in the Chhattisgarh region is the mahua, and a large number of tribal people gather, prepare, and shell the plant's fruits, blossoms, and seeds as a means of subsistence. Mahua is a plant of Indian origin with many wonderful, but unexplored characteristics. Mahua has been used for non-medical purposes, although only a little amount of data and surveys have been published addressing its pharmacological characteristics. This is a natural plant that is often cultivated without the use of any resources. It is an evergreen or semi-evergreen tree that is around 20 metres tall. It is found in India's green forest regions and has a wide, spherical crown that is both entire and short.

Fig 1: Tree and Flower of Mahua

Near the ends of branches, 10–30 centimeter long, thick, pointed leaves are grouped and glared. Because the flowers on this tree are tiny, sweet, and have a calming scent, all elephants visit it during flowering season in order to consume the flowers [16]. People from the tribe used to clean the area around Mahua so that it would be easier to collect and sell the flowers that were dropping to the local market, giving them a job.

The fruits begin to ripen following this brief flowering season and are then harvested by indigenous people.
To understand all properties and uses of Mahua, we classified its properties into 3 main categories for review, as given in table 1.

Table 1: Medicinal, Nutraceutical, and Economical properties of *Madhuca indica* [25-17]

Properties	Descriptions
Medicinal Properties	Hepatoprotective, Wound healing, Antiburns, Bone healing, Emollient, Skin disease, Rheumatism, Headache, Laxative, Anti Haemorrhoids, Bronchitis, Anti ulcer, Astringent, Tonsillitis, Swelling gum, Diabetes, Stomach
Nutraceutical Properties	Increase Immunity, Facilitate digestion, Antioxidant, Stimulant, Tonic, Energetic, Glucose booster, Etc.
Economical Properties	In Alcohol production, Jelly, Sweet candy, Chocolate, Jam, Vegetable, Biodiesel, Fuel production, Oil production, Fertilizer, Animal food, Etc.

Taxonomy of Mahua (11)

Botanical name	*Madhuca longifolia*
Family	Sapotaceae
Sub- family	Caesalpinioideae
Genus	Madhuca
Species	longifolia
Order	Ericaleae

Mahua, Mohwa, Mauwa, Mahwa, Maul, Mahwla, Madhuca, Ippa, IIlupei, Poonam, and so on are examples of common names [11].

Regional Sources: Regarding India The mahua plant is widely distributed in the states of West Bengal, Maharashtra, Odisha, Madhya Pradesh, and Chhattisgarh. This tree grows readily in the districts of Raigarh, Ambikapur, Dantewada, Bilaspur, Mahasamund, Durg, Janjgir, Champa, etc. in Chhattisgarh

Cultivation and Collection: Since it is a wild tree, it is not purposefully cultivated today and may be found in nature; nonetheless, there is a pressing need to cultivate this plant and make the required genetic alterations to make it more valuable for commercial purposes. To improve the plant's chemical composition, increase its ability to fight illness, and increase blooming, scientific knowledge and agricultural instruments must be applied [23]. Mahua should be grown in either a farm or a natural location for greater constituent availability, and its seeds should be dispersed there so that in the future picking flowers and unripe and mature fruits would be simpler. March and April are usually when flowers bloom, and July through September is when cultivation is often completed. Following this period, the blossom turns into fruit, which is beneficial while it's both ripe and unripe. The Mahua plant is helpful in all parts, but the flower, fruit, seed oil, and seed cake are the most valuable parts. Table 2 provides information on the current phytoconstituents and their percentage amounts.

Fig 2: Dry Mahua Flowers

Fig 3: Fresh Mahua Flower

Table 2: Phytochemical screening and nutritional properties of Mahua (*Madhuca indica*) [24]

Phytoconstituents	Presence (+/-)	Other constituents	Percentage (%)
Volatile oil	Absent (-)	Moisture	19.8
Tannins	Present (+)	Protein	06.37
Proteins	Present (+)	Calcium	8
Carbohydrate	Present (+)	Cane Sugar	3.43
Amino acids	Absent (-)	Total Sugar	54.06
Alkaloids	Present (+)	Total Invert	54.24
Flavonoids	Absent (-)	Reducing Sugar	50.62

1. **Nutraceutical Properties and Traditional uses of Mahua (*Madhuca indica*)**

Saturated sugar solution (Syrup): The Mahua tree's flowers are rich in sugars, water, and minerals. This amount of sugar is utilized for a variety of things, such as producing sugar syrup, consuming it raw, or drying it in the shade [16, 24, 12]. Making sugar syrup from Mahua is a fairly simple and practical method that involves drying the fresh bloom in the shade, which causes the water to evaporate and concentrates the sugar. After that, this is removed by soaking it in water. The colour achieved is not very nice; it appears to be a semi-dark black colour that has been treated with lime or activated charcoal before being made more concentrated.

Ready-to-serve beverage: RTS drink preparation technique, the flowers were cleaned and washed before being cooked in water for 10 minutes. The juice was then extracted by pulping and straining. The juice was then combined with sugar syrup and a little quantity of citric acid. While stirring and heating the solution, the components were well combined. After separating the scum and water vapours from the produced syrup mixture, KMS (Potassium meta- bisulphite) was added and cooked. The packing was completed once the juice was made. Glass bottles were cleaned and sterilised before being

filled and sealed. After sealing, the bottles were sterilised once more with hot water (28).

Squash: In order to prepare the squash.
Dried mahua flowers were washed and then cooked for 10 minutes in a 1:1 (weight: volume) ratio with water. A muslin cloth was used to strain the cooked substance. It was possible to extract clarified mahua juice. Sugar syrup was made by heating sugar, water, and citric acid together. The syrup mixture was separated from the scum and water vapour. Along with KMS, the produced sugar syrup was blended with the boiling clarified juice. The produced liquid was poured into 500ml bottles that had been thoroughly cleaned and sterilized (28).

Bar: Mahua flowers that were dry and clean were carefully cleaned before cooking for ten minutes. The cooked flower was ground with a small amount of water to create the pulp.50% of the pulp was added to the sugar, which was then boiled for a further few minutes to thoroughly dissolve the sugar into the pulp. When the pulp was heated, it was combined with the pectin (1.55%) and citric acid (0.4%). Cooking was maintained until the substance reached a jelly consistency. After that, it was spread out on an aluminium tray with a thickness of 10 to 15 mm and dried at 60 °C in a tray dryer (28).

Fig 4: Mahua Energy Bar

Candied mahua flower: The mahua flower was cleaned and dried, then thoroughly cleaned with tap water and blanched in 0.25% citric acid. For a day, it was steeped in a 40% sugar solution. The flower was steeped in the same solution for another day, and the next day, the solution's concentration was raised to 60% by heating it. This procedure was repeated, increasing the solution's strength by 5% daily until it reached 75%, and it was maintained for a week. Ultimately, the flowers were shade- dried and sealed in airtight plastic bags for research on preservation (28).

Production of alcoholic beverages: Mahua tree flowers have high sugar content. The flowers are collected and dried in the shade, which concentrates the flowers. The concentrated dried flower is then used as a source of sugar for the subsequent fermentation process, which produces alcoholic beverages. During the fermentation process, the microbes convert sugar into carbon dioxide and ethanol by using this glucose as their energy source. One of the most popular approaches and sources of income for India's tribal population, particularly in Chhattisgarh, Orissa, and other areas, is this. After this procedure, acetone, wine, brandy, ethanol, and lactic acids are produced [16, 12–8].

The preparation of Sweet meals: In the tribal regions of India, particularly in Chhattisgarh, mahua is probably used to make sweet meals. All tribal people of Baster, Raigarh, Ambikapur, and Dantewada, known as "Aadiwasi Kabila," share this trait rather frequently. They start by gathering the dried flowers and properly cleaning them. Next, they fried them in "Desi Ghee," or butter, and add a pinch of sugar (because sugar is naturally contained in Mahua flowers). This creates Mahua's sweet and juicy cuisine. Eating fried Mahua in ghee is thought to stimulate breastfeeding and pregnant women's milk production [1, 12, 19, 8].

Laddu: Mahua flowers that had been cleansed and dried were roasted and pulverised into a powder to make laddu. Mahua flower powder, semolina, white sesame, and fennel seeds were all toasted before being combined and cooked in ghee for two to three minutes. The mixture was then formed into tiny balls by hand, and laddu was made.

Fig 5: Mahua Sweet

Fig 6: Mahua Cookies

Jam Preparation: The Mahua flower was used in a novel way in the state of Bihar following the prohibition on the manufacturing and sale of alcoholic beverages. They started using it to create jam and jelly. The flowers are first cleaned and immersed in water for the entire night, causing the blooms to swell. After that, they are taken out of the water and put in a new vessel over the fire to be cooked, where they are mashed with a fruit masher. After that, sugar and pectin are added until jelly forms [16, 19, 12, and 08]

Fig 8: Mahua Jam

Bio-fertilizer Property: The leftover pulp and other materials were examined for the bio-fertilizer property following the fermentation procedure used to produce the alcohol. It was mentioned to the researchers how they conducted their investigation. They combined the leftover Mahua flower pulp with regular sand and used the combination to establish a basic plant alongside another regular sand plant. They discovered that the mahua and sand mixture functions well as fertilizer after the experiment's allotted period, and following X-ray diffracto gram (XRD) examinations, the existence of calcium, nitrogen, phosphorus, and potassium (NPK), as well as their combination, was verified. Thus, it benefits the farmers and indigenous people. These can be used as bio-fertilizers after being fermented to produce alcohol or other goods [9, 19, 12].

Fig 7: Mahua bio-fertilizers

Cattle feed: It has been noted in a number of study and review papers that the fermented seed cake and blossom pulp of Mahua may be fed to calves in order to nourish them. Although it was clear that floral residue behaved as expected, some researchers hypothesised that once the oil was removed, the seed cake would be slightly hazardous to some species of animals. Therefore, before feeding the seed cake to any animal, including cattle, its chemical composition should be evaluated [19]

Fig 9: Cattle feed

Production of household oil: The Mahua flower develops into fruits and eventually seeds. The tribal people used to gather the seed at the end of the flowering season [16, 7, 19] and sell it to the local market since it is quite valuable and rich in oily content. A small group of neighbours carry it to the oil extractor and get the oil. Because the fruit is named "Dori," this oil is also known as "Dori oil." This oil has several applications in medicine, non-medicine, nutraceuticals, economy, and other fields. During the Indian festival of Diwali, this oil is said to be just as significant as cow ghee. This is a benefit of using Mahua in the petroleum and automotive industries. The alternative generation of petrol and diesel is the primary focus of the state government of Chhattisgarh and the central government of India.

Fig 10: Mahua oil for Household

Biodiesel: There are several ways to produce biological petroleum using components derived from plants [2– 20]. One of the suggested plants is mahua. The Mahua plant's mature, healthy, dry seeds are smashed in a pestle and mortar before the oil is extracted using the Soxhlet method. Thus, the collected oil was combined with commercial diesel and utilized as a fuel.

Source of employment: After outlining all potential applications for Mahua, both medical and otherwise, it is clear that tribal people in Chhattisgarh and other states are taking advantage of the open work opportunities this plant offers. Every component of the Mahua tree, including the flowers, fruits, seeds, and leaves, may be readily collected and sold in nearby marketplaces. They will receive compensation in exchange, which gives them a job [7, 15]. Even if they now

receive payment in return for Mahua products, the sum is insufficient for them. The government ought to offer some sort of incentive program to all Mahua collectors who work as "Tendu Patta" collectors.

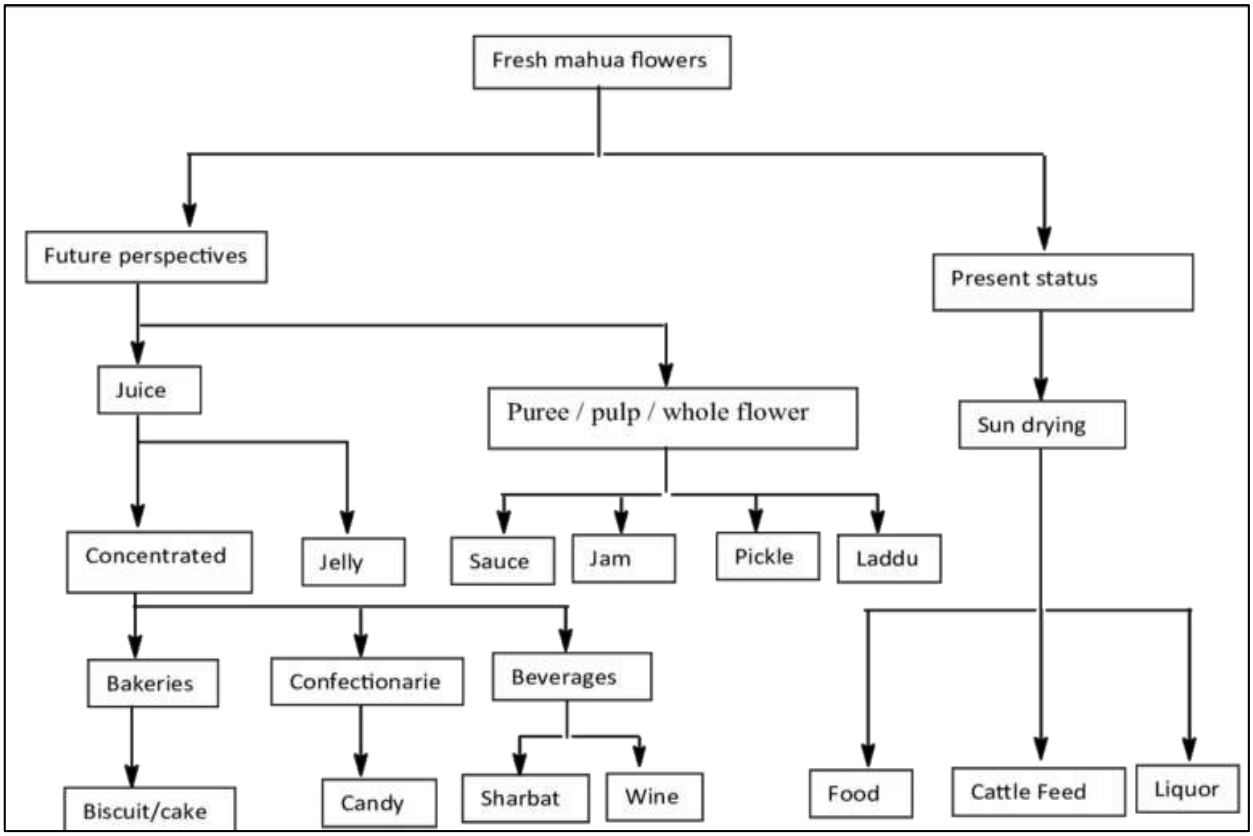

Fig 11: Utilization of Mahua Flower

Medicinal Uses

Anti-Inflammatory Effect: Our immune system's defense response causes inflammation. The immune system begins to function the moment a foreign particle enters our body. Phagocytic activity and WBC migration are the first steps in this process [6]. Prostaglandin is produced, which initiates pain, after phosphide, which creates arachidonic acid, starts the stepwise process of inflammation. In nature, almost all anti- inflammatory medications work by selectively or non-selectively suppressing COX. A few researches have demonstrated the anti-inflammatory properties of mahua [22, 26].

Antidiabetic Activity: The antidiabetic properties of *Madhuca indica* have also been demonstrated. The effects of this plant's methanolic extract on streptozotocin-induced diabetes in male albino Wistar rats were compared to those of rats receiving normal insulin therapy. The rat that had taken the extract orally had significantly lower blood sugar levels after 30 days of assessment intervals. This finding validates *Madhuca indica*'s antidiabetic properties [13–3].

Antimicrobial Activity: Mahua (*Madhuca indica*) leaves and bark were traditionally utilised by tribal people in several parts of Chhattisgarh to cure wounds [15]. They first crush the young, fresh leaves to release their active ingredients. Then, they apply the juice or extract to their wounds. After applying the extract on a regular basis, they see positive results and the wound begins to heal, revealing Mahua's antimicrobial activity.

Antioxidant Properties: The Mahua plant's antioxidant activity is highly valuable since it has the potential to enhance the efficacy of other pharmacological actions when combined with them. Antioxidants enhance both immunomodulatory and hepatoprotective effects. The scavenging of DPPH, ABTS, nitric oxide radical, hydrogen peroxide, and other substances has demonstrated this ability. The researchers used ethanol and hydroalcoholic as solvents to extract the Mahua bark and shade- dried leaves. Mahua's antioxidant qualities can help reduce the likelihood of developing asthma and other cell damage [10, 1].

Nephroprotective Activity: The kidney, a crucial organ of the body, filters blood and removes hazardous substances that are water soluble through urine. There are additional reports of nephroprotective properties for mahua. The Mahua plant's leaves were pulverised, dried in the shade, and then sieved. Next, the plant was extracted using ethanol as a solvent in a Soxhlet system. Paracetamol was used as a causative agent to cause nephrotoxicity in albino Wistar rats used in the investigation. Rats were killed after 14 days of testing, and biochemical and histological criteria were used to assess the extract's nephroprotective effects. The positive outcomes provide an opportunity for more in-depth research [14].

Skin-related illness: The Mahua tree's parts and oil are utilized as all-purpose treatments in the state of Chhattisgarh. Mahua oil is used externally to the skin by tribal people in Chhattisgarh to relieve pain and itching. They massage the thick oil all over their body to relieve itchy rashes brought on by bug bites and rough skin. Because oil has a strong

fragrance, it also keeps mosquitoes away. More work has to be done on the formulation to make it more marketable by lowering its distinctive fragrance and turning it into a pleasant perfume [16, 17, and 26].

Treatment for Constipation: Constipation is caused by a deficiency of water in the stool, which makes it thick and difficult to pass. There are several herbal remedies that relieve constipation in various ways. Dried Mahua flowers are thought to have mass laxative properties; when taken at night, they absorb water from the stomach, expand, and force the contents of the digested meal down the rectal pathway [27, 5]. The Mahua flower's laxative properties are justified by its high fiber content. Because it softens and eases the passage of the stool, the oil is also utilized as a laxative.

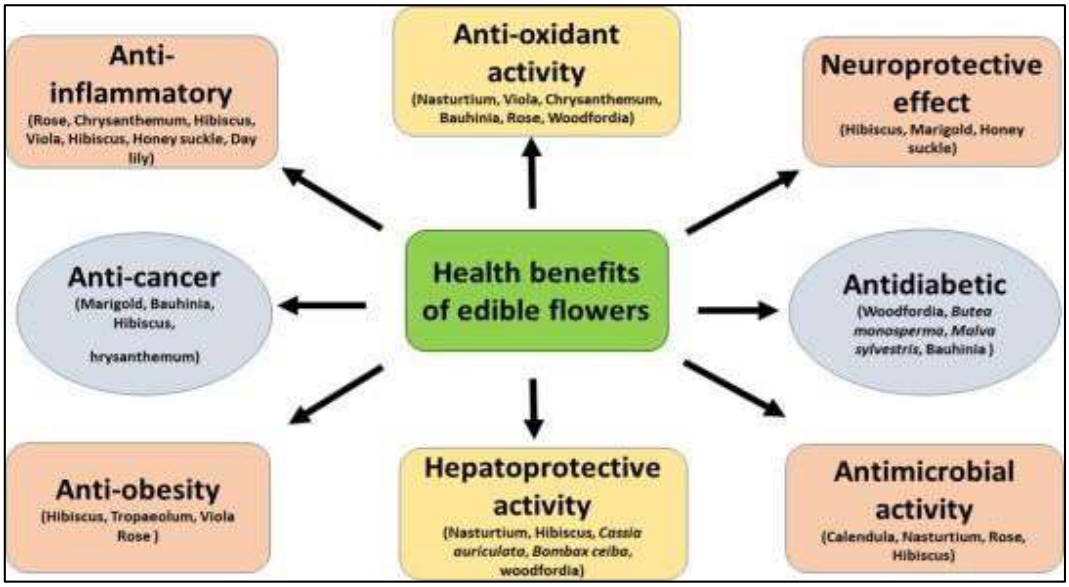

Fig 12: Medicinal uses of mahua

Conclusion

A survey of the literature led to the conclusion that mahua (*Madhuca longifolia*) is a very nutrient-dense tree with a variety of ethno-medical benefits, including antibacterial, anticancer, hepatoprotective, and analgesic qualities. Many studies have been conducted on the mahua flower, fruit, and seed to emphasise its therapeutic qualities, however there have only been a small number of experimental studies done to use the plant as a food or component. Review reveals that only mahua flower is commonly utilized in the commercial production of spirits, not in the cooking of food or medicinal. However, because of inadequate understanding and processing methods, this extremely helpful and nutritious tree is underutilized. Thus, the moment has come to divert mahua flowers for commercial usage in a variety of culinary items. Fruit and seeds will also be utilized to make medications. This endeavor might raise the country's potential for producing jobs and revenue.

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