

# *Pongamia pinnata*: Phytochemical constituents, Traditional uses and Pharmacological properties: A review

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Many herbal remedies individually or in combination have been recommended in various medical treatises for the cure of different diseases. The *Pongamia pinnata*, commonly known as 'Karanj', has been recognized in different system of traditional medicines for the treatment of different diseases and ailments of human beings. It contains several phytoconstituents belonging to category flavonoids and fixed oils. The fruits and sprouts of *P. pinnata* were used in folk remedies for abdominal tumours in India, the seeds for keloid tumours in Sri Lanka and a powder derived from the plant for tumours in Vietnam. In Sanskrit India, seeds were used for skin ailments. Today, the oil is used as a liniment for rheumatism. Leaves are active against *Micrococcus*; their juice is used for cold, cough, diarrhoea, dyspepsia, flatulence, gonorrhoea and leprosy. Roots are used for cleaning gums, teeth and ulcers. Bark is used internally for bleeding piles. Juices from the plant as well as oil are antiseptic. In the traditional systems of medicines, such as Ayurveda and Unani, the *P. pinnata* plant is used for anti-inflammatory, anti-plasmodial, anti-nonciceptive, anti-hyperglycaemics, anti-lipidoxidative, anti-diarrhoeal, anti-ulcer, anti-hyperammonic and antioxidant. Its oil is a source of biodiesel. It has also alternative source of energy, which is renewable, safe and non-pollutant.

**Key words:** Karanj, *Pongamia pinnata*, phytochemical constituents, traditional uses and pharmacological properties

## INTRODUCTION

*Pongamia pinnata* pierre [Synonyms: *Derris indica* (Lam.) Bennett, *Milletia novo-guineensis* Kane and Hat, *Pongamia glabra* Vent., *Pongamia pinnata* Merr.] belonging to the family Fabaceae (Papilionaceae). It is also called *Derris indica* and *Pongamia glabra*.<sup>[1]</sup> It is a medium-sized evergreen tree with a spreading crown and a short bole. The tree is planted for shade and is grown as ornamental tree. It is one of the few nitrogen fixing trees producing seeds containing 30-40% oil. It is a fast growing, glabrous, deciduous, trunk diameter to 60 cm, bark smooth, gray. Leaves - imparipinnate, shiny, young, pinkish red, mature leaves glossy and deep green; leaflets - 5-9, the terminal leaflet larger than the others, stipels none, stipules caduceus. Flowers - fragrant, white to pinkish, paired along rachis in axillary, pendent, long racemes or panicles, cup-shaped, truncate, short-dentate, lowermost lobe sometimes longer; standard suborbicular, broad, usually with two inflexed basal ears, thinly silky-haired outside; wings oblique, long, somewhat adherent to the obtuse keel; keel petals coherent at apex, stamens Monadelphous, vexillary stamen free at the base but joined with others into a closed tube, ovary subsessile to short-stalked, pubescent;

ovules two, rarely three, glabrous; stigma small, terminal. Pod short stalked, oblique-oblong, flat, smooth, thickly leathery to subwoody, indehiscent, one-seeded, seed thick. It is an Indo-Malaysian species, a medium-sized evergreen tree, common on alluvial and coastal situations from India to Fiji, from sea level to 1200 m. Now found in Australia, Florida, Hawaii, India, Malaysia, Oceania, Philippines and Seychelles. It is commonly known as Karanj.<sup>[2]</sup> The present review will possibly help to the bridge between traditional claims and modern therapy on *P. pinnata*.

## TRADITIONAL USES

The fruits and sprouts are used in folk remedies for abdominal tumours in India, the seeds for keloid tumours in Sri Lanka and a powder derived from the plant for tumours in Vietnam. In Sanskrit India, seeds were used for skin ailments. Today, the oil is used as a liniment for rheumatism. Leaves are active against *Micrococcus*; their juice is used for cold, coughs, diarrhoea, dyspepsia, flatulence, gonorrhoea and leprosy. Roots are used for cleaning gums, teeth, and ulcers. Bark is used internally for bleeding piles. Juices from the plant as well as the oil are antiseptic. It is said to be an excellent remedy for itch, herpes and pityriasis versicolor. Powdered seeds are valued as a febrifuge, tonic and in bronchitis and whooping cough. Flowers are used for diabetes. Bark has been used for beriberi. Juice

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of the root is used for cleansing foul ulcers and closing fistulous sores. Young shoots have been recommended for rheumatism. Ayurvedic medicine described the root and bark as alexipharmic, anthelmintic and useful in abdominal enlargement, ascites, biliousness, diseases of the eye, skin and vagina, itch, piles, splenomegaly, tumours, ulcers and wounds; the sprouts, considered alexiteric, anthelmintic, aperitif and stomachic, for inflammation, piles and skin diseases; the leaves, anthelmintic, digestive and laxative, for inflammations, piles and wounds; the flowers for biliousness and diabetes; the fruit and seed for keratitis, piles, urinary discharges and diseases of the brain, eye, head and skin, the oil for biliousness, eye ailments, itch, leucoderma, rheumatism, skin diseases, worms and wounds. Unani system uses the ash to strengthen the teeth, the seed, carminative and depurative, for chest complaints, chronic fevers, earache, hydrocele and lumbago; the oil is used as fuel for cooking and lamps.<sup>[3]</sup> The oil is also used as a lubricant, water-paint binder, pesticide and in soap-making and tanning industries. The oil is known to have value in folk medicine for the treatment of rheumatism, as well as human and animal skin diseases. It is effective in enhancing the pigmentation of skin affected by leucoderma or scabies.

## PHYTOCHEMISTRY

Six compounds (two sterols, three sterol derivatives and one disaccharide) together with eight fatty acids (three saturated and five unsaturated) have been isolated from the seeds of *P. pinnata*. Their structures were elucidated with the help of physicochemical methods and spectroscopic techniques. The metabolites, beta-sitosterol acetate and galactoside, stigma sterol, its galactoside and sucrose are being reported for the first time from this plant. The saturated and unsaturated fatty acids (two monoenoic, one dienoic and two trienoic) were present in exactly the same amount. Oleic acid occurred in highest amount (44.24%), stearic (29.64%) and palmitic (18.58%) acids were the next in quantity. Hiragonic and octadecatrienoic acids were present in trace amounts (0.88%). Karangin, pongamol, pongagalabrone and pongapin, pinnatin and kanjone have been isolated (Figs. 1 and 2) and characterized from seeds. Immature seeds contain a flavone derivative 'pongol'. The other flavonoid isolated from the seeds includes 'Glabrachalcone isopongachromene'. The leaves and stem of the plant consist of several flavone and chalcone derivatives such as Pongone, Galbone, Pongalabol, pongagallone A and B.<sup>[3]</sup>

Chemical investigation of stems of the mangrove plant, *P. pinnata*, resulted in isolation and characterization of five structurally unusual flavonoids pongamones A-E, along with 16 known flavonoid metabolites. Their structures were determined on the basis of spectroscopic analyses

and by comparison of their spectroscopic data with those of related compounds reported in the literature. Pongamones A-E were assayed against DHBV RCs DNAP and HIV-1 RT *in vitro*. A possible biogenetic pathway of the isolated compounds is also proposed.<sup>[4]</sup>

Further investigation of the flavonoid constituents of *P. pinnata* from Japan resulted in the isolation of 18 flavonoid compounds including nine new ones, pongamones III-XI, from its root bark. The new structures were determined to be (2S)-3',4'-dimethoxy-6'',6''-dimethylpyrano[2'',3'':7,8]-flavanone (III), (2S)-6,3',4'-trimethoxy-6'',6''-dimethylpyrano[2'',3'':7,8]-flavanone (IV), (2S)-7-methoxy-6-O- $\gamma,\gamma$ -dimethylallyl-3',4'-methylenedioxyflavanone (V), 2'-hydroxy-3,4,5'-trimethoxy-6'',6''-dimethylpyrano[2''3'':4'3'] chalcone (VI), 2',4'-dimethoxy-3,4-methylenedioxy dihydrochalcone (VII), 2',5', $\beta$ -trimethoxy-3,4-methylenedioxy-6'',6''-dimethylpyrano[2'',3'':4',3'] dihydrochalcone (VIII), 2, $\beta$ -dimethoxy-3,4-methylenedioxy-furano[2'',3'':4',3']-dihydrochalcone (IX),  $\beta$ -hydroxy-2',4',6'-trimethoxy-3,4-methylenedioxy chalcone (X) and 3-methoxy-furano-[2'',3'':7,6]flavone (XI), respectively, by means of spectral analysis and synthesis.<sup>[5]</sup> *Pongamia pinnata* fruits afforded three new furanoflavonoid glucosides, pongamosides A-C and a new flavonol glucoside, pongamoside D. The structures of these compounds were established on the basis of spectroscopic studies. This is the first time that furanoflavone glucosides have been found as naturally occurring compounds.<sup>[6]</sup>

The title compound, C<sub>18</sub>H<sub>12</sub>O<sub>4</sub>, known as pinnatin, is a furanoflavone isolated from *Derris indica* furanoflavone nucleus is almost planar. The phenyl ring is axially attached to the furanoflavone skeleton. The methoxy group deviates slightly from the plane of the molecule. The molecules are linked in a zigzag manner through C-HO interactions into molecular ribbons along the b axis. Further stabilization is provided by weak C-H interactions.

## PHARMACOLOGICAL ACTIVITIES

### Anti-inflammatory Activity

It has been reported that 70% ethanolic extract of *P. pinnata* leaves has potent anti-inflammatory activity against different phases (acute, subacute and chronic) of inflammation without side effect on gastric mucosa. They also observed significant anti-pyretic action of the extract against Brewer's yeast-induced pyrexia.<sup>[7]</sup>

### Anti-plasmodial Activity

It has been reported that *P. pinnata* is one of the plant, which shows anti-plasmodial activity against *Plasmodium falciparum*.<sup>[8]</sup>

### Antioxidant and Anti-hyperammonemic Activity

It has been observed that effect of *P. pinnata* leaf extract on circulatory lipid peroxidation and antioxidant status was evaluated in ammonium chloride-induced hyperammonemia rats. It enhanced lipid peroxidation in the circulation of ammonium chloride-treated rats was accompanied by a significant decrease in the levels of vitamin A, vitamin C, vitamin E-reduced glutathione, glutathione preoxidase, superoxide dismutase and catalase. It showed that PPET modulates these changes by reversing the oxidant-antioxidant imbalance during ammonium chloride-induced hyperammonemia and this could be due to its anti-hyperammonemic effect by means of detoxifying excess ammonia, urea and creatinine and antioxidant property.<sup>[9]</sup>

### Anti-diarrhoeal Activity

It has been evaluated that anti-microbial effect of crude decoction of dried leaves of *P. pinnata* and also evaluated its effect on production and action of enterotoxins (Cholera toxin, *Escherichia coli* labile toxin and *E. coli* stable toxin)

and adherence of enteropathogenic *E. coli* and invasion of enteroinvasive *E. coli* and *Shigella flexneri* to epithelial cells. The decoction had no anti-bacterial, anti-giardial, and anti-rotaviral activities, but reduced production of cholera toxin and bacterial invasion to epithelial cells.

The observed result indicated that decoction of *P. pinnata* has selective anti-diarrhoeal action with efficacy against cholera and enteroinvasive bacterial strains causing bloody diarrhoeal episode.<sup>[10]</sup>

### Anti-ulcer Activity

It has been reported that methanolic extract of *P. pinnata* roots showed significant protection against aspirin and 4 h PL, but not against ethanol-induced ulceration. It showed tendency to decrease acetic acid-induced ulcer after 10-day treatment. Ulcer protective effect of PPRM was due to augmentation of mucosal defensive factors such as mucin secretion, life span of mucosal cells, mucosal cell glycoproteins, cell proliferation and prevention of lipid per oxidation rather than on the offensive acid-pepsin secretion.<sup>[11]</sup>

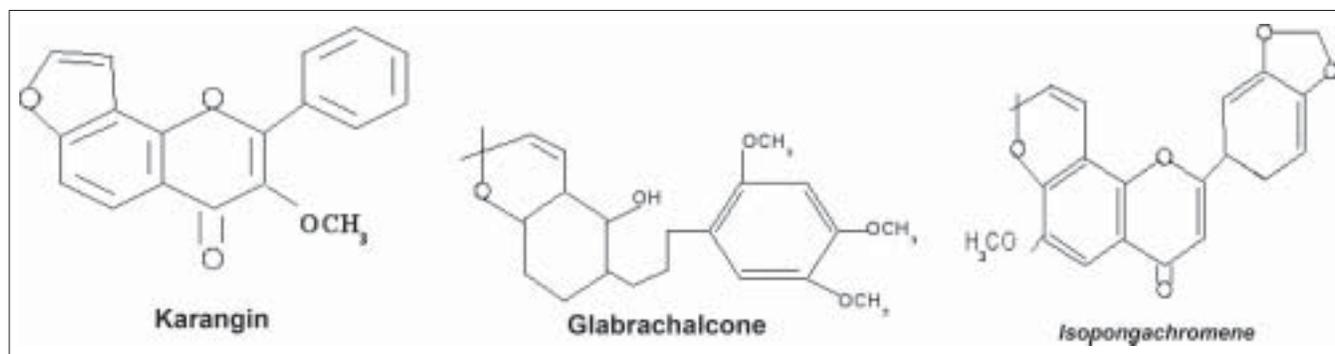


Figure 1: Chemical structure of some phytoconstituents of pongamia pinnata

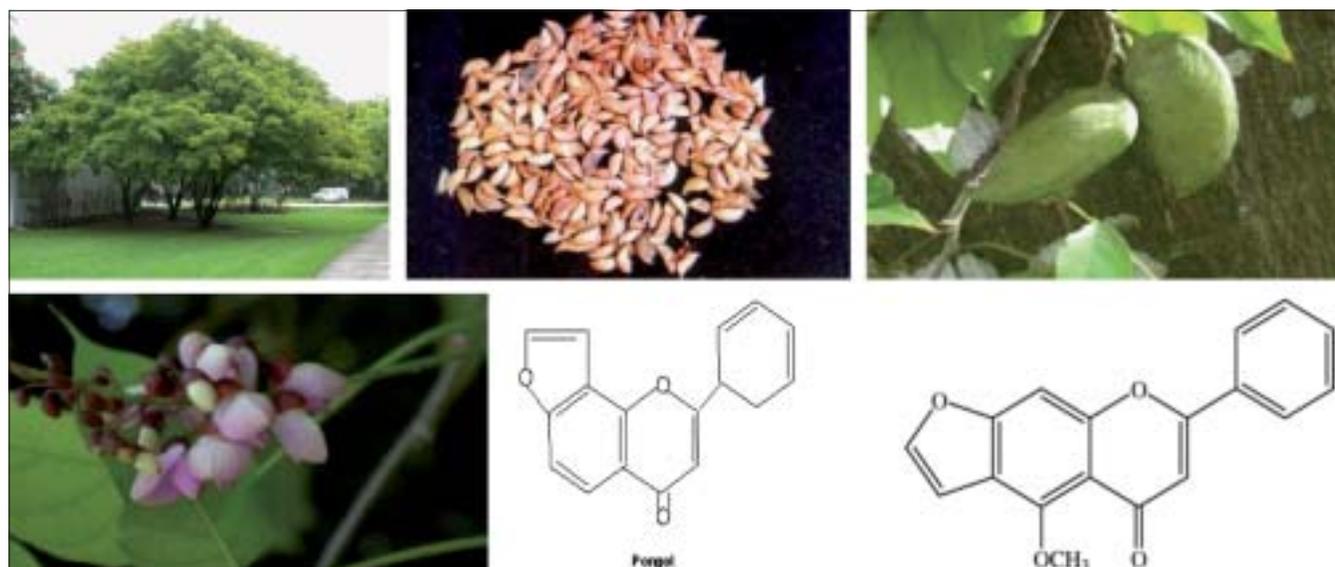


Figure 2: Trees, seeds, fruits, flavors and structure of isolated compounds of *P. pinnata*

### Anti-hyperglycaemic and Anti-lipidperoxidative Activity

It has been reported that oral administration of ethanolic extract of *P. pinnata* flower shows significant anti-hyperglycaemic and anti-lipidperoxidative effect and enhancement in antioxidant defense system in alloxan-induced diabetic rats. These results suggested that the treatment of *P. pinnata* extract could be used as a safe alternative anti-hyperglycaemic drug for diabetic patients.<sup>[12]</sup>

### CONCLUSION

From the time immemorial, plants have been widely used as curative agents for variety of ailments. Concentrated fruits or seeds extract can be found in various herbal preparations are widely available in market today. *Pongamia pinnata* preparation oil is widely available and employed by practitioner of natural health for treatment of rheumatism. In the traditional systems of medicines, such as Ayurveda and Unani, the *P. pinnata* plant is used for anti-inflammatory, anti-plasmodial, anti-nonceptive, anti-hyperglycaemic, anti-lipidperoxidative, anti-diarrhoeal, anti-ulcer, anti-hyperammonic and antioxidant. Its oil is a source of biodiesel. It has also alternative source of energy, which is renewable, safe and non-pollutant.

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