



Review On: Botanical Description, Phytoconstituents and Pharmacological Activity of *Pongamia pinnata* (Linn.) Pierre Plant

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ABSTRACT

Pongamia pinnata (Linn.) Pierre belongs to the *Fabaceae* family and is one of the plants with various therapeutic uses. In many nations, conventional medicine has used all of its constituent parts to treat and prevent a variety of diseases. Additionally, the extract from the plant shows analgesic, antifungal, anti-bacterial, anti-inflammatory, anti-nociceptive, anti-hyperammonic, anti-lipoxidant and anti-oxidant properties. It has a variety of phytoconstituents like alkaloids, glycosides, flavonoids, carbohydrates and fixed oils. This paper discusses the current knowledge of the pharmacological properties, phytochemistry and traditional usage of plant. *Pongamia pinnata*'s roots are effective at preventing gonorrhoea, Dental hygiene and gum health enhancement. To increase the scrofulous, the root paste is applied locally. The fresh bark of *Pongamia pinnata* tastes mucilaginous and delicious, but it quickly turns caustic and unpleasant. It helps with ulcers, ophthalmology, dermatopathy, vaginopathy and beri-beri. The digestive, laxative properties of *Pongamia pinnata* leaves are effective in treating cough, diarrhoea, leprosy and dyspepsia. Flowers are useful for reducing Dipsea in diabetics as well as for lowering Kapha and Vata. The seeds have carminative, acrid, bitter, haematinic and anthelmintic properties. They treat anemia, inflammation, persistent fevers, and hemorrhoids. The oil has anthelmintic and astringent properties and is suggested for herpes, lumbago, leprosy and ophthalmia. It produces biodiesel from its oil.

Keywords: *Pongamia pinnata*, *Fabaceae*, Phytochemistry, Pharmacological properties.

INTRODUCTION

Pongamia pinnata (Linn.) Pierre [Synonyms: *Pongamia pinnata* Merr, *Milletia novo-guineensis* Kane and Hat, *Pongamia glabra* Vent, *Derris indica* (Lamk.)] belongs to the *Fabaceae* (*Papilionaceae*) family. *Pongamia glabra* and *Derris indica* are other names for this plant.^[1] The versatile legume tree *Pongamia pinnata* is native to south-east Asia, Indian subcontinent and it has a high potential seed yield of 20,000 seeds per tree and it is among the trees that produce non-edible oil.^[2] It is a nitrogen-fixing, drought-resistant leguminous tree that can tolerate light cold, water logging and has a good tolerance for salinity. Additionally, it adapts effectively to unfavourable weather patterns and soil moisture content. It is cultivated as a shade tree and windbreak on tea estates.^[3]

The several portions of this plant have all been widely utilized in traditional medicine to heal a variety of ailments and wounds. Professor Limaye conducted the first research of this species in 1925, which was more than 80 years ago. As a result of his research into the chemical characteristics of *Pongamia pinnata*, the karanjin and a furanoflavone that has become a characteristic of this plant, was isolated. International researchers, particularly those from China and India, have since conducted a large number of studies based on the information regarding the plant's medicinal qualities, which are primarily attributed to Indian traditional medical practitioners and documented in Ayurvedic medical system. Numerous compounds from various classes, such as terpenoids and flavonoids, were discovered as a result of the phytochemical studies. According to the pharmacological investigations, this plant exhibited a wide variety of biological properties.^[4]

Both in traditional and modern medicine, medicinal plants continue to offer beneficial therapeutic agents.^[5] Traditional remedies are becoming more popular due to the negative consequences of contemporary medicine and research is presently being done to determine the scientific underpinnings of their therapeutic activity. The tree has a diverse uses and having the ability to produce biodiesel. *Pongamia* as a medicinal herb in Traditional system like Ayurveda and Siddha.^[7]

One of the biggest problems facing modern medicine is the escalating issue of antimicrobial resistance (AMR). The rise of resistant microbial strains has been driven by the extensive and frequently improper use of antibiotics, which has reduced the effectiveness of routinely used medicines and raised morbidity, death and healthcare expenses. As a result, scientists have focused on natural



sources of antimicrobial agents, especially medicinal plants, which have long been used as stores of bioactive substances.^[8] The *Pongamia pinnata* plant's promise as a natural antibacterial agent has been further supported by the strong antimicrobial activity demonstrated by its various extracts (ethanol, methanol and aqueous) against bacterial and fungal strains.^[9]

Extracts of *Pongamia pinnata* have shown strong antibacterial action against a variety of bacteria, such as *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans*, in a number of in vitro investigations. These plant-based antimicrobials frequently work by rupturing bacterial cell walls, changing the permeability of membranes and preventing the creation of proteins or nucleic acids. Phytochemicals may have benefits over synthetic antibiotics, including decreased toxicity, fewer adverse effects and a decreased propensity to foster resistance.^[10]

The entire plant has been used as a crude medication to cure a variety of conditions, including tumors, piles, skin conditions, itching, abscesses, severe rheumatic joint wounds, ulcers, diarrhoea, etc. More recently, reports have indicated that *Pongamia pinnata* is an effective source of biomedicines, particularly antibacterial and therapeutic compounds.^[11] The plant *Pongamia pinnata* has anti-nociceptive, anti-inflammatory, anti-ulcer, anti-oxidant, anti-plasmodial, anti-lipoxidative, anti-hyperammonic and anti-hyperglycemic properties.^[1]

Pongamia pinnata has a wide variety of bioactive components that are primarily in charge of its therapeutic qualities, according to phytochemical studies.

The most notable substances are:

- Pongamol, another important furanoflavonoid with antioxidant and antimicrobial properties.
- Karanjin, a furanoflavonoid with antibacterial, antifungal and insecticidal properties.
- Flavonoids and tannins, substances having well-established antibacterial and anti-inflammatory properties.
- Fixed oils, extracted from seeds and high in fatty acid like palmitic, oleic and linoleic acid may have antibacterial and wound-healing properties.
- Glycosides and steroids, which are present in the bark and leaves and have been shown to have analgesic and antibacterial effects.

The purpose of this review is to compare the antimicrobial effectiveness of traditional antibiotics with *Pongamia pinnata* extracts. It looks at their individual modes of action, range of antibacterial activity and possibility for incorporation into contemporary treatment plans. In the continuous quest for innovative ways to counteract antibiotic resistance, it is crucial to comprehend the relative efficacy of plant-based antimicrobials and antibiotics.^[9]

GEOGRAPHICAL DISTRIBUTION

Pongamia is widely distributed over South Eastern Asia, Australia, India, the Seychelles Islands, and tropical Asia. It can also be found locally along riverbanks in the Maharashtra (India); it is especially common along Deccan rivers and in tidal and beach woodland in the Konkan.^[12]

TAXONOMICAL NOMENCLATURE^[13]

Kingdom: plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Fabales

Family: Leguminosae

Genus: *Pongamia*



Species: *pinnata*

COMMON NAMES

English: Indian beech

Kannada: Honge

Hindi, Bengali and Gujarat: Karanja, Karanj

Sanskrit: Naktamala

Telugu: Pongam, Ponga

Malayalam: Punnu, Pungu

Panjab: Sukhehein, Karanj, Paphri

Assam: Karchuw

TRADITIONAL USES

It includes a number of phytoconstituents that are belongs to fixed oil and flavonoid categories. In traditional medicine, *Pongamia pinnata* fruits and sprouts were used to treat malignancies.

Medical treatises have suggested the use of herbal remedies to treat a variety of illnesses. It is acknowledged in various traditional medical systems for the treatment of various human illnesses and conditions. This plant's seed extract causes uterine contractions and has hypotensive properties. Bronchitis, persistent fever, whooping cough, chronic skin conditions, and painful rheumatic joints are all treated with powdered seed.^[14]

Roots of *Pongamia* is utilized to treat ulcers, gums and helps to maintain the teeth hygiene and their bark are used to treat the internal bleeding of piles. Biodiesel can be produced from its oil. It also has a safe, non-polluting, renewable alternative energy source. The leaves have anti-*Micrococcus* properties and its juice is used to treat leprosy, gonorrhoea, cough, diarrhoea, dyspepsia, flatulence and colds. Liver pain, lumbago, ulcers, scabies and persistent fever are all treated with seed oil. The plant's oils and juices have antiseptic properties.^[15]

BOTANICAL DESCRIPTION

Allen and Allen state that the fast-growing *Pongamia pinnata* tree reaches 40 feet height and spreads outward to create a broad, spreading canopy that offers mild shade. This plant's botanical descriptive traits are listed below,

PLANT

- Evergreen, Medium sized, deciduous and perennial tree.
- Height: 30 to 40 feet
- Growth rate: Rapid
- Texture: Medium

- Number of Chromosomes: 22 ^[16]



Fig 1: *Pongamia pinnata* plant

LEAVES

- The young leaves are imparipinnate, shine, immature, pinkish red in colour.
- The matured leaves are dark green and lustrous in nature.
- The latter leaflets are bigger than the others, have no stipels and have caduceus stipules.^[16]



Fig 2: Leaves

FLOWER

- The flowers are odorous in nature and has white to pinkish in colour, paired with rachis in axillary.
- It is pendent, cup-shaped, truncate, short-dentate, and has lengthy racemes or panicles.
- Occasionally longer lowermost lobe; suborbicular standard, broad, typically as two inflexed basal ears, out layer covered with thin silky natured hairs, oblique Wings, and obtuse keel are long and adherent.
- They have short-stalked, pubescent Ovary and contains two ovules, rarely three.
- Globrous, with a small, terminal stigma; cohesive keel petals at the apex; monadelphous, vexillary stamens that are free at the base but join to form a closed tube.^[16]



Fig 3: Flower

PODS

- 2-3cm wide, 3-6cm long, smooth and brown colour.
- short-stemmed, indehiscent, 1-2 seeded and seeds are thick.^[17]



Fig 4: Pods

SEEDS

- Elliptical or compressed ovoid, been like shape.
- 10-15 cm long, dark brown colour.
- It produces an oil which can use as Biofuel.^[17]



Fig 5: Seeds

ROOT

- It has Taproot.

- Root is dense and length.
- There are several lateral roots that are fully grown.^[17]



Fig 6: Root

BARK

- It is a deciduous, glabrous tree that grows quickly.
- It has 60 cm diameter of trunk and Soft in nature.
- Thin Gray to brown and inside yellow in colour.^[17]



Fig 7: Bark

GROWTH PATTERN

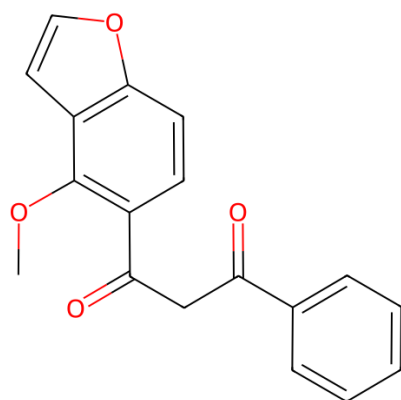
The optimum growth occurs between sea level and elevation about 1200 meters, with 500 to 2500 mm of rainfall each year. Furthermore, it is believed that *Pongamia pinnata* is a species that can withstand both drought and salt condition. It has a high tolerance for alkalinity and saline environments. The ideal pH range for soil growth is 6.5 to 8.5, with a reported range of 6 to 9. It drops its leaves in April and begins growing new ones in May. Its flowers bloom from April to June, while the following year's pods ripen from March to May.^[1]

PHYTOCHEMISTRY^[18]

This multipurpose medicinal plant is a unique source of many kinds of chemical components and these are responsible for its therapeutic effect of plant.

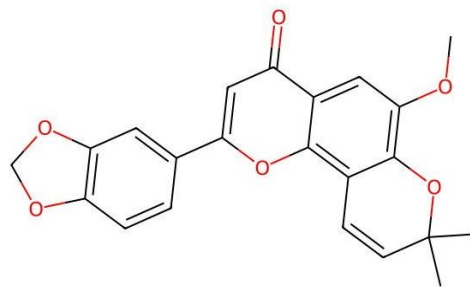
SEEDS:

This plant's seeds have specifically same quantity of saturated and unsaturated fatty acids like monoenoic, dienoic and trienoic. The more percentage of oleic acid (42.44%), followed by 29.64% of stearic acid and 18.58% of palmitic acids are present. By using seeds, alkaloids like kanjone, kanugin, pongapin, gamatay, glabrin, kankone and flavonoids like karangin, pongamol, pongagalabrone, pinnatin, Glabrachalcone and Isopongachromene have been isolated.



A

Fig 8: A. Pongamol

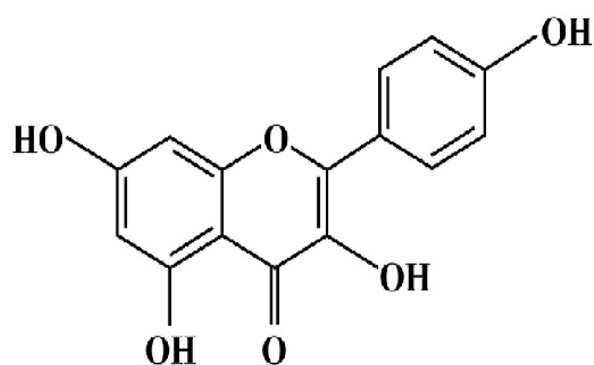


B

B. Isopongachromene

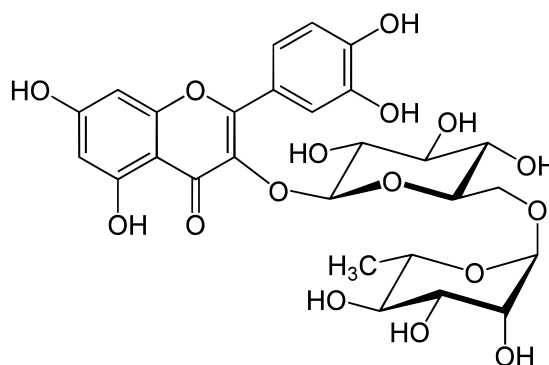
LEAVES:

Pongamia pinnata leaves have resulted in the isolation of two novel isoflavonoid diglycosides, retinoid, along with nine metabolites like kaempferol 3-O-beta-D-rutinoside, vitexin, vecinin-2, isoquercitrin, rutin, kaempferol 3-O-beta-D-glucopyranoside, 11,12-dihydroxy-munduserone, quercetin and kaempferol.



C

Fig 9: C. Kaempferol

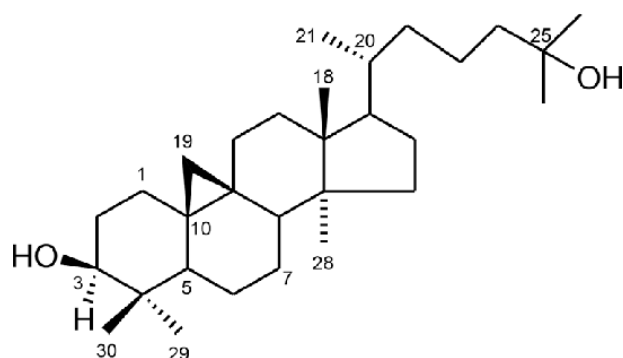


D

D. Rutin

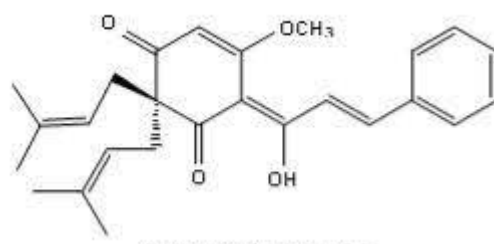
BARK:

The two new flavone compounds like 3-methoxy-(3,4-dihydro-3-hydroxy-4-acetoxy)-2,2-dimethylpyrano-(7,8;5,6)-flavone and 3-methoxy-(3,4-dihydro-4-hydroxy-3-acetoxy)-2,2-dimethylpyrano-(7,8;5,6)-flavone were extracted from the plant along with Cycloratan-23-ene-3-β,25-diol, Pongaflavanol, Tunicatachalcone, Caryophyllene oxide, isolonchocarpin, ovaliflavanone A and obovatachalcone.



E

Fig 10: E. Cycloart-23-ene-3beta,25-diol

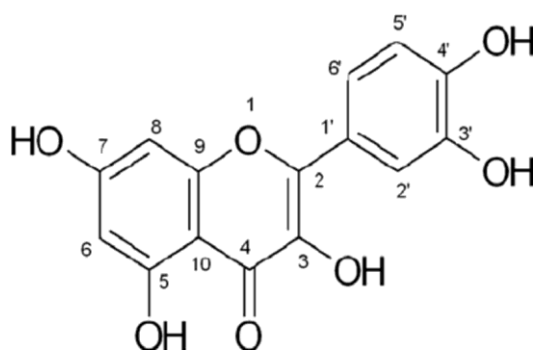


F

F. Tunicatachalcone

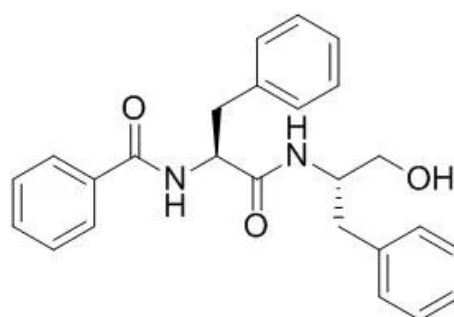
FLOWER:

Flower contains Karanjione, Quercetin, triterpenes, simple flavones, Chemnoflavanone, hydroxyl furanoflavones, aurantiamide acetate and beta sitosterol glucoside.



G

Fig 11: G. Quercetin



H

H. Aurantiamide

Table 1: Pharmacological Overview of *Pongamia Pinnata*

Sl.NO	PLANT PARTS	ACTIVE CONSTITUENTS	PHARMACOLOGICAL ACTIVITY
1	Leaves ^[19]	Kaempferol, Quercetin and Flavonoidal compounds	Anticonvulsant activity
2	Flower ^[18]	Quercetin, Karanjin, Kaempferol, Kanjone.	Anti-oxidant activity
3	Seeds ^[18]	Pongamol and Glabrachalcone	CNS Depressant, Promoted increased sensitivity to sound and touch.
4	Fruits ^[18]	Pongamol, Karanjin	Antihyperglycemic activity
5	Seed oil ^[20,11]	Karanjin, Triglycerides and Flavonoids	Leprosy, ophthalmia, Anthelmintic, Styptic.
6	Bark ^[21]	Cycloart-23-ene-3beta,25-diol	Wound healing, Anti-microbial, Anti-oxidant, Anti-inflammatory and Anti-diabetic activity.



PHARMACOLOGICAL ACTIVITY

❖ Antifungal Activity:

➤ The antifungal activity of seed oil shows high effect against *Aspergillus niger*, then *Aspergillus terreus* and *Candida albicans*. 100% Pure oil shows the highest inhibitory action, while oil showed at least 40–45% inhibition for all tested fungi.^[9]

➤ The only constituent of this plant that appears to have been investigated for antifungal action is triterpene 118. It showed relatively little effect against Mold-type fungus like *Aspergillus niger* and *Aspergillus fumigatus*, but more effective contrary to the fungi (yeast-type) like *Candida albicans*, they show 100mg/ml of MIC and it has no any effect against *Penicillium notatum*.^[22]

❖ Antibacterial Activity:

➤ *Pongamia pinnata* leaves and oil exhibit antibacterial effect towards *Aspergillus niger*, *Staphylococcus aureus*, *Chromobacterium* and *Pseudomonas aeruginosa*. This was determined by utilizing MIC (Minimum Inhibitory Concentration).

➤ *Pongamia pinnata* leaves are said to exhibit antibacterial properties. It is evident that the extracts can be employed to treat enteric infectious diseases and have significant potential as antibacterial agents against enteric pathogens.^[1]

❖ Anti-inflammatory Activity:

➤ *Pongamia pinnata* 26–27 leaf 70% ethanolic extract has demonstrated to have strong anti-inflammatory traits against acute, sub-acute and chronic stages of inflammation without having an adverse reaction to the mucosal membrane of stomach. Also, *Pongamia* is noted that their extract shows strong antipyretic effect on pyrexia is brought on Brewer's yeast.^[14]

❖ Anti-viral Activity:

➤ The *Pongamia pinnata* leaves are used to extract the Bis (2-methylheptyl) phthalate and it has antiviral properties towards *Penaus monodon Fabricius* (White Spot Syndrome Virus).^[23]

➤ At 1 and 20 mg/ml (w/v) concentration, respectively, the crude seed aqueous extraction totally prevents development of HSV-1 (herpes simplex virus type-1) and HSV-2 (herpes simplex virus type-2).^[22]

❖ Anti-diabetic activity:

➤ In diabetic alloxane-induced rats, oral administration of *Pongamia pinnata* flower demonstrated strong anti-hyperglycemic effects by their 300 mg/kg bw of ethanolic extract, significantly reduces the glucose levels in blood as comparable to reference medication glibenclamide (600 µg/kg bw). Additionally, flower's aqueous extract showed potent antihyperglycemic action and markedly increased insulin level in plasma. The extract also controls the effect of hexokinase and glucose-6-phosphatase in alloxan-induced diabetic rats.^[7]

❖ Anti diarrheal activity:

➤ To ascertain this behaviour, the crude decoction of dried *Pongamia pinnata* leaves was evaluated for its antibacterial properties. The effects on development and action of enteropathogenic *E. coli*, *enterococcus* (stable toxin, *Escherichia coli* labile toxin and cholera toxin), enteroinvasive *E. coli* and *Shigella flex* epithelial cells were also assessed. According to this study, a decoction of *Pongamia pinnata* shown specific anti-diarrheal activity against enteroinvasive bacteria and cholera, which caused the bloody diarrhoea episode.^[11]

❖ Anti plasmodial Activity:

➤ The *plasmodium falciparum* activity was prevented by utilizing the *Pongamia pinnata* extracts.^[24]

❖ Anti-lice activity:

➤ The increasing trend of pediculicidal medication resistance to the phrase "head louse" established the groundwork for research into developing new anti-lice agents for medicinal plants. The sample's various *Pongamia Pinnata* leaf extracts were tested for their



ability to fend off the head louse *Pediculus humanus capitis*. According to the results, P.E. extract showed modest pediculicidal effects when combined with methanol extract.^[25,26]

❖ **Anti-oxidant:**

➤ Leaf extract from *Pongamia pinnata* exhibits antioxidant action and vascular lipid peroxidation. Rats with ammonium chloride-induced hyperammonium have been used to test it. In rats given ammonium chloride, this increases lipid peroxidation in the bloodstream, leading to decreases the vitamin A, C and E levels. This also lowers the glutathione peroxides, catalase glutathione and superoxide dismutase activities.^[14]

❖ **Nuero protective activity:**

➤ The ethanol extract from *P. pinnata* stem bark was found to have a neuroprotective effect on rats' monosodium glutamate-induced neurotoxicity. Monosodium glutamate injections via the intraperitoneal method at a rate of 2 g/kg body weight each day for seven days resulted in neurotoxicity. Following one hour of monosodium glutamate treatment, 200-400 mg/kg of *Pongamia pinnata* stem bark ethanol extract was given orally. For comparison, 30 mg/kg, p.o of dextromethorphan was utilized as the standard medication. According to the study, an ethanolic extract from stem bark of *Pongamia* exhibits significant neuroprotective effects in albino rats.^[27]

❖ **Antinociceptive activity:**

➤ The Analgesic effect of the different root extraction of *Pongamia pinnata* was assessed by Srinivasan *et al.* In tail flick test, the ethanol extract (EE), petroleum ether extract (PEE) and n-butanol extract (BE) of *Pongamia pinnata*'s root had a notable analgesic effect. Significant analgesic action was also demonstrated by PEE and direct EE of the seeds at doses greater than 100 mg/kg.^[28]

Benefits of *Pongamia Pinnata* Plant

❖ **NITROGEN FIXATION:**

Pongamia can fix nitrogen, they also improve the soil fertility and stability, which helps sequester carbon and makes them more beneficial for the long-term carbon storage. Enhanced nitrogen levels, that encourages the higher plant growth in the immediate vicinity, which raises the region's total biomass and carbon uptake. Furthermore, by promoting the development of stable organic compounds that are less likely to decompose, nitrogen enrichment in the soil aids in carbon stabilization.^[13]

❖ **PREVENTION OF SOIL EROSION:**

Additionally, *Pongamia*'s strong root structure can lessen soil erosion, which is a significant contributor to soil carbon loss. *Pongamia* contributes to the preservation of soil organic matter, which is necessary for long-term carbon sequestration, by stabilizing the soil and halting erosion. Through their root exudates, the trees also contribute a significant amount of organic matter to the soil. This increases the amount of soil organic carbon (SOC) by fostering the growth of soil microbes that primarily depend on available carbon.^[29]

❖ **AGROFORESTRY PROGRAMMES:**

Pongamia can be incorporated into agroforestry initiatives to help farmers design multipurpose landscapes that benefit the economy, the environment and society. By producing 100 biofuels and other tree-derived products, these systems can boost local economics, increase biodiversity and improve water quality.^[30]

❖ **SOIL IMPROVER:**

Fertility is increased when leaves and press cake are added to soils. In the tropics, decomposed flowers are prized for providing unique plants with excellent nutrients, particularly when cultivated in a greenhouse.^[1]

❖ **SHELTER OR SHADE:**

In grasslands, trees have been planted for shade because grass grows naturally beneath them. In Sri Lanka, tea plantations cultivate *Pongamia pinnata* as a windbreak.^[1]



❖ RECLAMATION:

Pongam is a great option for recovering a range of wastelands, including salty soil reclamation, because to its ability to withstand mild salinity levels. Reforestation of marginal lands is another use for it.^[1]

CONCLUSION

As a traditional medicine, *Pongamia pinnata* has been used extensively. Every part of this plant has therapeutic qualities and is used to treat wounds, diabetes, tumors and skin conditions. In the old Ayurvedic medical system, *Pongamia pinnata* has been utilized extensively as a remedy for a number of different conditions. According to this review literature, *Pongamia pinnata* (Linn.) is a significant medicinal plant with a wide range of pharmacological properties like antifungal, anti-oxidant, analgesic, anti-nociceptive, antibacterial, anti-hyperammonic, antilipoxidant and anti-inflammatory. Numerous chemical components like flavonoids, alkaloids, glycosides, fixed oil and carbohydrates found in plant and they are responsible for its diverse pharmacological and therapeutic qualities. It is also one of the most significant biofuel crops, marking a significant milestone in the biofuel industry. However, the evaluation of *Pongamia pinnata* (Linn.) is necessary to explore the hidden regions with their practical therapeutic uses that may be benefits for the good humanity.

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