



## Phytonutrients Investigation and Pharmacological Activity of *Plumbago Zeylanica* L -An Overview

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### ABSTRACT

In recent times the blind dependence on synthetics has got over and people are returning to the naturals with hope of safety and security. Herbs are thus staging a comeback as the only solution to insidious and debilitating effects of synthetic drugs. *Plumbago zeylanica* is one such important medicinal plant which is being used the world over in the traditional system of medicines. With a herbal 'renaissance' occurring across the globe, the plant is being used extensively in commercial preparations of medicines owing to its wide range of biological activities. The present study summarizes our current knowledge of botany, major bioactives, traditional and medicinal uses of *P zeylanica* as a foreword to further studies on mass propagation of this valuable species.

**Keywords:** *Plumbago zeylanica*, morphology, traditional value, phytochemistry.

### INTRODUCTION

*Plumbago zeylanica*, a rambling subscandent perennial herb or under shrub with green branches, stems somewhat woody, spreading, terate, striate, glabrous. Leaves alternate, ovate or oblong, petiole narrow, amplexicaul at the base and often dialted into stipule like auricles. Flowers white, in axillary and terminal elongated spikes, bisexual. Calyx densely covered with stalked, sticky glands. Corolla white, very slender, tubular. Stameus, free. Ovary superior, 5-gonous, one celled, ovule one, basal. Roots are light yellow coloured when fresh, reddish brown when dry, found in the form of tough pieces, straight unbranched or slightly branched with or without secondary roots, with uniform and smooth texture, strong and characteristic odour with acid and bitter taste.

The naphthoquinones plumbagin, composed naphthoquinones like plumbagin, 3-biplumbagin, chloroplumbagin, chitranone, elliptone. The coumarins seselin, 5-methoxyseselin, suberosin and xanthyletin. Other compounds were 2,2-dimethyl-5-hydroxy- 6-acetylchromene, plumbagin acid,  $\beta$ sitosterol,  $\beta$ -sitosteryl-glucoside, bakuchiol, 12-hydroxyisobakuchiol, saponaretin, isoorientin, isoaffinetin, psorealen.

Roots of *P. zeylanica*: Two plumbagic acid glucosides, 3'-O- $\beta$ -glucopyranosyl plumbagic acid and 3'-O- $\beta$ -glucopyranosyl plumbagic acid methylester along with five naphthoquinones (plumbagin, chitranone, maritranone, elliptone and isoshinanolone), and five coumarins (seselin, 5-methoxyseselin, suberosin, xanthyletin and xanthoxyletin) were isolated from the roots of *Plumbago zeylanica*. All coumarins were not previously found in this plant. Cytotoxicity of these compounds to various tumor cells lines was evaluated, and plumbagin significantly suppressed growth of Raji, Calu-1, HeLa, and Wish tumor cell lines. Two plumbagic acid glucosides, 3'-O- $\beta$ - glucopyranosyl plumbagic acid and 3'-O- $\beta$ -glucopyranosyl plumbagic acid methylester were isolated from the root of *Plumbago zeylanica*.

### BOTANICAL CLASSIFICATION

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Ranunculales
Family	:	Plumbaginaceae
Genus	:	Plumbago
Species	:	<i>zeylanica</i>

**VERNACULAR NAMES**

Tamil	:	Kodiveli, Chitramoolam
Eng	:	Lead war
Telugu	:	Chitramulam
Sanskrit	:	Agni, Vahni, Krishanu, Huashaa, Dahana, Hutabhuk
Hindi	:	Chira, Chitra
Kannada	:	Chitramula, Vahni, Bilichitramoola
Malayalam	:	Vellakeduveli, Thumpokkoduve



PART	MORPHOLOGY
Root	Roots are 30 cm or more in length, 6 mm or more in diameter, stout, cylindrical, friable, blackish red in colour, light yellow coloured when fresh, reddish brown when dry, straight unbranched or slightly branched with or without secondary roots, with uniform and smooth texture. It has characteristic odour with acrid and bitter taste. Bark is thin and brown in colour.
Stems	Somewhat woody, spreading, terate, striate, glabrous
Leaves	Leaves are simple, alternate, 8 cm long and 3 cm broad, ovate or oblong, petiole narrow, amplexicaul at the base and often dilated into stipule like auricles .
Flowers	Flowers are white in colour, 10-25 cm long, inodorous, inbracteate, axillary and terminal elongated spikes, and bisexual. Calyx densely covered with stalked, sticky glands. Corolla is white, very slender, and tubular and Stamens 5, free. Ovary superior, 5-gonous, one celled, ovule one basal .
Fruit	Capsule oblong, 4-5 mm long, glabrous
Seeds	Seeds are oblong, dark purplish, and 4 mm long

PART	PHYTOCHEMISTRY
Root	The root bark of <i>P. zeylanica</i> contains plumbagin. The root yield new pigment, viz, 3-chloroplumbagin, 3, 3- biplumbagin, binaphthoquinone identify as 3', 6'- biplumbagin, and four other pigments identify as isozeylanone, zeylanone, elliptinone, and droserone 2, 3. The isolation of plumbagin, droserone, isoshinanolone and a new naphthalenone i.e., 1, 2 (3)-tetrahydro-3, 3'-plumbagin is reported from the phenolic fraction of the light petrol extract of the roots .
Stems	Stem contain plumbagin, zeylanone, isozeylanone, sitosterol, stigmaterol, campesterol, and dihydroflavinol-plumbaginol.
Leaves	Leaves contain plumbagin, chitanone
Flowers	Flowers contain plumbagin, zeylanone, and glucose.
Fruit	It contains plumbagin, glucopyranoside, and sitosterol.
Seeds	Seeds contain plumbagin

PART	PHARMACOLOGICAL ACTIVITY
Root	root is bitter, laxative, expectorant, tonic, abortifacient, good appetizer, useful in rheumatism, laryngitis, scabies and disease of spleen
Stems	The ethanolic stem extract inhibited the growth of <i>Leishmania amazonensis</i> promastigotes by 88% at 100 µg/ml
Leaves	Leaves are caustic, vesicant, aphrodisiac, good for scabies, stimulant, and also use in sore and swelling 6. They are used to treat infections and digestive problems such as dysentery. Externally a paste is applied to painful rheumatic areas or to chronic and itchy skin problems
Flowers	Digestent
Fruit	Digestant
Seeds	Seed decoction is prescribed to reduce muscular pain.

## SCIENTIFICALLY VALIDATED USES

### ❖ Antioxidant activity

The antioxidant is its ability to trap free radicals. Highly reactive free radicals and oxygen species are present in biological systems from a wide variety of sources. These free radicals may oxidize nucleic acids, proteins, lipids or DNA and can initiate degenerative disease. Zahin et al. (2009) carried out *in vitro* antioxidant activity and total phenolic content of methanolic extracts of *P. zeylanica* (root), *A. calamus* (rhizome), *H. indicus* (stem) and *H. antidysenterica* (bark). The order of antioxidant potential according to FTC assay was found to be highest in *P. zeylanica*. Natarajan et al. (2006) carried out antioxidant activity of a salt–spice–herbal mixture against free radical induction. A combination of spices (*P. nigrum*, *P. longum* and *Z. officinale*), herbs (*C. rotundus* and *P. zeylanica*) and salts make up *Amrita Bindu*. It was interesting to note that rats with *Amrita Bindu* pretreatment showed significantly lower levels of free radicals, lipid peroxidation and protein carbonyls along with significantly higher levels of antioxidants when compared with rats without *A. Bindu* pretreatment on PHZ administration. These results reveal that *A. Bindu*, a salt–spice–herbal mixture exerts a promising antioxidant potential against free radical induced oxidative damage.

### ❖ Anti-inflammatory activity

Anti – inflammatory refers to the property of a substances or treatment that reduces inflammation. Anti-inflammatory drugs make up about half of analgesics, remedying pain by reducing inflammation as opposed to opioids. Dang et al. (2011) conducted experimental study to evaluate anti-inflammatory activity of *Phyllanthus emblica*, *P. zeylanica* and *C. rotundus* in acute models of inflammation, namely carrageenan induced rat paw edema and acetic acid induced peritonitis in mice. In carrageenan induced paw edema, *P. emblica*, *P. zeylanica* and *C. rotundus* showed a trend to reduce the edema while the combination of *P. emblica* + *P. zeylanica* (PI: 20.64%) showed results comparable to aspirin (23.74%). Whereas in a model of acetic acid induced peritonitis, all the plant drugs, that is, *P. emblica*, *P. zeylanica*, *C. rotundus* and a combination of *P. emblica* + *P. zeylanica* showed a significant decrease in the protein content of the peritoneal exudates compared with the disease control group ( $p < 0.05$ ). Sheeja et al. (2010) carried out the anti-inflammatory and antinociceptive activities of various leaf extracts of *P. zeylanica* (petroleum ether, chloroform, acetone, ethanol, and aqueous) using *in vivo* experimental models at two dose levels (200 and 400 mg/kg, p.o.). The acetone extract significantly ( $p < 0.01$ ) reduced inflammation in the carrageenan induced rats when compared to the control group. As for the analgesia effect, the acetone and petroleum ether extracts significantly ( $p < 0.01$ ) decreased the pain stimulus only in the later phase of the formalin test, suggesting that the drug could be peripherally acting. Yedapo (1996) investigated the phosphate buffered saline extract of the roots of *P. zeylanica* for anti-inflammatory activity. The extract stabilized red blood cells subjected to both heat and hypotonic induced lyses. The extract exhibited a biphasic response. The enzymatic activities of both alkaline and acid phosphatases were reduced, while adenosine triphosphatase activity was stimulated in the liver homogenates of formaldehyde induced arthritic rats.

### ❖ Anti arthritic Activity

Poosarla and Athota (2007) investigated the role of an ethyl acetate fraction of the root extract of *P. zeylanica* in its antiarthritic activity in collagen type II-induced arthritis in DBA/1 mice and in the suppression of humoral antibody and stimulation of T cell mediated responses. PZE-6 suppressed collagen type II-induced arthritis in DBA/1 mice in a dose-dependent manner. In addition, the treatment with *P. zeylanica* stimulated Con A induced T-cell proliferation to normal levels in arthritic mice.

### ❖ Anti-cholesterol activity

Anticholesterol is a naturally occurring antibody to cholesterol produced by mammals. It is believed that this antibody serves a 'housekeeping' or protective role for the host animal, helping to protect the animal from harmful forms of cholesterol such as LDL and VLDL. Alpana (1996) studied effect of *P. zeylanica* in hyperlipidaemic rabbits and its modification by vitamin E. There was significant reduction in serum total cholesterol, LDL cholesterol and triglyceride levels. Marked reduction was observed with the formulation of *P. zeylanica* and vitamin E. The total cholesterol/HDL and LDL/HDL cholesterol ratios were found significantly ( $p < 0.01$ ) decreased.

### ❖ Hepatoprotective activity

The liver protective is ability to prevent damage to the liver. This damage is known as hepatotoxicity. Rajesh et al. (2009) conducted a study to evaluate the hepatoprotective activity of methanolic extract of aerial parts of *P. zeylanica* in CCl<sub>4</sub>-induced hepatotoxicity in wistar rats. The extract of aerial parts of *P. zeylanica* have shown very significant hepatoprotection against CCl<sub>4</sub>-induced hepatotoxicity in wistar rats by reducing serum total bilirubin, SGPT, SGOT and ALP levels. Histopathological studies also confirmed the hepatoprotective nature of the extract.

### ❖ Central Nerves Systems activity

#### a. Anti Convulsant

Vishnukanta and Rana (2010) carried out a study on pharmacological and clinical therapeutical uses of Ayurvedic medicinal plants, one of which was *P. zeylanica*. Leaf extract of this plant were evaluated for anticonvulsant activity using PTZ induced convulsion and maximum electro shocked induced convulsion. It was found that extract has no anticonvulsant activity.

#### b. Locomotor behaviour and central dopaminergic activity

Bopaiah and Pradhan (2001) studied the effects of a 50% ethanol extract of the root of *P. zeylanica* on locomotor behavior and central dopaminergic activity in rats. The results showed that the extract specifically enhanced the spontaneous ambulatory activity without inducing stereotypic behavior. The neurochemical estimations revealed elevated levels of DA and HVA in striatum compared with the control rats ( $p < 0.01$ ).

#### c. Memory enhancer

Memory enhancers, are drugs, supplements, nutraceuticals, and functional foods that improve one or more aspects of mental function, such as working memory, motivation, and attention (Sanjana Datta and Mishra, 2012).

### ❖ Hyperglycemia activity

Hyperglycemia is a condition in which an excessive amount of glucose circulates in the blood plasma. Olagunju et al. (1999) studied the effects of the ethanol extract of the root of *P. zeylanica* on key enzymes of glycolysis and other biochemical parameters in the rat. The results show that thigh muscle hexokinase, phosphofructokinase, pyruvate kinase and lactate dehydrogenase activities were significantly reduced ( $p < 0.05$ ) by 12.07, 51.02, 24.32 and 25.16%, respectively in rats treated with the ethanol extract of *P. zeylanica* when compared with the controls.

### ❖ Anti-viral activity

It's Act as an anti-viral drug as in the skin disease Neubert et al. (2006) studied antiviral activities of some Ethiopian medicinal plants used for the treatment of dermatological disorders. In this study, the antiviral activities of the 80% methanolic extracts of *Acokanthera schimperi*, *Euphorbia schimperi*, *Inula confertiflora*, *Mutinus elegans*, and *P. zeylanica* plants have been examined against coxsackievirus B3 (CVB3), influenza A virus and herpes simplex virus type 1 (HSV-1) using cytopathic effect (CPE) inhibitory assays in HeLa, MDCK, and GMK cells, respectively. lym CVB3 was inhibited by the extracts of *P. zeylanica* and HSV-1 by *I. confertiflora*.

### ❖ Cytotoxic and antibacterial activity

Aziz et al. (2008) studied an inhibitory effect of plumbagin on growth and invasion of hormone in refractory prostate cancer. The results indicate for the first time, using both *in vitro* and *in vivo* preclinical models, that PL inhibits the growth and invasion of PCa. Plumbagin inhibits multiple molecular targets including PKC $\epsilon$ , a predictive biomarker of PCa aggressiveness. Plumbagin may be a novel agent for therapy of hormone-refractory PCa. Chen et al. (2011) synthesized, characterized and evaluate preliminary cytotoxicity of five lanthanide (iii)-plumbagin complexes-plumbagin (5-hydroxy-2-methyl-1,4-naphtho quinone, H-PLN) was isolated from *P. zeylanica*, the anticancer traditional Chinese medicine (TCM). Five new lanthanide (III) complexes of deprotonated plumbagin were synthesized. Xu and Lu (2010) investigated plumbagin induces ros-mediated apoptosis in human promyelocytic leukemia cells *in vivo*-plumbagin, a naphthoquinone from the roots of *P. zeylanica* is known to possess anticancer and anti-bacterial activity. The results showed that i.p. injection of plumbagin (2 mg/kg body weight) daily for 3 weeks resulted in a 64.49% reduction of tumor volume compared with the control. These results indicate that plumbagin has potential as a novel therapeutic agent for myeloid leukemia. In another study, Yang et al.

(2010) reported that plumbagin activates erk1/2 and akt via superoxide, src and pi3-kinase in 3t3-l1 cells. Plumbagin, derived from the plant *P. zeylanica*, has been shown to chronically activate ERK1/2 and inhibit Akt activity in cancer cells. These results suggest that plumbagin activates NAD(P)H oxidase, Src, and PI3K, and that the activated PI3K or PDK1 subsequently stimulate Akt and Ras–Raf–MEK1/2–ERK1/2 in 3T3-L1 cells.

#### ❖ Antiplasmodial activity

Simonsen et al. (2001) carried out *in-vitro* screening of Indian medicinal plants for antiplasmodial properties against *Plasmodium falciparum*. Of 80 analyzed ethanol extracts, from 47 species, significant effects were found for 31 of the extracts one of that was *P. zeylanica*

#### ❖ Wound healing activity

Reddy et al. (2002) studied wound healing effects of *H. indicum*, *P. zeylanica* and *A. indica* in rats. The ethanolic extracts of *H. indicum*, *P. zeylanica* and *A. indica* were evaluated for their wound healing activity in rats. *H. indicum* possesses better wound than *P. zeylanica* and *A. indica*.

#### ❖ Anti cancer activity

Anticancer may act via different mechanisms including enhancement of natural defences against cancer, deactivation of carcinogens, and blocking the mechanisms by which carcinogens act (Sanjana Datta and Mishra, 2012).

#### ❖ Anti allergy activity

The Anti Allergy relating to any agent or measure that prevents, inhibits, or alleviates an allergic reaction (Sanjana Datta and Mishra, 2012).

#### ❖ Anti-fertility activity

Edwin et al. (2009) evaluated the antifertility properties of extracts of leaves of *P. zeylanica*. The effects of petroleum ether, chloroform, acetone, ethanol and aqueous extracts of the leaves of *P. zeylanica* on the estrous cycle of rats were studied at two dose levels, namely, 200 and 400 mg/kg. The acetone and ethanol extracts were most effective in interrupting the estrous cycle of the rats ( $p < 0.05$ ). The animals exhibited a prolonged diestrous stage of the estrous cycle corresponding to a temporary inhibition of ovulation. The antiovarian activity was reversible on discontinuation of treatment. Both extracts showed significant oestrogenic and anti-oestrogenic activity ( $p < 0.05$ ).

### 16. Antiplasmodial activity

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## CONCLUSION

Over the past decade, herbal medicine has become an item of global importance with both medicinal and economic implications. The history of medicine includes many ludicrous therapies, never the less, ancient wisdom has been the basis of modern medicine and will remain as one important source of future medicine and therapeutics. In present review, we have made an attempt to congregate the botanical, phytochemical, pharmacological and ethno pharmacological information on *Plumbago zeylanica*. Survey of literature reveals the presence of naphthaquinone, plumbagin, chitanone, zelanone, flavonoids, terpenoids and steroids. Scientific research on this plant reported the antibacterial, antifungal, anticarcinogenic, analgesic and anti-inflammatory and antiallergic activity of various parts of this plant.

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