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, terete, striate, glabous. Leaves alternate, ovate or oblong, petiole narrow, amplexicaul at the base and often dialed 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. Stamens, free. Ovary superior, 5-locous, 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 acrid and bitter taste.

The naphthoquinones plumbagin, composed naphthoquinones like plumbagin, 3-biplumbagin, chloroplumbagin, chitranone, elliptone. The coumarins seselin, 5-methoxyseselin, suberosin and xanthyliet. Other compounds were 2,2-dimethyl-5-hydroxy- 6-acetylcromene, plumbagin acid, ßsitosterol, ß-sitosteryl-glucoside, bakuchiol, 12-hydroxyisobakuchiol, saponaretin, isoorientin, isoaffin etin, psorealen.

Roots of P. zeylanica: Two plumbagic acid glucosides, 3′-O-β-glucopyranosyl plumbagic acid and 3′-O-β-glucopyranosyl plumbagic acid methylester along with five naphthoquinones (plumbagin, chitranone, maritinone, elliptinone and isoshinanolone), and five coumarins (seselin, 5-methoxyseselin, suberosin, xanthyletin and xanthylietin) 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-β-glucopyranosyl plumbagic acid and 3′-O-β-glucopyranosyl plumbagic acid methylester were isolated from the root of Plumbago zeylanica.

BOTANICAL CLASSIFICATION

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae</th>
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<tbody>
<tr>
<td>Division</td>
<td>Magnoliophyta</td>
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<tr>
<td>Class</td>
<td>Magnoliopsida</td>
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<tr>
<td>Order</td>
<td>Ranunculales</td>
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<tr>
<td>Family</td>
<td>Plumbaginaceae</td>
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<tr>
<td>Genus</td>
<td>Plumbago</td>
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<tr>
<td>Species</td>
<td>zeylanica</td>
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### VERNACULAR NAMES

<table>
<thead>
<tr>
<th>Language</th>
<th>Vernacular Names</th>
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<tbody>
<tr>
<td>Tamil</td>
<td>Kodiveli, Chitramoolam</td>
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<td>Eng</td>
<td>Lead war</td>
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<td>Telugu</td>
<td>Chitramulam</td>
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<tr>
<td>Sanskrit</td>
<td>Agni, Vahni, Krishanu, Huashaa, Dahana, Hutabhub</td>
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<td>Hindi</td>
<td>Chira, Chitra</td>
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<td>Kannada</td>
<td>Chitramula, Vahni, Bilichitramoola</td>
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<td>Malayalam</td>
<td>Vellakeduveli, Thumpokkoduve</td>
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### PART

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<thead>
<tr>
<th>PART</th>
<th>MORPHOLOGY</th>
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<tbody>
<tr>
<td>Root</td>
<td>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.</td>
</tr>
<tr>
<td>Stems</td>
<td>Somewhat woody, spreading, terate, striate, glabous</td>
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<tr>
<td>Leaves</td>
<td>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.</td>
</tr>
<tr>
<td>Flowers</td>
<td>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.</td>
</tr>
<tr>
<td>Fruit</td>
<td>Capsule oblong, 4-5 mm long, glabrous</td>
</tr>
<tr>
<td>Seeds</td>
<td>Seeds are oblong, dark purplish, and 4 mm long</td>
</tr>
</tbody>
</table>
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 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.

**PART** | **PHYTOCHEMISTRY**
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Root | The root bark of *P. zeylanica* 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, ellipitnine, and drosorone 2, 3. The isolation of plumbagin, drosorone, isosominalone 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, stigmasterol, 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 *Leishmania amazonensis* 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 | Digestant
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. Zahirin 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 *Anmtra Bindu*. It was interesting to note that rats with *Anmtra Bindu* pretreatment showed significantly lower levels of free radicals, lipid per-oxidation 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 substance 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-cholesterole 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 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 CCl4-induced hepatotoxicity in wistar rats. The extract of aerial parts of *P. zeylanica* have shown very significant hepatoprotection against CCl4-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 Nervous Systems activity

a. Anti Convulsant

Vishnukanta and Rana (2010) carried out a study on pharmacological and clinical therapeutic 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. Locomotorbehaviour 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 glucosecirculates in the blood plasma. Oligunju 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 a 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*, *Euphorbiaceae schimperi*, *Inula confertiflora*, *Mutinus elegans*, and *P. zeylanica* plants have been examined against cox-sackievirus B3 (CVB3), influenza A virus and herpes simplex virus type 1 Kupka (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 a inhibitory effect of plumagin on growth and invasion of human invasive 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. Plumagin inhibits multiple molecular targets including PKCepsilon, a predictive biomarker of PCA aggressiveness. Plumagin 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)–plumagin complexes–plumagin (5-hydroxy-2-methyl-1,4-naptho quinone, H-PLN) was isolated from *P. zeylanica*, the antitumor Chinese medicine (TCM). Five new lanthanide (III) complexes of deprotonated plumagin were synthesized. Xu and Lu (2010) investigated plumagin induces caspase-mediated apoptosis in human promyelocytic leukemia cells in vivo-plumagin, a napthoquinone from the roots of *P. zeylanica* is known to possess anticancer and anti-bacterial activity. The results showed that s.p. injection of plumagin (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 plumagin 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 p3-kinase in 303-11 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 antiovulatory activity was reversible on discontinuation of treatment. Both extracts showed significant oestrogenic and anti-oestrogenic activity (p < 0.05).

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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 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.

**REFERENCES**


