PHYTOCHEMICAL STUDY AND EVALUATION OF VARIOUS PHARMACOLOGICAL ACTIVITIES OF *PONGAMIA PINNATA*

Shubham Pramanick[1], Kamal Bhandari[1], Mr. Praveen Semwal[2]

1Scholar, School of Pharmacy and Research, Dev Bhoomi Uttarakhand University, Dehradun, Uttarakhand, India

2Assistant Professor, School of Pharmacy and Research, Dev Bhoomi Uttarakhand University, Dehradun, Uttarakhand, India

Abstract:

This study focuses on the current knowledge about the *Pongamia Pinnata'*s phytochemistry & medicinal uses. *Pongamia pinnata* is native to India, Myanmar, Nepal, Bangladesh, Thailand and locally it's broadly available in the state of Maharashtra and very common in the coastal areas. *Pongamia Pinnata* generally known as 'Karanj' and in some parts it also known as 'Indian beech'. It contains various types of phytoconstituents from alkaloids, glycosides, flavonoids. Every part of *Pongamia Pinnata* contains medicinal property, root is used for its anti-inflammatory and anti-ulcer property, stem contains a significant amount of CNS sedation property and antipyretic activity, leaf contains anthelmintic property, fruit is used to treat abdominal tumors and also beneficial for female genital tract, seed is useful in inflammation and chronic fevers, Oil is very useful in leprosy, piles and chronic fever, bark is used to treat bleeding piles. To utilize the pharmacological benefits of this plant on a commercial level, alcoholic extract (specifically methanolic and ethanolic) from different parts like roots, flowers, and seeds can be used effectively. For the vast range of medicinal properties, *Pongamia Pinnata* has been widely used as a natural medicine in various countries, especially in India as traditional system of medicine like Ayurveda and Siddha.

Keywords: - *Pongamia Pinnata,* Karanj, Pongamol, anti-inflammatory, anti-ulcer, anti-diabetic, anthelmintic

Introduction:

A significant non-edible minor oilseed tree that primarily grows in semiarid areas is *Pongamia pinnata* (L.). It most likely originated in India and is found growing naturally in Florida, Australia, Sri Lanka, Bangladesh, Malaysia, Vietnam, Thailand, India, Pakistan, Japan, and the Philippines. There are billions of Pongamia trees in India, where they are grown for profit and seed is sold from December to April **[10,14]**. In India, the "*Pongamia pinnata*" is being grown in many gardens and along innumerable roadways, and it is quickly rising to the top of the list of beloved city trees. *Pongamia Pinnata* has long been used as a traditional medicine, particularly in the Ayurvedic and Siddha schools of Indian medicine. For the treatment of tumors, skin conditions, piles, itching, ulcers, painful rheumatic joint wounds, diarrhea, etc., all parts of the plant have been utilized as basic drugs. It is widely recognized for its use as, gonorrhoea, wound healing, relieving rheumatic pains, lumber, piles, and animal feed. With insecticidal and nematoidal properties, *Pongamia pinnata* has been widely used in agriculture

and environmental management. More recently, reports of its efficacy as a biomedicine source have focused on its antibacterial and therapeutic properties **[7,19]**. In the past few decades, the growth of herbal medicine has resulted in the discovery of new substances and the creation of innovative formulations that have been applied to the treatment of a variety of illnesses. One of the most notable species among these herbal plants is *Pongamia pinnata* **[28]**.

Plant description:

The *Pongamia Pinnata* plant grows quickly. This tree may grow to a height of 35 to 40 feet and is medium in size, evergreen, deciduous, and perennial. It grows quickly, reaching a height of 40 feet and spreading its canopy to provide soft shade. It has a medium texture and grows quickly. Alternate, oddly pinnately complex, hairless, and up to 2–4 inches wide, the leaves are evergreen. White, pink, and lavender flowers are two to four in number, and they are pea-shaped and short-stalked, reaching a length of 15 to 18 mm. Pods are firm, indehiscent, brown, smooth, and have thick walls. It is 2–3 cm wide and 3–6 cm long. The seeds of this plant are 10 to 15 cm long, compressed, ovoid, and oily. The taproot is long and thick, and the lateral roots are many and well-developed. The thin Gray bark turns greyish-brown, and the inner becomes yellow **[20]**.

Geographical Distribution:

Bangladesh, India, Nepal, Myanmar, and Thailand are the native habitats of this plant. This plant is suitable for production in exotic locations including China, Indonesia, Fiji, Australia, Egypt, Japan, Solomon Island, Mauritius, Malaysia, Sri Lanka, New Zealand, Pakistan, Papua, Philippines, Samoa, Seychelles, New Guinea, Sudan, and the United States of America **[1,20]**.

Medicinal value:

Table 1: Medicinal Importance of *Pongamia pinnata* **[4, 11, 16, 20]**

Serial number	Plant part	Medicinal use
1.	Root	➢ Gonorrhea is treated using a root juice mixture made with coconut milk and lime water. ➢ Roots are used to treat skin and vaginal disorders and are bitter anti-helmintic. ➢ Juice from the root is used to treat dirty ulcers and seal fistulous sores.
2.	Stem	➢ Significant CNS sedative and antipyretic, antipyretic, antidiabetic, analgesic, and anti-inflammatory properties are demonstrated by aqueous extracts of stem bark. ➢ These extracts can also be used to treat wounds, ophthalmopathy, acne, genitalia, sinuses, stomach pain, intestinal disorders, malaria, bleeding piles, beriberi, anthelmintic, and hemorrhoids.
3.	Leaf	➢ Leaf juice is used to treat leprosy, cough, dyspepsia, diarrhea, flatulence, colds, and gonorrhea, ➢ Leaves have hepatoprotective, digestive, and laxative properties and are used to treat wounds, piles, and inflammations.

Serial number	Plant part	Medicinal use
4.	Fruit	➢ These fruits are used to cure leprosy, piles, ulcers, female genital system disorders, abdominal tumors, and the upward migration of the wind in the belly.
5.	Seed/ Seed oil	➢ used to treat keloid tumors, rheumatic rheumatism, skin conditions, and hypertension. ➢ Seed powder is also used as a tonic, febrifuge, and treatment for whooping cough and bronchitis. ➢ An oil and zinc oxide mixture used to treat eczema. ➢ It's also beneficial for whooping cough, scabies, rheumatism, and arthritis.
6.	Bark	➢ Shows antiprotozoal activity
7.	Flower	➢ When combined with additional substances, powdered dried flowers are used in diabetes to quench thirst and dysepsia in diabetes. ➢ To treat bleeding piles. ➢ Renal protective activity.

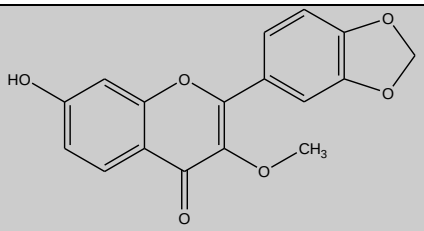
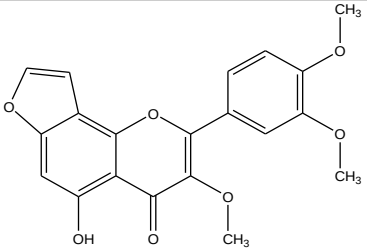
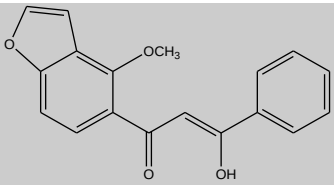
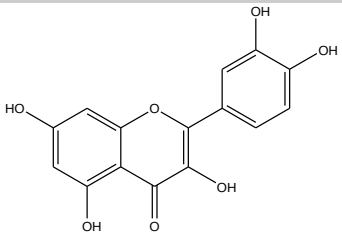
Phytochemistry:

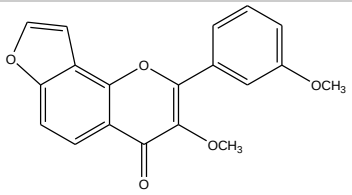
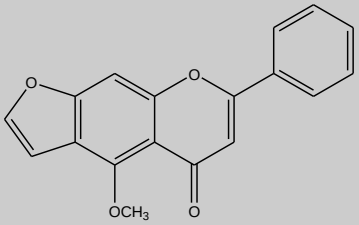
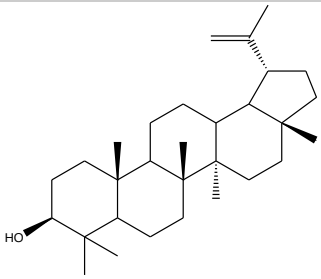
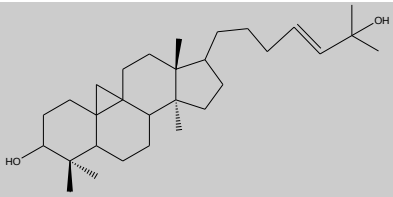
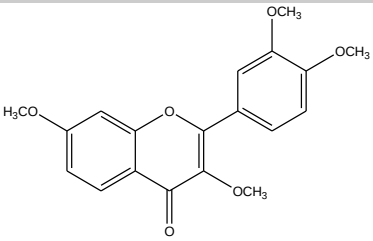
Pongamia pinnata's phytochemical investigations led to the separation of flavonoid derivatives, including chalcones, flavones, and flavans. This species also contained a number of chemicals from other classes, including steroids, disaccharides, fatty acids, esters, amino acid derivatives, sesquiterpenes, diterpenes, and triterpenes **[3]**. Five unsaturated and three saturated fatty acids as well as one disaccharide, three sterol derivatives and two sterols have been identified in *Pongamia pinnata* seeds. Both spectroscopic and physicochemical methods were used to clarify their structures. This plant is the first to be documented to produce the metabolites galactoside and beta-sitosteryl acetate, stigma sterol, galactoside, and sucrose. There were precisely equal amounts of unsaturated and saturated fatty acids (one dienoic, two trienoic and two monoenoic). The most abundant acid was oleic (44.24%), followed by stearic (29.64%) and palmitic (18.58%) acids. Traces of octadecatrienoic and hiragonic acids were detected (0.88%). From the seeds pongamol, kanjone, pongapin, pinnatin, pongagalabrone, and karangin have been identified and isolated. A flavone derivative called "pongol" is detected in developing seeds. "Glabrachalcone isopongachromene" is one of the other flavonoids that were extracted from the seeds. *Pongamia pinnata*'s leaves and stem contain flavone and chalcone chemicals, including ponggalabol, galbone, ponggone, and pongagallone A and B **[2]**. Following chemical analysis of the stems of mangrove plants like Pongamia pinnata, five structurally remarkable flavonoids, known as pongamones A–E, were separated and categorized, along with sixteen flavonoid metabolites that were discovered. Spectroscopic study served as the foundation for the discovery of their structures, and their spectroscopic data were compared to those of comparable compounds that have been documented in the literature. DHBV RCs DNAP and HIV-1 RT were compared to Pongamones A-E In vitro. Additionally, the probable biogenetic pathway of solitary composites is estimated. When eighteen flavonoid constituents and nine new ones, pongamones III–XI, were isolated from root bark, more research on the flavonoid components of Pongamia pinnata from Japan was conducted. The chemical structures of these compounds were analyzed through spectroscopic techniques.

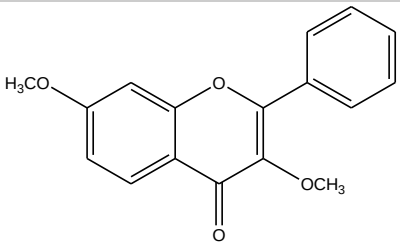
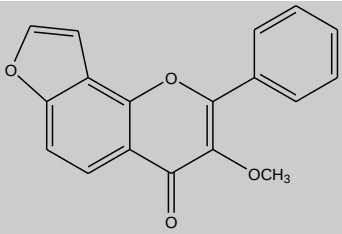
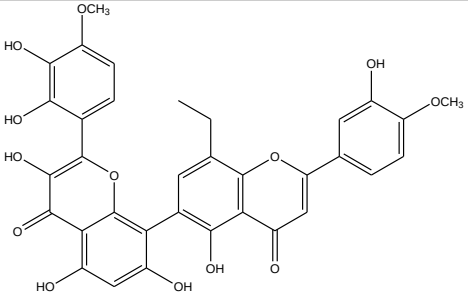
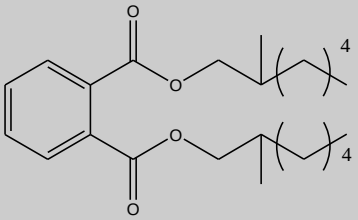
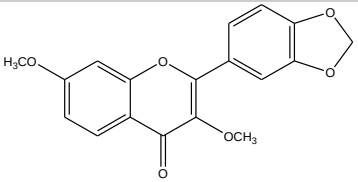
Notably, this study marks the first instance of furanoflavone glucosides being identified as naturally occurring compounds **[1]**.

Phytoconstituents:

Table 2: Phytoconstituents of *Pongamia pinnata* with their structure and pharmacological activity **[3,5,11,20]**

Serial No	Phytochemical name	Structure	Pharmacological activity
1	3-methoxy-7-hydroxy-3′,4′-methylenedioxyflavone		Antioxident
2	3,3′,4′-trihydroxy-4H-furo[2,3-h] chromen-4-one		Antioxident
3	Pongamol		Antioxident, Anti-diabetic
4	Quercetin		Antimicrobial

Serial No	Phytochemical name	Structure	Pharmacological activity
5	Pachycarin D		Antimicrobial
6	Pinnatin		Antimicrobial
7	Lupeol		Antiprotozoal
8	Cycloart-23-ene-3β,25-diol		Antioxidant, Anti-fungal
9	Fisetin tetramethyl Ether		Cytotoxicity

Serial No	Phytochemical name	Structure	Pharmacological activity
10	3,7-dimethoxyflavone		Cytotoxicity
11	Karanjin		Anti-inflammatory, Anti-diabetic
10	Pongamiaflavonylflavonol		Anti-diabetic
11	Bis(2-methylheptyl) phthalate		Anti-viral
12	Demethoxykanugin		Anti-inflammatory

Phytochemical analysis:

Table 3 displays the findings of the crude powder's qualitative phytochemical examination. Secondary metabolites with potential medical use were identified by preliminary phytochemical screening **[13,15,22,35]**.

Table 3: Qualitative phytochemical analysis of *Pongamia pinnata*'s leaf

Serial number	Phytochemicals	Result
1	Tannins	++
2	Terpenoids	++
3	Saponins	+++
4	Flavonoids	++
5	Cardiac glycosides	+++
6	Phlobatannins	-
7	Glycosides	-
8	Alkaloids	++
9	Resins	+
10	Anthraquinones	-

Less (+), moderate (++), and high (+++) levels of phytochemicals are present; none are present (-).

Pharmacological Activity:

Due to *Pongamia pinnata's* numerous traditional uses, researchers have looked into its pharmacological characteristics and confirmed its potential as a therapeutic cure. Numerous investigations showed that this plant had a wide range of pharmacological properties, including cytotoxicity, anti-hyperammnonemic, anthelminthic, insecticidal, anticonvulsant, anti-inflammatory, anti-parasite, anti-diabetic, antioxidant, and antibacterial properties **[3]**.

- **Antiviral activity:**
  The most commercially significant farmed marine crab species worldwide suffer catastrophic mortality from White Spot sickness, which is due to the significantly virulent and infectious White Spot sickness virus. Bis (2-methylheptyl) phthalate, which was isolated from *Pongamia pinnata* leaves, exhibits antiviral qualities against the White Spot Syndrome Virus of Penaeus monodon Fabricius. Studies have shown that administering an ethanolic extract and a purified compound from *Pongamia pinnata* leaves orally enhances the survival rate of *Penaeus monodon* infected with WSSV. Shrimps were administered pelletized feed infused with an ethanolic extract of *Pongamia pinnata* leaves at 200 and 300 microg extract/g of shrimp body weight daily both before and after WSSV infection. The WSSV-infected shrimp fed 200 and 300 microg extract/g had respective survival rates of 40% and 80% **[5]**. There was antiviral activity in the coarse aqueous seed extract. At doses of 1 and 20 mg/ml (w/v), respectively, it completely inhibited the growth of HSV types 1 and 2, and it didn't show any kind of cytotoxic effects **[16]**.

- **Anti-diarrhoeal Activity:**
  A crude infusion of dried *Pongamia pinnata* leaves has been studied for its antibacterial properties, as well as its effects on enterotoxin production and activity, Shigella flexneri and Enteroinvasive Escherichia coli invasion of epithelial cells, and enteropathogenic Escherichia coli adherence. The infusion decreased the bacterial penetration of epithelial cells and the synthesis of cholera toxin, but it lacked antibacterial, antigiardial, and antirotaviral properties. The findings indicate that the decoction of *Pongamia pinnata*

possesses a specific antidiarrheal property, effectively combating enteroinvasive bacterial strains responsible for cholera and episodes of bloody diarrhea **[6,16,31]**.

- **Cardio protective property:**
  The effects of the petroleum ether fraction from *Pongamia pinnata* stem howl on a diabetic rat model caused by streptozotocin-nicotinamide. The study's findings showed that diabetic rats' cardiomyopathy had decreased **[16,28]**.

- **Antiulcer activity:**
  The aqueous extract from *Pongamia pinnata* roots significantly reduced gastric secretion, acid production, and peptic activity in rats with acetyl salicylic acid (ASA)-induced ulcers, while having no impact on mucin activity. It also led to a significant reduction in the ulcer index. The methanolic extract of Pongamia pinnata roots showed an intense ulcer-protective action by stimulating the mucosal defense mechanisms, like mucin release, longevity of mucosal cells, mucosal cell glycoproteins, cellular proliferation, and inhibition of lipid peroxidation rather than looking at the deleterious secretory action of acid pepsin. Moreover, mucin activity was observed to be uniform with the variations in the compositions of fructose and hexose of the carbohydrate **[7]**. Using a variety of ulcer models, the gastroprotective benefits of a hydroalcoholic extract of *Pongamia pinnata* leaves. It shows that 400 mg/kg of HLEPP considerably lowers the ulcer index and provides strong protection against gastric ulcers brought on by pylorus ligation, aspirin, ethanol, and indomethacin **[17]**.

- **Antimicrobial Activity:**
  Extracts from *Pongamia pinnata* have antimicrobial properties against a range of bacterial and fungal species. Bark extracts showed the strongest antibacterial activity of any plant portion, especially when extracted using aqueous methanol. This was shown by the lowest minimum inhibitory concentrations (MICs) and the greatest inhibition zones. Due to the disruption of microbial cell processes like membrane integrity and nucleic acid production caused by the high phenolic and flavonoid content, the antibacterial efficacy is linked to this substance. *Pongamia pinnata* appears to be a promising source for the development of plant-based antibacterial medicines for use in pharmaceutical applications, according to these findings **[8]**. Strong antibacterial activity was demonstrated by most seed extracts **[23]**. the capacity of a combination of several antibiotics and *Pongamia pinnata* seed coat extract to suppress MRSA in vitro. Only at high concentrations does the *Pongamia pinnata* extract exhibit bactericidal activity against MRSA when given alone. However, when combined with other medications that were typically not MRSA inhibitory, we discovered that the *Pongamia pinnata* extract showed synergistic effects with the majority of the tested antibiotics, even at very low doses, with the exception of aztreonam **[12]**. According to reports, one of the plants that has anti-plasmodial activity against Plasmodium falciparum is *Pongamia pinnata* **[2,6]**.

- **Antidiabetic Activity:**
  Studies on *Pongamia pinnata* leaf extracts show notable antidiabetic effects in rats with diabetes caused by alloxan. Both aqueous and ethanolic extracts demonstrated significant reductions in blood glucose levels that were on par with the common antidiabetic medication Glibenclamide. These extracts also showed promise in improving glucose

metabolism and insulin secretion by improving body weight, lipid profiles, and urine sugar levels in diabetic rats. Flavonoids, triterpenoids, and polyphenols are examples of bioactive substances that are thought to have an antidiabetic impact; they may work in concert **[18,31,33]**.

- **Anti-Lice Activity:**
  Pongamia pinnata leaf extracts have been found to have potent anti-lice properties, especially against Pediculus human's capitis. At higher doses, the petroleum ether extracts completely inhibited the development of nymphs and achieved 100% lice death, exhibiting the strongest pediculicidal and ovicidal effects among the various extracts studied **[34]**. Extracts of methanol and chloroform demonstrated a modest level of efficacy, however water extracts did not. Particularly when synthetic pediculicides are not working, the study emphasizes *Pongamia pinnata's* promise as a natural alternative for controlling lice infestations **[24]**.

- **Anticonvulsant Activity:**
  Pongamia pinnata's ethanolic extract has strong anticonvulsant properties. The study showed that in mice subjected to maximal electroshock convulsions, the ethanolic extract of *Pongamia pinnata* successfully shortened the duration of the tonic and hind limb extension phases. It was discovered that the extract's anticonvulsant properties were on par with those of the common antiepileptic medication phenytoin sodium. The presence of phytochemicals with known anticonvulsant qualities, such as flavonoids, may be the cause of the anticonvulsant action. These substances may work by altering other neurotransmitter systems or raising GABA levels **[25]**. Rats that received the leaf extract were protected from chemically induced seizures, and their convulsive episodes lasted less time than those in the control group **[32]**.

- **Antioxidant and Anti-hyperammonemic Activity:**
  It was reported that the ammonium chloride-induced hyperammonemia in rats was affected by *Pongamia pinnata* leaf extract, and hence, its circulatory lipid peroxidation. The Vitamin A, C, E, reduced glutathione peroxidase, superoxide dismutase, catalase, and glutathione levels reduced significantly after treating the rats with ammonium chloride, which also increased the circulatory lipid peroxidation of the rats. In cases of ammonia-induced hyperammonemia from ammonium chloride, it was proven that ethanolic Pongamia pinnata extract (PPET) normalizes these abnormalities by repositioning the oxidation-antioxidation balance. This could be credited to its primary antioxidant activity or its anti-hyperammonemic action. It helps get rid of more creatinine and urea than ammonia **[9,26,30]**.

- **Anti-inflammatory activity:**
  After 10 days of treatment, the methanolic extract of roots demonstrated a strong defence against aspirin-induced mucosal damage and a propensity to lessen ulcers caused by acetic acid **[3]**. Studies have demonstrated that a 70% ethanolic extract of *Pongamia pinnata* leaves exhibits significant anti-inflammatory effects across all phases of inflammation—acute, subacute, and chronic—while preserving the integrity of the gastric mucosa. In addition, it was observed that this extract could also prevent pyrexia caused by Brewer's yeast **[2,4]**.

- **Neuroprotective activity:**
  According to the current study, rats are protected against monosodium glutamate-induced neurotoxicity by *Pongamia pinnata* stem bark ethanol extract. Monosodium glutamate intraperitoneal (IP) injections at a dosage of 2g/kg body weight (BW)/day for seven days resulted in neurotoxicity. An hour of monosodium glutamate treatment was followed by the oral administration of the ethanolic fraction of *Pongamia pinnata* stem bark (200 and 400 mg/kg). The reference medication used for comparison was oral dextromethorphan (30 mg/kg). An ethanolic extract of *Pongamia pinnata* plant stem bark has been shown to have a significant neuroprotective effect in albino rats **[16]**. Rats were considerably protected against the neurotoxicity caused by monosodium glutamate (MSG) by an ethanol extract of the stem bark of Pongamia pinnata. The ionic equilibrium in brain tissue was restored, antioxidant enzyme levels (GSH, SOD, and CAT) were raised, and behavioral function was improved. In histopathology, there was less edema and neuronal injury. Overall, it supported the neuroprotective impact of Pongamia pinnata, which is probably caused by its GABA-enhancing and antioxidant qualities **[36]**.

- **Anticancer Activity:**
  The methanol extract of *Pongamia pinnata* fruits significantly reversed the resistance of human gastric adenocarcinoma (AGS) cells to Tumor Necrosis Factor (TNF)-related apoptosis-inducing ligand (TRAIL). Using bioassay-guided fractionation, researchers isolated six known flavonoids and a newly identified furanoflavanone compound. Among them, two compounds notably enhanced the sensitivity of TRAIL-resistant AGS cells to TRAIL by increasing death receptor 5 (DR5) promoter activity. These findings suggest that *Pongamia pinnata* contains bioactive compounds capable of overcoming TRAIL resistance, potentially offering a novel approach to cancer treatment **[29]**.

- **Thrombolytic activity:**
  The crude extracts of *Pongamia pinnata* antithrombotic in vitro activity were assayed using streptokinase (100 µL) as a positive control. Venous blood samples from normal human volunteers were withdrawn, transferred to sterile, pre-weighed Eppendorf tubes, and kept for 45 minutes at 37ºC for coagulation. Weight variations from the tubes after clot dispersion were obtained once the released liquid was aspirated post incubation. 500 µL of plant extracts or materials were added at a concentration of 5 mg/ml in Eppendorf tubes. Streptokinase and 100 µL of distilled water were added separately to the control tubes. After incubation for 90 minutes at 37ºC, the tubes were checked for clot lysis. The remaining fluid was carefully removed from the tubes, and weighed once again. Weight differences before and after clot lysis were represented as a percentage of clot lysis **[27]**.

- **Wound healing activity:**
  Comparing the Pongamia pinnata-treated groups to the control group, the former had a significantly greater rate of wound healing. Leaf extract had a significant impact on wound healing, whereas usual groups treated with vitamin E demonstrated a progressive closure of wounds. The top layer of the wound was surgically removed and then histologically studied. Histological examination of the tissue stained with hematoxylin and eosin from the rat wounds treated with Pongamia pinnata and vitamin revealed more fibroblast proliferation, angiogenesis, keratinization, and epithelialization and less scarring than the vehicle-treated or control group **[21]**. An 80-year-old woman's chronic, non-healing leg wound, which was serious enough to need amputation, healed entirely in 8 weeks by

combining: Leech therapy, *Pongamia pinnata* bark paste, *Flueggea leucopyrus* leaf paste and ayurvedic internal medications **[37]**.

Conclusion:

The development of science and technology over the last several decades has aided in the progression of medical research and practice. New chemicals with plant origins have been identified and discovered as a result of these advancements. From ancient times, herbal therapy has been utilized, and it has a significant impact on both disease treatment and maintaining human health. According to a thorough review of the literatures, *Pongamia pinnata* is a significant medicinal plant with a wide range of pharmacological properties. Numerous chemical components found in the plant are what give it its diverse pharmacological and therapeutic qualities. The *Pongamia pinnata* genus has been traditionally used as a medicinal plant for centuries in various countries, especially in India. Medicinal properties exist in every part of this plant and is used to treat skin diseases, diabetes, rheumatism, wounds, piles, ulcers, and tumors. The results of phytochemical studies indicated the presence of many compounds in this plant. About many flavonoid derivatives of this plant have been reported. This review has provided an overall understanding of the phytochemical analysis and the medicinal uses of *Pongamia pinnata* which is also mentioned in Ayurveda and Unani system of medicines. Additional research is needed to explore the phytochemistry and the mechanisms through which its chemical components exhibit specific biological activities. This will provide a comprehensive understanding of the chemical composition and intricate therapeutic effects of this species. This should be supplemented with additional clinical research on the safety and toxic effects of extracts from all parts of the plant, as well as other compounds derived from it, to ensure safety and evaluate their potential as sources for modern pharmaceuticals.

References:

1. Nadeem, F., Inam, S., Rashid, U., Kainat, R., & Iftikhar, A. (2016). A review of geographical distribution, phytochemistry, biological properties and potential applications of Pongamia pinatta. *Int. J. Chem. Biochem. Sci*, *10*, 79-86.
2. Chopade, V. V., Tankar, A. N., Pande, V. V., Tekade, A. R., Gowekar, N. M., Bhandari, S. R., & Khandake, S. N. (2008). Pongamia pinnata: Phytochemical constituents, traditional uses and pharmacological properties: A review. *International Journal of Green Pharmacy (IJGP)*, *2*(2).
3. Al Muqarrabun, L. M. R., Ahmat, N., Ruzaina, S. A. S., Ismail, N. H., & Sahidin, I. (2013). Medicinal uses, phytochemistry and pharmacology of Pongamia pinnata (L.) Pierre: A review. *Journal of ethnopharmacology*, *150*(2), 395-420.
4. Sangwan, S., Rao, D. V., & Sharma, R. A. (2010). A review on Pongamia pinnata (L.) Pierre: A great versatile leguminous plant. *Nature and science*, *8*(11), 130-139.
5. Arote, S. R., & Yeole, P. G. (2010). Pongamia pinnata L: a comprehensive review. *Int J Pharm Tech Res*, *2*(4), 2283-2290.
6. Yadav, R. D., Jain, S. K., Alok, S., Prajapati, S. K., & Verma, A. (2011). Pongamia pinnata: an overview. *International Journal of Pharmaceutical Sciences and Research*, *2*(3), 494.
7. Ghumare, P., Jirekar, D. B., Farooqui, M., & Naikwade, S. D. (2014). A review of Pongamia pinnata–an important medicinal plant. *Current Research in Pharmaceutical Sciences*, 44-47.

8. Sajid, Z. I., Anwar, F., Shabir, G., Rasul, G., Alkharfy, K. M., & Gilani, A. H. (2012). Antioxidant, antimicrobial properties and phenolics of different solvent extracts from bark, leaves and seeds of Pongamia pinnata (L.) Pierre. *Molecules*, *17*(4), 3917-3932.
9. Sharma, P., JOSHI, A., SHARMA, A. K., & Dwivedi, K. N. (2013). Phytochemical and Pharmacognostical Study of Karanja (Pongamia Pinnata Linn.) Seed. *The International Journal of Pharmaceutical Research and Bio-Science*, *2*(4), 323-332.
10. Usharani, K. V., Naik, D., & Manjunatha, R. L. (2019). Pongamia pinnata (L.): Composition and advantages in agriculture: A review. *J Pharmacogn Phytochem*, *8*(3), 2181-2187.
11. Khatri, P., & Patel, R. (2013). A phytochemical overview of various parts of Pongamia pinnata (Karanj). *World J. Pharm. Res*, *2*, 146-165.
12. Su, P. A., Li, S. L., Tang, H. J., Chen, C. C., Lu, Y. C., Cheng, K. C., ... & Lai, C. C. (2020). In vitro synergy of Pongamia pinnata extract in combination with antibiotics for inhibiting and killing methicillin-resistant Staphylococcus aureus. *Antibiotics*, *9*(3), 103.
13. Niranjan, K., Viviyan, S., & Jeyaseelan, E. C. (2013). Screening for anti-microbial and phyto chemical properties of different solvents extracts of leafs of Pongamia pinnata.
14. Sarje, S. K., Farooqui, S., Punam, S., Shital, S., & Mayur, N. (2020). Phytochemical, Pharmacognostical and quantitative estimation of Pongamia pinnata leaves extract A preliminary study to identify phytoconstituent. *World Journal of Pharmaceutical Research*, *9*(3).
15. Menpara, D., & Chanda, S. (2014). Phytochemical and pharmacognostic evaluation of leaves of Pongamia pinnata L.(Fabaceae). *Pharma. Comm*, *4*(2), 3-7.
16. Akram, M., Nimesh, S., Chishti, M. A., Ahmad, M. I., Dhama, S., & Lal, M. (2021). Pongamia pinnata: An updated review on its phytochemistry, & pharmacological uses. *Pharmacy & Pharmacology International Journal*, *9*(5), 194-199.
17. Giri, M. A., Bhalke, R. D., & Pal, S. C. (2010). Gastroprotective effect of hydroalcoholic leaves extract of Pongamia pinnata. *International Journal of Pharma and Bio Sciences*, *1*(3), 1-6.
18. Sikarwar, M. S., & Patil, M. B. (2010). Antidiabetic activity of Pongamia pinnata leaf extracts in alloxan-induced diabetic rats. *International journal of Ayurveda research*, *1*(4), 199.
19. Sikarwar, M. S., & Patil, M. B. (2014). Antihyperlipidemic activity of Pongamia pinnata leaf extracts. *Turk J Pharm Sci*, *11*(3), 329-338.
20. Thakur, S. H. I. F. A. L. I., Kaurav, H., & Chaudhary, G. (2021). Karanj (Pongamia pinnata)—an ayurvedic and modern overview. *Asian J Pharm Clin Res*, *14*(6), 86-92.
21. Dwivedi, D., Dwivedi, M., Malviya, S., & Singh, V. (2017). Evaluation of wound healing, anti-microbial and antioxidant potential of Pongamia pinnata in wistar rats. *Journal of traditional and complementary medicine*, *7*(1), 79-85.
22. Anuradha, R., & Krishnamoorthy, P. (2012). Screening of phytochemicals and identification of chemical constituents of Pongamia pinnata by GC-MS. *Inter J Chem Tech Res*, *4*, 16-20.
23. Ujwal, P., Kumar, M. P. M. P., Naika, H. R., & Hosetti, B. (2007). Antimicrobial activity of different extracts of Pongamia pinnata. *Medicinal and aromatic plant science and Biotechnology*, *1*(2), 285-7.

24. Samuel, A. J. S. J., Radhamani, S., Gopinath, R., Kalusalingam, A., Vimala, A. G. K. A., & Husain, A. (2009). In vitro screening of anti-lice activity of Pongamia pinnata leaves. *The Korean journal of parasitology*, *47*(4), 377.
25. Manigauha, A., Patel, S., Monga, J., & Ali, H. (2009). Evaluation of anticonvulsant activity of Pongamia pinnata Linn in experimental animals. *Int J Pharm Tech Res*, *4*, 1119-1121.
26. Essa, M. M., Subramanian, P., Suthakar, G., Manivasagam, T., & Dakshayani, K. B. (2005). Protective influence of Pongamia pinnata (Karanja) on blood ammonia and urea levels in ammonium chloride-induced hyperammonemia. *J Appl Biomed*, *3*(3), 133-138.
27. Afrin, S., Muhit, M. A., Sohrab, M. H., Hasan, C. M., & Ahsan, M. (2020). Antioxidant, Thrombolytic, Antimicrobial and Cytotoxic Activities of Flavonoids Isolated from the Root Bark of Pongamia pinnata: Antioxidant, thrombolytic, antimicrobial and brine shrimp. *Dhaka University Journal of Pharmaceutical Sciences*, *19*(1), 1-8.
28. Harsha, T. L., Tejaswini, K. S., Nischith, S. S., MM, R. K., Bharathi, D. R., & Ahmed, S. S. (2022). Phytopharmaceutical and pharmacological aspects of "pongamia pinnata"-a comprehensive review. *International Journal of Health Care and Biological Sciences*, 38-44.
29. Minakawa, T., Toume, K., Ahmed, F., Sadhu, S. K., Ohtsuki, T., Arai, M. A., & Ishibashi, M. (2010). Constituents of Pongamia pinnata isolated in a screening for activity to overcome tumor necrosis factor-related apoptosis-inducing ligand-resistance. *Chemical and Pharmaceutical Bulletin*, *58*(11), 1549-1551.
30. Bholane, A., & Hiremath, V. V. (2020). A critical review on Karanja (Pongamia pinnata) & its medicinal properties. *Journal of Ayurveda and Integrated Medical Sciences*, *5*(02), 194-202.
31. Pulipati, S., Babu, P. S., Lakshmi, D. N., Navyasri, N., Harshini, Y., Vyshnavi, J., & Prasanth, M. (2018). A phyto pharmacological review on a versatile medicinal plant: Pongamia pinnata (L.) pierre. *Journal of Pharmacognosy and Phytochemistry*, *7*(4), 459-463.
32. Jain, N. (2024). PHARMACOLOGICAL STUDY ON THE PLANT PONGAMIA PINNATA (L.) PIERRE: Article History: Submission: 25-02-2024, Revision: 18-03-2024, Acceptance: 15-05-2024, DOI Information: https://doi. org/10.56815/IJMSCI. V4I1. 2024/13-26. *International Journal of Medical Science*, 13-26.
33. Saghir, F., Hussain, K., Tahir, M. N., Raza, S. A., Shehzadi, N., Iftikhar, S., ... & Siddique, S. (2021). Antidiabetic screening, activity-guided isolation and molecular docking studies of flower extracts of Pongamia pinnata (L.) pierre. *Journal of Medicinal plants and By-Products*, *10*(1), 85-92.
34. Raja, R. R., & Sreenivasulu, M. (2016). Pongamia Pinnata—Phytotherapeutic review. *World Journal of Pharmaceutical Research*, *5*(4), 505-511.
35. Jagannath, P., Biswajit, S., & Gurudutta, P. (2021). Pharmacological evaluation for Anti-Anxiety and CNS depressant activity of hydro-alcoholic leaves extract of Pongamia pinnata. *Journal of Drug Delivery & Therapeutics*, *11*(4-S), 22-25.
36. Swamy, A. V., Patel, N. L., Gadad, P. C., Koti, B. C., Patel, U. M., Thippeswamy, A. H. M., & Manjula, D. V. (2013). Neuroprotective activity of pongamia pinnata in monosodium glutamate-induced neurotoxicity in rats. *Indian journal of pharmaceutical sciences*, *75*(6), 657.

37. Balasooriya, D., Karunarathna, C., & Uluwaduge, I. (2021). Wound healing potential of bark paste of Pongamia pinnata along with hirudotherapy: A case report. *Journal of Ayurveda and Integrative Medicine*, *12*(2), 384-388.