CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
SJIF Impact Factor: 7.187

Available online at: http://www.iajps.com *Review Article*

A REVIEW ARTICLE ON MILLETTIA (PONGAMIA) PINNATA: A MULTIPURPOSE MEDICINAL PLANT

Preeti Rathod[1], Shubham S. Gulhane[2], Sakshi D. Ambhore[3]

[1]Department of Quality Assurance, P. Wadhwani College of Pharmacy, Moha Phata, Yavatmal – 445001, Maharashtra, India

[2]Department of Pharmaceutics, P. Wadhwani College of Pharmacy, Moha Phata, Yavatmal – 445001, Maharashtra, India

[3]Department of Quality Assurance Gawande College of Pharmacy, Sakharkherda-443201 Maharashtra, India

1. Abstract:

Millettia pinnata (synonym Pongamia pinnata), commonly referred to as Karanja or Indian Beech, is a medium-sized leguminous tree that has attracted immense scientific and industrial attention due to its diverse medicinal, agricultural, and environmental applications. Belonging to the Fabaceae family, this plant is distributed widely across India and Southeast Asia and is now cultivated in tropical and subtropical regions worldwide. In the Ayurvedic, Siddha, and Unani systems of medicine, it is prescribed for a variety of ailments including skin diseases, rheumatism, wounds, and diabetes.

Modern scientific investigations have validated its pharmacological properties, demonstrating anti-inflammatory, antimicrobial, antioxidant, hepatoprotective, and wound-healing activities, which are largely attributed to bioactive compounds such as karanjin, pongamol, flavonoids, sterols, and fixed oils. In addition to its medicinal relevance, M. pinnata plays a vital role as a nitrogen-fixing tree, a source of renewable biofuel, and an environmentally sustainable solution in agriculture and reforestation. This review consolidates available literature on its botanical features, pharmacognostic standards, physicochemical and phytochemical characteristics, pharmacological activities, industrial applications, and marketed formulations. The paper emphasizes its potential as a multipurpose medicinal plant of immense therapeutic and economic value.

Keywords: *Millettia pinnata, Pongamia pinnata, Karanja oil, pharmacognosy, phytochemistry, biofuel, medicinal plants.*

Corresponding author:

Preeti Rathod,

Department of Quality Assurance, P. Wadhwani College of Pharmacy, Moha Phata, Yavatmal – 445001, Maharashtra, India

QR CODE

Please cite this article in press Preeti Rathod et al., A Review Article On **Millettia (Pongamia) Pinnata***: A Multipurpose Medicinal Plant, Indo Am. J. P. Sci, 2025; 12(09).*

2. INTRODUCTION:

Medicinal plants remain the cornerstone of traditional systems of medicine and continue to inspire the development of novel therapeutic agents in modern pharmacology. Among the numerous plants with multipurpose applications, *Millettia pinnata* (synonym *Pongamia pinnata*) holds a special place. Known by various vernacular names such as Karanja in Sanskrit and Hindi, Kanuga in Telugu, and Indian Beech in English, this tree has been revered for centuries for its healing properties.

Fig 1.Millettia (Pongamia) Pinnata

The plant is native to the Indian subcontinent and Southeast Asia but has adapted successfully in other tropical and subtropical regions across the world. Its medicinal uses are well-documented in classical texts of Ayurveda, Siddha, and Unani medicine, where the oil extracted from seeds, bark, and leaves has been recommended for conditions such as eczema, leprosy, ulcers, rheumatism, and piles. In recent years, the plant has gained additional recognition for its ability to produce renewable biofuel, act as an organic pesticide, and restore soil fertility through nitrogen fixation.

Given its broad utility, researchers have investigated *M. pinnata* extensively, focusing on its pharmacognostic characteristics, chemical composition, biological activities, and industrial potential. This review provides a comprehensive account of these aspects to highlight its multipurpose significance and to encourage further exploration into its role in modern healthcare and sustainable industries.

3. Botanical Information

Millettia pinnata is a medium-sized, glabrous tree that typically grows between 15 and 25 meters in height. It belongs to the family Fabaceae (Leguminosae). The tree is characterized by its glossy, pinnate leaves that usually contain five to seven ovate-lanceolate leaflets. The bark of the tree is grey-brown, smooth in younger trees, and becomes fissured as the plant ages. The flowers are papilionaceous in nature, pinkish-white to lilac in color, and occur in axillary racemes, giving the tree ornamental value in addition to its medicinal importance. The fruit is a flat, woody, and indehiscent pod measuring 5–7 cm in length and usually contains one or two seeds. These seeds are brown, ovoid, and serve as the source of Karanja oil, a non-edible fixed oil with vast medicinal and industrial applications.

The plant is widely distributed throughout India, Sri Lanka, Bangladesh, Myanmar, and other Southeast Asian countries. It has also been successfully introduced in regions of Australia, Africa, and the United States, particularly in tropical and subtropical climates. Its ecological role as a nitrogen-fixing species contributes to soil fertility and makes it an ideal candidate for reforestation and land reclamation projects.

4. Pharmacognostic Study

Pharmacognostic evaluation provides essential information for the identification and authentication of medicinal plants. In the case of *Millettia pinnata*, both macroscopical and microscopical characteristics have been described in detail.

Macroscopically, the leaves of the plant are imparipinnate with alternate arrangement, smooth texture, and a glossy green surface. The bark is greyish-brown and displays fissures as the plant matures. The flowers are small, attractive, and pinkish-white to lavender in shade, while the fruits are indehiscent, elliptic pods enclosing one to two seeds.

Microscopical examination of the leaf reveals an epidermis covered with a thick cuticle and the presence of paracytic stomata. The palisade tissue generally consists of two layers, followed by a spongy mesophyll. Collateral vascular bundles surrounded by sclerenchymatous sheaths are also observed. The stem shows polygonal cork cells, secondary phloem containing fibers and parenchyma, and xylem vessels with pitted thickening. Medullary rays are usually uniseriate to biseriate. Powder microscopy of the plant demonstrates fragments of epidermis with stomata, elongated thick-walled fibers with tapering ends, and abundant oil globules in the seed powder, confirming the presence of fixed oils.

Organoleptic characters are also distinctive: the leaves are green, bark is greyish brown, and seeds are brown in color. The odor of the oil is strong and unpleasant, while the taste is bitter, acrid, and pungent. These characteristics aid in preliminary identification and quality control.

5. Physicochemical Parameters

Physicochemical analysis plays a crucial role in the standardization of herbal drugs. For *Millettia pinnata*, the loss on drying has been recorded between 7–8%, which indicates moderate moisture content. The total ash value lies in the range of 6–7%, while the acid-insoluble ash is around 1–2%, reflecting the inorganic content and purity of the drug. Water-soluble ash values are usually between 3–4%, suggesting the presence of soluble mineral salts. Extractive values in different solvents further provide insight into the nature of phytochemicals present: alcohol extractive value is about 6–8%, water extractive value is 10–12%, and ether extractive value ranges between 4–5%. These parameters form an important basis for assessing the quality, safety, and efficacy of the crude drug.

Table 1: Pharmacognostic and Physicochemical Parameters of *Millettia pinnata*

Parameter	Standard Range/Observation
Loss on drying	7–8%
Total ash	6–7%
Acid-insoluble ash	1–2%
Water-soluble ash	3–4%
Alcohol extractive value	6–8%
Water extractive value	10–12%
Ether extractive value	4–5%

6. Phytochemical Constituents

Phytochemical investigations of *Millettia pinnata* have revealed a diverse spectrum of secondary metabolites responsible for its biological activities. The plant is particularly rich in flavonoids and furanoflavonoids such as karanjin, pongamol, glabrin, and pinnatin. Among these, karanjin is considered the major bioactive marker compound. Sterols including β-sitosterol and stigmasterol have also been identified, contributing to its anti-inflammatory and antioxidant activities.

In addition, the plant contains glycosides, alkaloids, tannins, and saponins. The seeds are the source of Karanja oil, a fixed oil composed primarily of fatty acids such as oleic, linoleic, stearic, and palmitic acids. These fatty acids not only serve industrial purposes but also impart medicinal properties, especially antimicrobial and wound-healing effects. The chemical richness of the plant makes it a valuable source for pharmacological exploration.

Table 2: Major Phytochemical Constituents of *Millettia pinnata*

Class	Compounds Identified	Significance
Flavonoids & Furanoflavones	Karanjin, Pongamol, Glabrin, Pinnatin	Anti-inflammatory, antimicrobial, antioxidant
Sterols	β-sitosterol, Stigmasterol	Anti-inflammatory, hepatoprotective
Glycosides	Various glycosides	Therapeutic modulation
Fixed oils	Oleic, Linoleic, Stearic, Palmitic acids	Antimicrobial, wound healing, industrial uses
Others	Tannins, Saponins, Alkaloids	Astringent, antiseptic, antimicrobial

7. Pharmacological Activities

Extensive pharmacological research has confirmed the traditional claims regarding the medicinal value of *Millettia pinnata*. Its anti-inflammatory activity has been demonstrated in experimental models such as carrageenan-induced paw edema in rats, where significant reduction in swelling was observed. Antimicrobial and antifungal studies have shown the effectiveness of karanja oil and seed extracts against a variety of pathogens including *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*.

The plant also exhibits potent antioxidant activity, as confirmed by radical scavenging assays like DPPH and ABTS. This property contributes to its hepatoprotective effects, which have been evaluated in models of CCl_4-induced liver toxicity, showing restoration of liver enzymes and histological protection.

In the management of diabetes, *M. pinnata* extracts have been found to lower blood glucose levels in streptozotocin-induced diabetic rats, possibly through improved insulin sensitivity and antioxidant defense. Its wound-healing activity is attributed to enhanced collagen synthesis and faster epithelialization in excision and incision wound models. Moreover, the insecticidal and pesticidal potential of its seed oil and cake has been exploited in agriculture, where it serves as a natural alternative to chemical pesticides.

8. Industrial and Environmental Applications

Beyond medicine, *Millettia pinnata* has gained industrial significance due to the production of biodiesel from its seed oil. Karanja oil methyl ester (KOME) is considered a promising renewable fuel that can reduce dependence on fossil fuels. In

agriculture, the seed cake left after oil extraction is utilized as organic manure, rich in nitrogen and other nutrients, thereby enhancing soil fertility.
The plant also plays an important role in environmental conservation. Being a nitrogen-fixing tree, it improves soil quality and is widely planted for reforestation, erosion control, and reclamation of wastelands. Its ability to thrive in saline and drought-prone soils further makes it suitable for ecological restoration. Industrially, the oil is also used in soap making, leather tanning, and as a lubricant. Cosmetic formulations such as shampoos, medicated soaps, and herbal hair oils often include karanja oil as an active ingredient for its antifungal and antibacterial properties.

9. Marketed Products of *Millettia pinnata*

A variety of marketed formulations are based on *Millettia pinnata*, reflecting its acceptance in both traditional and modern healthcare. In Ayurvedic medicine, Karanja Taila is widely prescribed for skin conditions like eczema, psoriasis, scabies, and leprosy. Brands such as Baidyanath, Dabur, and Patanjali manufacture and market Karanja oil either as a pure extract or in combination with other herbs. Karanja Ghrita, a medicated ghee, is also employed in skin diseases and ulcers.

Topical preparations such as ointments, balms, and creams enriched with karanja oil are marketed for their anti-inflammatory and antiseptic benefits. In agriculture, Karanja seed cake is sold as an organic manure and pest repellent, often blended with neem cake. Neem-Karanja oil formulations are marketed as biopesticides and are widely used in organic farming. Industrial and cosmetic products include herbal soaps and shampoos containing karanja oil, which are valued for their antifungal cleansing properties. In addition, Karanja oil methyl ester is commercially promoted as biodiesel in certain regions

Table 3: Marketed Products of *Millettia pinnata*

Product Type	Examples	Applications
Ayurvedic oils	Karanja Taila (Baidyanath, Dabur, Patanjali)	Skin diseases, wounds, rheumatism
Medicated ghee	Karanja Ghrita	Skin disorders, ulcers
Topical preparations	Ointments, creams, balms with karanja oil	Anti-inflammatory, antiseptic
Agricultural products	Neem-Karanja bio-pesticide, Karanja seed cake	Pest control, organic manure
Cosmetic formulations	Herbal soaps, shampoos, hair oils	Antifungal, antibacterial, dandruff treatment
Industrial products	Karanja oil methyl ester (KOME)	Biodiesel production

10. CONCLUSION:

The comprehensive evaluation of *Millettia pinnata* highlights its status as a pharmacognostically well-characterized, phytochemically rich, and pharmacologically validated medicinal plant. The presence of diverse bioactive compounds such as karanjin and pongamol underpins its therapeutic potential against inflammation, microbial infections, oxidative stress, diabetes, hepatic damage, and wounds. Beyond its medicinal value, the plant contributes to sustainable industries through its role in biodiesel production, biopesticides, organic fertilizers, and ecological restoration projects.

Its widespread distribution, traditional acceptance, and growing industrial relevance make it an invaluable resource for integrated healthcare and sustainable development. Future research should focus on clinical validation of its pharmacological claims, standardization of formulations, and development of novel therapeutic agents from its bioactive constituents. Thus, *Millettia pinnata* exemplifies the convergence of traditional knowledge and modern science, emerging as a truly multipurpose medicinal plant.

11.REFERENCES:

1. Allen, L. V., & Ansel, H. C. (2013). *Ansel's pharmaceutical dosage forms and drug delivery systems* (10th ed.). Lippincott Williams & Wilkins.
2. Banker, G. S., & Rhodes, C. T. (2002). *Modern pharmaceutics* (4th ed.). Marcel Dekker.
3. Brahmankar, D. M., & Jaiswal, S. B. (2009). *Biopharmaceutics and pharmacokinetics: A treatise* (2nd ed.). Vallabh Prakashan.
4. Chaurasia, G. (2016). A review on pharmaceutical preformulation studies in formulation and development of new drug molecules. *International Journal of Pharmaceutical Sciences Review and Research, 40*(1), 115–121.
5. Dressman, J. B., & Reppas, C. (2000). In vitro–in vivo correlations for lipophilic, poorly water-soluble drugs. *European Journal of Pharmaceutical Sciences, 11*(S2), S73–S80.
6. Gennaro, A. R. (2000). *Remington: The science and practice of pharmacy* (20th ed.). Lippincott Williams & Wilkins.
7. Kumar, R., & Patil, S. (2018). Importance of preformulation studies in the development of

pharmaceuticals. *International Journal of Pharmaceutical Sciences and Research, 9*(7), 1000–1007.
8. Lachman, L., Lieberman, H. A., & Kanig, J. L. (2008). *The theory and practice of industrial pharmacy* (4th ed.). CBS Publishers.
9. Martin, A. (2011). *Physical pharmacy: Physical chemical principles in the pharmaceutical sciences* (6th ed.). Lippincott Williams & Wilkins.
10. Niazi, S. K. (2007). *Handbook of preformulation: Chemical, biological, and botanical drugs*. CRC Press.
11. Patel, R., & Patel, M. (2017). Preformulation studies and their importance in pharmaceutical product development. *Journal of Pharmacy and Bioallied Sciences, 9*(3), 111–118.
12. Porter, C. J. H., Trevaskis, N. L., & Charman, W. N. (2007). Lipids and lipid-based formulations: Optimizing the oral delivery of lipophilic drugs. *Nature Reviews Drug Discovery, 6*(3), 231–248.
13. Rowe, R. C., Sheskey, P. J., & Quinn, M. E. (2009). *Handbook of pharmaceutical excipients* (6th ed.). Pharmaceutical Press.
14. Shah, V. P., & Amidon, G. L. (2014). In vitro dissolution profile comparison—statistics and analysis. *Pharmaceutical Research, 31*(5), 1020–1029.
15. Singh, S., & Bakshi, M. (2000). Guidance on conduct of stress tests to determine inherent stability of drugs. *Pharmaceutical Technology, 24*(2), 1–14.
16. Sinko, P. J. (2011). *Martin's physical pharmacy and pharmaceutical sciences* (6th ed.). Wolters Kluwer Health.
17. Sweetman, S. C. (2009). *Martindale: The complete drug reference* (36th ed.). Pharmaceutical Press.
18. Tangri, P., & Khurana, S. (2011). Basics of oral controlled drug delivery systems. *Tropical Journal of Pharmaceutical Research, 10*(3), 275–281.
19. Vyas, S. P., & Khar, R. K. (2002). *Controlled drug delivery: Concepts and advances*. Vallabh Prakashan.
20. Yadav, A. V., & Shete, A. S. (2010). Formulation and evaluation of gastroretentive drug delivery system of ciprofloxacin. *Indian Journal of Pharmaceutical Education and Research, 44*(2), 149–157.