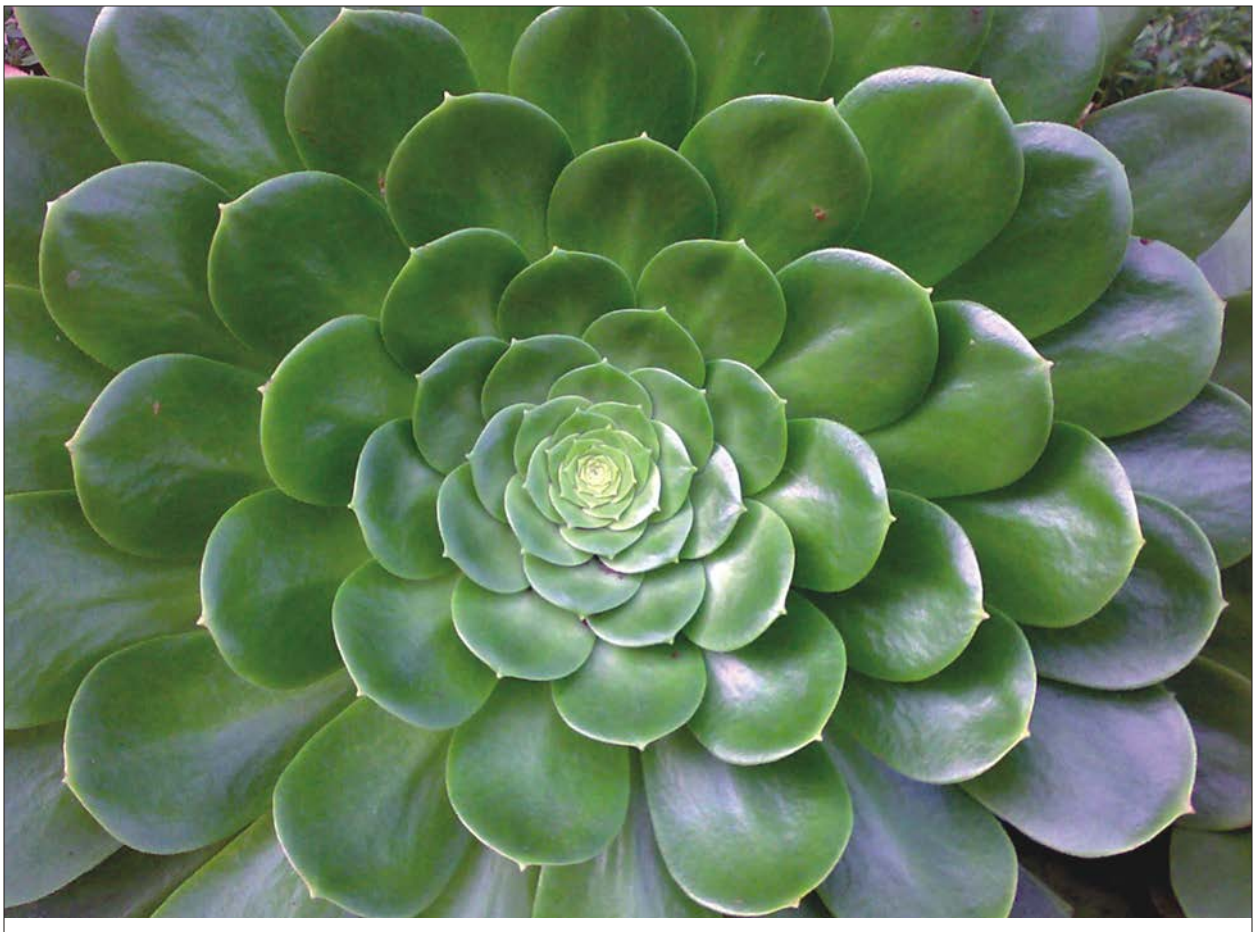

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Plumeria rubra L. (Apocynaceae): Ethnobotany, Phytochemistry and Pharmacology: A Mini Review

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ABSTRACT

Plumeria rubra L. (Apocynaceae) is a deciduous ornamental tree species with fragrant flowers native to Mexico, Central America, Colombia and Venezuela but also cultivated in tropical and subtropical countries. The plant is known to possess biological activities viz., antibacterial, antifungal, antiviral, antialgal, larvicidal, molluscicidal, piscicidal, nematicidal, antioxidative and free radical scavenging, hypolipidemic, proteolytic, cytotoxic, abortifacient activities etc. A number of phyto-constituents are reported from the plant which signifies biological activities and diverse ethnomedicinal uses of this plant species. The present review deals with the literature involving ethnobotany, phytochemistry and pharmacology of the plant.

Key words: *Plumeria rubra*, ethnobotany, phytochemistry, pharmacology, review

INTRODUCTION

Plumeria rubra L. (Apocynaceae) commonly known as 'Frangipani' is an ornamental tree species bearing fragrant flowers. The plant is native to Mexico, Central America, Colombia and Venezuela but cultivated in tropical and subtropical countries. The plant is reportedly used in a number of traditional medicinal preparations throughout Asia and Latin America for diabetes, diarrhea, dysentery, intestinal worms, stomach-ache, toothache, earache, eye-cleaning, tongue cleaning, finger nail pain, wound healing, fractures, blisters, sores, subcutaneous mycosis, rabies, malaria, rheumatism, asthma, cancer, birth control, women complaints, lactation, pediatric care, ethnoveterinary (diarrhoea and dysentery and snakebite), piscicidal, offering to god and as ornamental and it is also utilized as part of folk ritual due to its aesthetic values. A number of preclinical pharmacological investigations were performed to elucidate its bioactivities such as antibacterial, antifungal, antiviral, antialgal, larvicidal, molluscicidal, piscicidal, nematicidal, antioxidative and free radical scavenging, hypolipidemic, proteolytic, anticancer, abortifacient properties. A number of phytochemicals have been isolated from the plant, a few of which were correlated with its bioactivity. A systematic compilation on ethnobotanical, phytochemical and pharmacological aspects has been given in this paper.

Ethnobotany

Diabetes: Hypoglycemic effect of the flowers infusion (local name: Flor de mayo) is exploited by the Mexicans (Andrade-Cetto and Heinrich, 2005).

Diarrhoea: Local people of Puttaparthi Mandal, Anantapur town, Sri Sathya Sai taluk of Anantapur district, Andhra Pradesh, India use the plant bark (local name: Deva Ganneru) (Basavaraju *et al*., 2009).

Dysentery: The leaf and flower (local names: Lal kathgolachi, Golachi) is prescribed in dysentery by the ethnic people in West and South district of Tripura, India. Decoction of bark is given in amoebic dysentery (Sen *et al*., 2011). Bark (local name: Tayuk saka) is used in dysentery and loose motion by the Nicobari tribe of Car Nicobar Island, India (Gupta *et al*., 2004).

Intestinal worms: Bark (local name: Tayuk saka) is used by the Nicobari tribe of Car Nicobar Island, India (Gupta *et al*., 2004).

Stomach-ache: A preparation made by stem bark of the plant along with *Thevetia peruviana* flowers and *Achyranthus aspera* roots is prescribed by the people of Nawalparasi district, Central Nepal (Bhattarai *et al*., 2009). Stem bark of the plant (local name: Yerra champangi) with that of Neem is prescribed in the Visakhapatnam district, Andhra Pradesh, India (Kumar *et al*., 2011). Root paste (local name: Adavi Ganneru) with ghee is administered by the people of Boath, Adilabad district, Andhra Pradesh, India (Ramana, 2008).

Toothache: In Mexican traditional medicine flowers and latex of the plant (local names: Cacaloxochitl, Flor de mayo) is used (Ruiz-Teran *et al*., 2008).

Earache: In Mexican traditional medicine latex of the plant (local names: Cacaloxochitl, Flor de mayo) is used (Ruiz-Teran *et al*., 2008).

Eye-cleaning liquid: In Mexican traditional medicine latex of the plant (local names: Cacaloxochitl, Flor de mayo) is used (Ruiz-Teran *et al*., 2008).

Tongue cleaning: Bark is rubbed on the tongue by the Karens of Middle Andaman, India (Sharief *et al*., 2005).

Finger nail pain: Juice (local name: Kathachampa) is used by the people of Mayurbhanj district, Orissa, India (Rout and Panda, 2010).

Wound healing: Bark paste (local name: Deva kanagile) is applied externally by the traditional people of Sagar taluk of Shimoga district, Karnataka, India (Rajakumar and Shivanna, 2010).

Fractures: Leaf juice (local name: Tayuk saka) is used by the Nicobari tribe of Car Nicobar Island, India (Gupta *et al*., 2004).

Blisters: Latex (local name: Tayuk saka) is used to cure blisters caused by mosquito bites by the Nicobari tribe of Car Nicobar Island, India (Gupta *et al*., 2004). In another report, latex is applied by the Nicobarese on blisters directly (Verma *et al*., 2010).

Sores: In another report, latex (local name: Tayuk saka) is applied by the Nicobarese on sores directly (Verma *et al*., 2010).

Subcutaneous mycosis: The plant is used for the purpose in Latin America (Gaitan *et al*., 2011).

Rabies: A preparation made by stem bark, jaggery and dead dragonflies are prescribed as a cure by the people of Nawalparasi district, Central Nepal (Bhattarai *et al*., 2009).

Malaria: In South Vietnam, it is used against malaria (Nguyen-Pouplin *et al*., 2007).

Rheumatism: Local people of Puttaparthi Mandal, Anantapur town, Sri Sathya Sai taluk of Anantapur district, Andhra Pradesh, India use the plant bark (local name: Deva Ganneru) (Basavaraju *et al*., 2009).

Asthma: Stem bark decoction (local name: Pandhara-champha) is prescribed in asthma by the people of Jalgaon district, Maharastra (Patil *et al*., 2008).

Cancer: It is used as an anticancerous plant in Cameroon (Kuete and Efferth, 2011).

Birth control: In Assam (local name: Gulancha), the ethnic communities use the flowers in a particular dose for permanent sterilization of female (Kalita *et al*., 2011). In the same state, the plant is being used in birth control as a folk remedy (Tiwari *et al*., 1982).

Women complaints: In Mexican traditional medicine flowers and latex of the plant (local names: Cacaloxochitl, Flor de mayo) are used in vaginal bloodshed (Ruiz-Teran *et al*., 2008).

Lactation: Either fruits or seed-paste (local name: Kathchampa) with sugar candy water are prescribed to mothers by the people of Sundargarh district, Orissa, India (Prusti and Behera, 2007).

Pediatric care: A children symptom known as Hot Q in Hong Kong is treated by the flowers along with some other plants' flowers (Kong *et al*., 2006).

Ethnoveterinary (diarrhoea and dysentery): Bark is prescribed with that of Schima wallichii to the animals in a dose dependent manner by the people of Nawalparasi district, Central Nepal (Bhattarai *et al*., 2009).

Ethnoveterinary (snakebite): Pods (local name: Son chapa) boiled in milk are prescribed by the people of Jalna district, Maharastra, India (Deshmukh *et al*., 2011).

Piscicidal: In Nepal it is used as ethnobotanical practice as a piscicidal plant (Joshi and Joshi, 2006).

As offering to god: Flowers (local name: Kaattu arali) are used by the Paliyars of Theni district of Tamil Nadu, India (Ayyanar *et al*., 2010). In Buddhism flowers are used as offering to God in Xishuangbanna, southwest China (Hongmao *et al*., 2002).

Ornamental: A variety of the plant (local name: Kaathali champa) is used by the people of Barak Valley, Assam, North East India (Das and Das, 2005). The plant is used as an ornamental in the home gardens of Balzapote, Veracruz, Mexico (Chavero and Roces, 1988). Ethnobotanical uses of *P. rubra* are enlisted in Table 1.

Table 1: Ethnobotanical uses of *P. rubra*

Ethnobotanical use	Plat parts used/method of preparation	Using community/area of use	References
Diabetes	Flowers infusion	Mexico	Andrade-Cetto and Henrich (2005)
Diarrhoea	Bark	Puttaparthi Mandal, Anantapur town, Sri Sathya Sai taluk of Anantapur district, Andhra Pradesh, India	Basavaraju *et al*. (2009)
Dysentery	Leaf and flower, decoction of bark	West and South district of Tripura, India; Nicobari tribe of Car Nicobar Island, India	Sen *et al*. (2011)
Intestinal worms	Bark	Nicobari tribe of Car Nicobar Island, India	Gupta *et al*. (2004)
Stomach-ache	Stem bark (with *Thevetia peruviana* flowers and *Achyranthus aspera* roots), stem bark (with *Neem*), root paste	Nawalparasi district, Central Nepal, Visakhapatnam district, Andhra Pradesh, India, Boath, Adilabad district, Andhra Pradesh, India	Bhattarai *et al*. (2009) Rao *et al*. (2011) Venkat Ramana (2008)
Toothache	Flowers and latex	Mexico	Ruiz-Teran *et al*. (2008)
Earache	Latex	Mexico	Ruiz-Teran *et al*. (2008)
Eye-cleaning	Latex	Mexico	Ruiz-Teran *et al*. (2008)
Tongue cleaning	Bark	Karens of Middle Andaman, India	Sharief *et al*. (2005)
Finger nail pain	Plant juice	Mayurbhanj district, Orissa, India	Rout and Panda (2010)
Wound healing	Bark paste	Sagar taluk of Shimoga district, Karnataka, India	Rajakumar and Shivanna (2010)
Fractures	Leaf juice	Nicobari tribe of Car Nicobar Island, India	Gupta *et al*. (2004)
Blisters	Latex	Nicobari tribe of Car Nicobar Island, India	Gupta *et al*. (2004) and Verma *et al*. (2010)
Sores	Latex	Nicobari tribe of Car Nicobar Island, India	Verma *et al*. (2010)
Subcutaneous mycoses	Plant	Latin America	Gaitan *et al*. (2011)
Rabies	Stem bark, jaggery and dead dragonflies	Nawalparasi district, Central Nepal	Bhattarai *et al*. (2009)
Malaria	Plant	South Vietnam	Nguyen-Pouplin *et al*. (2007)
Rheumatism	Bark	Puttaparthi Mandal, Anantapur town, Sri Sathya Sai taluk of Anantapur district, Andhra Pradesh, India	Basavaraju *et al*. (2009)
Asthma	Stem bark decoction	Jalgaon district, Maharastra	Patil *et al*. (2008)
Cancer	Plant	Cameroon	Kuete and Efferth (2011)
Birth control	Flowers	Assam, India	Tiwari *et al*. (1982) and Kalita *et al*. (2011)
Women complaints	Flowers and latex	Mexico	Ruiz-Teran *et al*. (2008)
Lactation	Fruits or seed-paste with sugar candy water	Sundargarh district, Orissa, India	Prusti and Behera (2007)
Pediatric care	Flowers with some other plants' flowers	Hong Kong	Kong *et al*. (2006)
Ethnoveterinary (diarrhoea and dysentery)	Bark	Nawalparasi district, Central Nepal	Bhattarai *et al*. (2009)
Ethnoveterinary (snakebite)	Pods boiled in milk Plant	Jalna district, Maharastra, India Nepal	Deshmukh *et al*. (2011) Joshi and Joshi (2006)
Piscicidal			
As offering to god	Flowers	*Paliyars* of Theni district of Tamil Nadu, India	Ayyanar *et al*. (2010)
Ornamental	Plant	Barak Valley, Assam, North East India, Balzapote, Veracruz, Mexico	Das and Das (2005) and Chavero and Roces (1988)

Phytochemistry: Iridoids such as fulvoplumierin, allamcin, allamandin, plumericin, 15-demethylplumieride, plumieride, alpha-allamcidin, beta-allamcidin and 13-O-trans-p-coumaroylplumieride; 2,5-dimethoxy-p-benzoquinone and lignan liriodendrin were isolated from the bark of Indonesian *P. rubra* (Kardono *et al*., 1990). Furthermore, four new iridoids such as plumeridoids A, B and C and epiplumeridoid C and several known compounds like

1-(P-hydroxyphenyl) propan-1-one, isoplumericin, plumericin, dihydroplumericin, allamcin, fulvoplumerin, allamandin, plumieride, P-E-coumaric acid, 2,6-dimethoxy-P-benzoquinone, scopoletin, cycloart-25-en-3 beta,24-diol, 2,4,6-trimethoxyaniline, ajunolic acid, ursolic acid, oleanolic acid, beta-amyrin acetate, betulinic acid, lupeol and its acetate, 2,3-dihydroxypropyl octacosanoate, glucoside of beta-sitosterol, stigmasterol and beta-sitosterol were reported from the plant species (Kuigoua *et al*., 2010). Cardiac glycosides were also found to be present (Radford *et al*., 1986). Absolute configuration of plumericin and isoplumericin from the plant was later on revised on the basis of X-ray crystal structure and Circular Dichroism (CD) spectra (Elsasser *et al*., 2005). Crude protein, oil, hydrocarbon, polyphenol, saponification value, ash and lignin content of the species were measured to test its efficacy as an alternative energy source (Augustus *et al*., 2003). Essential oil of the flowers has yielded 2-methylbutan-1-ol, β-phenylethyl alcohol, nanodecane, heneicosane, benzyl salicylate, tetradeconoic acid, octadecanoic acid and phenylacetaldehyde (Sulaiman *et al*., 2008). A phytochemical screening of the plant has revealed the presence of carbohydrate, tannin, steroid, glycoside and flavonoid (Zaheer *et al*., 2010). A novel lupin alkaloid, Plumerinine was also isolated from the plant (Kazmi *et al*., 1989).

Pharmacology: The plant has been investigated for antibacterial (Hamburger *et al*., 1991; Egwaikhide *et al*., 2007, 2009; Kuigoua *et al*., 2010; Baghel *et al*., 2010; Dey *et al*., 2011), antifungal (Kuigoua *et al*., 2010; Souza *et al*., 2011; Gaitan *et al*., 2011), antimicrobial (Mahady, 2002), antialgal (Kuigoua *et al*., 2010), larvicidal (Ramos *et al*., 2009; Patil *et al*., 2012), molluscicidal (Hamburger *et al*., 1991), piscicidal (Joshi and Joshi, 2006), nematicidal (Joymati, 2010), antioxidative and free radical scavenging activities (Ruiz-Teran *et al*., 2008), hypolipidemic (Merina *et al*., 2010), proteolytic (De Freitas *et al*., 2010), cytotoxic (Kardono *et al*., 1990; Hamburger *et al*., 1991; Rekha and Jayakar, 2011), abortifacient (Dabhadkar and Zade, 2012) and anti HIV (Tan *et al*., 1991) properties. The biocatalytic activity in terms of lipase activity in hydrolysis and acyl transfer reactions of latex was compared with that of babaco (*Vasconcellea* x *Heilbornii* Cv.) (Cambon *et al*., 2006). Six compounds such as four iridoids, fulvoplumierin, allamcin, allamandin and plumericin; 2,5-dimethoxy-p-benzoquinone and lignan liriodendrin were isolated from different extracts of the plants all showing toxicity to murine lymphocytic leukemia and various human cancer cell-lines (breast, colon, melanoma, lung, fibrosarcoma, KB) (Kardono *et al*., 1990). Plumericin from *P. rubra*, a Cameroonian traditional anticancerous plant was tested against 60 NCI cell lines and the probable mode of action was determined (Kuete and Efferth, 2011). Heartwood of the plant has produced plumericin, isoplumericin and 4-hydroxyacetophenone with cytotoxic efficacy (Hamburger *et al*., 1991). Fulvoplumierin, an iridoid, yielded from *P. rubra* was found to inhibit human immunodeficiency virus type 1 (HIV-1) responsible for causing acquired immunodeficiency syndrome (AIDS) (Tan *et al*., 1991). Fulvoplumierin was also found to inhibit HIV 2 (Tan *et al*., 1992). Latex proteins from the plant were investigated for antifungal property against plant pathogens along with some other latex bearing plants (Souza *et al*., 2011). Potentiality of laticifer proteins for larvicidal activity against *Aedes aegypti* was tested (Ramos *et al*., 2009). Silver nanoparticles synthesized from the plant latex were found to possess larvicidal activity against *Aedes aegypti* and *Anopheles stephensi* (Patil *et al*., 2012). Immunoreactive cardiac glycosides were reported form the plant in significant amount indicating its probable toxicity (Radford *et al*., 1986). Subcutaneous mycoses causing fungi *Fonsecaea pedrosoi* was inhibited by the extracts of the plant (Gaitan *et al*., 2011). Plumericin and isoplumericin isolated from the heartwood of *P. rubra* was found to possess antibacterial as well as molluscicidal activities (Hamburger *et al*., 1991). Pharmacological activities of *P. rubra* are listed in Table 2.

Table 2: Pharmacological activities of *P. rubra*

Pharmacological activity	Associated compounds (if any)	References
Antibacterial	Plumericin, isoplumericin	Hamburger *et al*. (1991), Egwaikhide *et al*. (2007, 2009), Kuigoua *et al*. (2010), Baghel *et al*. (2010) and Dey *et al*. (2011)
Antifungal		Kuigoua *et al*. (2010), Souza *et al*. (2011) and Gaitan *et al*. (2011)
Antimicrobial		Mahady (2002)
Antialgal		Kuigoua *et al*. (2010)
Larvicidal		Ramos *et al*. (2009) and Patil *et al*. (2012)
Molluscicidal	Plumericin, isoplumericin	Hamburger *et al*. (1991)
Piscicidal		Joshi and Joshi (2006)
Nematicidal		Joymati (2010)
Antioxidative		Ruiz-Teran *et al*. (2008)
Hypolipidemic		Merina *et al*. (2010)
Proteolytic		De Freitas *et al*. (2010)
Cytotoxic	Fulvoplumierin, allamcin, allamandin, plumericin, 2,5-dimethoxy-p-benzoquinone, liriodendrin, isoplumericin, 4-hydroxyacetophenone	Kardono *et al*. (1990), Hamburger *et al*. (1991) and Rekha and Jayakar (2011)
Abortifacient		Dabhadkar and Zade (2012)
Anti HIV	Fulvoplumierin	Tan *et al*. (1991, 1992)

CONCLUSION

The present review represents tremendous medicinal, ethnobotanical and pharmacological uses of the plant species. Further work is still needed to elucidate its phytochemical profiling and metabolic pathways which might be manipulated for production of important secondary metabolites from the plant species using biotechnological tools. The information cited here indicates towards a possible linkage among traditional uses, photochemistry and pharmacology of this medicinal plant. Further research is suggested to describe its bioactivity and traditional use after elucidating the characteristics of bioactive components present in the active extracts.

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