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RESEARCH ARTICLE

A MULTIFARIOUS POTENT HERB: PLUMBAGO ZEYLANICA –A MINI REVIEW

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ABSTRACT

Plumbago Zeylanica is a medicinal plant belonging to Plumbaginaceae family. It is commonly known as Chitrak. It's all parts are used but roots contains the most bioactive compound, Plumbagin which exhibit a wide spectrum of biological and pharmaceutical activities such as anti-malarial, anti-obese, anti-ulcer, anti microbial, anticancer, anti-inflammatory, antioxidant etc. The aim of this review is to provide a comprising knowledge related to chemical constituents, traditional uses, pharmaceutical activity and bioactive compound of the plant.

Key words:

Plumbago Zeylanica, anti-microbial, anti-ulcer, anti-inflammatory, medicinal properties, chemical constituent, plumbagin,

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INTRODUCTION

Novel drug compounds have become an inspiration (Iwu, 1993); traditional medicines using plant extract provide health coverage to over 80% of the world population especially in developing the world (WHO, 2002). In fact most of the plant produces a various bioactive molecules making them useful for various types of diseases (Julsing *et al.*, 2013). *Plumbago Zeylanica*. L (commonly known as Chitraka, Chitramulamu, Tellachitramulamu, Agnichela, Agnimaala or its trade names of "lead wort-white flowered" and "Ceylon lead wort") belongs to Plumbaginaceae family has been reported to be used in variety of folk medicine in Africa and Asia (Ravikumar and Sudha, 2011). The family Plumbaginaceae consists of 10 genera and 280 species. The genus *Plumbago* includes 3 species, namely *Plumbago Indica* L. (*P. Rosea* L.) *P. Capensis* L. and *P. Zeylanica* L., which are distributed in several parts of India. Among these species *Plumbago Zeylanica* grows in all districts of plains in Andhra Pradesh, as common, wild or in cultivation due to its more therapeutic uses (Chetty *et al.*, 2006).

Classification of Chitrak is as follows: Kingdom: Plantae, Subkingdom: Tracheobionta

Superdivision: Spermatophyta, Division: Magnoliophyta, Class: Magnoliopsida, Subclass: Caryophyllidae, Order:

Caryophyllales, Family: Plumbaginaceae, Genus: *Plumbago* and Species: *Zeylanica*.

Chemical Constituents and medicinal properties

The petroleum ether, ethanol and aqueous extract of *Plumbago Zeylanica* revealed the presence of alkaloids, carbohydrates, triterpenoids, flavonoids, gums, mucilage, protein, fatty acids and saponin (Kumar *et al.*, 2011).

The leaves, stems and roots of *Plumbago Zeylanica* consist of 4 macro elements (Na, K, Ca and Mg) in good amount, five essential microelements (Zn, Fe, Mn, Cr, and Co) and eight other elements (Mo, Sb, Bi, Cd, Sr, Pb, Cd, and As) respectively were detected by inductively coupled plasma atomic emission spectrometry (ICP-AES). Many anti-cancer and antioxidant drugs usually possess these elements (Ganeshan *et al.*, 2013)

All parts of the plant are used but roots are considered as the most active and form prominent and effective herbal drug (Chaudhari *et al.*, 2015).

Roots

It contains **Napthoquinone** like (5,7-dihydroxy-8-methoxy-2-methyl-1,4-napthoquinone (plumbagin), Biplumbagin (Chitranon), Chloroplumbagin, Maritinone, Elliptinone,

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Lapachol, **Coumarins** like 5-mrthoxyseselin, seselin, suberosin, xanthyletin, xanthoxyletin, **Plumbic acid**, enzymes like invertase and protease along with other compounds such as plumbazeylanone, droserone, isozeylanone, fructose, glucose, zeylanone (Pant *et al.*, 2012)

Roots are stomachic, carminative, astringent to bowel, anti-helmenthic, and used to cure intestinal troubles, dysentery, leucoderma, inflammation, piles, bronchitis, itching, disease of liver, consumption, ascites (Chaudhari *et al.*, 2015).

Leaves: leaves contain plumbagin, chitanone, plumbagic acid (Pant *et al.*, 2012). Leaves are used to treat infections and digestive problems such as dysentery (Chaudhari *et al.*, 2015).

Stem: - It contains plumbagin, zeylanone, dihydroflavinol, campesterol, isozeylanone, sitosterol, stigmaterol, and plumbaginol (Pant *et al.*, 2012).

Flower: - plumbagin, glucopyranoside, sitosterol. It acts as a digestive aid.

Seeds: - it contains plumbagin (Pant *et al.*, 2012) and decoction of seed is used to reduce muscular pain (Chaudhari *et al.*, 2015).

Traditional Uses: The medicinal properties of *Plumbago Zeylanica* have been used in different places to cure different disease as shown in table 1.

Table 1 *Plumbago Zeylanica* used against different diseases

S.No.	Places	Disease in which it is used	Reference
1	India	Fever, malaria, diarrhoea, dyspepsia, piles, skin disease, leprotic lesions	Gupta <i>et al.</i> , 1993
2.	Nepal	Antiviral medicine	Kamboj and Dhawan, 1982
3.	Taiwan	Anti- helicobacter medicine	Kamboj and Dhawan, 1982
4.	Assam	For family planning, birth control and permanent sterilization	Tiwari <i>et al.</i> , 1982
5.	Northwest-Ethiopia	Gastro-intestinal	Giday <i>et al.</i> , 2006
6.	South- western Nigeria	Parasitic disease, scabies, ulcers	Gupta <i>et al.</i> , 1993
7.	Madras	Antioxidant in the form of amrita bindu formulation (a salt- spice herbal mixture)	Natrajan <i>et al.</i> , 2006

Pharmaceuticals and therapeutic properties

Antimicrobial properties

Ahmed *et al.*, (2007) investigated the anti-bacterial property of alcoholic crude extract of *Plumbago Zeylanica* against the growth of multi-resistant (16-23 lactam antibiotics) strains of *E. coli* and *Shigella*. It showed the high activity with MIC value of 0.64-10.24 mg/ml as compared to other plant extract.

Durga *et al.*, (1990) found the delayed growth of *E. coli* and *staphylococcus aureus*, inoculated in an antibiotic (streptomycin, rifampicin) however completely in the medium of antibiotic and plumbagin and thus regulate gastrointestinal flora (Iyengar and Pendse, 1966).

Aquil *et al.*, (2006) evaluate the presence of anti- methicillin resistant *staphylococcus aureus* (MRSA) activity in roots.

The petroleum ether, ethanol and aqueous extract of leaves and stems of *Plumbago Zeylanica* have inhibitory effect against bacteria and fungi by paper disc method. The maximum activity of ethanol extract has been seen against *micrococcus luteus* (12mm). As compared with standard ethanol extract showed a significant antifungal activity (Ravikumar and Sudha, 2011).

Antiulcer activity

Falang *et al.*, (2012) have investigated the anti-ulcer activity of aqueous root extract of *Plumbago Zeylanica* on aspirin and indomethacin induced acute gastric ulceration in albino rats. Results were assessed by determining and comparing the ulcer score, ulcer index and percentage protection of the extract with negative and positive control groups. The extract at doses, 25, 50 and 100 ml/kg found statistically significant ($p < 0.05$) dose dependent inhibition of aspirin induced gastric mucosal damage while in the indomethacin induced ulcer 50 and 100 mg/kg respectively exhibited statistically significant ($p < 0.05$). Along with this oral acute toxicity testing showed oral LD₅₀ to be greater than 5000 mg/kg which indicated the wide margin of safety of root extract.

Anti-obesity

A clinical study has been done under the investigation of Kotecha and Rao (2007) on obese patient taken from I.P.G.T & R. Hospital at Jamnagar, Gujarat. In this study an intervention of *Plumbago Zeylanica* and haridra powder in the dose of 500mg and 1gm/4times a day respectively in a capsule form for 45 days with restricted diet schedule of low calorie diet was done. The results showed the intervention of chitrak is highly significant ($p < 0.001$) in losing the weight of the patient than haridra as well as it is statistically significant in all the body circumferences.

Anti- inflammatory

Napalchyal *et al.*, (2013) conducted a clinical study on 30 patients taken from OPD and IPD of National Institute of Ayurveda, Jaipur. 15 patients were given a chitrakadi churna prepared by grinding the fresh cleaned and dried chitraka roots, endrayava, patha, kutaki, atish and haritaki in the dose of 4gms BD (both times a day) with lukewarm water after meal for 15 days. They found significant improvement in stiffness, dizziness, pain, swelling and tenderness.

Sheeja *et al.*, (2010) and Dang *et al.*, (2011) has been used three medicinal plants namely *Phyllanthus Emblica*, *Plumbago Zeylanica* and *Cyprus Rotundus* to analyse two models of acute inflammation. The result showed *Plumbago Zeylanica* reduce the oedema (Sheeja *et al.*, 2010 and Dang *et al.*, 2011) as well as it suppress the activation of NF-Kappa B in tumour cells and prevented graft versus host disease- induced mortality in mice (Checker *et al.*, 2009).

Another study revealed that the anti inflammatory effect has been seen in the carrageenin induced raw paw oedema in rats. This intervention study consists of four groups where two groups were treated with 300 and 500mg/kg which confirms

the 31.03 and 60.3% inhibition of acute inflammation (Arunachalam *et al.*, 2010)

Hypocholesterolemic activity

Sharma *et al.*, (1991) carried out a clinical study in which an active component plumbagin isolated from the roots of *Plumbago Zeylanica* and introduced in the hyper-lipidemic rabbits which reduces serum cholesterol and LDL- Cholesterol by 53 to 86% and 61 to 91% respectively. Plumbagin prevents the accumulation of cholesterol and triglycerides in liver and aorta.

Another study revealed that the administration of 500mg/kg of ethanolic extract of *Plumbago Zeylanica* (roots) for 60 days with normal diet to hyper-lipidaemic rabbits significantly reduced the serum cholesterol, LDL, cholesterol and triglycerides and the reduction was almost double in total cholesterol and LDL cholesterol when it is given in combination with Vitamin E and triglyceride level was markedly reduced (Ram, 1996).

Hepatoprotective

The oral administration of ethanolic extract (100-200mg/kg) for 6 weeks in streptozotocin diabetic rats increased hepatic hexokinase activity and decreased hepatic glucose-6-phosphatase, serum acid phosphatase (ACP), alkaline phosphatase (ALP) and lactate dehydrogenase (LDH). This proclaims it's hypoglycaemic and hepato-protective nature which also able to upgrade biochemical damages in streptozotocin induced diabetic rats (Zarmouh *et al.*, 2010).

Wound healing activity

Jyothi *et al.*, and Kodati *et al.*, (2013) found the wound healing activity of the ethanolic root extract of *Plumbago Zeylanica* in wistar rats. They also found that the presence of phytochemical such as alkaloids, terpenoids, flavonoids etc., in root extract is responsible for wound healing activity. Other studies (Bryan *et al.*, 2012; Schremi *et al.*, 2010; Kumar *et al.*, 2015) provided strong evidence for a role of oxidative stress in the pathogenesis of non-healing ulcers. The normal physiology of wound healing depends on low levels of reactive oxygen species and oxidative stress, an overexposure to oxidative stress leads to impaired wound healing. Antioxidants are postulated to help control wound oxidative stress and thereby accelerate wound healing (Jyothi *et al.*, 2013)

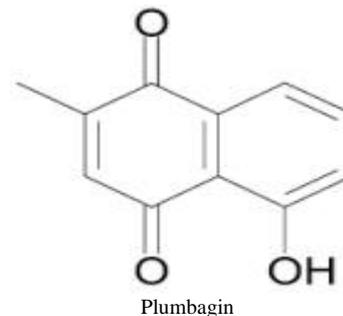
Cytotoxicity

Plumbagin is a bioactive compound present in *Plumbago Zeylanica* which modulates cellular proliferation, carcinogenesis and radio-resistance. All these reactions regulated by the activation of transcription factor NF- Kappa B activation pathway. *Plumbago* inhibits this activation induced by TNF, other carcinogens and inflammatory stimuli like phorbol myristate acetate. In certain tumour cells plumbagin suppress the constitutive NF- Kappa B activation, over all. The authors believe that plumbagin is a potent inhibitor of NF-

KAPPA B activation pathway. This leads to the suppression of gene products (Sandur *et al.*, 2006).

Bioactive Compound – Plumbagin

Plumbagin (2-methyl-5-hydroxy-1, 4-naphtho-quinone) is a yellow crystalline bioactive phytoconstituent (Navneet *et al.*, 2010) about 0.03% of dry weight of the roots (Chauhan, 2014). It is a natural naphthaquinone showing a broad range of pharmaceutical activities (Arunachalam *et al.*, 2010).



Plumbagin have proved to have anti-carcinogenic activity (Eldhose *et al.*, 2014), antioxidant, cardio-protective, anti-malarial, antifungal, anti-atherosclerotic, central nervous system stimulatory, anti-hyperglycemic, anti-inflammatory (Yuan-Chuen *et al.*, 2005; Yen-Ju *et al.*, 2006; Vanisree *et al.*, 2004). It has also anticancer properties (Singh and Udupa, 1997) and studies on mouse embryonic fibroblast cells suggest that the cytotoxic action of plumbagin may be due to apoptotic species cascade through the generation of reactive oxygen species (ROS) (Srinivas *et al.*, 2004) such as superoxide anion and hydrogen peroxide (Kawiak *et al.*, 2007). Plumbagin generates ROS via redox cycling (Inbaraj and Chignell, 2004), the leakage of mitochondrial respiratory chain (Kuo *et al.*, 2006), or the depletion of intracellular glutathione levels (Powolny and Singh, 2008). This may accounts for its cytotoxic and apoptotic effects (Su-Jung *et al.*, 2010; Ganeshan and Gani, 2013).

The anticancer and anti-proliferative activity of plumbagin tested in either *in vivo* or *in vitro* models. The structure of the plumbagin has been reported to closely resemble the vitamin K and the anticoagulant property of the *Plumbago* might be similar to coumarin derivative, the haemorrhage may be due to the competitive inhibition of vitamin K activity, needed for the synthesis of clotting factors (Santhakumari and Rathinam, 1978) The anticoagulant activity of the *Plumbago* was reported after an hour exposure and the effect of *Plumbago* on platelets and coagulation profile lead to the development of an antithrombotic drug (Vijaykumar *et al.*, 2006 and Ganeshan and Gani, 2013).

CONCLUSION

Overall compiled review suggests the use of *Plumbago Zeylanica* against various diseases is effective. As *Plumbago Zeylanica* is a popular and effective medicinal herb, chemically it is rich in active compounds such as plumbagin, chitranone, zeylanone, coumarins etc., which attributes its multipurpose medicinal properties. This herbal plant have great potential to

be integrated into conventional medical practices for the treatment and management of different metabolic diseases, inflammations, diabetes, obesity, hepato-toxicity, cancer and other disease. The aim of this review is to attract the attention of researchers to make new herbal formulations from *Plumbago Zeylanica*. This may lead to development of a common weed into beneficial nutraceutical and pharmaceutical product.

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