



Review Article

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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 naphthoquinones, 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, naphthoquinones, 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 [4].

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 naphthoquinones [6]. Naphthoquinones present in the plant are plumbagin, chitrone, 3-biplumbagin, 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-acetylchromene, saponaretin, isoaffinetin, etc. Among all these Plumbagin, is the most important bioactive compounds present in *P. zeylanica*.

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Plumbagin

Plumbagin (5-hydroxy-2-methyl-1, 4- naphthoquinones- $C_{11}H_8O_3$) (Figure 1) is a naphthoquinones which is mostly present in roots of this plant [7]. It is a stirring yellow pigment that patently appears in the *Plumbaginaceae* family. Plumbagin is soluble in organic solvents like acetone, chloroform, alcohol, benzene and acetic acid [8].

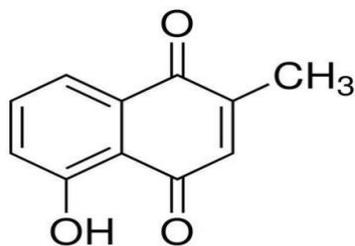


Figure 1: Structure of Plumbagin

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 studied 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 Napalchyal *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-fluoro Uracil 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

Maniafu *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 μ g/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]. Vishnukanta *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 hyper-lipidemic 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 [35]. 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 [36]. Similarly, another study reported that MS media containing 2mg/l BAP+ 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 actives 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 manufacturing 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.

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