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Pongamia pinnata: an updated review on its phytochemistry, & pharmacological uses

Abstract

The term herb is also acknowledged as botanical medication or usage of herb-based traditional medicinal practice in herbal medicine, and it refers to a herb or plant component that is utilized to formulate remedy to aid in the therapeutic procedure through sickness and ailment. Medicinal plants play an important role in both herbal medicine and modern pharmaceuticals. *Pongamia pinnata (P. pinnata)* has been recognized in different schemes of herbal medication for the treatment of a variety of diseases and ailments in humans. It comprises a variety of phytoconstituents and has a broad variety of pharmacological properties. Because of its thick network of lateral roots, it is a favored plant for managing earth corrosion and connecting sand mounds. The most significant properties of *P. pinnata* is that it can be used as biofuel besides used in the treatment of many diseases like cancers, stiff joints, hemorrhoids, bowel movement, vaginopathy, wound healing, cardioprotective, etc. This analysis examines existing knowledge of common uses, phytochemistry, and biological activities, as well as limitations that require future study.

Keywords: lice, sanskrit, ethanol, cancers, traditional, rats

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Abbreviations: *P. pinnata, Pongamia pinnata; E. coli, Escherichia coli;* PPEt, *Pongamia pinnata* leaf extract; HSV, herpes simplex virus; BW, body weight; IP, Intraperitoneal; PPSB, *Pongamia pinnata* stem bark; *P. aeruginosa, Pseudomonas aeruginosa; S. aureus*, *Staphylococcus aureus*

Introduction

Pongamia pinnata Linn. Pierre is a glabrous hierarchy of medium altitude. *P. pinnata*, also known as *Derris indica*, is a monotypic species (Figure 1) that develops prolifically along Myanmar's beaches and canal reservoirs. The hierarchy is well recognized designed for its many uses and as a possible biodiesel resource.[1] The seeds are said to contain 28% to 34% oil on average, with a high percentage of polyunsaturated fatty acids.[2] *P. pinnata* is an element of the *Fabaceae* folks and is notorious in Telugu as kanuga, Hindi as Karanja, and English as Indian beech. From a botanical standpoint, it's worth noting that the genus nomenclature is especially perplexing since many species from other genera are interchangeable. *Millettia pinnata* Linn. Panigrahi, *Pongamia glabra Vent*, and *Derris indica Lam*. Bennet is all common name for this plant.[3] The following are some of the various vernacular names for *P. pinnata*: Kannada- Honge, hulagilu; Urdu- Karanj; Bengali- Karach; Sanskrit- Naktamala; Punjabi- Sukhchain; Malayalam- Pungu, Punnu.[4] It used to be found only in Asia, but now it can be present in India, Malaysia, Australia, Hawaii, Oceania, Florida, the Philippines, and Seychelles. It was widely grown in India's coastal forests, as well as near streams and rivers.[5] An average mass partially forever green glabrous hierarchy with a small bole and dispersion peak reaching 18 meters or further in altitude, with greyish-green or brown bark blotchy with gloomy brown spots, flecks, stripes or strips; leaflets 5 to 7 ovate, acuminate, or elliptic leaves; crops bulky, timbered, flat, condensed, with a little bowed beak, seeds 1 or 2 per pod, reinform to almost surrounding, horizontal or furrowed, flushed brown rubbery.[6] 6 composites (2 sterols, 3 sterols derived, and 1 double sugar) are found in *P. pinnata* seeds, along with 8 fatty acids (3 saturated and 5 unsaturated). Physicochemical methods and spectroscopic techniques were used to deduce their structures. Seeds have yielded *karangin, pongagalabrone, pongapin, pinnatin*, and *kanjone*. Flavones and chalcone derived for instance *Galbone, Pongone, Pongalbol, Pongagallone* A, and B are found in the plant's leaves and stem.[7] *P. pinnata* fruits contain 3 novel *pongamosides* A-C, *furnoflavanoid* and *glucosides*, as well as *pongamoside* D, a new *flavanol glucoside*. Spectroscopic experiments were used to determine the structures of these compounds. *Furanoflavone glucosides* have been discovered for the first time in naturally occurring compounds.[8] The root extract of *P. pinnata* contains anticancer compounds such as *paclitaxel, fluorophenylalanine, vinblastin, vincristine* (sulfate), *teniposide, fluoxetine,* and *etoposide* derivatives. By applying a combination of lubricating and zinc oxide to skin illnesses, such as sores, herpes, scabies, and parallel cases of eczema, has been beneficial. In the case of a slow liver, the grease has been employed as a medicinal agent that promotes the discharge of bile from the system, purging it downward and promoting the appetite or assisting digestion.[9] Styptic and anthelmintic, oil is beneficial for ulcers, piles, leprosy, persistent pyrexia, and soreness in the liver. Joints or connective tissue disorders, asthma, scabies, and whooping cough are all symptoms of this herb. The powdered seeds are used as a medicine to reduce fever, energizer, treatment of inflammation of bronchioles and whooping cough, irritations, chest infections, hemorrhoids, and anemia are all treated with this herb.[10]

Figure 1 *Pongamia pinnata* Linn.: (A) whole plant, (B) seeds and, (C) leaves.

The leaves decoction is used as a soak or a poultice for stiff joints. The leaves can also be utilized to treat diarrhea and cough. Leaf juice is used to treat flatulence, dyspepsia, and diarrhea.[11] Bleeding piles are treated with young leaves. Flu, tusis, loose or watery bowel movements, indigestion, accumulation of gas in the alimentary canal, sexually transmitted infections such as gonorrhea, and leprosy are all treated with leaf juice.[12] Yawn in a gonorrhea cure through the stem juice used. Watery fractions of stem howl have promoting calm or inducing sleep and properties against fever in the central nervous system. It is also useful for washing unclean boils, teeth washing, and gum reinforcing.[13,14] Bitter anthelmintic roots are utilized to manage vaginal and skin illnesses. The root's juice is used to treat foul sores and close fistulous tenders.[15] Oil flesh of seed is a leprosy treatment inflammation of bronchioles and whooping cough are common uses. Keloid tumors are treated with this drug.[16-18] Used to treat asthma, skin problems, and rheumatoid arthritis. Internally, bark can help with bleeding stacks, hemorrhoids, beriberi, ophthalmopathy, dermatopathy, vaginopathy, and ulcers benefit from its anthelmintic and alexeteric properties. Reduce spleen swelling for bleeding piles and beriberi. Helpful in the management of psychiatric disorders, tusis, and colds.[19] Flowers- To quench thirst in diabetics, dehydrated flowers in residue are combined with further constituents and taken as a decoction. Useful for high blood sugar levels, dyspepsia, and bleeding piles.[20] Fruits are used to treat abdominal tumors and are also useful for female genital tract problems, leprosy, cancers, masses, ulcers, and wind blowing upward in the belly. Wide traditional uses of *P. pinnata* have led scientists to investigate its pharmacological properties and to validate the uses of this species as a therapeutic remedy.[21] Several studies revealed that this plant exhibited various pharmacological activities such as antioxidant, antimicrobial, antiparasitic, anti-inflammatory, anticonvulsant, anti-diabetic, anti-hyperammonemia, cytotoxicity, anthelminthic, and insecticidal activities, etc. Table 1 and Table 2 describes the medicinal uses and pharmacological activities of all parts of this species.

Table 1 The medicinal uses of *Pongamia pinnata* Linn[40-43]

Plant part	Medicinal use
Whole part	Snakebite treatment of tumors, piles, skin diseases, wounds, and ulcers
Root	Wound, gastric treatment, gonorrhea, cleaning gums or teeth, ulcers, and is used in vaginal, and skin diseases
Leaf	Rheumatism, gonorrhea, skin diseases, genitalia, fever, piles, scabies, anthelmintic, diarrhea, dyspepsia, flatulence, glycosuria, antiseptic, blood purifier, and wound treatment
Seed/ seed oil	Keratitis, urinary discharges, piles, ulcer, chronic fever, rheumatism, leukoderma (Vitiligo), lumbago, scabies, leprosy, bronchitis, whooping cough, chronic skin diseases, wound treatment, chronic fever, hypertension, and liver pain
Fruit	Abdominal tumor, and anthelmintic
Flower	Diabetes
Stem/ bark	Diabetes, malaria, bleeding piles, beriberi, anthelmintic, haemorrhoids (Piles), ophthalmopathy, vaginopathy, skin diseases, genitalia, sinus, stomach pain, intestinal disorder, and wound treatment

Table 2 The pharmacological activities of all parts of *Pongamia pinnata* Linn[44-52]

Pharmacological activity	Used plant part	Description
Anthelmintic	Seed	The anthelmintic activity of the methanolic extract of the seeds which needed less time to cause the paralysis and death of Indian adult earthworm, Pherentima posthuma, than the extracts of leaf, wood, bark, and pericarp of the fruit did was further studied. The ethyl acetate extract exhibited higher anthelmintic activity against the earthworm followed by the petroleum ether extract
Antiparasitic	Leaf and bark	The bark and leaf extract with low Half-maximal inhibitory concentration values of 9 to 43µg dry extract/ml has been shown to possess anti-plasmodial activity against Plasmodium falciparum

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Table Continued...

Pharmacological activity	Used plant part	Description
Antihyperammonemic	Leaf	The levels of blood ammonia, circulatory urea, uric acid, non-protein nitrogen, and creatinine increased significantly in rats treated with ammonium chloride and decreased significantly in rats treated with the extract and ammonium chloride. There were no significant changes in the BW of the experimental animals when compared to controls (treatment without ammonium chloride and extract)
Immunomodulatory	Leaf	The aqueous extract showed maximum stimulation on Nitric Oxide activity by the RAW246.7 cells. The extract also induced remarkable production of Interleukin-10
Cytotoxicity	Leaf	The methanolic extract (100 mg/ml) was screened for cytotoxicity against the pancreatic adenocarcinoma cell line Panc-1(human pancreatic cancer), using a label-free biosensor assay. The anti-proliferation activity of the extract was presented as the fraction of Panc-1 cell survival relative to untreated controls after 24 hour-exposure to the plant extract. The extract exhibited anti-proliferation activity of 0.14±0.07 fraction of Panc-1 cell survival. Control cultures and blank wells without cells received 100µL of medium with 0.5% (v/v) of ethanol
Anticonvulsant	Leaf	Treatment of pentylenetetrazole-induced convulsion in Wistar albino rats (80 mg/kg, IP) with the ethanolic extract (250mg/kg, IP) exhibited significant anticonvulsant activity by lowering the duration of the extension phase (3.7270.65) when compared to the control group (8.9470.42). The control used was 1% normal saline (1 ml/100 gm, orally)
Antiviral	Leaf	Oral administration of ethanolic extract of leaves (200 and 300 g extract/g of BW of shrimp/day) increased the survival rate for the White Spot Syndrome Virus-infected shrimp to 40 and 80%, respectively
	Seed	Crude aqueous extract of the seed completely inhibited the growth of HSV type-1 and type-2 at a concentration of 1 and 20 mg/ml (w/v), respectively
Antioxidant	Flower	Oral administration of a methanolic extract from the flowers (150 mg/kg BW/day) once for 90 days substantially increased the levels of enzymatic and non-enzymatic antioxidants on lead acetate-induced hepatic damage in rats
	Fruit	Treatment of hyperlipidemic rats with butanol fraction of the fruit extract decreased plasma levels of total cholesterol, triglyceride, and phospholipid by 29%, 21%, and 21%, respectively
	Root	The ethanolic extract (50mg/kg, orally for 5 days) decreased the ischemia-reperfusion increase in lipid peroxidation, superoxide dismutase activity, and a fall in Thyroid-stimulating hormone levels
	Seed	The methanolic extract of the seeds encouraged the levels of ferric reducing/antioxidant power, 1179 mmol Fe (II)/mg extract), inhibition of β-carotene degradation (41.13%), and radical scavenging activity against 2,2-diphenyl picrylhydrazyl (54.64%) and superoxide (54.53%)
Antibacterial	Fruit	Pre-treatment with methanolic extract of leaves 30 minutes before oral administration of castor oil on diarrhoeic mice (caused by E. coli) reduced the weight of wet feces to 232 mg and 126.6 mg for the concentration of 3 mg and 7.5 mg, respectively. Without pre-treatment with the extract (control), the weight of wet feces was 401 mg
	Leaf	Crude decoction of dried leaves had no activity against E. coli, Shigella flexneri, and Vibrio cholera, but reduced production of cholera toxin and bacterial invasion to epithelial cells
	Seed oil	(a) The oil exhibited antibacterial activity against S. aureus and P. aeruginosa. The maximum activity was recorded at 100%, whereas at 12.5% poor activity was noted. The minimum inhibitory concentration proved that the oil exhibited bacteriostatic activity at higher dilution factors. Clotrimazole and Ampicillin (1 mg/ml) were taken as control (b) The seed oil showed maximum antibacterial activity against Yersinia enterococcai followed by Listeria monocytogens, E. coli, Salmonella paratyphi, respectively. The 90% oil with dimethyl sulfoxide gave more inhibition rather than 100% seed oil. The standard used was Ampicillin (50 mg/ml)
Antifungal	Seed oil	The oil showed higher antifungal activity against Aspergillus niger than against Aspergillus fumigatus. The maximum activity was recorded at 100%, whereas at 12.5% poor activity was noted. Clotrimazole and Ampicillin (1 mg/ml) were taken as control
Antidiabetic	Flower	The oral administration of the ethanolic extract (300 mg/kg BW) demonstrate significant anti-hyperglycemic which considerably reduced the blood glucose concentration to a similar extent to that of the reference drug glibenclamide (600 µg/kg BW) in alloxan-induced diabetic rats
	Leaf	The routine post-treatment with ethanolic extract for 21 days showed potential hypoglycemic activity in oral glucose tolerance test and normoglycemic rats. The extract also exhibited antidiabetic activity in alloxan-induced diabetic rats

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Anti-inflammatory property

The authors demonstrated the anti-inflammatory efficacy of a 70% ethanol fraction of *P. pinnata* leaves in rats in severe, subacute, and constant inflammation representations. These results suggest that the fraction of *P. pinnata* leaves has significant anti-inflammatory commotion without ulcerative activity, suggesting that it may be utilized to cure a range of inflammatory ailments.[22] Albino rats were employed to test the anti-inflammatory efficacy of the watery fraction of *P. pinnata* stem bark in sharp and persistent inflammation sculpts. In together severe carrageenin-provoked rear mitt edema and constant (cotton pellet granuloma) inflammation forms, oral administration of *Pongamia pinnata* stem bark (PPSB) (400, 800 mg/kg) showed strong anti-inflammatory activity. The PPSB has potent anti-inflammatory properties without being ulcerogenic.[23]

Antiviral property

The coarse aqueous seed extract exhibited antiviral activity. It fully hindered the development of herpes simplex virus (HSV) type-1 and type-2 at concentrations of 1 and 20mg/ml (w/v), correspondingly, and showed no cytopathic effect. The rotavirus was not affected by a crude extract of dried leaves. Severe and persistent toxicological experiments in Swiss albino rats demonstrated the protection of *P. pinnata* seed fraction.[24] The commotion against the virus of bis (2-methyl heptyl) phthalate segregated from *P. pinnata* leaves in opposition to White Spot Syndrome Virus of Penaeus monodon Fabricius was examined.[25] In standard rats and alloxan-provoked diabetic rats, the activity against high blood sugar level and lipids peroxidative effects of an ethanol fraction of *P. pinnata* flowers were studied. In alloxan-induced diabetic rats, by mouth administration of an ethanol concentration of *P. pinnata* flowers (300 mg/kg BW) had a momentous effect against high sugar level, anti-lipid peroxidative, and antioxidant defense system enhancement effects. Standard rats treated with *P. pinnata* leaf extract (PPEt) alone, on the other hand, showed no major improvements in blood glucose levels, lipid peroxidation, or antioxidant status. As a result, the PPEt could be utilized as a secure high blood sugar level remedy option for diabetic enduring.[26]

Biofuel from Pongamia pinnata

The physical properties of *P. pinnata* seed oil as biofuel are very close to those of conventional diesel. Biofuel, on the other hand, has cleaner emission properties than traditional diesel. It contains no polyaromatic composites and emits less poisonous burn and dust. In the petroleum diesel generated by Indian plants, an extreme decrease in sulfur substance (350 ppm) and a superior cetane figure of more than 51 will be needed. Biofuel meets these 2 critical requirements and may help improve the greasy of short-sulfur (0.13% to 0.16%) diesel. The current flashpoint requirement for petroleum diesel is 350°C, which is lesser than the global average of >550°C. Biofuel can assist in increasing the flashpoint, which is a safety necessity.[27]

Hepatoprotective property

The hepatoprotective effects of PPEt were investigated during ammonium chloride-induced hyperammonemia. The points of ammonia in circulation, bilirubin, urea, aspartate transaminase, alanine transaminase, alkaline phosphatase, lactate dehydrogenase, gamma-glutamyl transferase, thiobarbituric acid reactive substances, and haptoglobin were all extensively higher in ammonium chloride-managed rats. In PPEt-treated animals, these levels were lower. PPEt appears to provide hepatoprotection in experimental hyperammonemia by affecting the points of lipid peroxidation creations and liver markers, which may be attributed to its capability to become free of harmful substances overload urea, and creatinine, ammonia, as well as its free radical hunting possessions by decreasing lipid peroxidation and the existence of ordinary antioxidants.[28]

Anti-diarrheal property

The antimicrobial outcome of a simple decoction of dehydrated leaves of *P. pinnata* was tested, as well as its effect on the substance that is harmful to the digestive system (*Escherichia coli* (*E. coli*) labile toxin, *E. coli* stable toxin, and cholera toxin), the devotion of disease-producing bacteria in intestinal tract such as *E. coli*, and attack of enteroinvasive *E. coli* and *Shigella flexneri* into epithelial cells. The concentrated liquid resulting from heating or boiling *P. pinnata* had no antibacterial, against giardiasis or anti-rotaviral properties. However, it did lower cholera poison production and the bacterial incursion of epithelial cells. As a result, it appears to be ineffective against toxin-induced diarrhea, as well as diarrhea caused by protozoa and viruses. It emerges to be mainly effective in opposition to cholera and enteroinvasive bacterial strains that cause bloody diarrheal periods among bacterial diarrhea. These findings back up their long-standing utilize as an anti-diarrheal treatment.[29]

Efficacy against lice

The rising pattern of pediculocidal drug resistance to the terms head louse provided the impetus for research into new anti-lice mediators for therapeutic plants. The head louse, pediculus humanus capitis was tested using different extracts of *P. pinnata* leaves in the lessons. The results showed that PPEt had moderate pediculocidal effects when combined with methanol extract.[30,31]

Anti-ulcer property

After 10 days of treatment, the methanol root extract of *P. pinnata* has been shown to provide significant protection against aspirin-induced mucosal damage and has the potential to reduce acetic acid-induced ulcers. The extract displayed ulcer-protective effects when mucosal protection factors such as mucin secretion, mucosal cell glycoproteins, mucosal cell life span, cell proliferation, and lipid peroxidation prevention were stopped.[32]

Antimicrobial, antioxidant, and wound healing properties

The wound healing, antioxidant potential, and antimicrobial properties of *P. Pinnata* were studied in Wistar rats. In methanol extracts of *P. Pinnata* leaf, enhanced lesion reduction and tensile potency, increased hexosamine and hydroxyproline content, antioxidant action, and reasonable action against microorganisms have been demonstrated by *P. pinnata.*[33]

Cardioprotective property

The authors used streptozotocin-nicotinamide to test the cardioprotective efficacy of *P. pinnata* in diabetic rats. The outcome of *P. pinnata* stem howl petroleum ether fraction on cardiomyopathy in diabetic rats was studied by the authors.[34]

Antipyretic and antinociceptive activity

The leaves of *P. pinnata* have antinociceptive and antipyretic properties. The author's used rats and mice to assess the body's response to potentially toxic stimuli efficacy of a 70% ethanolic fraction of *P. pinnata* leaves in dissimilar pain sculpts. *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.[35]

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Antibacterial property

The antibacterial activity of *P. pinnata* leaf chloroform fraction was superior to average adjacent to *E. coli*, *Pseudomonas aeruginosa (P. aeruginosa)*, and *Staphylococcus aureus (S. aureus)*, whereas acetone fraction was extra vigorous than normal in opposition to *P. aeruginosa* and *E. coli*. The petroleum ether fraction did not demonstrate substantial action against bacteria as evaluated to the normal.[36]

Neuroprotective activity

The current study found that *P. pinnata* stem bark ethanol extract protects rats from monosodium glutamate-induced neurotoxicity. Intraperitoneal (IP) injections of monosodium glutamate at a rate of 2g/kg body weight (BW)/ day for 7 days induced neurotoxicity. After 1 hour of monosodium glutamate therapy, *P. pinnata* stem bark ethanolic fraction (200 and 400 mg/kg) was given orally. Dextromethorphan (30mg/kg orally) was utilized as the ordinary medication for comparison. The ethanolic extract of *P. pinnata* plant stem bark has significant neuroprotective activity in albino rats, according to a report.[37]

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.[38]

Anti-diabetic property

In diabetic, alloxan-induced rats giving of an ethanol fraction of *P. pinnata* blossoms orally (300 mg/kg BW) had important antihyperglycemic effects, lowering blood glucose levels to a level comparable to that of the indication remedy glibenclamide (glyburide) (600mg/kg BW). The blossom's watery fraction had good antihyperglycemic properties and dramatically increased levels of plasma insulin. The fraction also controlled the actions of glucose-6-phosphatase and hexokinase in alloxan-provoked hyperglycemic rats (Table 1,2).[39]

Conclusion

In recent years, scientific research has focused on the fitness encouragement properties of plant foodstuff and their vigorous constituents. Numerous herbal medications have been prescribed for the treatment of various diseases in various medical treatises. This plant serves a variety of purposes and has significant medicinal and economic value. The significance of *P. pinnata* (Karanja) as an important medicinal plant was established by the plant parts for its pharmacological properties and indications, according to the current analysis. *P. pinnata* has long been utilized as a conventional remedy in several nations, particularly India. Due to its numerous established pharmacological activities and largely isolated phytoconstituents, the *P. pinnata* is a source of several marketplace formulations. It is a reliable biofuel, and further research into *P. pinnata* as a potent biofuel is needed, as well as many more studies in the pharmacognostic region. To fully recognize the phytochemical outline and multifaceted pharmacological consequences of this species, more research on the phytochemistry and mechanisms of chemical constituents in showing definite organic actions is required. Further experimental studies on the toxicity of every plant branch fractions and further composites concentrated from this plant are also required to guarantee their protection and determine their suitability for use as modern medicine sources.

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Conflicts of interest

The authors declare that they do not have a conflict of interest regarding article publication.

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