

# Nutraceutical Application and Action Mechanism of polyphenols by Plumbago zeylanica

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## Abstract:

Worldwide demand for medicinal plants is high since they have historically been used as a source of medicine. They have been utilised for a long time to cure disease and prevent health problems. One of the medicinal plants that is frequently used for its therapeutic properties is Ceylon leadwort also known as Plumbago zeylanica. It is an evergreen plant that may be found all over India. It includes a variety of bioactive polyphenols, including tri-terpenoids, alkaloids, flavonoids, naphthoquinones, glycosides, and saponins. Plumbagin is the main active ingredient among all the chemical components and has been linked to the plant's therapeutic applications, the total amount of plumbagin found in the Roots, the root, and root bark have a larger claim in traditional treatments against numerous ailments. It has a wide spectrum of medicinal properties, including anti-inflammatory, anti-microbial, anti-oxidant, memory enhancer, and anti-cancer. Many studies have been conducted to assess its potential for Nutraceutical use. The purpose of this review is to provide knowledge about this plant's phytochemistry & Nutraceutical properties

**Keyword:** *Plumbago zeylanica, Plumbagin, Naphthoquinones, Nutraceutical, anti-inflammatory, anti-oxidant, phytochemistry*

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## Introduction:

Inflammatory processes play a key role in the body's initial Protection in the event of an infection or tissue injury, minimizing more harm to the affected place. While Inflammatory reactions have a key role to play in biology In the early stages of infection, defence mechanisms. Chronic The inflammation has long been linked to a range of diseases, noninfectious disease, e.g. arthritis. Steroids play an important role to play in the management of inflammatory diseases.

*Plumbago zeylanica* is belong to the family Plumbaginaceae, it is a multifunctional medicinal plant. The most often utilised plant in Indian traditional medicine is *P. zeylanica*. The plant, which is widespread to South Asia, is found in most of the tropics and subtropics; it grows in deciduous forest, savannas, and scrub lands from sea level to a height of 2000m. The root is used to treat dysentery and as a laxative, expectorant, astringent, and abortifacient. Root bark extract is used as an antiperiodic. The chemical components of plumbago include naphthoquinones, flavonoids, terpenoids, and steroids, many of which are involved in a number of biochemical processes. Lead wort is a common name for *Plumbago zeylanica*. Lead wort is a common name for *Plumbago zeylanica*. In many regions of Asia and Africa, this plant is also known by many other names. It is known as "Chitrak" in India. Its roots are used in traditional medicine to treat a variety of conditions include inflammation, viral infections, and physical anxiety. According to reports, *P. zeylanica* roots have antioxidant, hypolipidemic, anti-atherosclerotic, stimulant of the central nervous system, and anti-fertility characteristics. The main objective of this plant review is to study the plant's potential benefits to human health. A family of naturally occurring phenols with a C6-C4 skeleton known as naphthoquinones is said to possess nutraceutical properties. As per Shailja Choudhar[

## Botanical Classification

- Kingdom: Plantae
- Order: Caryophyllales
- Family: Plumbaginaceae

- Genus: Plumbago
- Species: zeylanica

### Botanical Description:

*P. zeylanica* is a subscented, attractive perennial shrub with many branches and semi-woody stems. Its leaves are oblong-lanceolate, acute, constricted into a petiole, and simply alternating. Its flowers are carried in spikes, however the spike's rachis is pubescent or glandular. The white tube on the Corolla is long and lean. The roots are cylindrical and have transverse, small cracks at the bends. Oblong-shaped fruits and persistent, viscid calyx surround the capsules of this plant.

### Chemical Composition & Phytochemistry:

Flavonoids, alkaloids, glycosides, saponins, steroids, tannins, tri-terpenoids, coumarins, carbohydrates, phenolic compounds, fixed oils, lipids, proteins, and naphthoquinones are only a few of the secondary metabolites found in *P. zeylanica*. Plumbagin, chitranone, 3-biplumbagin, chloroplumbagin, and elliptone are naphthoquinones that are found in the plant. Seselin, 5-methoxy seselin, xanthyletin, 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. Plumbagin, one of these bioactive substances, is the most significant one found in *P. zeylanica*.

Plumbagin, zeylanone, isozeylanone, campesterol, stigmasterol, sitosterol, and dihydroflavinol—plumbaginol—are all found in the stem. Chitanone and plumbagin are found in leaves. Glucose, zeylanone, and plumbagin are found in flowers. Plumbagin, glucopyranoside, and sitosterol are all found in fruits and seeds.

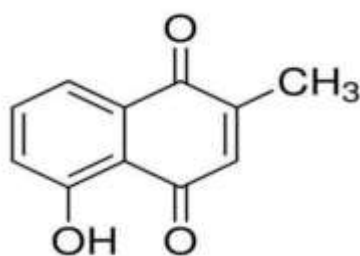
Plumbagin is present in *P. zeylanica*'s root bark. The root produces novel colours, including 3-chloroplumbagin, 3-biplumbagin, binaphthoquinone (3', 6' biplumbagin), and four additional pigments (isozeylanone, zeylanone, elliptinone, and droserone 2, respectively). From the phenolic portion of the light petrol extract of the roots, plumbagin, droserone, isoshinanolone, and a novel naphthalenone, 1, 2 (3)-tetrahydro-3, 3'-plumbagin, were isolated. Five naphthaquinones, including plumbagin, chitranone, maritinone, elliptinone, and isoshinanolone, as well as two plumbagic acid glucosides and five coumarins, including selen, methoxyseselin, suberosine, xanthyletin, and xanthoxyletin, were also isolated from the roots.

By using inductively coupled plasma atomic emission spectrometry (ICP-AES), it was discovered that the leaves, stems, and roots of *Plumbago Zeylanica* contain four macro elements (Na, K, Ca, and Mg) in good amounts, five essential microelements (Zn, Fe, Mn, Cr, and Co), and eight additional elements (Mo, Sb, Bi, Cd, Sr, Pb, Cd, and As). Most anti-cancer and antioxidant medications often contain these components.

Plumbagin and other secondary metabolites of *P. zeylanica* are thought to had a number of therapeutic effection. Both gram-positive (*Staphylococcus*, *Streptococcus*, *Pneumonococcus* sp.) and gram-negative (*Salmonella*, *Neisseria*) bacteria are susceptible to the antibacterial properties of plumbagin. Additionally, it is effective against several yeasts, fungi, and protozoa, including *Leishmania*, *Trichophyton*, *Epidermophyton*, and *Microsporium* species.

From the aerial portions, amino acids such as aspartic acid, tryptophan, tyrosine, threonine, alanine, histidine, glycine, methionine, and hydroxyproline were extracted.

The fact that *P. zeylanica* exhibits a variety of photochemical properties explains why its compounds are sold as Ayurvedic and homoeopathic medicines all over the world.



**Plumbagin:**

Plumbagin (2-methyl-5-hydroxy-1,4-naphthoquinone) is a yellow crystalline naphthoquinone. The bioactive phyto components that are found in the roots of *PZ* have been isolated by Soxhlet apparatus, followed by silica gel column chromatography, Thin Layer Chromatography and column chromatography, normal-phase liquid chromatography, reverse-phase liquid chromatography and liquid chromatography-tandem mass spectroscopy.

Plumbagin is an active ingredient that may be anti-cancer and antioxidant, cardioprotective, antimicrobial, antibacterial, antifungal, antimalarial, antifertility, anti-HIV activity, anti-atherosclerotic, and phagocytosis-potentiating in human white blood cells. Plumbagin may possess anti-cancer qualities & Additionally, research on mouse embryonic fibroblast cells indicates that reactive oxygen species (ROS) may be produced throughout the apoptotic cascade, which would explain why plumbagin has lethal effects.

Depending on the kind of cell, plumbagin can create ROS by a variety of processes, including redox cycling, mitochondrial respiratory chain leaks, or the depletion of intracellular glutathione levels. The cytotoxic or apoptotic effects of plumbagin may be caused by the production of ROS.

Plumbagin has the ability to regulate the effects of radiation in the treatment of tumours when used as a radio-sensitizer. It has been hypothesised that plumbagin's anticancer properties result from its disruption of microtubule polymerization through tubulin binding and induction of apoptosis. Additionally, plumbagin does not cause apoptosis in healthy cells, suggesting that it may be useful as a chemotherapy agent.

Due to its antimicrobial activity, plumbagin has also been shown to have oxidative effects in prokaryotic cells lacking superoxide dismutase (SOD). However, plumbagin itself does not have mutagenic effects; rather, it inhibits the mutagenic effects of other mutagens in *Salmonella typhimurium*, indicating that plumbagin is associated with an antimutagenic activity. Plumbagin does, in fact, function as an antioxidant and antigenotoxic agent.

Plumbagin also has the potential to be effective in the treatment of a number of disorders, including diarrhoea, skin rashes, liver toxicity, reproductive toxicity, and it may also affect white blood cell levels improvement, rise in serum phosphate level, and rise in acid phosphate level.

According to publications, plumbagin's structure is quite similar to that of vitamin K, and *PZ*'s anticoagulant properties match those of coumarin derivatives. The bleeding may be caused by the competitive suppression of vitamin K activity, which is necessary for the manufacture of clotting components. Following an hour of exposure, the *PZ*'s anticoagulant action was discovered, and as a result of its impact on platelets and the coagulation profile, an antithrombotic medication was created.

Additionally, studies have shown that plumbagin does not cause somatic mutations or clastogenic effects in *Salmonella typhimurium* 147, other strains of *E. coli*, or different *E. coli* strains when used in a micronucleus assay.

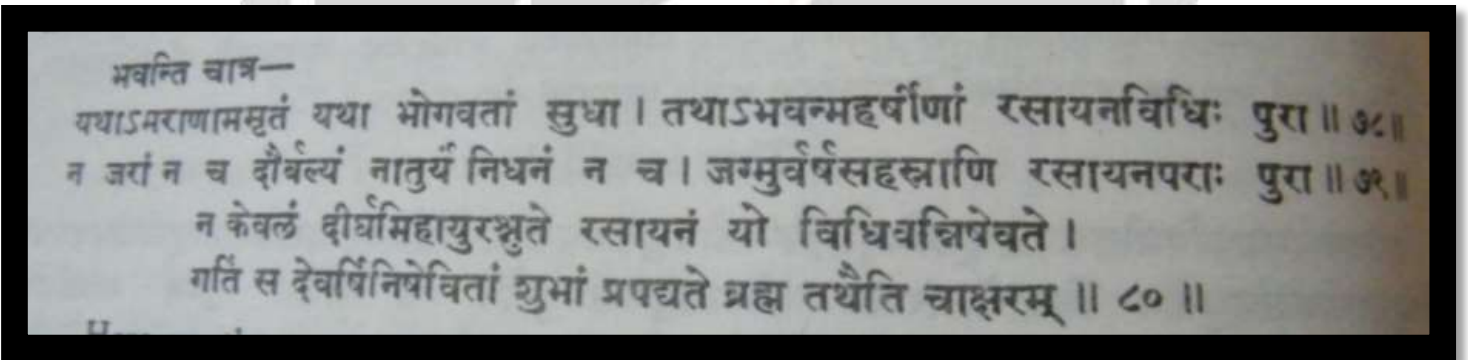
**Traditional use:**

*P. zeylanica* is a well-liked medicinal plant in Asia and Africa. Since the beginning of time, it has been used as a treatment for skin conditions, infections, and intestinal worms such as leprosy, scabies, ring-worm, hookworm, dermatitis, acne, sores, and ulcers. All portions of *P. zeylanica* have been used by traditional medical systems in various regions of the continents for a range of therapies. The root or the leaves, mashed with lemon juice, are used as a vesicant and anti-irritant in West Africa. In Nigeria, the roots are used to cure rheumatic swellings by being pounded with vegetable oil.

In Ethiopia, gonorrhoea, syphilis, TB, rheumatic pain, swellings, and wounds are all traditionally treated with powdered bark, root, or leaves. In other parts of Africa, the root is ground up and mixed with milk, vinegar, and water to make a paste that is used to cure black water fever, influenza, and shortness of breath. A decoction of the root and boiling milk is also used to treat inflammation of the mouth, throat, and chest.

Since ancient times, *P. zeylanica* has held a prominent position among therapeutic plants in India. Chitraka has been characterised as a tumor-negating and anti-dyspeptic substance by the traditional Indian medical system known as Ayurveda, which dates back to the Vedic eras (1500–8000 BC). *P. zeylanica* has been classified as an appetiser, anti-saturative, anti-anorexic, anti-haemorrhoidal, and pain reliever in Charaka Samhita, a significant text on the Ayurvedic school of medicine. *P. zeylanica* extracts are used in various dosages in herbal medications as Dabur Chitrak Haritaki, Medohar Guggulu, Morslim-Z, Divya Chandraprabhavati, etc.

The Rasayan tradition of Ayurveda focuses exclusively on Rasayan herbs and formulas that provide users longevity, age stabilisation, and longer-lasting youth. One gains longevity, memory, intellect, freedom from diseases, youth, excellence in lustre, complexion, voice, oratory, maximum strength in body and sense organs, respectability, and brightness through the rasayan therapy. It refers to obtaining the best Rasa, among other things. Adaptogen, antioxidant, anticancer, antiaging aphrodisiac, and



immunomodulator are further antiaging qualities.

The Rasayan was formerly the food of the great sages, much as the nectar was to the gods and the ambrosia was to the serpents. Early users of the Rasayan therapy experienced extraordinarily long lifespans free from the effects of old age, infirmity, disease, or premature death.



दीर्घमायुः स्मृतिं मेधामारोग्यं तरुणं वयः । प्रभावर्णस्वरौदार्यं देहेन्द्रियबलं परम् ॥ ७ ॥

वाक्सिद्धिं प्रणतिं कान्तिं लभते ना रसायनात् । लाभोपायो हि शस्तानां रसादीनां रसायनम् ॥ ८ ॥

Analnama, Paathi, Vyal, Ushan, and all other names for fire (Agni) are additional names for Chitrak. It makes the digestive system more capable. It alleviates inflammation, cough, piles, and leprosy.

‘यथास्वं चित्रकः पुष्पैः ज्ञेयः पीतसितासितैः यद्योत्तरं स गुणवान् विधिना च रसायनम् ॥  
 छायाशुष्कं ततो मूलं मांसं चूर्णीकृतं लिहन् । सर्पिषा मधुसर्पिभ्यां पिबन् वा पयसा यतिः ॥  
 छायाशुष्कं ततो मूलं मांसं चूर्णीकृतं लिहन् । सर्पिषा मधुसर्पिभ्यां पिबन् वा पयसा यतिः ॥  
 अम्भसा वा हितान्नाशी शतं जीवति नीरुजः । मेधावी बलवान् कान्तो वपुष्मान् दीप्तपावकः ॥  
 तैलेन लीढो मासेन वातान् हन्ति सुदुस्तरान् । मूत्रेण शिवत्रकुष्ठानि पीतस्तक्रेण पायुजान् ॥ (वा.उ. ३९)

The roots of the Chitrak, which have been shade-dried, provide power, wisdom, and life.

## चित्रक

चित्रकमूलं दीपनीय पाचनीय गुदशोथार्शः  
शूलहराणाम् ।

(च० सू०; 25/40)

चित्रको दहनो व्यालः पाठीनो दारुणोऽग्निकः ।  
ज्योतिष्को वल्लरी वह्नि पाली पाठी कटुः शिखी ॥  
कृष्णारुणोऽनलो द्वीपी चित्रभानुश्च पावकः ।  
चित्रकोऽग्निसमः पाके कटुकः कफशोफजित् ।  
वातोदरार्शो ग्रहणीक्षयपाण्डुविनाशनः ॥

(ध० नि०, शतपुष्पादिवर्ग; 80-81)

चित्रकोऽनलनामा च पाठी व्यालस्तथोषणः ।  
चित्रकः कटुकः पाके वह्निकृत्पाचनो लघुः ॥  
रूक्षोष्णो ग्रहणीकुष्ठशोथार्शः कृमिकासनुत् ।  
वातश्लेष्महरो ग्राही वातार्शः श्लेष्मपित्तहृत् ॥

(भा० प्र०, हरीतक्यादिवर्ग; 70-71)

**Literature Review with Respect to their Pharmaceutical Properties :****Anti-inflammatory Properties:**

- In a clinical research by **Napalchyal et al(2012)**. on 30 patients who were recruited from the OPD and IPD of the National Institute of Ayurveda, Jaipur, 4 mg of chitraka churna was administered twice daily to 15 patients with lukewarm water for 15 days. And they discovered a notable reduction in the discomfort brought on by inflammation of the bodily parts, including pain, swelling, soreness, and lightheadedness. Nikam D Dr, Shinde S Dr, Mishra D Dr; From 5th World Ayurveda Congress 2012 Bhopal, Madhya Pradesh, India. 7-10 Dec 2012. PA01.25. Clinical evaluation of chitrakadi churna and kshar basti in the management of amavata with special reference to rheumatoid arthritis. *Anc Sci Life*. 2012 Dec;32(Suppl 1):S75. PMID: PMC3800956.
- **Nile, Shivraj & Patil, Umesh & Park, S.W.. (2015)**. HPTLC analysis, antioxidant, anti-inflammatory and xanthine oxidase inhibitory activity of *Plumbago zeylanica* L. 42. 886-895. Using HPTLC and a -glucuronidase test, the phenolic content of the *Plumbago zeylanica* extract was measured in this work. Trolox and salicylic acid were used as benchmarks for comparing the anti-inflammatory effects findings. The HPTLC analysis revealed quercetin to be present. The extract's total phenolic and flavonoid content was equal to 286 and 260 mg of gallic acid, respectively, while the total flavonoid content was equal to 242 and 208 mg of quercetin. With IC50 values of 10.5 and 9.2 g at 100 g/mL, the *Plumbago zeylanica* extract had outstanding antioxidant and XO inhibitory action, exhibiting 92% and 86.5% inhibition, respectively. The findings for root extract's anti-inflammatory activity ranged from 45.1 to 88.5%, diene-conjugate's for glucuronidase test ranged from 40.2 to 86.2%, and shoot extract's ranged from 38.5 to 75.2% and 30.6 to 70.1%, respectively. These results validated the anti-inflammatory properties of *P. zeylanica* root and shoot extracts.
- **Zaki et Al(2018)**., plumbagin significantly inhibited the expression of high mobility group box 1 and consequently reduced the activity of nuclear factor-B (NF-B), tumour necrosis factor-alpha (TNF-), and myeloperoxidase (MPO) in inflammatory cascades. Zaki AM, El-Tanbouly DM, Abdelsalam RM, Zaki HF. Plumbagin ameliorates hepatic ischemia-reperfusion injury in rats: Role of high mobility group box 1 in inflammation, oxidative stress and apoptosis. *Biomed Pharmacother*. 2018 Oct;106:785-793. doi: 10.1016/j.biopha.2018.07.004. Epub 2018 Jul 11. PMID: 29990872.
- **Sheeja et al(2010)**., 5 used in vivo experimental models to investigate the anti-inflammatory effects of several *P. zeylanica* leaf extracts. Comparing the carrageenan-induced Mice to the control group, the acetone extract considerably (p 0.01) decreased inflammation. Sheeja E, Joshi SB, Jain DC. Bioassay-guided isolation of anti-inflammatory and antinociceptive compound from *Plumbago zeylanica* leaf. *Pharm Biol*. 2010 Apr;48(4):381-7. doi: 10.3109/13880200903156424. PMID: 20645715.
- **Oyedapo, O. (2008)**. Studies on Bioactivity of the Root Extract of *Plumbago zeylanica*. 34: 365–369; *Pharmaceutical Biology*; 10.1076/phbi.34.5.365.13249. The anti-inflammatory properties of the *Plumbago zeylanica* roots' phosphate buffered saline extract were examined. Red blood cells treated to hypotonic and heat-induced lyses were stabilised by the extract. The reaction to the extract was biphasic. In the liver homogenates of formaldehyde-induced arthritic rats, the enzymatic activities of both alkaline and acid phosphatases were decreased, although adenosine triphosphatase activity was increased. Thus, speculation is made regarding the extract of *P. zeylanica*'s potential anti-inflammatory properties.
- **Vembu Thanigavelan (2014)**. *Plumbago Zeylanica* Linn root bark hydroalcoholic extract has analgesic and anti-inflammatory effects in experimental rat models. In several formulations of Indian system of medicine for the treatment of cancer, the root bark of *Plumbago zeylanica* Linn has been employed because of its significant analgesic and anti-inflammatory properties. The purpose of the current investigation was to fill a knowledge gap regarding the effects of *Plumbago zeylanica* hydro alcoholic extract on inflammation and nociception. to research *Plumbago zeylanica* Linn's root bark's hydro-alcoholic extract's analgesic and anti-inflammatory properties. To create the test drug, root bark powder was extracted using the Soxhlet method with 85% methanol and 15% water. Rat tail immersion analgesia and a hot plate were used to study the analgesic effect. In vitro Human Red Blood Cell Membrane Protective effect, carrageenan-induced rat paw edoema, and a chronic inflammatory model in rats were used to examine the anti-inflammatory effect. When the extract's analgesic action was tested using the hot plate and

tail immersion methods and compared to the weak analgesic standard medication Paracetamol, the results showed considerable activity at a dosage of 350 mg/kg body weight. Studies on both acute and chronic inflammation in rats caused by carrageenan and complete frank's adjuvant revealed a modest anti-inflammatory effect at the primary phase of inflammation at a dosage of 250 mg/kg body weight, equivalent to typical indomethacin.

#### Antioxidant properties:

- **Zahin et al. (2009)**. According to the FTC test, *P. zeylanica* has the best antioxidant potential. The antioxidant activity and total phenolic content of methanolic extracts of *P. zeylanica* (root), *A. calamus* (rhizome), *H. indicus* (stem), and *H. antidysenterica* (bark) were studied in vitro.
- A salt, spice, and herbal mixture's antioxidant efficacy was tested by **Natarajan et al. (2006)** against the production of free radicals. Amrita Bindu is made up of salts, spices (*P. nigrum*, *P. longum*, and *Z. officinale*), herbs (*C. rotundus*, and *P. zeylanica*), and spices. It was fascinating to see that, after receiving PHZ, rats pretreated with Amrita Bindu had much reduced levels of free radicals, lipid peroxidation, and protein carbonyls as well as significantly greater levels of antioxidants. These findings show that the salt-spice-herbal combination A. Bindu has a promising antioxidant potential against oxidative damage caused by free radicals.
- **Ajayi et al.(2019)**, Gas chromatography-mass spectrometry was used to identify the bioactive components of *Plumbago zeylanica*'s methanolic and ethylacetate extracts. Using 1,1-diphenyl-2-picryl-hydrazyl, the free radical scavenging capacities of ME and EA were assessed. Oxalic acid, allyltridecyl ester, decane, 2-piperidinone-N-[4-bromo-n-butyl], and tetradecane are among the major bioactive chemicals discovered in the ME. chemicals derived from EA include 1-(ethenyloxy) octadecane and cis-13-octadecenoic acid. Despite being known, cis-13-octadecenoic acid was extracted for the first time from *P. zeylanica*'s root. At 350 g/ml of extract concentration, the maximum percentage antioxidant activity of ME and EA were 98.5% and 45.5%, respectively. Conclusions of this study support the use of *P. zeylanica* in conventional medicine for the treatment of many illnesses, and it may be a source of innovative therapeutic molecules in the future.

#### Anti cancer property:

- **Sachin Hiradeve (2011)**. Malignant diseases like cancer are characterised by the uncontrolled and fast proliferation of abnormal cells that can either cluster into growths or tumours or spread throughout the body. Cancer is the second-leading cause of death in the world after heart disease. The current work intends to screen preliminary phytochemicals and assess *plumbago zeylanica* Linn's anticancer activity against Ehrlich ascites carcinoma in an animal model. Results show that *plumbago zeylanica* Linn's ethanolic extract has strong anticancer action and, because to its greater amount of terpenoids and flavonoids, also significantly lowers increased levels of lipid peroxidation. Therefore, *plumbago zeylanica* Linn's ethanolic extract may have a wide range of therapeutic uses against cancer. In which Plumbagin blocks the activation of NF-kB brought on by TNF and other inflammatory and carcinogenic stimuli. Additionally, it reduced the tumour cells' constitutive NF-kB activity. The inhibition of IκB kinase, IκB phosphorylation, IκB degradation, P65 phosphorylation, P65 nuclear translocation, and the expression of NF-kB-dependent reporter genes activated by TNF, TNFR1 TRAF2, NIK, IKK-B, and the p65 subunit of NF-k B were sequentially correlated with the suppression of NF-KB activation. Additionally, it inhibits nuclear and recombinant p65's direct DNA binding, which is inhibited both in vitro and in vivo by dithiothreitol. This suggests plumbagin is an effective inhibitor of NF-kB-regulated gene products. This explains how it affects cell development and has anticancer, radiosensitizing effects.
- **Zhao at. al. (2006)**. According this investigations, the plant *P. zeylanica* contains bioactive compounds that have anti-cancer action against a number of cancer cell lines. Plumbagin can also stop the cell cycle, trigger apoptosis, and reduce cell growth in NB4 cells from the APL cell line.



- **Maqsood M at. Al. (2018).** According to a study, *P. zeylanica*'s methanolic extract was used against the cancer cell lines MCF-7 and HT-29, and it resulted in moderate anti-cancer activity and the inhibitory property when compared to the standard anti-cancer drugs tamoxifen for MCF-7 and 5-fluoro Uracil for HT-29.
- **Lu, Furong. (2017).** 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.
- **Anh Tho Nguyen, Hugues Malonne, Pierre Duez, R. Vanhaelen-Fastre, M. Vanhaelen, and Jeanine Fontaine. (2004).** The dichloromethane extract of aerial portions of *Plumbago zeylanica* was fractionated under bioassay guidance to isolate beta-sitosterol, beta-sitosteryl-3beta-glucopyranoside, beta-sitosteryl-3beta-glucopyranoside-6'-O-palmitate (1), lupenone, lupeol acetate, plumbagin, and trilinolein. Beta-sitosterol prevented Bowes cell proliferation, plumbagin was cytotoxic to MCF7 and Bowes cancer cell lines, and compound 1 demonstrated cytotoxic effect against these cancer cell lines. In which Male F344 In comparison to rats given azoxymethane (AOM) alone, those given plumbagin (200 ppm) in the food for two weeks starting one week before to the injection showed a decreased incidence and multiplicity of small intestinal tumours. Accordingly, plumbagin may be a potential neoplasia. When rats with hepatoma were given plumbagin, the levels of hexokinase, phosphoglucosomerase, and aldolase fell to nearly normal levels. Animals with hepatoma had lower levels of the gluconeogenic enzymes glucose-6-phosphate and fructose-1, 6-disphosphatase, whereas the treated animals had higher levels using plumbagin.

#### Antidiabetic Properties:

- **Muftah Zarmouh, Karthikeyan Subramaniam, and Kumar Ganesan. (2010)** This study examines the effects of oral administration of *Plumbago zeylanica* root extract on plasma antioxidant status and blood glucose in streptozotocin (STZ) diabetic rats. Hepatic enzymes in experimental diabetes were examined in the study. Increasing hepatic hexokinase activity and decreasing hepatic glucose-6-phosphatase, serum acid phosphatase (ACP), alkaline phosphatase (ALP), and lactate dehydrogenase (LDH) were the effects of oral administration of ethanolic extract (100, 200 mg/kg) in streptozotocin diabetic rats. In Streptozotocin-induced diabetic rats, the *Plumbago zeylanica* root extract is hypoglycemic, hepatoprotective, and capable of reducing biochemical damage. Thus this research revealed oral treatment of *P. zeylanica* root extract in ethanol (100 mg, 200 mg/kg/p.o.) and tolbutamide (250 mg/kg/p.o.) boosted hexokinase activity and lowered glucose-6-phosphatase activity in streptozotocin-treated diabetic rats.
- **Sunil Christudas at. al. (2012).** Indian medicine frequently uses the root of *Plumbago zeylanica* L. to treat diabetes mellitus. The current study's objective was to assess the anti-diabetic properties of plumbagin, which was extracted from *P. zeylanica* L. root, as well as its impact on GLUT4 translocation in rats with STZ-induced diabetes. Rats with STZ-induced diabetes received oral plumbagin (15 and 30mg/kgbw) for 28 days. On the twenty-first day, an oral glucose tolerance test was conducted. Investigations were conducted to determine how plumbagin affected body weight, blood sugar, plasma insulin, total protein, urea, creatinine, liver glycogen, plasma enzymes (SGOT, SGPT, and ALP), and enzymes involved in carbohydrate metabolism (glucose-6-phosphatase, fructose-1,6-bisphosphatase, and hexokinase). Skeletal muscle GLUT4 mRNA and protein expression were also investigated. All other biochemical markers were also dramatically changed to close to normal levels by plumbagin, which also significantly decreased blood glucose. Additionally, in treated diabetic rats, plumbagin considerably lowered the activities of fructose-1,6-bisphosphatase and glucose-6-phosphatase while significantly increasing the activity of hexokinase. In diabetic rats treated with plumbagin, there was increased GLUT4 mRNA and protein expression. According to the findings, plumbagin improved GLUT4 translocation and supported glucose homeostasis. It could be further investigated for potential use as a diabetic medication.

**Anti-bacterial properties:**

- **Abdul KM at. al. (1995)** The Salmonella paratyphi, Staphylococcus aureus, Escherichia coli, and Shigella dysenteriae multi-drug resistant clinical origin strains were examined using an alcoholic extract from the roots of Plumbago zeylanica. Against all of the studied microorganisms, the extract demonstrated significant antibacterial action.
- **Jeyachandran R at. al. (2009)** Plumbago zeylanica L. root chloroform extract shown antibacterial activity against Escherichia coli, Salmonella typhi, and Staphylococcus aureus. Lowest inhibition is shown against Proteus vulgaris and Pseudomonas aeruginosa, while moderate inhibition is seen against Klebsiella pneumonia, Serratia marcescens, and Bacillus subtilis. While water extract was shown to be ineffective against the bacterial strains, the methanolic extract had modest efficacy.
- **Shweta S at al. (2015)** It was shown that the crude extract of P. zeylanica leaves had an inhibitory effect on Candida, Bacillus cereus, E. coli, and Staphylococcus aureus. This suggests that P. zeylanica may have anti-microbial properties.

**Precautions:**

Chitrak can cause uterine contractions, stimulate menstrual flow or uterine bleeding, and possesses antifertility and antioviulatory properties. Additionally, it may reduce a mother's milk supply when she is nursing her infant. Therefore, it is advised to refrain from consuming Chitrak in any form throughout pregnancy and breastfeeding. To facilitate proper absorption of Chitrak, one should also avoid eating too many fried meals, spicy foods, sauces, and root vegetables like potatoes and tubers when using Chitrak formulation.

**Chitrak Dosage**

The effective therapeutic dose of Chitrak varies according to the patient's age, bodily strength, effects on hunger, illness severity, and overall health. In order to determine the precise dose for the precise time, it is required to visit an ayurvedic physician or practitioner. To cover up its unpleasant taste, take it twice day with milk, honey, or buttermilk. You can also take it as directed by your doctor.

- 2-3 gm of Chitrak Churna/Powder each day, or as directed by your ayurvedic doctor.
- Chitrak Gutika/Tablet: 1-2 gm twice day in split dosages, or as directed by your ayurvedic doctor.
- Chitrak Kashyam/Syrup: Take 5–10 ml in divided doses throughout the day, or as directed by your ayurvedic doctor.

**Nutritional Value:**

Nutritional Value	Crude extract (mg/grams)
PROTEIN	42
STRACH	45
SUGAR	55
LIPID	41
PHENOLS	3

### Nutraceutical Application:

The usage of dietary supplements is becoming increasingly important as a realistic strategy for lowering the risk of certain illnesses. Epidemiological research has linked regular *Plumbago zeylanica* intake to a lower risk of cancer and cardiovascular diseases. With regard to *Plumbago zeylanica*, possible health advantages, polyphenols seem to be crucial. It includes pertinent results on several therapeutic aspects of Chitrak in light of the increased interest in the beneficial health effects of tea. The main topics covered in this review include different types of *Plumbago zeylanica*, polyphenols, and their significance for nutraceuticals, as well as side effects and administration methods along with bioavailability.

There are many food supplements available in market both offline to online from Large scale industries to small one, There are many products in form of dried roots, Powder, Capsule etc.



### Conclusion:

The primary source of efficient traditional medications for the treatment of many ailments is medicinal plants. Several pharmacological actions of herbal medicines have led to their usage throughout the past ten years. The researchers now have prospects for more research and advancement in this area. One of the most significant medicinal plants, *Plumbago zeylanica*, has a number of pharmacological activities including anticancer activity, antibacterial activity, antioxidant activity, etc. The population of P is declining as a result of pharmaceutical firms' random sampling from the natural environment because of the plant's medicinal significance. *Zeylanica*, making it an overused plant. Thus, there is a requirement for a different method of mass-propagating this plant. Presented here demonstrates that *P. zeylanica* exhibits a variety of pharmacological actives against a number of illnesses. It is a potent bioactive substance and possesses a strong chance of being incorporated into current medical procedures to treat a variety of illnesses. The plant *P. zeylanica* is significant. The production of herbal products, yet there is still a need for powerful ambition to find a replacement method for the widespread this tree. For *P. zeylanica*'s expanding needs, using in-vitro procedures on a massive scale for development and subsequent ground plantings could be tremendously beneficial. The purpose of this review is to draw attention to *Plumbago zeylanica*'s significance and prospective pharmacological activity for the creation of novel herbal formulations.

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