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Phytopharmaceutical and pharmacological aspects of "*Pongamia pinnata*"-a comprehensive review

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Abstract

In the last few decades the importance of medicinal plant and its vitality in modern medicine has played a pivotal role in drug discovery and its development. The vast novelty, efficacy and least side effects of the plants have gained the attraction of the researchers, which has led to the exploitation of many traditional medicinal plants and herbs for their therapeutical activities. Even through these efforts there are still some traditional plants that are yet to be exploited for their therapeutic significance, one of such prominent plants is *Pongamia pinnata*. The plant shows diverse pharmacological activities due to presence of many primary and secondary metabolites. This diversity of many phytoconstituents like alkaloids, flavonoids, tannins, glycosides and other which may be the reason for its pharmacological activities which include wound healing, anti-inflammatory, antibacterial, anti-ulcer, anti-filarial, anti-diabetic and other activities. The present study is an effort to compile all the available details regarding the characteristics of the plant species, phytoconstituents, traditional use, pharmacological uses and research undertaken related to *P. pinnata*.

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Introduction

History reveals that the plants are the main source of medicine for treatment of various diseases. Different parts of plants such as root, stem, bark, leaves, flowers, fruits, seeds etc, have their own significance in terms of efficacy and potent medicinal properties and have been used as ailment to treat and prevent disease like ulcer, cancer, diabetes, infections etc. [1].

Different pharmacological activity of plants is because of the presence of different classes of phytoconstituents such as alkaloids, triterpenoids, phenols, flavonoids, isoflavonoids, coumarins and phytosterols [2].

The development of herbal medicine in the last few decades has led to identification of novel compounds and development of new formulations which have been used for treatment of various diseases. In the list of such herbal plants *Pongamia pinnata* can be considered as a prominent species [3].

Botanical distribution and important characteristic Geographical distribution

Pongamia pinnata is native to tropical and temperate South Eastern Asia, including Africa, India, Hawaii,

Oceania, Florida, Philippines, Pakistan, China, Bangladesh, Thailand, Seychelles, Malaysia and Australia. In India, It is prominently distributed in Maharashtra and along the Indian coastal regions [4].

Morphology

Pongamia pinnata [Fig.1] is a glabrous evergreen deciduous tree which grows up to 15–25 meter; it's a legume tree with a huge spreading canopy with linear or curved stem [Fig. 3] of 50–80 cm diameter and smooth or vertical grey-brown bark. The branches are hairless and have pale stipulate scars. The alternate imparipinnate leaves [Fig. 2] of the tree are short-stalked, round or cuneate at the base, young leaves are a delicate, glossy burgundy in color; as the season passes, they develop to a shiny, deep green leaves with pronounced veins [5, 6].

Flowering usually begins at 3–4 years, with little bunches of white, purple, or pink flowers [Fig. 4] which bloom throughout the year. The raceme-like inflorescences produce two to four fragrant flowers that measure 15–18 mm [0.59–0.71 in] in length. The flowers' calyx is truncated and bell-shaped, while the corolla has a rounded oval form having basal auricles and a green splotch in the center. The seeds [Fig. 6] of *Pongamia pinnata* are elliptical in shape and covered with a hard shell [Fig. 5] that appears brown in color at the time of maturity. An average weight of *P. pinnata* seed is 3.18g and its thickness varying form thickness from 5.00-10.00mm [7].



Fig. 1: *P. pinnata* tree



Fig. 2: Leaves

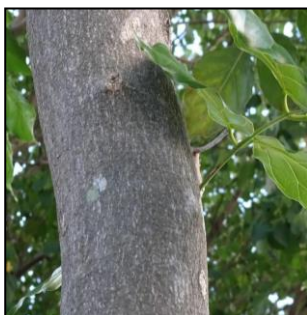


Fig. 3: Stem



Fig. 4: Flower



Fig. 5: Pods



Fig. 6: Seeds

Table: 01 Botanical classification [8] and vernacular information [9]

Content	Details
Botanical classification	Kingdom: Plantae Division: Magnoliophyta Class : Magnoliopsida Order : Fabales Family : Leguminosae Genus : <i>Pongamia</i> Species : <i>Pinnata</i>
Botanical name	<i>Pongamia pinnata</i> Linn
Synonyms	<i>Millettia pinnata</i> <i>Pongamia glabra</i> <i>Derris indica</i> <i>Cytisus pinnata</i>
Vernacular names	Kannada : Honge Sanskrit : Ghrtakarauja Telugu : Ganuga Hindi : Karuaini Tamil : Pongana Urdu : Karanja Malayalam : Pungu Gujarati : Kanaji Bengali : Dahara

Table: 02 Photochemical constituents [3, 4, 9-14]

Part of the plant	Chemical constituent
<i>Pongamia pinnata</i>	
Leaf	Fisetin tetramethyl ether, 3,7-dimethoxyflavone, Luteolin, 7-O-ethylchrysin, 7,4'-dimethoxy-5- hydroxy flavone, Kaempferol, Quercetin.

Flower	Fisetin tetramethyl ether, Demethoxykanugin, 3,7-dimethoxyflavone, Luteolin, 7-O-ethylchrysin, 7,4'-dimethoxy-5-hydroxy flavone, Kaempferol, Quercetin.
fruits	Fisetin tetramethyl ether, 3,7-dimethoxyflavone, Luteolin, 7-O-methylchrysin, 7,4'-dimethoxy-5-hydroxyflavone, Kaempferol, Quercetin
Seeds	Karanjin, Pongaflavone, karanjachromene, Isopongachromene, Gamatin, Kanjone
bark	Karanjin, Kanugin, Demethoxykanugin, Fisetin tetramethyl ether, 3,7-dimethoxyflavone, Luteolin, 7-O-methylchrysin, 7,4'-dimethoxy-5-hydroxy flavone, Kaempferol, Quercetin
Roots	Karanjin, Kanugin, Demethoxykanugin, Fisetin tetramethyl ether, 3,7-dimethoxyflavone, Luteolin, 7-O-methylchrysin, 7,4'-dimethoxy-5-hydroxyflavone, Kaempferol, Quercetin, pongapin

Traditional Uses

It evident that traditionally a few species of *Pongamia* have been and are being used as a drug in the native system of medicine to treat various illnesses. Different parts of *P. pinnata* are traditionally used since ancient times; roots of this plant are used to treat wounds, inflammation, dog bite, skin disease, vaginal infection etc. [3]. Crude root is used as toothbrush for maintaining oral hygiene; root juice is used for cleaning of ulcers. Leaves are used to treat cancer, diabetes, ulcer, and microbial infection. Flowers of this plant are used to treat bleeding haemorrhoids and diabetes; fruits are used for treatment of abdominal ulcers, tumours, and haemorrhoid [9]. Seed powder is used as antipyretic, whooping cough treating bronchitis, whooping cough and as a febrifuge. Bark is used to treat coughs, cold,

mental disorder, Hypotension, malaria etc. [04]. The seed oil is also used as a coagulant also used in treatment of leprosy, stomach pain, chronic ulcers and joint pain. The exudate from the barks is used in treatment of fish bites [11].

Pharmacological activities

Antibacterial activity

The present study showed the antimicrobial activity of various parts of *Pongamia pinnata* against several bacterial pathogens. Antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*, the results indicated that chloroform fraction showed potent activity. The extracts used in the study need to be further processed and may be used in large scale production for commercial and pharmaceutical applications in future [15].

Anti-inflammatory activity

Hydro-alcoholic [70%] extracts of *P. pinnata* leaves showed significant anti-inflammatory activity in severe, sub-acute and constant inflammation models. The report suggested that the leaves extract showed remarkable anti-inflammatory activity [16]. The aqueous extract obtained from bark of *P. pinnata* were reported to possess anti-inflammatory activity at doses of 400 mg/kg and 800 mg/kg were screened by sever and constant inflammation models using carrageen-provoked rear mitt edema and cotton pellet granuloma in albino rats [17].

Anti-psoriatic activity

Evaluation of anti-psoriatic activity of formulation containing *P. pinnata* leaves hydro alcoholic extract was evaluated using imiquimod-induced psoriatic mouse model. The results indicated noteworthy activity by reducing the psoriasis by decreasing the scaling of the skin [18].

Anti-convulsant activity

Petroleum ether extract of stem bark of *P. pinnata* at different concentrations were evaluated for their anticonvulsant efficacy in picrotoxin, pentylenetetrazol, strychnine, maximal electro shock, and isoniazid induced models. The results indicated that petroleum ether extract was found to have a good anticonvulsant effect in pentylenetetrazol and maximal electro shock model [19].

Antidiabetic activity

Antidiabetic potential of the ethanolic and ethanolic extract of stem bark of *P. pinnata* was evaluated employing Alloxan monohydrate induced diabetic rat model the results indicated that both the extract showed

potent activity but ethanolic extracts showed significant reduction in the serum biomarkers level [20].

Anti-filarial activity

Alcohol and aqueous extract of *Pongamia pinnata* leaves and flowers was evaluated by Invitro assays employing spontaneous movements of whole worm and nerve-muscle preparation of *S. cervi*. Both the extracts showed potential anti-filarial efficacy against the Cattle Filarial Parasite [21].

Antioxidant activity

Antioxidant activity of chemically synthesised Ag NPs from the leaves of *Pongamia pinnata* by DPPH, ABT+, Hydroxyl radical, Superoxide anion, and Nitric oxide scavenging assays revealed that the leaf extract showed potent activity. Ethyl acetate extracts from the seeds of *P. pinnata* displayed highest total phenolic content and total flavonoid content of 1.23 ± 0.04 g GAE g^{-1} and 0.95 ± 0.05 g CE g^{-1} respectively with total antioxidant displaying a IC_{50} value of 18.47 ± 0.33 μgml^{-1} [22].

Antinociceptive and Antipyretic Activity

The leaves of *P. pinnata* have been reported to have antinociceptive and antipyretic properties. The rats and mice were assessed for their body's response to potentially toxic stimuli against 70% ethanolic fraction of *P. pinnata* leaves in dissimilar pain sculptps. *P. pinnata* leaves extract was as well tested for its commotion against fever in rats with Brewer's yeast-induced fever. The extract of *P. pinnata* leaves was found to have momentous antinociceptive and commotion against fever [23].

Antiviral activity

The antiviral activity of an ethanolic extract of *Pongamia pinnata* leaves was tested and shown to be effective against White Spot Syndrome Virus in *Penaeus monodon* model. The coarse aqueous seed extract was evaluated for its anti-viral activity, the results suggested that extract fully hindered the development of herpes simplex virus both type-1 and type-2 at concentrations of 1 and 20mg/ml respectively without any cytopathic effect. The rotavirus was not affected by a crude extract of dried leaves [24].

Nano-pesticidal effect

Zinc oxide nanoparticles of *Pongamia pinnata* leaf extract were evaluated for their pesticidal activity; the results indicated that the nanoparticles were potent enough to cause toxicity against Pulse beetle called *Callosobruchus macula* [25].

Anti-diarrheal activity

The antimicrobial outcome of decoction of dehydrated leaves of *P. pinnata* was evaluated against *Escherichia coli*

labile toxin, *E. coli* stable toxin, and cholera toxin that are harmful to the digestive system was studied and were proven to have good anti-diarrheal activity [26].

Cardio protective property

The evaluation of petroleum ether fraction from stem howl of *P. pinnata* on streptozotocin-nicotinamide induced diabetic rat model. The outcome of the study indicated decrease in cardiomyopathy in diabetic rats [27].

Wound healing activity

The present studies results confirm that potent significant wound healing activity of *P. pinnata*. Wound contraction, increased tensile strength, increased hydroxyproline and hexosamine content, modulation of pro inflammatory and anti-inflammatory cytokine, moderate antimicrobial activity and *In-vivo* antioxidant activity explains the reputed wound healing observed [28].

Anti-ulcer activity

Methanol root extract of *P. pinnata* was evaluated for its anti-ulcer property against aspirin induced ulcers and was shown to have significant protection against mucosal damage along with potential to reduce acetic acid induced ulcers. The mucosal protection factors such as mucin secretion, mucosal cell glycoprotein, mucosal cell life span, cell proliferation, and lipid peroxidation prevention were stopped [28].

Neuroprotective activity

Ethanol extract of *P. pinnata* stem bark was evaluated for its neuroprotective activity in rats induced with mono sodium glutamate neurotoxicity. *P. pinnata* stem bark ethanolic fraction at the dose of 200 and 400 mg/kg was given orally. The ethanolic extract of *P. pinnata* plant stem bark has significant neuroprotective activity in albino rats and was found to possess activity in comparison with that of standard drug Dextromethorphan and thus can be used as a potential neuroprotective agent [29].

Anticonvulsant property

The petroleum ether fraction of *P. pinnata* branch growl and its portions were tested for anticonvulsant efficacy in laboratory animals by scientists. The effects of picrotoxin, pentylenetetrazol, strychnine, maximal electroshock, and isoniazid on mice have been studied using *P. pinnata* branch growl petroleum ether fraction. *P. pinnata* stem bark petroleum ether extract was found to have a good anticonvulsant effect [30].

Application of *Pongamia pinnata* in Biofuel industry

Mature karanja seeds have recently attracted the attention of commercial importance as an alternate

energy source because to their high oil content. The primary element of Karanja oil is furan. Among the substances discovered are flavones, karanjin, pongapin, kanjone, pongamol, and a diketone.

Oil-producing crop plants are critical for the energy and farming' economic growth. Biodiesel is produced from oil seeds that contain polyunsaturated fatty acids. In terms of physico-chemical characteristics and biodegradability, these organic seed oils outperform diesel fuels. *Pongamia pinnata* is one of these plant species. More research is needed to use this species as a biodiesel and biomedical source. Additionally, having an elite genotype of *P. pinnata* producing high oil-yielding seeds is critical for increasing biodiesel output.

The candidate plus tree [CPT] is a *P. pinnata* individual tree with superior morphological characteristics [girth, height, leaf number g wt-1, number of buds inflorescence-1, amount of blooming inflorescence-1, number of seeds inflorescence-1] compared to other individuals of the same species [31].

Conclusion

In the past few decades, the advancement of science and technology has encouraged the progress of research and field of medicine. This progress has led to the new discoveries and identification of new compounds from plant origin. Herbal medicine has been used since ancient times and has a huge impact on treatment of diseases and maintenance of human health. In this current review an effort was made to compile the implication of *Pongamia pinnata*, a tree with prominent traditional uses with diverse Phyto-chemical constituents and pharmacological activities. The literature survey revealed that the plant has already been exploited for its vast pharmacological activities and there were major reports regarding the therapeutic potency of its isolated compounds. These isolated compounds along with its extracts and fractions have been reported to have anti-inflammatory, wound healing, anti-diarrhoeal, anti-malarial, anti-cancer, anti-diabetic, anticonvulsant, neuroprotective, antipyretic, cardio protective, hepatoprotective, antiviral and many more diseases. Along with these activities it can be used as a source of biodiesel playing an important role in society. *P. pinnata* can be listed as one among many medicinally and economically valuable species and further more research towards its bio-actives and the principle behind its molecular mechanism can be done, formulated into novel formulation with more potent yield and efficacy.

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