



Plumbago auriculata Lam

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ABSTRACT

Plumbago auriculata Lam belongs to Plumbaginaceae, treated as ornamental as well as medicinal plant contains a very potent secondary metabolite, Plumbagin having many therapeutic properties. This review highlights the pharmacological aspects along with recent updates on phytochemical contents and *in vitro* techniques of the plant.

Keywords: Plumbagin, Root extract, Anti inflammatory, Plumbaginaceae

INTRODUCTION

Today's health care system rely largely on plant materials. Most of the world population depends on traditional medicine to meet daily health requirements, especially in the developing countries where plants are the main source of medicine. India has been considered as a treasure house of valuable medicinal and aromatic plant species. The WHO (World Health Organization) has been estimated that 80% of the world's population relies upon medicinal plants for their health care. From the ancient times to the present day, plants have been used as source of medicine in all traditions. The biological activity of the plant is due to the numerous varieties of phytoconstituents synthesized by the plants and accumulated by them. The natural bioactive compounds were isolated from plants and used in all Indian systems of Medicine. *Plumbago auriculata* Lam. (synonym: *Plumbago capensis* Thumb.) is a medicinal herb of family Plumbaginaceae. It is indigenous in South Africa and grown in garden in India as an ornamental plant. It is used medicinally in South Africa.¹ The genus name "plumbago" comes from the word "plumbum" which means lead. This is reference to the belief that plumbago can cure lead poisoning. *P. auriculata* most common species to be cultivated in lead polluted area. It is useful as a lead or cadmium controlling agent by means of phyto stabilization.^{2,3} In Malayalam it is known as Neelakoduveli, Krishna chirthraka in Sanskrit and blue leadwort in English.⁴ This review contains information about phytochemicals, *in vitro* methods and pharmacological activity of Plumbagin, a major phytoconstituent present in *P. auriculata*.

Plant Description

Plumbago auriculata, a perennial herb or small shrub up to 2m tall, stem erect, trailing or climbing diffusely branched. Leaves alternate, simple, elliptic to obovate, 3-4×1.5-2 cm, base acute to attenuate, apex (sub) acute, apiculate, petiole to 1 cm. Inflorescence compact, Raceme 3-4 cm. Calyx 1cm. corolla tube blue to

violet 3cm long lobes broadly obovate 1 cm long. Stamens 5, free, filaments 3 cm long, another 3mm. Ovary superior, 1 celled ovary 4 cm style 2 cm, filiform. Fruit an oblong, membranous Capsule. Up to 8mm long, tapering to apex enclosed in the persistent calyx, dehiscent, 1 seeded, seed oblong 7mm long slightly flattened, dark brown or black. Flowers and fruits throughout the year.⁵

Botanical Classification

Kingdom : Plantae
 Division : Magnoliophyta
 Class : Magnoliopsida
 Order : Plumbaginales
 Family : Plumbaginaceae
 Genus : Plumbago
 Species : auriculata⁶

Traditional Uses

This plant has been used traditionally to treat a range of ailments including wounds, broken bones, treatment of warts, powdered root is taken as a snuff for headaches and to dispel bad dreams. A stick of the plant is tucked into the thatch roof of huts to discourage lightning.⁷ A decoction of the aerial parts or roots of *plumbago auriculata* is taken to treat black water fever. Root infusion of *P. auriculata* is taken as an emetic. The powdered, roasted root is rubbed into scarification over fractures to promote healing, and is rubbed on the body to cure stitch. *P. auriculata* is grown in gardens throughout the tropics as an ornamental and as a hedge or live fence, in temperate region. In East Africa flowers and leaves of *P. auriculata* are used as dye for textiles: beige, lemon, yellow (if combined with alum) or gold (combined with chrome). The sap of root is grey-blue and is used for tattoos.⁸ The Pawara Bhil and Pardhi tribes in satpuda forest region of Dhule and Jalgaon district of Maharashtra having the habit of consuming the root juice



or extract of this plant for gastric acidity before each meal for a week.⁹

Phyto Chemical Investigation

Plumbagin is a secondary metabolite obtained from plumbago which exhibits highly potent biological activities. Chemically, plumbagin is hydroxyl-naphthoquinone (5-hydroxy-2-methyl-1, 4-naphthoquinone; chemical formula C₁₁ H₈ O₃). The naphthoquinones plumbagin and epi-isoshinanolone, the steroids sitosterol and 3-O glucosylsitosterol, plumbagic and palmitic acids have been isolated from *P. auriculata*¹⁰. All parts of *p. auriculata* contain naphthoquinone plumbagin, It possess a variety of pharmacological activities.¹¹ **Flowers** The flowers of the plant reported azalein, Capensinidin, and capensinidin – 3 – rhamnoside.¹² **Leaves** Leaves of the plant contain apigenin, luteolin and their glycosides.¹³ Plumbagin content more in leaves and stems of *p.auriculata* when compared with *P.zeylanica* and *P. rosea*.¹⁴ **Roots** Aryanathan reported the methanolic extract of plumbago *auriculata* roots has yielded α - amyryn acetate, plumbagin, α - amyryn, β – sitosterol, diomuscione, capensisone, isoshinanolone and β – sitosterol – β -glucopyranoside, Isoshinanolone and diomuscione. Aryanathan et al reported a new natural product Capensisone from this plant. TLC profile of *Plumbago auriculata* using with toluene ; ethyl acetate as solvent system, they observed fluorescent yellow spots with Rf value 0.4. Reishya observed in their work the chloroform and petroleum ether extracts of *p auriculata* showed maximum number of steroidal band (8) with different Rf values chloroform and acetone extracts of *P. auriculata* showed maximum number of phenolic bands (7) with varied Rf values. All parts of *P. auriculata* contain naphthoquinone plumbagin (2 methyl, juglone) plumbagin possess a variety of pharmacological activities.¹⁵

Pharmacological Activities

Anti-bacterial Activity

Anti-Helicobacter pylori and cytotoxic activity of detoxified root ethanol extract of *p. auriculata*, roots were detoxified with lime water and prepared the ethanol extract. Ethanol extract of the plant has possible activity against *H. Pylori* and cytotoxicity activity with MTT assay in HEG-17 cell lines. Plant ethanol extract (50-250 μ g/ml) have dose dependent cytotoxicity activity In HEG-17 cell lines. Zone of inhibition test of *P. Auriculata* in ethanol extract shows significant activity.¹⁶ Root extracts of *P. auriculata* were used to cure Plasmid medicated antibiotics resistance. The plasmids curing activity of plumbago extracts were determined by growth of organisms in presence of root extract. The physical loss of plasmid DNA was confirmed by agarose gel electrophoresis. This study reveals that the broad spectrum of antibacterial activity of plasmid curing potential (13-32%) of *P. auriculata* plant root extracts. So, that *P. auriculata* plant root extract can be used in

combination with antibiotics to prevent the development and spread of antibiotics resistance in treatment of nosocomial infection.¹⁷

Anti-inflammatory activity

A study showed that a hydro-alcoholic extract of the roots of *P. auriculata* showed a maximum of 46.88% inhibitory action on carageenan induced; paw edema at the dose of 250 mg/kg and inhibited the leukocyte migration in a dose dependent manner¹⁸.

Anti-fungal activity

Crude antifungal protein 20 KD from the young leaves was isolated and its toxic property was tested against the pathogen, *Macrophomina phaeolina*. The activity reported is the inhibition of spore germination in the pathogen.¹⁹

Anti-Oxidant activity

Antioxidant activity of leaves extract of *P. auriculata* studied by various methods. TBARS and NBT assay were performed to evaluate antioxidant activity. Ethyl acetate and ethanol crude extract had significantly higher antioxidant activity than petroleum ether and dichloromethane extract. NBT assay showed that at highest concentration ranges of 0.625-2.5mg/ml, the ethyl acetate and ethanol extract had the best ($p < 0.001$) superoxide scavenging activity compared to the toxin(KeN). The ethyl acetate and petroleum ether extracts significantly inhibited the proliferation of HeLa cells by 11.52% ($p < 0.05$) and 27.3% ($p < 0.001$) respectively at 10mg/ml compared to the control when evaluate with MTT assay. MTT assay result showed toxicity with 10mg/ml concentration of ethyl acetate extract that had the most promising antioxidant activity.²⁰ Ethanolic leaves extracts shows the highest antioxidant values, Based on result from the oxygen radical absorbance capacity (ORAC) and ferric reducing antioxidant (FRAP) of the plant²¹.

Anti-ulcer and gastro protective activity

The DPPH scavenging assay, Lipid peroxidise inhibition assay, Acid neutralising capacity test and ethanol induced ulcer model were used for assessing the anti ulcer activity of plant for *in vivo* studies. MTT results revealed that the plumbagin showed cytotoxic activity at 40.18 μ g/ml. *P.auriculata* having least cytotoxic effect. Even though significant anti ulcer activity were exhibited by all plumbaginales. *P. auriculata* has both gastro protective and ulcer healing properties was studied along with ranitidine, a standard drug.²²

Larvicidal Activity

A bioassay-guided fractionation and chemical examination of chloroform extract of *Plumbago capensis* roots resulted in isolation and characterization of two new naphthaquine derivatives along with six known compounds. Their structure were determined on the basis of extensive spectroscopic (IR, MS, 1D and 2D NMR)



data analysis and by comparison with the literature data. All the compounds were tested for their mosquito larvicidal activity against fourth instar larvae of *Aedes aegypti*, and of plumbagin showed excellent toxicity with LC_{50} values of 1.26 and 5.43 $\mu\text{g}/\text{mL}$. New compound displayed moderate toxicity against tested mosquito species.²³

Chitin Synthesis Activity

Kubo tested the effect of plumbagin isolated from crude aqueous methanol extract from the roots of *P. auriculata* in an *in vitro* chitin synthetase (UDP-N-acetylglucosamine: chitin N-acetylglucosaminyl transferase, EC 2.4.1.16) assay utilizing integument isolated from *Trichopulsia ni* larva. The result indicates that Plumbagin inhibits about 30% of chitin synthetase isolated from *T. ni* integument at a concentration of 3×10^{-4} M.²⁴

Antileishmanial Activity

The main objective of this study determines the antileishmanial activity of plumbagin, extracted from the roots of *p. auriculata* against Leishmanial Major parasite. In the study the result reported leishmanial activity and lacked any obvious cytotoxicity. Here the purity of plumbagin extract determined by HPLC and NMR spectroscopy. Existing information confirms that plumbagin has many antimicrobial, dermatological and cytological activities against protozoan parasites.²⁵

In Vitro Methods

The Plant can be propagated by seed, stem cutting and micropropagation methods. Conventional propagation of the plant is rather difficult and insufficient to meet the growing demand owing to the poor germination of seeds and death of young Seedlings under natural conditions. Alternatively, multiplication through *in-vitro* methods was attempted.² Explants used for callus culture was leaf, stem and shoot apex MS medium fortified with PGRs like NAA, IAA, IBA and 2,4-D. Individuals and combinations 1mg/L 2, 4-D shows best callusing. Quantitative spectrometry analysis of plumbagin from plant Samples and callus indicates that plumbagin content was maximum in roots which followed by callus. Generations of *in vitro* source of plumbagin, for therapeutic application will serve as continuous supply and will contribute to preserve the natural plant resources. Another study indicated 100% callus formation from shoot apex, leaves, and stem explants by using the hormones NAA (1.5mg/L) and 2, 4D (1mg/L). Whereas IBA treatment indicated 60% callus in stem explants and 55% in leaf explants.²⁶

The nodal explants regenerated on MS basal medium supplemented with benzyladenin (0.3mg/L) developed single shoots. After being transferred to the medium contain combinations of BA, NAA and IAA(1.0m/L, 1.0m/L,0.2mg/L) different concentration respectively for 1-2 generation single shoots was induced to form

multiple shoots with highest rate of multiplication. Rooting of micropropagated shoots achieved on half strength MS basal medium supplemented with 0.5mg /L of naphthalene acetic.²⁷

Molecular Analysis

RAPD analysis in particular has proven to be a rapid and effective mean of genomic mapping and is well suited for the genetic resource characterization²⁸ RAPD markers were used to measure genetic diversity of three species of *P.zeylanica*, *P,rosea*, *P, auriculata*. In this study similarity index and genetic distance values clearly indicated that two species are closely related, while *P, auriculata* showed divergence²⁹.

Similar results were also reported using isozyme and RFLP data for 3 species of plumbago.³⁰ The study of DNA isolation from leaf explants without liquid nitrogen performed by CTAB method of three species of plumbago, *P.auriculata* shows the highest DNA concentration(4.65 $\mu\text{g}/\mu\text{l}$)³¹.

Karyotype Analysis

Research on chromosome karyotype analysis of *Plumbago auriculata*, chromosome number $2n = 12$, which is different from *plumbago Linn*. Karyotype formula $2n = 2X = 8m (4 \text{ sat}) + 4sm$. The chromosome of *P. auriculata* belong to mini chromosome and its karyotype is 2B. This helps in genetic mechanism field.³²

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