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A REVIEW ON MAHUA (*MADHUCA LONGIFOLIA*): ITS CHEMICAL COMPOSITION AND PHARMACOLOGICAL PROPERTIES

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ABSTRACT

In developing countries, between 75% and 80% of the world's population depend on herbal products for the management of primary health issues. Herbal remedies derived from plants are considered among the most beneficial and least toxic therapeutic agents. Mahua, mahuwa, and mohula are common names for *Madhuca longifolia*, which belongs to the Sapotaceae family and it is also known as the butter nut tree. It is an economically important tree widely distributed across India. *Madhuca longifolia* is recorded to contain various bioactive compounds, including sapogenins, triterpenoids, steroids, saponins, flavonoids, and glycosides. Extensive pharmacological studies have demonstrated its ethnomedicinal properties, such as analgesic, hepatoprotective, antibacterial, anticancer, antiulcer, and antihyperglycemic activities. This review summarizes the traditional uses of different plant parts, their phytochemical constituents, and the reported pharmacological activities of *Madhuca longifolia*.

KEYWORDS: Mahua, Sapotaceae, *Madhuca longifolia*, Phytochemistry, Pharmacological effects.

INTRODUCTION

Despite initial challenges, Chhattisgarh formed on November 1, 2000, following its separation from Madhya Pradesh has developed into a rapidly progressing state. Indigenous tribal communities play an essential role in the collection and processing of minerals and medicinal plants, drawing extensively on traditional knowledge systems. Mahua *(Madhuca longifolia*), one of the most significant tree species in the region, constitutes an important source of livelihood for many tribal populations.[1]

Research indicates that approximately 80% of people in developing nations depend on traditional medicine for the management of common health conditions, with most remedies derived from higher plants. *Madhuca longifolia*, commonly referred to as Mahua or the butter nut tree and belonging to the family Sapotaceae. It is among the most valuable medicinal plants used in indigenous healthcare systems due to its broad spectrum of pharmacological activities.[2] In India, the species is widely distributed across Andhra Pradesh, Madhya Pradesh, Gujarat, Jharkhand, Bihar, Chhattisgarh, Uttar Pradesh, and Odisha.[3]

The tree exhibits strong drought tolerance and flourishes in open, sunlit environments, while shaded conditions hinder its growth. Although it prefers sandy soil, *M. longifolia* is capable of growing in shallow, rocky, clayey, and calcareous soils.[4] Morphologically, the Mahua tree possesses a wide-spreading crown and reaches an average height of about 17 m. young shoots, leaves, and petioles are densely covered with fine hairs, and the leaves are borne in clusters at the branch tips. The leaves are thick, leathery, and oval, featuring a wedge-shaped base and a short, pointed apex.

Flowering occurs in abundance, with flowers borne on stalks at the terminal ends of branches. The corolla is fleshy and yellowish-white, while the calyx is rigid and

densely clothed with rust-colored hairs. Each flower contains 20 - 30 stamens, most commonly 24 or 26, with anthers bearing stiff hairs on their dorsal surfaces. The fruit is an ovoid, green, fleshy berry containing one to four seeds.[5]

Preliminary phytochemical investigations of stem bark extracts prepared using ethanol, water, and chloroform demonstrated the presence of starch, terpenoids, proteins, mucilage, anthraquinone glycosides, cardiac glycosides, saponins, and tannins.[6] Nearly all parts of the Mahua tree including the bark, fruits, flowers, roots, seeds, and nut shells are employed in traditional medicine and are reported to possess diverse biological activities such as antibacterial, anthelmintic, analgesic, diuretic, tonic, antihyperglycemic, antioxidant, and astringent properties.[2,4,7]

MATERIAL AND METHOD

Literature survey was done with the help of Scopus, Google scholar, Web of science, PubMed which are database of research work papers and articles.

Articles from the last 10 years containing the keywords *Madhuca longifolia* were screened, and papers included development of nanoparticles of *M. longifolia* plant parts extracts.

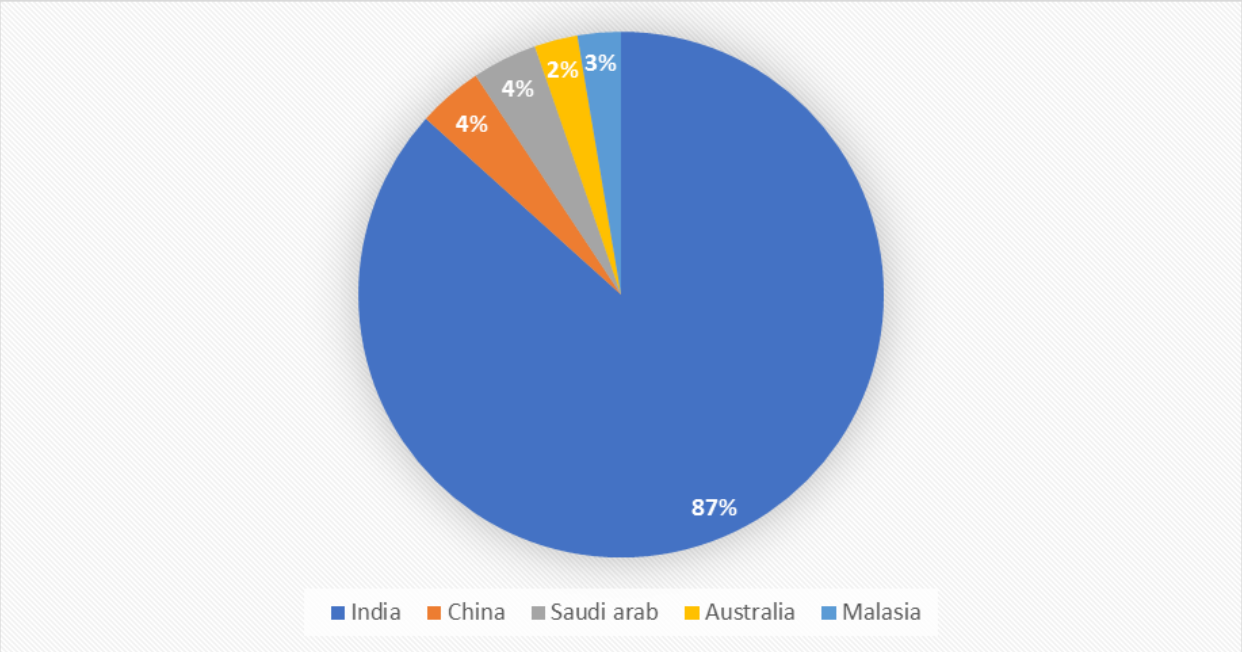

Figure 1: Top 5 countries that published research and review papers on *Madhuca longifolia* plant.

From 1960 to 2025, total number of 397 research and review articles were obtained on the topic of Mahua

↓

72 documents obtained on keyword of nanoparticles

↓

62 research articles and 10 review articles obtained on the basis of their phytochemical constituents and pharmacological activity

Table 1: List of published papers and their corresponding years.

Year	Paper published
2016	2
2017	1
2018	6
2019	5
2020	7
2021	7
2022	4
2023	11
2024	14
2025	11

68 research articles and review articles on *Madhuca longifolia* selected from last 10 years which is presented in figure 2.

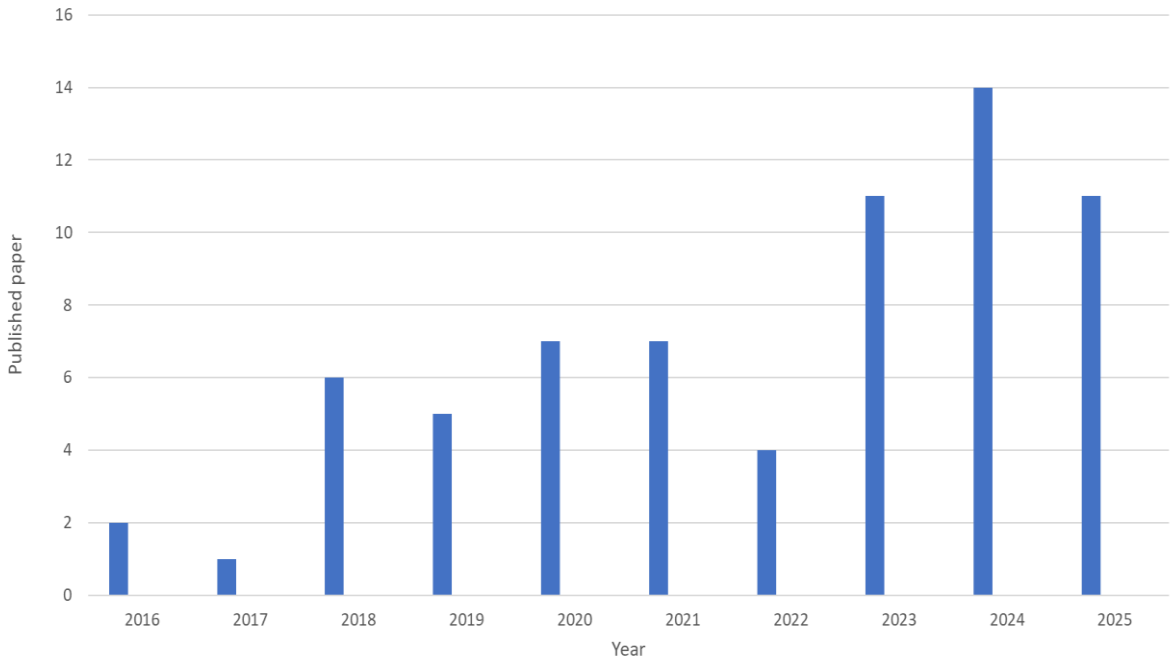

Figure 2: Graphical representation of published papers by year.

PLANT PROFILE

Vernacular/ common name[8]

Table 2: Common name of plant.

Country/state name	Common name
English	Honey tree, Butter tree
India	Mohua
Sri Lanka	Mi, Illuppai
Tamil	Illuppai
Hindi& Bengali	Mahua
Sanskrit	Madhukah
Kannada	Errape
Telugu	Lppi
Malayalam	Lrippa
Gujarat	Mahuda

SYNONYMS.[7]

Madhuca latifolia Macb., *Bassia latifolia* Roxb., *Mahua indica* J.F. Gmel.

Varieties: *Madhuca longifolia* (Koenig) J.F. Macb. var. longifolia, and *Madhuca longifolia* (Koenig) J.F. Macb. var. latifolia (Roxb.) Cheval.

DISTRIBUTION

Mahua trees are widely distributed across India and can also be found in other parts of Asia, such as the Philippines, Pakistan, and Sri Lanka, as well as in Australia. These trees flourish in semi-evergreen forests and along riverbanks, especially within the grazing zones of central India. In the Indian subcontinent, Mahua trees are predominantly found in the states of Uttar Pradesh, Madhya Pradesh, Odisha, Jharkhand, Chhattisgarh, Andhra Pradesh, Maharashtra, Bihar, Karnataka, Gujarat, and Rajasthan.[9]

TAXONOMY[10]

Taxonomical classification of Mahua is presented in table number 3.

Table 3: Taxonomy of Mahua tree.

Kingdom	Plantae
Order	Ericaceae
Family	Sapotaceae
Subfamily	Caesalpiniodeae
Tribes	Caesalpinieae
Genus	*Madhuca*
Species	*Longifolia*

BOTANICAL DESCRIPTION

Madhuca longifolia is a widely distributed deciduous tree native to Nepal, India, and Sri Lanka. It is a medium to large-sized tree, typically growing 10–15 m tall, with a dense, spreading, rounded cover that provides ample shade. The bark is thick, rough, and fissured, ranging in color from brownish to yellowish-grey, and exudes a white, milky latex when cut, revealing a reddish inner layer. The leaves, measuring approximately 15–25 × 8–15 cm, occur in pairs at the ends of branches. They are elliptic, leathery, cuneate at the base, and slightly pointed at the apex, with entire but faintly wavy margins. The underside is thick and hairy, with prominent oblique tertiary veins. The petioles are reddish and about 2 - 4 cm long. The tree bears numerous fragrant, white, fleshy flowers about 2 cm long, arranged in drooping clusters on slender pedicels near branch tips. The flowers have a tubular, yellowish-white corolla and a leathery calyx densely covered with rusty-colored hairs. Typically, 20 – 30 stamens are present, most often 24 or 26, with stiff-haired anthers. The fruit is a green, fleshy, oval berry measuring 2 – 4 cm in diameter. Each fruit contains one

to four elongated, glossy brown seeds, approximately 2 cm long.[1,11]

TRADITIONAL USES OF PLANT PARTS

There are some traditional uses of different parts of tree are mentioned in table number 4.

Table 4: Traditional use of different parts of tree.

Plant part	Traditional uses	References
Leaves	Chronic bronchitis, Cushing's disease, verminosis, gastropathy, dermatopathy, rheumatism, hemorrhoids	[12]
Flower	Helminths, acute and chronic tonsillitis bronchitis	[13]
Fruits	Astringent, lotion in chronic ulcer, acute and chronic tonsilitis and pharyngitis	[8,11]
Seeds	Anti-inflammatory, antiulcer and hypoglycaemic activity	[14]
Bark	Rheumatism, Ulcer, Inflammation, Bleeding, Spongy Gums, Tonsillitis, Diabetic, Stomach Ache, Anti Snake Poisoning, Astringent, Emollient, Fracture, Itching	[15]
Root	Bronchitis, diabetes, rheumatism, bleeding, ulcer, tonsillitis, pharyngitis and spongy gums	[16]

MORPHOLOGY

The morphology of different parts of tree, such as leaves, seeds, flowers, and bark, is presented in table number 5.

Table 5: Morphology of leaves, seed, flower, bark.

LEAVES		
Morphology	**Characterization**	**Reference**
Colour	Green	[6]
Odour	Characteristic	[6]
Taste	Bitter	[6]
Size	11-15cm long, 5-8cm wide	[6]
Shape	Lanceolate to ovate	[6]
Texture	Short	[6]
Apex	Acute	[6]
Arrangement	Opposite	[6]
Appearance	Smooth	[6]
SEED		
Colour	Brown	[17]
Odour	Characteristic	[17]
Taste	Bitter and astringent	[17]
Size	Ovoid to ellipsoid	[17]
Testa	Soft, light brown, shining	[17]
Perisperm	Thin layered, cream coloured	[17]
FLOWER		
Colour	Yellowish brown	[18]
Odour	Fragrant	[18]
Taste	Sweet	[18]
Texture	Granular and sticky	[18]
BARK		
Colour	Light brown shade	[19]
Odour	Characteristic smell	[19]
Taste	Distinct flavour	[19]
Dimension	4mm	[19]
Shape	Broadly spread	[19]

MICROSCOPY OF *MADHUCA LONGIFOLIA*

The microscopy of petiole consists of vascular bundles containing xylem and phloem, along with the endodermis, pericycle, and central pith. The transverse section (T.S.) of the leaf the leaf showed the presence of vascular bundle, xylem, phloem upper and lower epidermis. Uniseriate, covering trichomes were observed on the leaf surface. Paracytic stomata occur on both the adaxial (upper) and abaxial (lower) epidermal surfaces.[6] The stem of *Madhuca longifolia* composed of distinct layers, including cork cells, cortex, xylem, phloem, and a central pith.

PHYTOCHEMICAL CONSTITUENTS

Some phytochemical constituents of different parts of the tree are presented in table number 6.

Table 6: Phytochemical constituents present in plant.

Plant parts	Chemical constituents	References
Leaves	β-carotene and xanthophylls; erthrodiol, palmitic acid, myricetin and its 3- O-arabinoside and 3-O-L rhamnoside, quercetin and its 3-galactoside; 3β caproxy and 3β-palmitoxy- olean-12-en-28-ol, oleanolic acid, β-sitosterol and its 3-O-β-D glucoside, stigmasterol, β-sitosterol- β-D glucoside, n-hexacosanol, 3β caproxyolcan- 12-en-28-ol, β-carotene, n-octacosanol, sitosterol, quercetin.	[12,6,14,7,25]
Seeds	Arachidic, linolelic, oleic, myrisic, palmitic and stearic acids, α-alanine, aspartic acid, cystine, glycine, isoleucine and leucine, lysine, 6. Leaves methionine, proline, serine, threonine, myricetin, quercetin, Mi-saponin A & B.	[20,21,22]
Flower	Vitamin-C, Vitamin A	[18,8,24,26]
Bark	Ethyl-cinnamate, sesquiterene alcohol, α-terpeneol, 3β-monocaprylic ester of eythrodiol and 3β-capryloxy oleanolic acid. α- and β- amyrin acetates, Sterol, Flavonoids, triterpene	[5,13,8]
Fruits	n -hexacosanol, β-sitosterol and its 3β-D glucoside, quercetin, dihyroquercetin and α- and β- amyrin acetates	[11,4,23,24]

PHARMACOLOGICAL ACTIVITY- The folk and traditional claims of the medicinal uses of Mahua should be validated scientifically to heal a variety of diseases, hence this review focuses on pharmacological activities of Mahua which are presented in below**.**

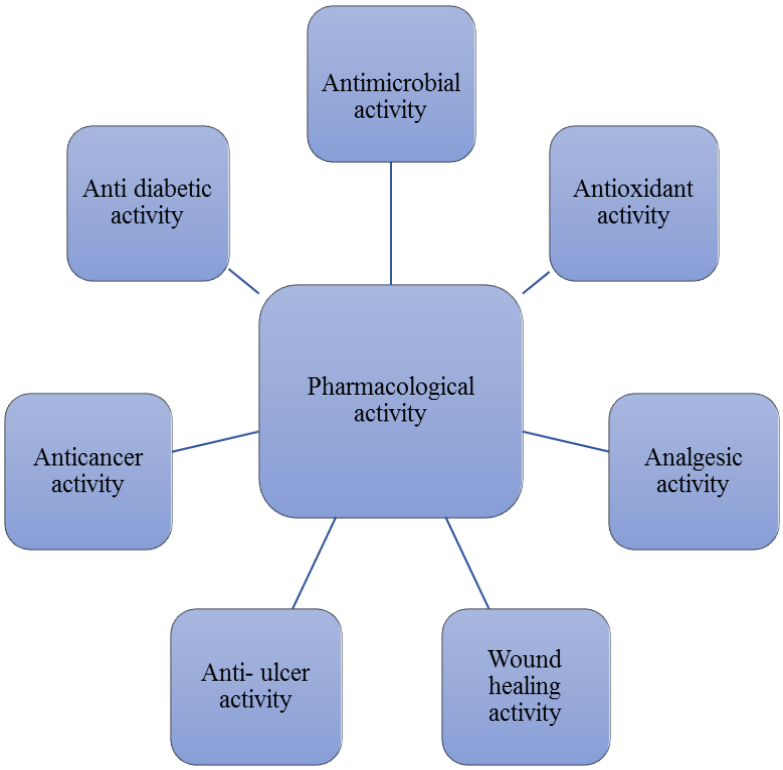

Fig. 3: Pharmacological activity of *Madhuca longifolia.*

Antimicrobial activity

Studies have shown that the stems and leaves of *Madhuca longifolia* possess notable antibacterial properties in acetone, water, and ethanol extracts. The antibacterial strength of stem bark extracts surpasses that of the leaf extracts. Both water and acetone extracts demonstrate a broad spectrum of activity. In micro-dilution tests, the bark extracts showed considerable antibacterial effectiveness and produced clear inhibitory zones in well-diffusion assays when evaluated against *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus species.*[5,13]

Antioxidant activity

The methanolic extract of mahua (*Madhuca longifolia*) leaves has demonstrated significant antioxidant

properties, comparable to those of butylated hydroxyanisole (BHA). Antioxidant capacity was evaluated through assays measuring reducing power, superoxide radical scavenging, and hydroxyl radical scavenging. The primary bioactive compound attributed to these antioxidant effects has been identified as madhucic acid.[4]

Analgesic activity

Tail-flick, hot-plate, and chemical-writhing tests in rodents demonstrated that aqueous and alcoholic extracts of *Madhuca longifolia* flowers exhibit dose-dependent analgesic effect. Furthermore, the plant's aerial parts exhibited strong analgesic effects in crude methanolic preparations. Methanolic extracts significantly decreased abdominal constrictions in acetic acid–induced nociception experiments; the effect increased proportionately with dose.[12]

Wound healing activity

The presence of phyto - ingredients that aid in wound healing may be the cause of this action. In comparison to the control in the excision wound model, the ether-benzene 95% crude ethanolic extract of *M. longifolia* leaves and bark showed a significant decreased in wound healing time. The rate of tissue growth and wound closure both significantly increased.[26]

Anti-ulcer activity

Naproxen-induced stomach antral ulceration has been shown to be effectively prevented by an aqueous extract made from *M. longifolia* leaves. The presence of quercetin, myricitrin, triterpenoid, sitosterol, and quercitrin phytochemicals were thought to be the cause of the extract's antiulcer effectiveness. The anti-ulcer qualities of the plant's alcoholic leaf extract have also been studied in vivo by a number of researchers.[27]

Anticancer activity

According to the Ayurvedic medical system, *Madhuca longifolia* bark can be applied locally to treat cancer.[6] In a mouse carcinoma model, the anticancer potential of *Madhuca longifolia* leaves acetone and ethanolic extracts was evaluated. Survival time, tumour volume, tumour weight, tumour cell count, body weight, haematological indices, and in vitro cytotoxicity was evaluated. Tumour volume, Tumour weight, and Tumour cell count were significantly decreased in mice given the extracts orally, whereas survival time and body weight were significantly increased. The effects were compared to those of 5-fluorouracil, a common anticancer drug.[28]

Anti–Diabetic activity

Diabetes mellitus is a metabolic disorder characterized by impaired insulin secretion and action. Experimental studies have demonstrated that bark extracts possess marked antihyperglycemic activity in animal models. The methanolic bark extract produced a dose-dependent reduction in blood glucose levels in normal, glucose-loaded, and streptozotocin (STZ)-induced diabetic rats, with the maximum effect observed at 200 mg/kg, comparable to the standard antidiabetic drug glibenclamide. Comparative evaluations of methanolic, petroleum ether, and aqueous bark extracts in STZ- and STZ-nicotinamide-induced diabetic rats indicated that the methanolic extract was the most potent. At a dose of 75 mg/kg, it exhibited significant antihyperglycemic and hypolipidemic effects by markedly increasing HDL cholesterol while effectively reducing blood glucose, total cholesterol, and triglyceride levels.[10]

Nanoparticles of the *Madhuca longifolia* tree extracts and their pharmacological activity

Different types of nanoparticles had synthesized using various parts of the *Madhuca longifolia* tree extracts, and their pharmacological activities vary accordingly.

Table 7: Nanoparticle formed in different part of plant extracts and biological activity.

Nanoparticle formed	Plant part used	Pharmacological activity	Reference
MgO nanoparticles	Flower extract	Synergistic action of sumatriptan	[29]
MgO nanoparticles	Flower extract	Removal of nigrosine dye	[30]
SiO_2 nanoparticles	Seed	Biodiesel	[31]
TiO2, MgO, TiO2/MgO nanoparticles	Flower extract	Anti-bacterial	[32]
Silver nanoparticle	Flower extract	Kinetic and thermodynamic study	[33]
MgO nanoparticle	Flower extract	Antimicrobial activity	[34]
Gold nanoparticle	Seed extract	Antimicrobial activity	[35]
Carbon nanoparticles	Flower extract	Detection of Cr6+	[36]
Palladium nanoparticles	Leave extract	Human lung cancer cells A549 and bacterial strains	[37]
Silver nanoparticles	Leave extract	Malaria	[38]
Titanium nanoparticles	Seed	Biodiesel	[39]
Silver nanoparticles	Leave extract	Anti-bacterial activity	[40]
MgO nanoparticles	Flower extract	Antibacterial activity	[41]
Silver nanoparticles	Leave extract	Antimicrobial, Anticancer, Anti-Inflammatory and Antioxidant Activities	[42]
MgO nanoparticles	Flower extract	removal of nigrosine dye	[43]
Silver nanoparticles	Leaves extract	Anti-cancer	[44]

CONCLUSION

A significant medicinal plant in Ayurvedic medicine, *Madhuca longifolia* is prized for its wide range of therapeutic applications. Its vast spectrum of pharmacological actions is attributed to its numerous bioactive ingredients, which include sapogenins, triterpenoids, steroids, saponins, flavonoids, and glycosides. Its anti-pyretic, anti-inflammatory, analgesic, antidiabetic, wound-healing, antibacterial, anticancer, and hormonal balance qualities have been reported in experimental research articles. *M. longifolia* is a prospective source for the creation of new medicinal compounds, given the growing demand for safe, plant-based medications worldwide. This review supports its potential pharmacotherapeutic uses and emphasises its phytochemical and pharmacological relevance.

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