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A review on various pharmacological activities of *Mesua Ferrea* (Nahor) seed oil

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Abstract
Mesua ferrea is a rare plant used in India and several parts of world for its potential medicinal and several other properties. *Mesua ferrea* is a rich source of secondary metabolites which are having multiple health promoting benefits. The seed oil is helpful in various skin diseases and is a useful analgesic. The phytochemical screening confirms the presence of phenyl coumarins, xanthones, triterpenoids, and flavanoids as main constituents of the plant. From the recent studies it has been proved that *Mesua ferrea* is having multiple health promoting benefits including antioxidant, antimicrobial, immunomodulatory, antiarthritis, water disinfectant properties, anti-inflammatory activity, anticancer activities and others. The seed oil of *Mesua ferrea* shows various pharmacological activities like antioxidant activity, antimicrobial activity, immunomodulatory activity, antiarthritis activity, water disinfectant properties and anti-inflammatory activity. The pharmacological activities are due to the presence of phenolic compounds, essential oil, xanthones and coumarines present within the seed of this plant. Apart from medicinal uses it is also being used as biofuel, pharmacological excipients, biolubricant, polymer industry, painting, as a firewood and substitute for gasoline etc. Overall Mesua ferrea exhibits various uses and important application which can act as gift for curing various disease and disorder.

Keywords: *Mesua ferrea*, Nahor, herbal medicine, Mesuol, anti-inflammatory, biofuel

Introduction

Herbal medicine forms a major component of traditional medicine worldwide and is increasingly popular due to its minimal side effects and long-lasting therapeutic benefits (Sivakrishnan, 2018) [27]. Traditional or folk medicine includes practices and knowledge used to diagnose, treat, and prevent diseases within a society, often outside conventional scientific frameworks. India leads globally in the use of herbal drugs, utilizing nearly 540 plant species in various formulations, with about 75% of the population relying on herbal medicines for treating different ailments (Moreira *et al*., 2014; Chachal *et al*., 2012a) [20]. The plant kingdom provides many plants with properties which are conducive to health and to secure the best results from the use of the plants as remedial agencies. *Mesua ferrea* Linn (Nagakesar), belonging to the family Guttiferae, is a rare medicinal plant traditionally valued for its antiseptic, anti-inflammatory, blood-purifying, anthelmintic, cardiotonic, diuretic, expectorant, antipyretic, purgative, antiasthmatic, and antiallergic properties (Chachal *et al*., 2012a). The genus *Mesua* comprises about 48 species (Chachal *et al*., 2012b). *M. ferrea* is an evergreen, medium- to large-sized ornamental tree widely distributed in tropical Asian countries, including India, Burma, Thailand, Indochina, Sri Lanka, Malaysia, and Nepal (Sharma *et al*., 2017; Chahar *et al*., 2012c) [6, 26]. In India, it is commonly found in the mid-hills of the Eastern Himalayas, the rainforests of Konkan and Karnataka in the Western Ghats, the Deccan Peninsula, northeastern regions, and the Andaman Islands (Asif *et al*., 2017) [3].

Traditionally the dried stamens of *Mesua ferrea* are used in the treatment of gout, haemorrhagic disorders, and urinary bladder diseases. Additionally, stamens of *Mesua ferrea* are also used for bleeding piles as a paste prepared with butter and sugar, and for relieving burning sensations in the feet when applied with repeatedly washed ghee. Syrup prepared from flower buds is used in dysentery (Chahar *et al*., 2013) [7]. The drug has also been incorporated into Arab and Unani systems of medicine, where it is described as digestive, diaphoretic, anti-dysenteric, and a uterine muscle depressant, forming part of several compound formulations (Kunwar & Priyadarsini, 2011) [16]. Additionally, the leaves and flowers are used as antidotes for snake and scorpion bites, while the fixed oil is applied in skin infections, wounds, scabies, and rheumatism (Chahar *et al*., 2013) [7].

Phytoconstituents of *Mesua ferrea*

A substantial number of efforts has been invested to identify and isolate different types of phytoconstituents from various parts of *M. ferrea*. It is reported to contain coumarins, xanthones, terpenoids and sterol type of phytochemicals (Asif *et al*., 2017) [3]. It was found that the heartwood gave xanthones such as euxanthone, mesuaxanthones A and B, which exhibit anti-inflammatory, anticancer, CNS depressant and antimicrobial activities (Thakur *et al*., 2021) [29]. The seed oil gave-phenyl coumarin analogues such as mesuol, mesuagin, mammeisin, mammeigin, mesuone, mesuarin, ferruols A/B, mammea A/AA, mammea A/AB and other “Mesua coumarins” with antimalarial, antidiabetic and cytotoxic activities (Arora *et al*., 2019; Asif *et al*., 2017) [2, 3]. Also contains phenolics, tannins, saponins, glycosides and fatty acids (oleic, linoleic, palmitic, stearic, arachidic) are widely reported across extracts (Hartanti *et al*., 2019) [11]. Stamens gave alpha- and beta-amyrin, beta-sitosterol, biflavonoids, mesuaferrones A and B, and mesuanic acid (Thakur *et al*., 2021) [29]. Table 1 shows various phytoconstituents of *M. ferrea* from different parts of the plant.

Table 1: List of various parts of *Mesua ferrea* with their phytoconstituents

Plant parts	Phytochemical constituents	References
Seed oil	4-Phenylcoumarins like mesuol, mesuagin, mammeisin, mammeigin and mesuone	Thakur *et al*., 2021 [29]; Arora *et al*., 2019 [2]
Heartwood	Mesuaxanthone-A, Mesuaxanthone-B, Ferrxanthone 1,5-dihydroxyxanthone (II), euxanthone 7-methyl ether (IV), β-sitosterol	Thakur *et al*., 2021 [29]; Arora *et al*., 2019 [2]; Asif *et al*., 2017 [3]
Trunk bark	Ferrol-A	Arora *et al*., 2019 [2]
Timber	2-Hydroxy-, 2-methoxy-, 4-hydroxy-, 1,5-dihydroxy-, 1,7-dihydroxy-, 1-hydroxy-5-methoxy, 1-hydroxy-7-methoxy-, 3-hydroxy-4-methoxy- and 1,5,6-trihydroxyxanthone	Arora *et al*., 2019 [2]; Asif *et al*., 2017 [3]
Leaves	Prenylated 4-phenylcoumarins (mesuol A/B, isomesuol, disparinols), quercetin rhamnosides, saponins, flavonoids, terpenoids	Hartanti *et al*., 2019; Zhang *et al*., 2025 [11, 30]
Stem bark	Mesuferrol-A and -B, (-) epicatechin, 1,7-dihydroxy- and 5-hydroxy-1-methoxyxanthone, Friedelin, 3β friedelanol, lupeol, 3-oxo-betulin and spinasterol	Arora *et al*., 2019 [2]; Asif *et al*., 2017 [3]
Stem	Amyrin (α and β), β-sitosterol, friedelin, lupeol	Arora *et al*., 2019 [2]; Asif *et al*., 2017 [3]
Rootbark	Mesuaferrin-A and -B, caloxanthone C, 1,8-dihydro-3-methoxy-6- methylanthraquinone, β-sitosterol, friedelin, betulinic acid, Mesuaferrin C, macluraxanthone, caloxanthone C, β-sitosterol, friedelin and betulinic	Arora *et al*., 2019 [2]; Asif *et al*., 2017 [3]; Teh *et al*., 2012 [28]

Pharmacological activities of *Mesua ferrea*

The pharmacological activities of *Mesua ferrea*, are extensive and well-documented across various studies. This plant exhibits a wide range of therapeutic properties attributed to its rich phytochemical composition, including xanthones, flavonoids, and triterpenoids. Recent scientific studies have highlighted the medicinal importance of different parts of *M. ferrea* against a variety of human ailments (Fig 1). Leaf polyphenols strongly inhibit α-glucosidase; some coumarins and a quercetin rhamnoside are more potent than quercetin and also enhance glucose uptake in 3T3-L1 adipocytes, indicating multi-target antidiabetic potential (Zhang *et al*., 2025) [30]. Additional bark flavonoid fractions show α-amylase inhibition and antioxidant support (Patil *et al*., 2023) [23]. Bark extracts reduce NO, PGE2, TNF-α and IL-1β in LPS-stimulated macrophages and decrease carrageenan-induced paw edema in rats (Ranganathaiah *et al*., 2016) [24]. Ethanolic leaf and branch extracts display *in vitro* and *in vivo* antimalarial activity with low toxicity; xanthones from roots also show antiplasmodial effects (Konyanee, *et al*., 2024) [14]. Flower extract is active against *C. acnes, S. epidermidis* and *S. aureus* and reduces NO and TNF-α, supporting anti-acne use (Nakyai *et al*., 2021) [22].

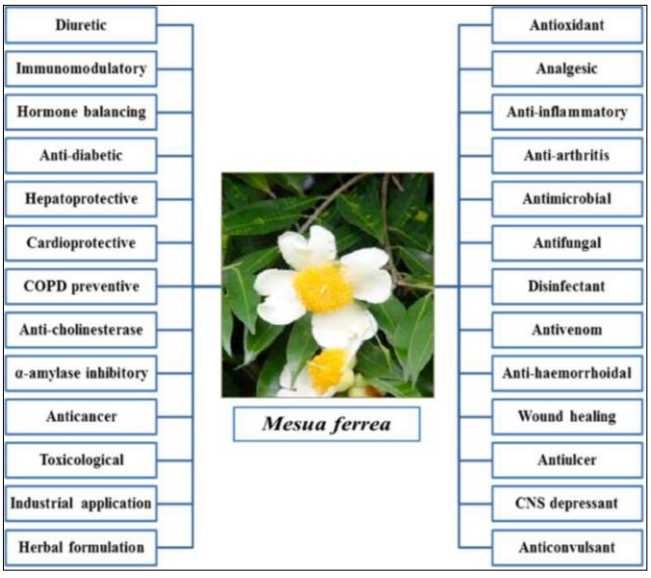

Fig 1: Various pharmacological activities of *Mesua ferrea* (Sharma *et al*., 2017) [26]

Mesua ferrea exhibits a wide range of pharmacological activities; however, this review specifically focuses on the pharmacological activities of *Mesua ferrea* seed oil.

Pharmacological activities of *Mesua ferrea* (nahor) seed oil

1. Antioxidant activity

Antioxidants are molecules that prevent cellular damage by neutralizing free radicals generated during oxidation reactions (Kunwar & Priyadarsini, 2011) [16]. The chemical antioxidants are suspected of being responsible for liver damage and carcinogenesis in laboratory animals. Therefore, the development and utilization of most potent antioxidants of natural origin are required (Chahar *et al*., 2013) [7].

The seed oil extracted from *Mesua ferrea* exhibits significant *in vitro* antioxidant activity, largely attributed to phenolic compounds that enhance or complement this effect (Chahar *et al*., 2012b) [5]. The phenolic components such as flavanoids, phenolic acids and phenolic diterpenes shows strong antioxidant activity due to their redox properties, which can play important role in chelating transitional metals, absorbing and neutralizing free radicals, quenching singlet and triple oxygen, or decomposing peroxides (Chahar *et al*., 2012b) [5]. Chachar and his co-workers investigated on *in-vitro* antioxidant activity of *Mesua ferrea* L. seed oil. The study found that *Mesua ferrea* seed oil exhibits significant antioxidant properties, with an EC50 value for free radical scavenging activity at 10.25 µg/ml. The total phenolic content is measured at 121.5 µg GAE/ml, indicating a strong capacity to neutralize free radicals (Chahar *et al*., 2012b) [5]. In a similar study on *in-vivo* antioxidant and immunomodulatory activity of mesuol by the same group of researchers found that, mesuol prevented cyclophosphamide-induced immunological and oxidative stress changes, with effects comparable to vitamin C. As a bioflavonoid, mesuol exhibited strong antioxidant activity in DPPH, ABTS, FRAP assays and high phenolic content, suggesting its immunomodulatory effect is mediated by antioxidant activity (Chahar *et al*., 2012a) [4].

2. Antimicrobial and disinfection properties:

Antimicrobial activity involves killing or inhibiting disease-causing microbes. Plant-derived antimicrobials are effective against infectious diseases, often with fewer side effects

than synthetic agents, and higher plants represent a valuable source of new antimicrobial compounds with novel mechanisms of action (Chanda *et al*., 2013; Khameneh *et al*., 2019) [10, 13]. *Mesua ferrea* seed oil demonstrates antimicrobial activity against various pathogens, making it a potential candidate for treating infections (Chahar *et al*., 2013) [7]. Ethanolic seed extract shows antibacterial activity, particularly against Gram-positive bacteria (e.g., *Bacillus cereus, Staphylococcus aureus*) (Chakraborty *et al*, 2023) [8]. A study by Chanda *et al*. reported that *Mesua ferrea* seed extracts prepared with organic solvents exhibited stronger antimicrobial activity than aqueous extracts. Lipophilic extracts were more effective, particularly against Gram-positive bacteria, likely due to essential oils, xanthones, and coumarins in the seeds. Gram-negative bacteria, yeast, and moulds were comparatively less susceptible, possibly because of their more complex or multilayered cell wall structures. These findings suggest that *M. ferrea* seed extracts may be useful against emerging drug-resistant microorganisms (Chanda *et al*., 2013) [10]. Another study by Rawat & Upadhyaya found that the seed extract from different solvents (hexane, methanol, aqueous) showed activity against *S. aureus, B. subtilis, E. faecalis, B. cereus, P. aeruginosa, Proteus vulgaris*, but not *E. coli*. *Proteus vulgaris and B. subtilis* were most sensitive to hexane/methanol extracts (Rawat & Upadhyaya, 2013) [25].
Adewale *et al*. (2011) [1] evaluated the disinfection potential of *Mesua ferrea* seed kernel oil (NSKO) using the pour plate method. The study demonstrated effective bacterial inactivation in surface water, indicating NSKO as a promising natural alternative to chlorine. Kinetic analysis showed that the disinfection process followed a first-order model with a reaction constant (k) of −0.040. The NSKO emulsion exhibited superior disinfection efficiency, achieving complete inactivation at 2 mg/ml, while results at 1 mg/ml also conformed to first-order kinetics, confirming its strong disinfectant potential (Adewale *et al*., 2011) [1].

3. Antiarthritic Activity

Rheumatoid arthritis (RA) is an autoimmune disorder causing progressive, irreversible damage to synovial joints, leading to pain, deformity, and loss of function. Current drug therapy includes NSAIDs for symptomatic relief and DMARDs for disease management; however, these treatments mainly control pain and inflammation and have limited ability to halt underlying immune-inflammatory processes or prevent cartilage and bone destruction (Mandavkar, 2010) [18]. In a study by Jalalpure and his co-workers on anti-arthritis activities of *M. ferrea* seed extracts, using two different *in vivo* models i.e., formaldehyde-induced and Complete Freund's Adjuvant (CFA) -induced arthritis in rats. In formaldehyde-induced model, significant reduction in the swelling of formaldehyde injected paw was observed in the seed extract treated rats compared to the control animals. Similarly, in CFA model, reduction in the arthritis lesions as noted by swelling volume in CFA injected paw was observed in *M. ferrea* seed extracts treated animals. An increase in body weight of *M. ferrea* seed extract treated rats was also observed, while in control CFA injected rats a decrease in body weight was observed at the end of treatment (Jalalpure *et al*, 2011) [12].

4. Anti-inflammatory Activity

Pain and inflammation are a pathophysiological response of living tissue to undesirable stimuli. Inflammation leads to the local accumulation of plasmic fluid and blood cells. The pharmacology of pain has become a complex field and mediators involved in the inflammatory reaction can induce, maintain or aggravate many diseases. More recently, completely synthetic compounds based on natural pharmacophores have been introduced into the market but, research and medical fields still struggle with side-effect profiles from these analgesic and anti-inflammatory substances that are undesirable. Therefore, development of newer and more substantial analgesic and anti-inflammatory drugs with lesser side-effects is necessary [18]. Traditionally *Mesua ferrea* is used in inflammation and septic conditions, to poultice wounds and skin eruptions. Carrageenan induced rat paw edema is a suitable test for evaluating anti-inflammatory drugs and has been frequently used to assess the anti-edematus effects of natural products (Asif *et al*., 2017; Chahar *et al*., 2012c) [3, 6]. Chachar *et al*. 2012 found that mesuol from seed oil exhibited significant antinociceptive (pain-reducing) and anti-inflammatory effects in standard mouse and rat models (acetic-acid writhing, hot plate, tail immersion, carrageenan paw edema), by reducing paw edema volume in a dose dependent manner (Chahar *et al*., 2012c). [6] The anti-inflammatory activity may be due to the inhibition of release of pro-inflammatory mediators of acute inflammation such as histamine and prostaglandin. Histamine is one of the important inflammatory mediators and is a potent vasodilator substance and increases vascular permeability. Thus, it can be estimated that the Mesuol may exerts anti-inflammatory effects by inhibiting the synthesis, release or action of inflammatory mediators *viz.* histamine, serotonin and prostaglandin involved in inflammation (Chahar *et al*, 2012c) [6].

5. Immunomodulatory Activity

Immunity is a balanced physiological process that enables the body to recognize and eliminate foreign substances. Immunomodulators are natural or synthetic agents that regulate immune responses by stimulation or suppression. Herbal immunomodulators influence both innate and adaptive immune systems to maintain immune homeostasis (Kumar *et al*., 2012) [15].
Seeds extracts of *M. ferrea* also display radioprotective and immunomodulatory effects against radiation-induced damage in mice and lymphocytes (Murthuza & Manjunatha, 2018) [21]. Immunomodulatory activity of *Mesua ferrea* seed oil are proved by studying the effect of mesuol isolated from the seed oil of *M. ferrea* on the immune system by using both humoral and cellular immune models (Chahar *et al*., 2012a) [4]. In a study performed by Chahar *et al.* on the immunomodulatory activity of mesuol, they found significant increase in the antibody titer values in rats which were previously antibody challenged and immunized by the introduction of sheep red blood cells (SRBCs) followed by immunosuppression by cyclophosphamide (Chahar *et al*., 2012a) [4]. Mesuol also shows cellular immune responses in cyclophosphamide-induced immunosuppressant rats due to the stimulation of T-cells. The mesuol treated rats shows increase in the thickness of food pads when exposed to sheep red blood cells (SRBCs, which are used as an irritant) (Chahar *et al*., 2012a) [4].

6. Other activities of *Mesua ferrea* seed oil

Apart from pharmacological attributes, numerous studies have highlighted the industrial applications of *M. ferrea*

seed oils as an alternative biofuel in the diesel and compression ignition engines, in paint industry, as a multi-purpose industrial coating preparation and as biomaterials (nanocomposites etc.). Some of the activities are as follows:

6.1 Pharmacological excipient

Pharmaceutical excipients play the greatest role in modern pharmaceutical dosage forms. Pharmaceutical excipients act as a vehicle to carry the API to the desired site of drug action in the desired dosage form. These vehicles can be either solid or different types of liquids.

Chakraborty with his coworker investigated for successful extraction and evaluation of *M. ferrea* L. seed oil as pharmaceutical excipient. The TLC and LC-MS study showed the oil composed of fatty acids similar to any USP grade oil. The acute toxicity study and MTT assay suggested the safety profile of the oil at cellular level in the living system. DSC and FT-IR study confirmed no chemical interaction with the general components of the lipid nanoparticles. Hence, *M. ferrea* L. seed oil could be effectively used as an excipient in the pharmaceutical nanoformulation (Chakraborty & Das, 2017) [9]. In another study by Lahan, (2024) [17] demonstrated the successful use of *Mesua ferrea* seed oil as a pharmaceutical excipient in resveratrol-loaded nanostructured lipid carriers (NLCs). The optimized formulation produced stable, spherical, and homogeneous nanoparticles with high entrapment efficiency and controlled drug release. The NLCs enhanced incorporation and delivery of poorly water-soluble resveratrol, highlighting the potential of *M. ferrea* seed oil in pharmaceutical nanoformulations (Lahan, 2024) [17].

6.2 Bio lubricant

Bio lubricants are generally prepared by chemical modification of plant-based oils such as tranesterification, epoxidation and esterification reaction. Mohamed and his coworkers reported that *Mesua ferrea* seed oil, obtained as a dark yellow extract, showed suitable properties for biolubricant production. The oil exhibited high free fatty acid content (7%), iodine value of 77.3 mg/g, phosphorus value of 33.5 ppm, and saponification value of 101.5 mg KOH/g, with an average molecular weight of 539.74 g. Viscosity optimization studies revealed that reaction temperature, time, and catalyst dosage significantly influenced lubricant quality, with near-benchmark viscosity achieved at temperatures above 150 °C, 80 minutes reaction time, and 0.8% catalyst (Mirghani *et al*., 2012) [19].

Conclusion

Mesua ferrea is widely used in India and other parts of the world for its medicinal and industrial importance. Traditionally, it has been employed as an astringent, stomachic, expectorant, analgesic, anti-inflammatory, antioxidant, antimicrobial, immunostimulant, and in conditions such as bleeding piles and burning sensation of the feet. The plant is a rich source of secondary metabolites, including phenyl coumarins, xanthones, triterpenoids, fats, and flavonoids, and is an ingredient of several Ayurvedic and Unani formulations. The seed oil exhibits diverse pharmacological activities such as antioxidant, antimicrobial, immunomodulatory, anti-arthritic, anti-inflammatory, and water disinfectant properties, attributed to phenolic compounds, essential oils, xanthones, and coumarins. Additionally, it has applications as a biofuel, biolubricant, pharmaceutical excipient, and in polymer and paint industries.

Although *Mesua ferrea* is having multiple health promoting benefits, several limitations remain, as most studies rely on preliminary *in vitro* assays. Further research is required to validate activities through advanced experimental models, assess pharmacokinetics, conduct comprehensive toxicity studies, and identify molecular targets, which may support the development of safe, cost-effective, natural therapies for chronic disorders.

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