A review on pharmaceutically important medical plant: 
**Plumbago zeylanica**

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**ABSTRACT**

Medicinal plants have been used as a source of medicine and they are in great demand worldwide. They have been used for many years to treat health disorders and prevent diseases. Plumbago zeylanica is one of the medicinal plants which are widely used for its therapeutic value. It contains several bioactive compounds like napthoquinones, flavonoids, alkaloids, glycosides, steroids, tri-terpenoids, tannins, fixed oils, fats, proteins, etc among all plumbagin is most important bioactive compounds. It possesses wide range of pharmaceutical activities such as anti-cancer, anti-diabetic, anti-malarial, anti-microbial, etc. Several studies have been done in evaluation of its pharmaceutical activities. The aim of the present review is to provide a comprising knowledge related to the chemical composition and pharmaceutical activity of P. zeylanica.

**Keywords:** Plumbago zeylanica, chemical composition, plumbagin, pharmaceutical activity.

**INTRODUCTION**

Plants are the important source of various useful materials and provide food, shelter, medicine etc. Detailed descriptions of plant and plant’s products about 700 herbs used for medicinal purposes to cure various ailments have been mentioned in various literatures like Ayurveda, Charak Samhita and Susrut Samhita. P. zeylanica is a medicinal plant which commonly known as “White leadwort” or “Chitrak”. It belongs to the Plumbaginaceae family and a perennial herb which is found in Uttar Pradesh, West Bengal, Maharashtra and also to some parts of South India [1]. It is one of the oldest herbs which are reported to be used in Ayurveda for several disorders over thousands of years. It contains various bioactive compounds like alkaloids, flavonoids, napthoquinones, glycoside, saponins, steroids, tri-terpenoids, coumarins, phenolic compounds, tannins, carbohydrate, fixed oils, fats and proteins [2, 3]. This plant have been reported to show anti-bacterial, anti-plasmodial, anti-tumour, hepatoprotective, central nervous system stimulatory activity, anti-fungal, anti-inflammatory, anti-hyperglycemic, anti-cancer, anti-atherosclerotic activity etc [4].

Leaves of P. zeylanica are dark green in colour and are simple, elliptical with hairy margins along with alternate placement on the stem with the distance of up to 3 inches and thickness of 1.5 inches. Petioles are thin and with an approximate length of 0.5 mm and native stipules are present [5]. Plants breed flower white in colour with diameter of 1/2 to 3/4 inch having the stalk measuring 4 to 12 inches along with a terminal raceme-type of inflorescence. Roots of P. zeylanica are long and slightly branched with very less secondary roots, having a smooth and unbroken texture, colour of the roots is light yellow when the plant is freshly plucked out of the ground and changes to reddish brown in colour when it is dried which often initiates in the form of hard pieces. These roots are usually very strong having a bitter taste and a distinct odour with acrid [6].

**Chemical composition**

P. zeylanica contains variety of secondary metabolites like flavonoids, alkaloids, glycosides, saponins, steroids, tannins, tri-terpenoids, coumarins, carbohydrates, phenolic compounds, fixed oils, fats, proteins and napthoquinones [6]. Naphthoquinones present in the plant are plumbagin, chintranone, 3-biplumbvagin, chloroplumbagin, elliptone. Coumarins are seselin, 5-methoxy seselin, xanthyletin, suberosin. Other compounds present in the plant are Plumbagin acid, β sitosterol, 2, 2-dimethyl-5-hydroxy-6-acetyclromene, saponaritin, isoaffinetin, etc. Among all these Plumbagin, is the most important bioactive compounds present in P. zeylanica.
Plumbagin

Plumbagin (5-hydroxy-2-methyl-1, 4- napthoquinones- C₁₇H₁₄O₃) (Figure 1) is a naphthoquinones which is mostly present in roots of this plant [7]. It is a striking yellow pigment that patently appears in the Plumbaginaceae family. Plumbagin is soluble in organic solvents like acetone, chloroform, alcohol, benzene and acetic acid [8].

![Structure of Plumbagin](image)

**Figure 1: Structure of Plumbagin**

Pharmaceutical activity of Plumbago zeylanica

P. zeylanica has been reported to possess wide range of pharmacological activities like anti-inflammatory, anti-diabetic, memory inducing, lipid metabolism, anti-malarial, allergic and modulatory, anti-fertility, anti-bacterial, anti-viral, anti-cancer, anti-oxidant, larvicidal. Roots are used as a traditional medicine in various regions like in Ethiopia the root, bark or leaf powder is used for treatment of syphilis, tuberculosis and gonorrhoea and in Zambia the root and leaf is used as a remedy for inflammation of mouth, chest and throat by boiling the plant part in milk and consuming it.

**Anti-microbial activity**

Crude alcoholic extract of P. zeylanica showed anti-bacterial property against the growth of multi-resistant strains of E. coli and Shigella. MIC value of 0.64-10.24mg/ml obtained when compared with other plant extract [9]. A study reported that methanolic extract of P. zeylanica root showed the anti-bacterial effect against Bacillus subtilis cultures [10]. Ethanolic extract of P. zeylanica showed anti-microbial activity against Salmonella typhi, Pseudomonas aeruginosa, Bacillus subtilis and Staphylococcus aureus where as acetone and chloroform showed moderate activity [11]. Effect of crude extract of P. zeylanica leaves against E.coli, Bacillus cereus, Staphylococcus aureus, and Candida was observed and it was found that they exhibits inhibition zones which indicates the potential anti-microbial activity of P. zeylanica [12].

**Anti-diabetic activity**

A study investigated that 500mg of Plumbago zeylanica and 1gm of haridra powder in form of capsules given 4 times for 45 days with restricted diet schedule of low calorie diet to the obese patient [13]. Results showed that P. zeylanica is highly significant in the weight loss of the patient as compared to the haridra. Another study reported the effect of Plumbago zeylanica extract on diabetic rats. Extract reported to decrease the activity of glucose-6-phosphate and meanwhile increasing the activity of hexokinase when the ethanolic extract at a concentration of 100mg. 200mg/kg along with tolbutamide was administered orally to the streptozotocin treated diabetic rats [14]. Plumbagin isolated from the P. zeylanica enhance the protein and GLUT4 mRNA expression in diabetic rats and thus indicates the enhanced GLUT4 translocation and contribution to the glucose homeostasis [15].

**Anti-inflammatory activity**

A study reported that hydro-alcoholic extract of P. zeylanica leaf showed anti-inflammatory activity [16]. A study showed that P. zeylanica reduces the oedema thus comforting the body part, it is also investigated to suppress the NF-kappa B activation in the tumour cells and also prevention of graft versus host disease [17, 18, 19]. A study revealed the anti-inflammatory effect of P. zeylanica in carrageenin induced raw paw oedema in rats. In the investigation four groups were taken where two groups were treated with 300mg/kg and 500mg/kg which confirm the 31.03 and 60.30% acute inflammation inhibition [7]. A clinical study conducted on 30 patients who were taken from the OPD and IPD of National Institute of Ayurveda, Jaipur by Napalchaly et al., where 4mgs of chitraka churna was given to 15 patients for twice a day with lukewarm water for 15 days. And they found a significant improvement in the pain, swelling, tenderness and dizziness cause due to inflammation of the body parts [20].

**Anti-Cancer Activity**

Various reports state that the plant P. zeylanica consists of bioactive compound which possess anti-cancer activity against various cancer cell lines. A study also reveals that Plumbagin can inhibit cell proliferation, block cell cycle and induce apoptosis of APL cell line NB4 cells [21]. Ethanolic extract of P. zeylanica possess significant anti-cancer activity against Ehrlich Ascites Carcinoma in animal model, and also it reduces elevated level of lipid per-oxidation having presence of higher terpenoids and flavonoids [22]. A report showed that methanolic extract of P. zeylanica were used against MCF-7 and HT-29 and it results in moderate anti-cancer activity and the inhibitory property compared with the standard tamoxifen for MCF-7 and 5-fluoracil for HT-29. 50.23% of MCF-7 cell death and 25.17% of HT-29 cell inhibition were observed [23]. A study reported that plumbagin suppressed the BAX, BCL-2, pro-caspase-3 expression and cleaved caspase-3 in gastric cancer cells. Plumbagin inhibits the apoptosis in human gastric cancer cells that may be due to its ability to suppress the STAT3 and Akt phosphorylation [24].

**Larvicidal activity**

Maniatha et al., reported the larvicidal activity of three Plumbago spp. Hexane and chloroform crude extracts of P. zeylanica showed highest larvicidal activity against A. gambiae i.e. LC50 6.4 and 6.7 μg/ml respectively [25]. A reported show that P. zeylanica extract possesses larvicidal activity against second, third, and fourth instar larvae of Aedes aegypti. LC (50) values of all the extracts in different solvents of P. zeylanica were less than 50 ppm against all tested larval instars [26].

**Central nervous system activity**

A study reported that hydro-alcoholic leaf extract of P. zeylanica were evaluated for its CNS activity and it was found that the extract showed significant CNS depressant activity with the muscle relaxant properties [27]. Vishnuakanta et al., also investigated the anti-convulsant activity of hydro-alcoholic leaf extract of P. zeylanica and results showed that it did not possess the anti-convulsant activity [28].

**Hypo-cholesterolemic activity**

A clinical study carried by Sharma et al., which utilized the root extract of P. zeylanica containing Plumbagin, when administered to the hyperlipidemic rabbits reduced the serum cholesterol and LDL by a 53% to 86% and 61% to 91% respectively. The compound Plumbagin restricts the cholesterol and triglyceride accumulation in the liver and aorta [29]. A study also reveals a significant decrease in the serum cholesterol, LDL cholesterol and triglyceride when 500mg/kg ethanolic extract of P. zeylanica was administered to hyper-lipidemic rabbits [30].

**Wound healing activity**

Wound healing activity of methanolic extract of P. zeylanica root reported in wistar albino rats [31]. A study investigated the wound healing activity of ethanolic root extract of P. zeylanica in wistar rats and found that the activity is due to the presence of phytochemicals such as terpenoids, alkaloids, flavonoids, saponins etc. and these...
compounds are responsible for the wound healing activity of the plant [32]. Another study reported the evidence of oxidative stress in pathogenesis of non-healing ulcers. As the wound healing mainly depends on low level of oxidant so the antioxidant nature of the plant extract obtained from P. zeylanica helps in controlling the wound oxidative stress thus accelerating wound healing [33].

In-vitro studies in Plumbago zeylanica

P. zeylanica is grown and propagated mostly by seed cultivation, semi-ripe cuttings which are preserved with growth regulators. Due to the long time sprouting of seed in 21-30 days and the deterioration in germination rate by extended storage, traditional approaches for proliferation are problematic and less efficient, also the secondary metabolite content is very low. Hence, to minimize the growth time as well as to enhance the biomass and biochemical content of the plant, in-vitro cultivation of this plant is an efficient tool. A study reported the maximum shooting in MS media supplemented with 27.2µM Adenine Sulphate + 2.46 µM IBA and rooting in MS media supplemented with 4.92 µM IBA [34]. Dohare et al., observed maximum number of shoots in MS media supplemented with 1mg/l BA+ 1mg/l NAA and maximum number of roots in half strength MS media supplemented with 1mg/l IAA [33]. A report shows the maximum number of roots in MS media containing 0.1 mg/l NAA+ 1.5 mg/l Kinetin from nodal explants [34]. Similarly, another study reported that MS media containing 2mg/l BA+ 0.2mg/l NAA showed the maximum number of shoots from nodal explants where as MS media containing 1mg/l IBA showed the maximum number of roots [37].

CONCLUSION

Medicinal plants are the prime source of effective conventional drugs for the treatment of different diseases. Herbal medicines have been used for the past decade due to their several pharmacological activities. They have provided opportunities to the researchers for future research and development in this field. Plumbago zeylanica is one of the important medicinal plants which have several pharmacological properties such as anticancer activity, antimicrobial activity, antioxidant activity, etc. Due to the medicinal importance of this plant, pharmaceutical industries do random sampling from the natural environment and there is a decrease in the population of P. zeylanica which make it an over-exploited plant. So there is a need of an alternative process for mass propagation of this plant. This review suggests that P. zeylanica shows various pharmacological activities against several diseases. It is an effective bioactive compound and has a great potential to be integrated into conventional medical practices for the treatment of various diseases. P. zeylanica is an important plant in herbal medicinal plants but still there is a requirement of strong determination to fine an alternative process for mass proliferation of this plant. Using in-vitro methods at huge scale for development and successive ground plantations should be immeasurably valuable for the growing demands of P. zeylanica. Aim of this review is to bring attention towards importance of Plumbago zeylanica and its potential pharmaceutical activity for the development of new herbal formulations.

Source of Support: Nil.
Conflict of Interest: None Declared.

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HOW TO CITE THIS ARTICLE