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PLUMBAGO ZEYLANICA L.: A MINI REVIEW

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ABSTRACT:

In recent times the blind dependence on synthetics has got over and people are returning to the naturals with hope of safety and security. Herbs are thus staging a comeback as the only solution to insidious and debilitating effects of synthetic drugs. *Plumbago zeylanica* is one such important medicinal plant which is being used the world over in the traditional system of medicines. With a herbal 'renaissance' occurring across the globe, the plant is being used extensively in commercial preparations of medicines owing to its wide range of biological activities. The present study summarizes our current knowledge of botany, major bioactives, traditional and medicinal uses of *P zeylanica* as a foreword to further studies on mass propagation of this valuable species.

Keywords: *Plumbago zeylanica, morphology, traditional value, chemical constituents, medicinal properties, in vitro studies*

[I] INTRODUCTION

Plumbago zeylanica L. (Synonym: *P.viscosa* Blanco) (chromosome number 2n=24) is a multipurpose medicinal herb of family Plumbaginaceae. A native of South Asia, the species is distributed throughout most of the tropics and subtropics; growing in deciduous woodland, savannas' and scrublands from sea-level up to 2000 m altitude [1, 2, 3, 4]. The sap of *P. zeylanica* causes discoloration of the skin resembling the colour of lead accounting for its Latin name *Plumbago* and the popular name leadwort. The species is also known by several names in different parts of the world viz. bleiwurz/zahnkraut (in German), sanza (in Swahili), mosikomabe (in Tswana) and ensain (in Arabia). In India the plant enjoys a wide distribution ranging from Central India to West Bengal, Maharashtra and various parts of Southern India. The plant has several vernacular names in the country viz. chitraka/chitramol (in Hindi), chitra (in Sanskrit), agni/vahini (in Gujarati), chitramula (in Kannada), chitrakmula/ bilichitramula (in Malyalam), veellakeduveli (in Punjabi), chitra (in Bengali), chita (in Tamil), kodiveli/chitramoolam (in Telugu) [3]. The trade name, however, remains to be Chitraka [5, 6].

1.1 Morphology

There is no consistency in the literature citing the classification of *P. zeylanica* as herb or shrub. Some authors have described it as a perennial dicot herb [7,8] while it has also been designated as a shrub by others [9].*P. zeylanica* plant attains a height of about 0.5–2 m (1.6–6.6 ft) (Figure 1A). The leaves are alternate, simple, ovate or ovate-lanceolate, elliptical or oblong, 0.5–12 cm in length with a tapered base and often with a hairy margin. The stipules are

absent and the petiole is narrow (0–5 mm long) with small auricles in young leaves.

The inflorescence is of terminal raceme-type about 6–30 cm long and many-flowered. Flowers are white in colour [4, 7] and are borne in axillary and terminal elongated spikes (Figure 1B, C). They are bisexual, regular, pentamerous, pedicellate and sweet-scented. The stamens are free, included. The style is filiform with five elongated stigma lobes and the ovary is superior, single-celled. The flowers are also characterized by having a tubular calyx (7–11 mm long and 5-ribbed) with glandular trichomes (hair) secreting a sticky mucilage. The plant flowers round the year and pollination is primarily by insects. The mucilaginous glands aid in trapping insects and fruit dispersal by animals.

The fruit of the plant is an oblong (7.5–8 mm long) five-furrowed capsule containing single seed. Each seed is oblong in structure, 5–6 mm long and reddish- brown to dark brown in colour. Roots are straight, smooth, branched or unbranched, with or without secondary roots and about 30 cm or more in length and 6 cm in diameter [3]. They are light- yellow when fresh and become reddish-brown on drying. The roots have a strong and characteristic odour with acrid and bitter taste [7].

1.2 Traditional Uses

P. zeylanica is a popular medicinal herb throughout Africa and Asia. It has been used as a remedy for skin diseases, infections and intestinal worms viz. leprosy, scabies, ringworm, hookworm, dermatitis, acne, sores and ulcers since time immemorial. The traditional systems of medicine in different parts of the continents have been utilizing all parts of *P. zeylanica* for a variety of treatments. In West Africa the root or the leaves crushed with lemon juice, are used as a counter-irritant and vesicant. In Nigeria the roots pounded with vegetable oil are used as a treatment for rheumatic swellings. Powdered bark, root or leaves are used as a conventional method to treat gonorrhoea, syphilis, tuberculosis, rheumatic pain, swellings and wounds treatment system in Ethiopia. In other regions of Africa a paste of the root in vinegar, milk and water is used to treat influenza and black water fever; root infusion is taken orally to treat shortness of breath; root decoction with boiled milk is swallowed to treat inflammation in the mouth, throat and chest. In Mauritius and Rodrigues a root decoction is also used to treat diarrhoea and dyspepsia.

In India *P. zeylanica* commands an important place among medicinal herbs in India since ancient times. Ayurveda, the Indian indigenous system of medicine dating back to the Vedic ages (1500-8000 BC), has described chitraka as tumor-negating and anti-dyspepsic. In Charaka Samhita (an important work on Ayurvedic system of medicine) *P. zeylanica* has been categorized as an appetizer, anti-saturative, anti-anorexic, anti-haemorrhoidal and pain-reliever [3]. Herbal medicines such as Dabur Chitrak Haritaki, Medohar Guggulu, Morslim-Z, Divya Chandraprabhavati etc. use *P. zeylanica* extracts in different amounts (Figure 4).

1.3 Chemical constituents and medicinal properties

P. zeylanica contains a variety of important chemical compounds. Different plant parts of the plant possess naphthaquinones, alkaloids, glycosides, steroids, triterpenoids, tannins, phenolic compounds, flavanoids, saponins, coumarins, carbohydrates, fixed oil and fats and proteins [1, 10, 11, 12, 13]. Of all the chemical constituents' plumbagin is the principle active compound. Plumbagin (5-hydroxy-2-methyl-1, 4- naphthoquinone- $C_{11}H_8O_3$) is primarily present in roots in higher amounts with only about 1% in the whole plant [14]. The important chemicals reported in *P. zeylanica* can be classified as in Figure 5.

A wide range of medicinal properties of *P. zeylanica* are attributed to Plumbagin and other secondary metabolites. Plumbagin has shown antibacterial activity against both gram-positive (e.g. *Staphylococcus*, *Streptococcus*, *Pneumonococcus* sp.) and gram-negative (e.g. *Salmonella*, *Neisseria*) bacteria. It is also active against certain yeasts and fungi (*Candida*, *Trichophyton*, *Epidermophyton* and *Microsporum* spp.) and protozoa (*Leishmania*) [1, 11, 15, 16]. In low concentrations, plumbagin exhibits antimitotic activity comparable to that

of colchicine. Plumbagin also has strong antifeedant and moulting inhibiting effects on insects and has nematicidal and acaricidal activities. The various biological activities exhibited by *P. zeylanica* (Table 1) account for the products of this plant being traded worldwide as Ayurvedic and homeopathic medicine.

[II] Propagation

P. zeylanica can be propagated by seeds, rooted shoots from the base of the plant or by semi-ripe cuttings, treated with a growth hormone. Seeds germinate in 21–30 days. However, prolonged storage of seeds (over 3 months) results in a drastic decline in germination rate. Sowing seeds in a nursery with subsequent transplantation into the field at a density of 60 x 60 cm is a preferred method of *P. zeylanica* plants propagation. Although the species can be grown in a variety of soils, ranging from red soil, with very little topsoil, to deep black soil; the plants prefer well drained/deep sandy loam to clayey loam soil with high organic content. In natural habitats, the plants thrive well in moist soil with high organic content and partially shaded locations with intermediate to warm temperatures.

However, conventional methods of propagation have proven to be difficult and inadequate to meet the escalating demand of plant in market. This is mainly attributed to poor seed germination and premature death of seedlings on plantation under normal conditions [52].

Alternatively, the technique of *in vitro* propagation has been successfully utilized for mass multiplication of this species using nodal explants, axillary buds, leaf or root explants and callus cultures (Table 2).

[III] Prospects

Despite a descent hold of *P. zeylanica* in the herbal industry and a lot of efforts being made to develop an alternate method of mass propagation of the species, unsystematic collection of plants from the wild continues. This poses a threat to the existing natural stands of *P. zeylanica*. Besides, collection of plants for medicinal preparations without proper identification poses a risk of adulteration in medicinal preparations requiring *P. zeylanica* as a major constituent. Rapid multiplication of elite genotypes through micropropagation and refining as well as shortening the breeding process using marker-aided selection positively contributes to crop improvement. Application of *in vitro* developed techniques for large scale multiplication and subsequent field plantations shall be immensely useful in meeting the ever increasing demand of this important medicinal herb

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S.N.	Activity	Reference
1.	Anticancer	[17], [18], [19]
2.	Acaricidal	[20]
3.	Antiarthritic	[21]
4.	Anticandidal	[22]
5.	Anticonvulsant	[4]
6.	Antiallergic	[23]
7.	Antibacterial	[24], [25], [27],
8.	Antimycotic	[25], [27]
9.	Artherosclerotic	[28]
10.	Anti-fertility	[29], [30], [31]
11.	Anti-diabetic	[32]
12.	Antiviral	[33]
13.	Hyperlipidaemic	[34]

14.	Anti-invasive	[35]
15.	Antioxidant	[36], [37], [38]
16.	Antiplasmodial	[39]
17.	Cardiotonic	[37], [38]
18.	Cytotoxicity	[5]
19.	CNS stimulant	[3], [40]
20.	Hepatoprotective	[8], [41]
21.	Immunomodulatory	[42], [43], [44]
22.	Larvacidal	[45]
23.	Neuroprotective	[37], [38]
24.	Anti Inflammation	[46], [47]
25.	Genotoxicity	[48], [49], [50]
26.	Central Dopaminergic	[51]

Table 1: Biological activities of *P. Zeylanica*

Explant	**Shoot initiation**	***In vitro* multiplication**	**Rooting**	**Percent survival regenerated plantlets**	**References**
Node	1.0 mg/l BAP + 0.01 mg/l IAA	1.0 mg/l BAP + 0.01 mg/l IAA	1/2X + 0.25 mg/l IBA	95%	[53]
Node	27.2 µ M adenine sulfate +2.46 µ M indole-3-butyric acid (IBA)	27.2 µ M adenine sulfate +2.46 µ M indole-3-butyric acid (IBA)	4.92 µ M IBA	90%	[54]
Node	8.87 µmol/L BAP + 0.49 µmol/L IBA.	MS 09+ 4.43 µ mol/L BAP + 0.25 µ mol/L IBA.	½ X MS + 0.49 µ mol/L IBA	-	[55]
Node	6.7 mg/l BA and 1.4 mg/l IAA	4.4 mg/l BA and 1.4 mg/l IAA	IBA (1.2 mg/l)	96%	[56]
Leaf	callus from leaf- 6.7 mg/l BA, 1.42 mg/l IAA and 160 mg/l AdS	organogenesis- - 6.7 mg/l BA, 1.42 mg/l IAA and 160 mg/l AdS			
Leaf	callus- 2.0 mg/l 2,4-D	organogenesis- BAP 3.5 mg/l + NAA 0.3 mg/l	3.0 mg/l NAA	80%	[57]
Node	1.0 mg/l BAP +1.0 mg/l GA3	1.0 mg/l BAP +1.0 mg/l GA3	½ X 1.0 mg/l BAP +0.5 mg/l IAA	60%	[58]
Nodal	20mg/l BAP+1.5mg/l IAA+1.0mg/l IBA	2.0 mg/l BAP+1.5mg/l IAA+1.0 IBA	1.5mg/l NAA+1.5mg/l IAA+2.0mg/l IBA	95%	[59]
Node and Shoot tip	Liquid MS + 1.0 mg/l BAP + 0.5 mg/l IBA +2.0 mg/l Ads	1.0 mg/l BAP + 0.5 mg/l IBA +2.0 mg/l Ads	1/2X + 0.5 mg/l NAA	100%	[52]
Stem	2.0 mg/l BAP + 1.5 mg/l IAA	0.75 mg·L-1 BAP + 1.0 mg·L-1 IAA + 1.0 NAA + 1.0 mg/l Ads			
Node	M4 + 0.4 mg/l NAA + 3.5 mg/l BAP			55%	[60]
Embryo	20 mg/l NPK + 20 mg/l citrus sinensis juice			100%	
	M1 + 0.01 mg/l NAA + 2 BAP			80%	
Node	1.5 mg/l BAP+0.75 mg/l IBA + 0.75 mg/l Ads + 10% coconut milk	1.5 mg/l BAP+0.75 mg/l IBA + 0.75 mg/l Ads + 10% coconut milk	1/2X + 0.75 mg/l IBA	100%	[61]
Node	1.0 mg/l BAP	1.0 mg/l BAP + 0.5 mg/l GA3	1.5 mg/l IBA	90%	[4]
Leaf	1.5 mg/l BAP	1.5	1.5 mg/l IBA	90%	

Table 2: *In vitro* propagation studies on *P. zeylanica*

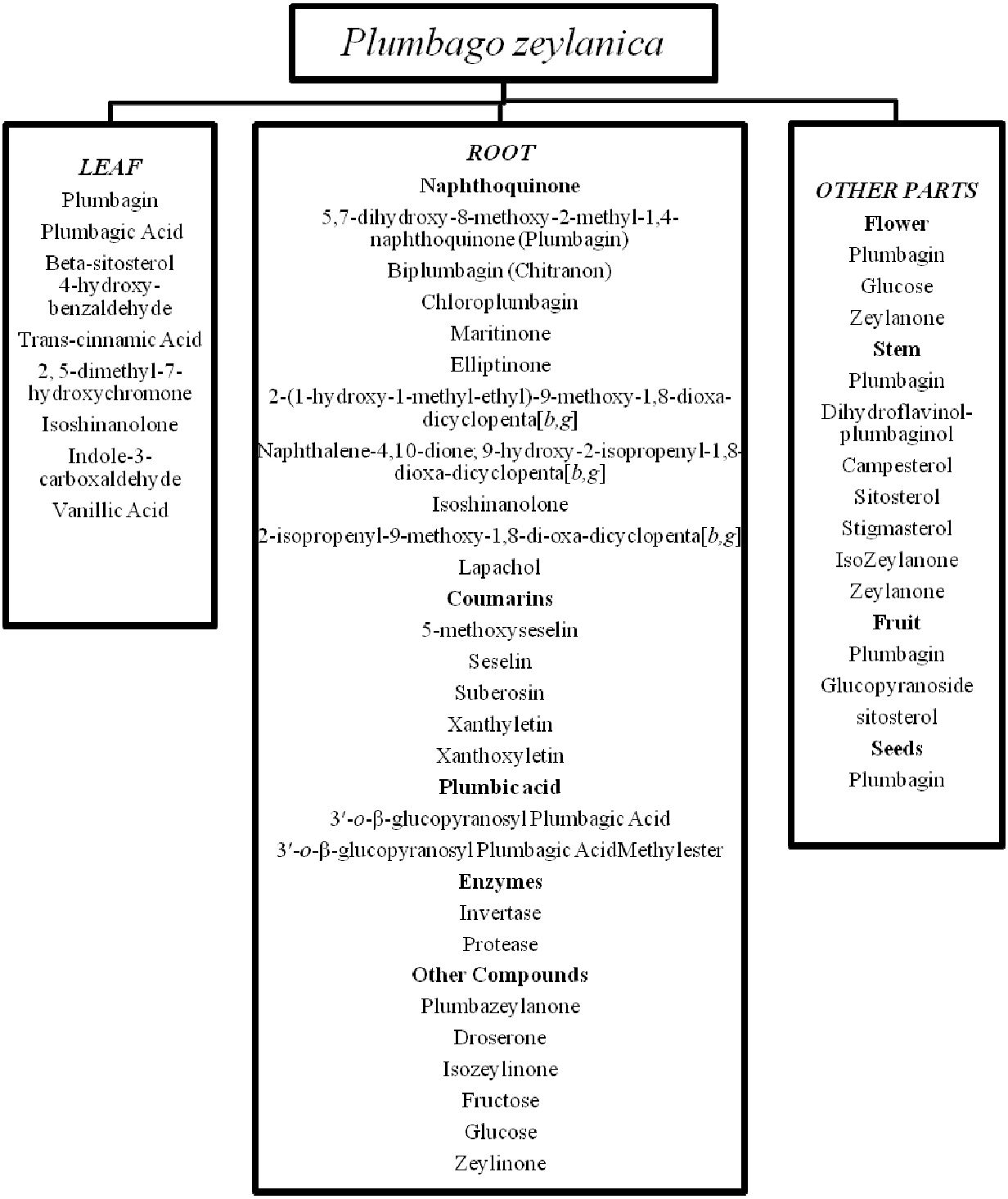

Figure 4: Chemical constituents of *Plumbago zeylanica*