



## A Review on *Plumbago Zeylanica* Linn

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### ABSTRACT

*Plumbago zeylanica* Linn., often known as Ceylon leadwort or Chitrak has a high medicinal potential and is used to cure a variety of diseases worldwide. Both Ayurveda and Unani place a high value on it. It has a large variety of phytochemicals with a variety of pharmacological functions. The review highlights *Plumbago zeylanica* Linn's medicinal uses, phytochemistry, and pharmacological activity, urging further research for new medications and plant usage.

Keywords: *Plumbago zeylanica*, Phytoconstituents, Anti-inflammatory, Anti-Cancer

Ayurveda is a science that uses natural resources like animals, Plants and minerals to treat disease. It continues to be one of the oldest still-practiced traditions, and it has a strong intellectual and experiential foundation. It is extensively practised in India, and other nations. The Atharvaveda (about 1200 BC), Charak Samhita, and Sushrut Samhita (about 500-1000 BC) provide detailed information of over 700 herbs. Ancient wisdom can be shown in scholarly descriptions of Charaka's legacy written in modern language, which is best done alongside comments from modern science and medicine. Ayurveda remains an important aspect of Indian healthcare, especially in treating chronic diseases alongside contemporary medicine. There are over 40,000 plant species in India, and thousands of them have been given medicinal characteristics. There are roughly 2000 in the literature; native systems typically use 500–700.

Worldwide, tropical and subtropical nations are home to the weedy plant species *Plumbago zeylanica*. There are 10 genera in the Plumbaginaceae family, consisting of 280 species. 3 species of the genus *Plumbago*—*Plumbago indica* L. (*P. rosea* L.), *Plumbago capensis* L., and *Plumbago zeylanica* L. are found throughout India.

Plumbaginales is a superorder that includes two families: Plumbaginaceae and Limoniaceae. The chemical constituents of this compound comprise a series of active compounds, namely naphthoquinones, flavonoids, terpenoids, and steroids. Many of these compounds have been found to be involved in various biodynamic activities. Chitraka is another name for plumbago. When used topically, the substance known as chitraka causes discolouration of the skin. According to Charaka, it contains the following properties: dipaniya, a appetiser, trptighna, an anti-saturative, agnimandya nasaka, a remedy for anorexia; arsoghna, a remedy for haemorrhoids and sulaghna, a remedy for colic symptoms. It was mentioned by Sushruta as a stanya sodhakalactodepurant and sukra sodhaka a sperm purifying plant. Later Ayurvedic writings listed chitraka's additional qualities as being anahaghna deflatant, gulmaghna tumor mitigating, ajirna nasaka dyspepsia-alleviating, etc [1]

### 1. Botanical description

Plumbaginaceae family has 280 species in 10 genera, with *Plumbago* being one of them and consisting of 15-20 angiosperm species. 3 species of the genus *Plumbago* i.e *Plumbago indica* L. , *Plumbago capensis* L., and *Plumbago zeylanica* L. are found throughout India. Among these species, *Plumbago zeylanica* is ubiquitous, wild, or cultivated in all districts of Tamilnadu, Andhra Pradesh, Karnataka, and Kerala because of its more medicinal benefits [2]

#### 1.1 Classification

**Kingdom:** Plantae

**Subkingdom:** Tracheobionta

**Division:** Magnoliophyta

**Order:** Caryophyllales

**Family:** Plumbaginaceae

**Genus:** *Plumbago*

**Species:** *Zeylanica*

**Sanskrit Synonyms:** Agni, Vahini

### 1.2 Botany:

There are 280 species in the family Plumbaginaceae, divided into 10 genera. The genus *Plumbago* contains three species that are found across India: *Plumbago indica* /*P. Rosea* , *P. capensis* , and *Plumbago zeylanica*. *Plumbago zeylanica* is a natural plant that grows in several locations throughout India, but it is also cultivated due to its extensive therapeutic uses[3]. *Pz* is not universally agreed upon in the literature as a plant or shrub.

**Roots:** Its roots have a smooth, undivided texture, a light yellow hue when fresh, and a reddish to pale brown tint when dry. They are 30 cm or longer, 6 mm or larger in diameter, minimally branching, and have a very small number of secondary roots. The dried roots have a consistent, cylindrical shape, a smooth surface, are very hard, bitter, and have a distinct, unpleasant fragrance [4]

**Stem :**The stems are spreading, terete, striate, and somewhat woody. It is around 5-2 m tall. Brown and thin is the bark . Simple, oval, dark green leaves with hairy margins and alternate positions on the stem with a gap of up to 3 inches and a thickness of 1.5 inches are present. Native stipules are present, and the petioles are slender and around 0.5 mm long.

**Inflorescence:** The inflorescence is a terminal raceme-type with many flowers that is between 6 and 30 cm long.

**Flowers:** Flowers are bisexual, 10–25 cm long, and between 1/2 and 3/4 inch in diameter. Flowers are produced on spikes, and the spike's rachis is pubescent or glandular. The flowers have a tubular calyx with five ribs that is 7 to 11 mm long. They also have glandular trichomes that exude a gooey mucilage. The corolla is thin and tubular, and it is white in colour. There are five free stamens present. The ovary is superior, 5-gonous, one-celled and basal-17 ovule.

The plant blooms all year round, and insects are mostly responsible for pollination. The mucilaginous glands facilitate animal fruit distribution and insect capture.

**Fruits :** Fruits are rectangular capsules with five ridges that are 7.5-8 mm long and one seed within.

**Seeds:** Each seed has an oblong shape, is 5–6 mm long, and ranges in colour from reddish-brown to dark brown . A persistent viscid calyx surrounds each seed's capsule. In order to assess genetic differentiation and population structure within the species, Panda et al. (2015) [22] investigate the patterns and levels of morphological and genetic variability within/among populations and determine whether these variations are dependent on geographical factors[5]



Fig a ) plumbago zeylanica flower



Fig b) Plumbago zeylanica dried root.

### 3. Microscopic description:

The transverse section of the root shows the following structure:

**Cork:** The cork's outermost layer is made up of five to seven rows of dark brown, cubical to rectangular cells.

**Secondary cortex:** The secondary cortex is made up of two to three rows of rectangular, light brown cells with thin walls, the majority of which are filled with starch grains.

**Cortex:** Consists of large, irregularly shaped parenchymatous cells that range in size and form from polygonal to tangentially elongated. Some of these cells contain starch grains, and some of the fibres are dispersed individually or in groups of two to six.

**Phloem:** A narrow zone of polygonal, thin-walled cells with regular components and phloem fibres, similar to the cortical zone. Phloem fibres are lignified with pointed ends and a narrow lumen, and they resemble secondary cortex in size and shape. They typically occur in groups of two to five but can occasionally occur alone.

**Cambium:** indistinct.

**Xylem:** Pale yellow to white; radial or single rows of xylem channels; tracheids also contain starch granules.

**Medullary ray:** Radially elongated, single to multilayered, and filled with simple to complex starch grains. Stone cells missing.

**Leaves:** The leaves are irregularly shaped and are organised as dicotyledons. The leaf's T.S. reveals the following structure. One palisade layer, two to three spongy layers, and one lamina.

**Mesophyll:** Idioblast cells have occasionally been discovered in intercellular gaps that contain less tannin than *P. indica*.

**Trichomes:** No trace of trichomes [4]

#### 4. Traditional uses:

*Pz* possesses various medicinal properties utilized in traditional medicine, including being an abortifacient, alexeteric, antipyretic, antiseptic, aphrodisiac, astringent, carminative, choleric, diaphoretic, digestive, diuretic, expectorant, laxative, stimulant, and tonic. Its root decoction has been used to treat gonorrhoea when combined with the roots of *Moringa borziana*. Lung and breast cancer are treated with infusions of *Pz* root and other components in Iwo, Ibadan, and Southwest Nigeria. The roots or leaves are powdered and used to treat gonorrhoea, syphilis, tuberculosis, rheumatic pain, swellings, and wounds in Ethiopia. Crushed root is also applied to skin sores to treat anthrax. The roots are used in Nigeria to cure ulcers, scabies, and rheumatic swelling. Root paste made with milk, vinegar, salt, and water is applied externally for leprosy and other stubborn skin conditions. Cold infusion treats blackwater fever and flu. Plumbagin, derived from naphthoquinone, prevents triglyceride build-up in liver and aorta. [5]

**Table no. 1**

S/N	Disorder	Parts used	Description
1.	Diarrhoea	Roots	The paste made from 1-2g of root is consumed with 30-60ml of buttermilk, 2-3 times daily.
2.	Peptic ulcers, piles, appetite enhancer	Roots	The decoction made from the root bark churnam is to be taken orally twice a day for about 1 to 2 weeks. The recommended dosage for adults is 30 to 60 ml, while for children it should be limited to 5 to 10 ml divided into smaller doses.
3.	Hypercholesteremia	Roots	The root powder is consumed orally, twice a day with honey for 3 months, at a dosage of 2-5 grams.
4.	Abortifacient	Roots	Administering 3-5 g of chitraka root paste locally in the vaginal tract for 3-5 days.
5.	Anaemia	Roots	The recommended dosage is 1 to 3 grams of a mixture of chitraka and <i>Abutilon indicum</i> (L.) Sweet root powder, taken with milk once a day for a period of three months.
6.	Leukoderma psoriasis	Roots	The recommended dosage of chitraka powder (1 part), dried ginger, <i>Piper longum</i> L. and <i>Piper nigrum</i> L. (1 part each) is 2-3 grams, taken orally with ghee or honey twice a day for a period of three months.

#### 5. Chemical composition:

Flavonoids, alkaloids, glycosides, saponins, steroids, tannins, tri-terpenoids, coumarins, carbohydrates, phenolic compounds, fixed oils, lipids, proteins, and naphthoquinones are only a few examples of the secondary metabolites found in *P. zeylanica*. Plumbagin, chitranone, 3-biplumbagin, chloroplumbagin, and elliptone are naphthoquinones that are found in the plant. 5-methoxy seselin, xanthyletin, Seselin and suberosin are coumarins. Plumbagin acid, -sitosterol, 2, 2-dimethyl-5-hydroxy-6-acetylchromene, saponaretin, isoaffinetin, and other substances are also found in the plant. [6]

Plumbagin is the most common and broad spectrum phytochemical of *Plumbago zeylanica*. The leaves and root bark of this plant contain a substance called plumbagin, while the root yields new pigments such as 3-chloroplumbagin, 3,3-biplumbagin, binaphthoquinone identified as 3',6'-biplumbagin, and four other pigments identified as isozeylanone, zeylanone, elliptinone, and droserone. Plumbagin, droserone, isoshinanolone, and a new naphthalenone called 1,2(3)-tetrahydro-3,3'-plumbagin were isolated from the phenolic fraction of the light petrol extract of the roots. Additionally, two plumbagic acid glucosides, namely 3'-o-betaglucopyranosyl plumbagic acid and 3'-o-beta-glucopyranosyl plumbagic acid methyl ester, along with five naphthaquinones (plumbagin, chitranone, maritnone, elliptinone, and isoshinanolone), and five coumarins (seselin, methoxyseselin, suberosine, xanthyletin, and xanthoxyletin) were also isolated from the roots. These findings were reported by Lin and coworkers.

Different researchers have reported various phytochemicals found in different parts of *Plumbago zeylanica*. Plumbagin, zeylanone, isozeylanone, stigmasterol, campesterol, campesterol, and dihydroflavonol plumbagin are found in the stem. Plumbagin and chitanone are found in the leaves. The flowers contain plumbagin, zeylanone, and glucose. Finally, the fruit contains plumbagin, glucopyranoside, and sitosterol. Plumbagin is found in the seeds and root bark of *P. zeylanica*. The root of the plant produces several novel pigments, including binaphthoquinone (also known as 3',6'-biplumbagin), isozeylanone, zeylanone, elliptinone, and droserone. Plumbagin, droserone, isoshinanolone, and a novel naphthalenone called 1,2(3)-tetrahydro-3,3'-plumbagin were isolated from the phenolic portion of the light petrol extract of the roots. The roots also contain five naphthoquinones, including plumbagin, chitrone, maritnone, elliptinone, and isoshinanolone, as well as two plumbagic acid glucosides and five coumarins, including selen, methoxyseselin, suberosine, xanthyletin, and xanthoxyletin. Plumbagin (2-methyl-5-hydroxy-1,4-naphthoquinone), a yellow crystalline bioactive phytoconstituent, was discovered in the roots of *P. zeylanica* through the use of the Soxhlet device and silica gel column chromatography. [7]

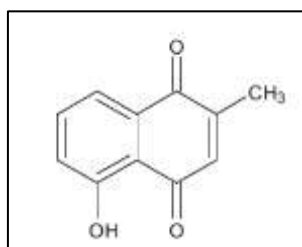
## 6. Bioactive compound

### 6.1 Plumbagin :

Plumbagin (2-methyl-5-hydroxy-1,4-naphthoquinone) is a yellow, crystalline, bioactive phytoconstituent that is found in the roots and was extracted from PZ using the Soxhlet device and silica gel column chromatography. [8]

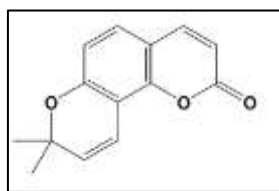
Plumbagin is an active substance that has the potential to be anticarcinogenic and antioxidant, cardioprotective, antimicrobial, antibacterial, antifungal, antimalarial, anti-HIV activity, anti-atherosclerotic and potentiate phagocytosis in the human white blood cells.

Reactive oxygen species (ROS) including superoxide anion and hydrogen peroxide are known to be produced by plumbago. Depending on the kind of cell, plumbago creates ROS by a variety of processes, including redox cycling, mitochondrial respiratory chain leakage, and intracellular glutathione depletion. The production of ROS may explain plumbagin's cytotoxic and apoptotic effects. [9]



### 6.2 Seselin:

Seselin (2,2-Dimethyl-1,5-dioxaphenanthrene-6(2H)-one; 8,8-Dimethyl-2H,8H-benzo[1,2-b:3,4-b']dipyran-2-one) is an angular pyranocoumarin isolated from PZ. (10) Seselin has demonstrated various biological effects including antinociceptive in vivo effects, antibacterial activity, and impacts on the proliferation of numerous cancer cell lines including leukaemia and lymphoma cells. It has also been used to treat mouse ear and paw edoema. (4)



### Macro, micro and some essential elements detected in *P. zeylanica*:

Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) was used to conduct some elemental analysis on the leaves, stems, and roots of *P. zeylanica*. Samples contained high levels of 8 additional elements, 4 macro-elements (Na, K, Ca, Mg), 5 essential microelements (Zn, Fe, Mn, Cr, Co), and 5 other microelements (Mo, Sb, Bi, Cd, Sr, Pb, Cd, As). (7)

## 7. Pharmacological Activities:

Numerous pharmacological effects of *P. zeylanica* have been described, including anti-inflammatory, anti-diabetic, memory-inducing, lipid metabolism, anti-malarial, allergic and modulatory, anti-fertility, anti-bacterial, anti-viral, anti-cancer, antioxidant, and larvicidal effects. Roots are used as traditional medicines in many different countries. For medicinal purposes, the people of Ethiopia use powdered root, bark, or leaf to cure diseases such as syphilis, tuberculosis, and gonorrhoea. Similarly, in Zambia, the plant's root and leaf are boiled in milk and consumed as a remedy for mouth, chest, and throat inflammation.

### **7.1 Antimicrobial Activity:**

The crude alcohol extract of *Plumbago zeylanica* inhibited the development of multi-resistant *E. coli* and *Shigella* strains. When compared to other plant extracts, a MIC value of 0.64-10.24mg/ml was obtained.(11) According to research, *P. zeylanica* root's methanolic extract had an antibacterial impact on *Bacillus subtilis* cells. The ethanolic extract of *P. zeylanica* was found to be effective against *Salmonella typhi*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, and *Staphylococcus aureus*, while acetone and chloroform had only mild action.(23) Additionally, it was discovered that the crude extract of *P. zeylanica* leaves had inhibitory effects on *E. coli*, *Bacillus cereus*, *Staphylococcus aureus*, and *Candida*. This suggests that *P. zeylanica* may possess antimicrobial properties.(12).

### **7.2 Anti-inflammatory Activity:**

The anti-inflammatory properties of a phosphate buffered saline extract of roots were studied. Red blood cells that were driven to lyse by heat or hypotonicity were stabilised by the extract. In rats with formaldehyde-induced arthritis, the enzymatic activities of alkaline and acid phosphatases were reduced, while adenosine triphosphatase activity increased. There is speculation that the extract may have anti-inflammatory effects. (13)

### **7.3 Anti-diabetic Activity:**

In a trial, 500 mg of *Plumbago zeylanica* and 1 gm of haridra powder were administered four times daily for 45 days to obese patients along with a low-calorie diet restriction [48]. Results indicated that *P. zeylanica*, when compared to haridra, is significantly significant in the patient's weight reduction. A further study examined how *Plumbago zeylanica* extract affected diabetic rats. When the ethanolic extract was used at a dosage of 100 mg, it was observed to reduce the activity of glucose-6-phosphate while boosting the activity of hexokinase. Rats with diabetes treated with streptozotocin received 200mg/kg of tolbutamide orally.(14)

### **7.4 Anti-Cancer Activity:**

According to several investigations, the plant *P. zeylanica* contains bioactive compounds that have anti-cancer effect against many cancer cell lines. Plumbagin can also reduce cell growth, stop the cell cycle, and cause apoptosis in the NB4 cells of the APL cell line, according to a research(6). *P. zeylanica* extract inhibits cancer and lowers lipid peroxidation due to terpenoids and flavonoids. According to a recent study, researchers tested the methanolic extract of *P. zeylanica* against MCF-7 and HT-29 cell lines. The results indicated that the extract had a moderate level of anti-cancer activity and inhibitory properties, when compared to commonly used anti-cancer drugs such as tamoxifen for the MCF-7 cell line and 5-fluoro Uracil for the HT-29 cell line. According to a study, plumbagin inhibited the expression of BAX, BCL-2, pro-caspase-3, and caspase-3 in gastric cancer cells. Plumbagin can reduce the phosphorylation of STAT3 and Akt, which may explain why it suppresses apoptosis in human stomach cancer cells.(6)

### **7.5 Larvicidal activity:**

Three *Plumbago* spp. were shown to have larvicidal action, according to Maniafu et al. *P. zeylanica* crude extracts in hexane and chloroform had the best larvicidal activity against *A. gambiae*, with LC50 values of 6.4 and 6.7 g/ml, respectively [51](16). There is evidence that *P. zeylanica* extract has larvicidal action against *Aedes aegypti* larvae in their second, third, and fourth instars. All extracts of *P. zeylanica* in various solvents had LC(50)(15) values of less than 50 ppm against all larval instars tested.(17)

### **7.6 Anti-malarial activity:**

The PZ root has been used to treat fever or malaria and may have antiplasmodial effects. The study's antiplasmodial abilities against *Plasmodium falciparum* were tested in vitro. Mosquitoes that have been infected with the malaria parasite often transfer the disease to humans Conversely,, methanol extracts of PZ roots were shown to have the maximum larvicidal potential when used against *Anopheles aegypti* and *A. stephensi*. (17)

### **7.7 Anticonvulsant Activity:**

Research on the pharmacological and clinical therapeutic applications of Ayurvedic medicinal herbs, including *P. zeylanica*. This plant's leaf extract was tested for anticonvulsant activity utilizing convulsions generated by PTZ and maximal electroshock. The extract was discovered to have no anticonvulsant effects.(18)

### **7.8 Central Nervous System Activity:**

Rats' locomotor behaviour and central dopaminergic activity were examined in response to a root extract of *P. zeylanica* in 50% ethanol. The extract considerably boosted the rats' spontaneous motility. The stereotypic behaviour that a dopamine agonist is known for producing shown biphasic effects. The outcomes demonstrated that the *P. zeylanica* root extract particularly increased spontaneous ambulatory movement without producing stereotypical behaviour.(19).

### 7.9 Hypercholesterolemic Activity:

Sharma et al. 32's pharmacological and clinical tests revealed that PZ extract possesses hypolipidemic and antiatherosclerotic properties. Plumbagin, an active ingredient derived from PZ, significantly slows the progression of atherosclerosis and reduces the build-up of triglycerides and cholesterol in the liver and aorta. It has been suggested that the Ayurvedic remedy "Panchcole," which includes PZ as one of its main constituents, will have a hypolipidemic impact.(20) Sharma et al. 32's pharmacological and clinical tests revealed that PZ extract possesses hypolipidemic and antiatherosclerotic properties. Plumbagin, an active ingredient derived from PZ, significantly slows the progression of atherosclerosis and reduces the build-up of triglycerides and cholesterol in the liver and aorta. It has been suggested that the Ayurvedic remedy "Panchcole," which includes PZ as one of its main constituents, will have a hypolipidemic impact.[20]

### 7.10 Antibacterial Activity:

Salmonella gallinarum, Escherichia coli, Proteus vulgaris, and Klebsiella pneumoniae were all susceptible to the aqueous extract and its partition (Petroleum ether, dichloromethane, methanol, and aqueous residual). Plumbago zeylanica root extracts tested positive for action against Bacillus subtilis, Escherichia coli, Proteus vulgaris, Salmonella typhimurium, Pseudomonas aeruginosa, and Staphylococcus aureus in both aqueous and alcoholic forms. The Salmonella paratyphi, Staphylococcus aureus, Escherichia coli, and Shigella dysenteriae multi-drug resistant clinical origin strains were examined using an alcoholic extract from roots of Plumbago zeylanica. Against each of the studied microorganisms, the extract displayed significant antibacterial activity. At low concentrations, plumbagin potentiates the release of oxyradicals to increase the bactericidal activity of macrophages, whereas at higher concentrations, it inhibits this activity in BALB/c mice [21]

The chloroform extract of roots of Plumbago zeylanica showed significantly increased activity against Escherichia coli, Staphylococcus aureus and Salmonella typhi. The methanol and aqueous extracts showed moderate and lower activity against gram-positive and gram-negative bacterial strains.(23)

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