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Plumeria pudica: A Comprehensive Review of its Pharmacological Properties

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ABSTRACT

Plumeria pudica a species of the family Apocynaceae and also known as Bridal Bouquet or White Frangipani is an ornamental plant with medicinal properties that has been discovered to grow in tropical as well as subtropical world. The plant has been used as a therapeutic agent in the treatment of various diseases such as Inflammation, Diarrhea, Asthma, Skin Diseases and Rheumatism. The plant has a wide range of bioactive compounds such as Flavonoids, Alkaloids, Glycosides, Tannins, Terpenoids, and Saponins, which are found in its Leaves, Flowers, Roots, Barks, and Latex, and which are responsible to its medicinal properties. Recent studies have revealed that the plant has been found to possess a number of biological activities like Anti-Inflammatory, Antimicrobial, Antioxidant, Anti-Diarrheal, Anti-Helminthic, Anti-Cancer, Anti-Ulcerative Colitis, etc. The plant has also been utilized in the production of silver nanoparticles and this has made the plant even more useful in nanotechnology as a therapeutic agent.

The present review will provide a detailed taxonomic, botanical description, geography, phytochemistry, traditional and pharmacological activity of *Plumeria pudica*. In this research paper, *Plumeria pudica* will be targeted in terms of its therapeutic features and its significance as a natural source of future drug development..

KEYWORDS

Plumeria pudica, Apocynaceae, Phytochemistry, Medicinal plant, Anti-Inflammatory activity, Antioxidant activity, Anti-diarrheal activity, Silver nanoparticles, Green synthesis, Traditional uses, Bioactive compounds, Drug discovery.

I. INTRODUCTION

Medical plants are a significant source of medication in traditional and modern medicine. *Plumeria pudica* is one of them and has received a lot of interest because of its wide range of pharmacological characteristics. The plant is popularly known as Bridal Bouquet and it is very popular in tropical areas. The different sections of the plant such as its Leaves, Flowers, Roots, Barks, and Latex have been used as an alternative medicine to the treatment of many disorders. Recent phytochemical investigations have revealed the presence of several bioactive compounds responsible for its medicinal effects. [1]

Medicinally significant compounds are abundant in plants since the same plant i.e. the Arial part of the plant has exhibited similar or dissimilar medicinal activity based on the distribution of the phytoconstituents. *Plumeria pudica* plants are mainly flowering bushes and they are usually located in the tropical areas of the globe, even India. *Plumeria pudica* is a perennial ornamental plant that is classified in the family Apocynaceae and has been described by the availability of attractive, fragrant and frequently seen flowers both in gardens and in places of worship. The *Plumeria pudica*, belonging to the family Apocynaceae, is a perennial ornamental plant, which has been characterized by the presence of attractive, fragrant, and commonly found flowers in gardens as well as worshiping places. The plants *Plumeria pudica* have been used as a purgatory agent in the treatment of various diseases, such as Rheumatism, Asthma, Piles, Gonorrhea, Blood Disorders, and Tumours etc. The plant has fragrant flowers with aromatic properties, whereas the oil extracted from the flowers of *Plumeria pudica*, i.e., the warming oil, has been used for the treatment of Anxiety, Fear, Tremors, Insomnia, etc. [2]

The field of nanotechnology is a new field in both biomedical and scientific studies. Nanoparticles are the basic constituents of nanotechnology. Nanoparticles are small and, therefore, possess some special physicochemical characteristics, which are more useful in biomedical and healthcare applications. Generally, physical as well as chemical methods are employed for the synthesis of nanoparticles, which are toxic in nature. Therefore, green synthesis using biological sources, especially plants, has been employed as a safe, cost-effective, as well as environment-friendly approach, where plant extracts act as reductants as well as stabilizers. Silver nanoparticles are among other

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nanoparticles that have been researched widely because of the potential biomedical uses of the particles. Silver nanoparticles have been stated to be Antimicrobial, Anticancer, Antioxidant, Drug Delivery and Healing properties. Synergistic activity has been reported to have better properties on plant-mediated silver nanoparticles. Besides, free radicals have been known to cause OIxidative stress which has been cited to be one of the leading causes of diseases such as Cancer and Cardiovascular Diseases. [3]

Inflammation is an adaptive immune response to noxious stimuli. However, chronic Inflammation can cause diseases. Arthritis is an inflammatory disease that causes pain and swelling in joints. Rheumatoid arthritis is a chronic inflammatory disorder that causes pain and swelling in joints.

Anti-Inflammatory drugs are effective in treating Inflammation but are associated with side effects. Therefore, it is important to look for plant extracts that are safe and effective. Medicinal plants like *Plumeria pudica* are rich in bioactive compounds **like flavonoids and terpenoids**. These compounds are responsible for the medicinal properties of these plants. In previous studies, *Plumeria pudica* plants exhibited antimicrobial, antioxidant, and Anti-Inflammatory properties. [4]

Plumeria pudica is an important medicinal plant. *Plumeria pudica*, just like other medicinal plants, reveals the significance of medicinal plants in drug discovery. Medical plants serve as a source of drugs since time immemorial. The plants have proved useful in assisting the researchers to discover new drugs. Plant compounds and in particular secondary metabolites have been of great importance in drug discovery. [5]

II. PLANT PROFILE(6)

Table 1: Taxonomical Classification

Kingdom:	Plantae
Division:	Spermatophyta
Subdivision:	Angiosperm
Class:	Dicotyledons
Subclass:	Gamopetalae
Series:	Bicarpellatae
Order:	Gentianales
Family:	Apocynaceae
Genus:	*Plumeria*
Species:	*pudica*

III.Vernacular Names of *Plumeria pudica* (7,8,9,10)

English:	Bridal bouquet, White frangipani
Hindi	Champa, Safed Champa
Sanskrit:	Champaka
Kannada:	Devachampa, Champa
Tamil:	Perungalli, Arali
Malayalam:	Kallipoo, Temple tree
Telugu:	Deva Ganneru
Bengali:	Champa
Indonesian:	Kembang Kamboja
Filipino:	Kalachuchi

IV.BOTANICAL DESCRIPTION(11)

Plumeria pudica, which is also known by other names such as White Frangipani, Wild Plumeria, and Lei Flowers, is a shrub that only has one trunk or perhaps 2 slender trunks which start to branch out near the soil to form a thick somewhat disseminating crown. The leaves are also very deep green in color and their shape is like a fiddle or maybe a spoon. This tree is covered with big bunches of bright white Flowers that have a small yellow center and this is exactly how this tree came to be named. The flowers have no fragrance at all.. The picture of the *Plumeria pudica* plant has been shown below in **figure 1**

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Figure 1 : *PLUMERIA PUDICA* Plant

V.Geographical Distribution of *Plumeria pudica*

Plumeria pudica Jacq is a species of an exotic and decorative plant that is a member of the Apocynaceae family and it is native to Central and South America, located between Panama and Northern Venezuela. It is however found to be distributed in different countries around the world in the tropics, such as India. [12]

The species does not occur in the wild in India, but is known to be distributed and grown in other tropical and subtropical areas because of its decorative use. It is present in other states in India such as Kerala, Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh, and Telangana. As an example, it is widely occurring in Kerala state where the rainfall is 2000 to 2400 mm and the temperature is 26 to 27.5 o C in various districts. [13]

Distribution in Karnataka [14]

Plumeria pudica and its variants are widely planted as an ornamental plant in the Indian state of Karnataka. The districts in Karnataka wherein this species is found are mentioned below:

- Ballari (Bellary)
- Kolar
- Chamarajanagar
- Dakshina Kannada
- Udupi

Besides the areas mentioned above, the plant can be found in the following habitats in the cities of Karnataka like Davanagere, Bengaluru, Mysuru and Mangalore:

- Botanical gardens/nurseries.
- Roadside avenue plantations.
- Residential gardens/parks.

Ecological and Distribution Pattern (Statistical/Environmental Insight) [15, 16]

- **Climate range:** Tropical; optimum temperature range 25-30C.
- **Rainfall adaptability**: 1000 to 2400 mm per annum (based on the distribution pattern in Kerala)
- **Habitat type:** Cultivated ornamental (infrequently naturalized)
- **Flowering:** Approximately during the year in good conditions.

In Karnataka State, because of the deficiency tolerance and adaptability, this species is commonly found in the dry and semi-arid districts like Ballari and Kolar, and in the coastal humid districts Dakshina Kannada and Udupi.

VI.PHYTOCHEMISTRY OF *PLUMERIA PUDICA*[26]

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Several compounds with different biological activities and chemical composition have been isolated from *Plumeria pudica*. These are Saponins, Flavonoid, Glycosides, Phytosterols, Tannins, Terpenoids, Amino Acids, and Proteins. The most significant metabolites among the various kinds of compounds that have been isolated in the plant include Flavonoids and Terpenoids which possess varying biological properties.

Sl no	Parts	Phytochemicals present	Reference
1.	Leaf	Phenolic compounds, tannins, saponins, carotenoids, coumarins, tocopherols, terpenes, isothiocyanates, sulfates, sulforaphanes, terpenoids, alkaloids, flavonoids, phytosterols, phytoestrogens, and indoles.	(17)(18)(19)(20)
2.	Stem	The majority of the stem extracts exhibited significant levels of primary metabolites, including proteins, amino acids, and carbohydrates, which were consistently identified across all extracts. Additionally, alkaloids, terpenoids, phenols, flavonoids, and glycosides were present in all examined stem extracts	(21)
3.	Root	Carbohydrates, Glycosides, Alkaloids, Protein & Amino acid, Tannins & Phenolic compounds, Flavonoids, Fixed oil and Fats, Steriods & Triterpenoids, Waxes, Mucilage & Gums	(6)
4.	Flower	Carbohydrates, Glycosides, Flavanoids, Alkaloids, Tannins, Phenolic compounds and Terpenoids are found to be present in *Plumeria pudica* flowers	(2)(5)
5.	latex	The milky latex of *P. pudica* is reported to possess **proteins, enzymes, alkaloids, cardiac glycosides, terpenoids, phenolic compounds, and resins**. Latex proteins are associated with **antimicrobial, anti-inflammatory, and wound-healing properties**.	(22)(23)(24)(25)

VII.TRADITIONAL USES[11,27]

1. **Leaves:** Decoction applied in the treatment of cracks and eruptions that occur on soles of feet.
   - Infusion/extract used in the treatment of asthma.
   - Applications: Ulcer, leprosy, Inflammation, and rubefacient.
2. **2. Flowers:** Aromatic and bechic (as administered in the treatment of cough); when used in pectoral syrups.
   - *Plumeria pudica* flower decoction was used in the treatment of diabetes mellitus in Mexico.
3. **Bark:** Decoction taken as purgative, febrile and cooling tea to prevent heat stroke.
   - Uses as a counter-irritant in the treatment of gum Inflammation as a result of toothache.
   - *Plumeria pudica* Bark as a plaster on hard tumours.
4. **Roots:** Bark decoction in the treatment of asthma, constipation, in promoting menstruation and in reducing fever.
5. **Latex** (milky sap): Use with coconut oil, as a treatment of arthritis, rheumatism; of pruritic skin lesions.
   - Use: As a rubefacient in rheumatic pain.
   - Use in skin disorders like herpes, scabies, and ulcers.
   - Purgative, cardiotonic, diuretic, and hypotensive.

6. Fruit & Seeds: Fruits are said to be consumed in the West Indies.

- Used as an abortifacient in India.
- Used for hemostasis

VIII.PHARMACOLOGICAL ACTIVITIES

The plant parts of *Plumeria pudica* have traditionally been used in the various pharmacological properties have Anti-Bacterial, Anti-Diarrheal, Anti-Inflammatory, Anti-Helminthic and Nociceptive Properties, and in the treatment of Gynecological Disorders, Bowel Disorders, Neurodegenerative Diseases such as Alzheimer, Skin Disorders, Respiratory Diseases, Fever, Blood Disorders, but, since the Arial of the plant, etc. has been done in the majority of the studies. This study has been done with an aim of evaluating the pharmacognostical as well as phytochemical properties of the flower of the plant, which will help in the authentication of the plant. [5]

8.1 Antidiarrheal effect[11, 28]

The *Plumeria pudica* latex contains a water soluble bioactive protein fraction named LPPp that

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has been reported to have extraordinary Antidiarrheal activity. The bioactive fraction has been demonstrated to have Antidiarrheal effects in experimental models of Castor Oil-Induced Diarrheal, Cholera Toxin-Induced Diarrheal and Prostaglandin E2 (PGE2)-Induced Diarrheal models. It has been observed that the bioactive fraction when used in the dosages of 10, 20 and 40 mg/kg leads to a reduction in the frequency and severity of Diarrheal stools, intestinal motility and intestinal fluid accumulation. Prevention of Oxidative stress by ensuring maintenance of the glutathione level and inhibiting the formation of malondialdehyde has also been noted to be caused by the bioactive fraction. The latex proteinases and proteinase inhibitors also play a part in the protective effect of the latex in the prevention of Diarrheal disease by limiting the scope of intestinal Inflammation and damage by toxins. The bioactive fraction of *Plumeria pudica* has an Antidiarrheal effect similar to that of loperamide, which is an Antidiarrheal medication of standard. Hence, it is possible to conclude that *Plumeria pudica* has powerful Antidiarrheal activity.

8.2 Anti-Inflammatory & Nociceptive activity [11, 28, 29]

Plumeria pudica has shown potent Anti-Inflammatory and Nociceptive Activity. *Plumeria pudica* latex was tested on carrageenan induced paw edema and Inflammation induced by Dextran, Histamine, Serotonin, Bradykinin and Prostaglandin E2. *Plumeria pudica* latex was tested as an Anti-Inflammatory agent by intraperitoneal injection of carrageenan (1, 5, 10, and 40 mg/kg) at various doses (1, 5, 10, and 40 mg/kg). Carragenin-induced paw edema was found to have a decrease in paw volume because of the prevented myeloperoxidase activity, which led to the decreased neutrophil migration. *Plumeria pudica* latex prevented the migration of leukocytes to the peritoneal cavity induced by Carrageenan and Pro-Inflammatory Cytokines like Interleukin-1 (IL-1) and Tumor necrosis factor-alpha (TNF-alpha) in the peritoneal fluid. To measure the Nociceptive activity, Acetic Acid-Induced Writhing Test and Formalin-Induced Licking test were used. Carrageenan (500 µg) and Dextran (500 µg) were injected into the right hind paw of the rats in the paw edema test. Paw volume was measured at given time intervals with a plethysmometer. The pretreatment of the rats with the latex fractions, heat-treated latex (LP100 o C), dithiothreitol-treated latex (LPDTT), and iodoacetamide-treated latex (LPIAA) exhibited a significant Anti-Inflammatory activity compared to the control rats. The positive control rats were treated with indomethacin and their Anti-Inflammatory activity was similar to the negative control rats. The paper revealed the existence of strong Anti-Inflammatory and analgesic amino acids in *Plumeria pudica* latex.

8.3 Anthelmintic Activity[11, 28]

The *Plumeria pudica* leaf has demonstrated good Anthelmintic properties against the Indian earthworm, Pheretima posthuma, an experimental host of intestinal helminths due to the anatomical and physiological similarity between this experimental host and the human intestinal helminths. Different solvent extracts such as Petroleum Ether, Ethyl Acetate, Chloroform and Methanol have been investigated in their Anthelmintic potential. The research has revealed that all the extracts have exhibited good Anthelmintic effects in a concentration-dependent fashion as indicated by the paralysis and subsequent death of the worms. Methanolic extract has been demonstrated to have strong Anthelmintic effects which in turn have been quantified by the paralysis at 110 min and 90 min and the subsequent death at 130 min and 120 min respectively, against concentration of 10mg/ml and 20mg/ml respectively. The effect of the Anthelmintic activities is attributed to the development of immobility, which is followed by the inability of the worms to respond to stimuli, which, in turn, results in the eventual destruction of the worms. These observed activities would be due to the presence of bioactive phytochemicals that might be the ones causing interference with the neuromuscular coordination and metabolism of the parasites. The findings have determined the effectiveness of the *Plumeria pudica* leaf extracts in demonstrating a strong dose-dependent Anthelmintic effect, which could be adopted as a form of natural medicine in the management of helminthic infections.

8.4 Antibacterial Activity [3]

Plumeria pudica silver nanoparticles have been reported to have the potential Antibacterial activity against Gram-positive bacterial strains and Gram-negative bacterial strains. The well diffusion technique has been used to test the Antibacterial activity of PP-AgNPs on the bacteria, Bacillus subtilis MTCC 2394, Pseudomonas aeruginosa MTCC 741, Escherichia coli MTCC 448, and Klebsiella pneumoniae MTCC 109. Compared to the standard drug ciprofloxacin, the greatest Antibacterial activity has been observed with a concentration of 40 µL, then with a concentration of 16.33 ± 0.14, 15.67 ± 0.27, and 15.42 ± 0.24 mm zone

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of inhibition, respectively, of E. coli, K. The Gram-negative bacteria have proven to be more sensitive in comparison to the Gram-positive bacteria. This could be because the peptidoglycan layer of Gram-negative bacteria is thinner thus enabling the nanoparticles to penetrate effortlessly into bacterial cell wall. The effects of Antibacterial properties of PP-AgNPs could be connected to the interaction with the bacterial cell wall, the disruption of the bacterial cell membrane, the interference with bacterial enzymes, and DNA that can inhibit the growth of bacteria and lead to the death of the bacteria. Silver nanoparticles with Antibacterial properties mediated by *Plumeria pudica* can be employed as a possible drug in the nearest future.

8.5 Ulcerative Colitis / Gastroprotective activity [11, 28]

In addition to the Anti-Inflammatory properties of *Plumeria pudica*, the plant has also demonstrated a significant protective property against Inflammatory Ulcerative Colitis, which is a condition that results in severe intestinal Inflammation. Here, mice were subjected to Ulcerative Colitis by the intracolonic injection of a 6% solution of acetic acid. Concurrently, the *Plumeria pudica* latex protein extract (LPPp) was applied to the animals to determine its protective ability. The animals were sacrificed through euthanasia 8 hours after the administration of the acetic acid solution. The animals had the colons extracted to examine the wet weight, macroscopic and microscopic lesion scores, myeloperoxidase (MPO) activity, interleukin-1b (IL-1b), glutathione (GSH), malondialdehyde (MDA) and superoxide dismutase (SOD). The findings showed that latex protein extract of *Plumeria pudica* at 40 mg/kg dose had a significant effect on the reduction of Ulcerative Colitis caused by acetic acid.. The LPPp treatment had a strong Anti-Inflammatory effect on MPO and IL-1b, which suggests that LPPp suppressed the inflammatory cell infiltration and pro-inflammatory cytokines release. Moreover, LPPp therapy enhanced the antioxidant condition, as evidenced by the revival of GSH, SOD, and reduction in lipid peroxidation, as shown by a reduction in the levels of MDA. It shows that latex proteins of *Plumeria pudica* can protect against intestinal damage by inhibiting inflammatory cellular infiltration and the release of pro-inflammatory cytokines, or the production of oxidative stress.

8.6 Anticancer activity [3]

The role of PP-AgNPs on the HepG2 cell line, a human liver cancer cell line is determined using the MTT assay. The cells are placed in MEM media to a total volume of 100 µL on a microtitre plate to a final concentration of 5,000-10,000 cells/well. It was then incubated at a duration of time of 24 h to allow the cell growth. The cells are added with different concentrations of PP-AgNPs at 0, 25, 50, 100, 200, 300 µg/mL for a period of time equal to 24 h and 48 h, respectively. Afterwards 50 µg MTT reagent was introduced and allowed to be incubated over a time period of 4 h at 37 ◦C. The MTT reagent was dissociated, and at that point 50 µL of DMSO was put in solution in order to dissolve the crystals of purple formazan. A microplate reader is used to study the cells at 570 nm.

8.7 Anti-leishmanial activity [3]

Anti-leishmanial activity MTT was used to determine the in vitro anti-leishmanial activity of petroleum ether, chloroform, and methanol extracts of *P. pudica* against Leishmania donovani promastigotes. The extracts exhibited concentration-dependent inhibition towards the promastigotes. The methanol extract was the most active in anti-leishmanial activity, as compared to the other extracts: chloroform and petroleum ether extracts.

8.8 Anti-periodontitis activity [3]

P. pudica latex proteins (LPPp) demonstrated a decrease in the gingival bleeding index, probing pocket depth and alveolar bone height, and a decrease in gingival myeloperoxidase activity. Moreover, LPPp also improved Malondialdehyde, Glutathione, and Histopathology of the liver tissues.

8.9 Alzheimer's disease [11, 28]

Alzheimer disease is a progressive neurodegenerative disease, which has been linked to the elevation of the acetylcholinesterase. The enzyme is involved in the hydrolysis of the neurotransmitter acetylcholine to form Choline and Acetic Acid. This leads to the impairment of the neurotransmission in the brain. Inhibition of the enzyme acetylcholinesterase has been the only management strategy that has been used to manage the Alzheimer disease. This has been accomplished in order to increase the levels of the neurotransmitter acetylcholine at the junctions with the resultant improvement in cognitive functioning in the brain. The fact is that it has been known that plant compounds have been provided by nature with the capability of inhibiting the enzyme acetylcholinesterase. This has been used as a management style towards Alzheimer disease.

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Hence, the acetylcholinesterase inhibitory potency of the methanolic extract of the leaves of *Plumeria pudica* was evaluated with the help of the titrimetric technique on the brain homogenate of Danio rerio under in vitro and in vivo environments. This demonstrated that the enzyme acetylcholinesterase was reduced in the presence of the methanolic extract of *Plumeria pudica* hence indicating that the plant can be used as a management tool towards Alzheimer disease.

8.10 Gynecological disorders[11, 28]

Gynecology disorders like Vaginal Infections, and Menstrual abnormalities are prevalent in women of all ages. Poor hygienic conditions, lifestyle, and dietary habits predispose them more in rural women. Medicinal plants have been also reported to have been used in Ayurvedic and conventional medicine in the treatment of gynecological disorders in India due to their low toxicity and greater efficacy than synthetic compounds. The scientific validation and standardization of these herbal formulations by different scientific methods and techniques is important in order to make the medicinal use of the plants effective and rational in the treatment of different diseases. The medicinal properties of *Plumeria pudica* and three other medicinal plants were assessed in this study to determine their possible application in the treatment of gynecological diseases through the conventional medicinal system. The research findings demonstrate that *Plumeria pudica* can be used to cure gynecological problems among women.

IX.Conclusion:

Plumeria pudica is an important medicinal and ornamental plant of family Apocynaceae, which exhibits a broad range of pharmacological activities supported by traditional as well as modern scientific research. The presence of different bioactive compounds like flavonoids, alkaloids, glycosides, tannins, terpenoids, and saponins is an important contributing factor for the medicinal value of the plant.

Plumeria pudica has been studied for a wide range of pharmacological activities, including significant Anti-Inflammatory, Antidiarrhoeal, Antimicrobial, Antioxidant, Anthelmintic, Anticancer, and Gastroprotective Activities, as well as promising effects in diseases Like Ulcerative Colitis, Periodontitis, and Neurodegenerative Diseases like Alzheimer's.

The traditional use of different parts of the plants, i.e., Leaves, Flowers, Bark, Roots, and Latex, also supports its use in treating a variety of conditions, from Asthma, Skin Problems, and Rheumatism, to Gastrointestinal disorders. Despite the pharmacological profile of the plant, which holds promise, the use of this plant still calls for well-planned clinical trials, standardization, toxicity, and mechanisms of action, which can prove its efficacy, safety, and use in humans. In addition, future research should be conducted on the isolation of the compounds and their use as potential lead compounds for drug development.

In conclusion, *Plumeria pudica* holds promise as a potential source for the development of new drugs, and its use in medicine can prove to be a significant contribution towards the development of safe and potent drugs in the future.

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