

RG/98/15101

NA-207

SRI LANKAN MEDICINAL PLANT

MONOGRAPHS AND ANALYSIS

VOL - 6

PLUMBAGO INDICA



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FR-1040

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SRI LANKA.

SPONSOR

NATIONAL SCIENCE FOUNDATION

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First published in 1999

National Library of Sri Lanka-Cataloguing –in-Publication Data

Arambewela , Lakshmi
Plumbago indica /Lakshmi Arambewela. Ruvina Silva.–
Colombo : National Science Foundation, 1999
Vol 6 -18p;30cm.-(Sri Lankan medicinal plant monograph & analysis)

ISBN 955-590-024- 8 Price : Rs. 150.00

i 615.321 DDC 21	ii Title
iii Silva, Ruvina jt..au.	iv Series
1 Medicinal plants	2. Botany, Medical

ISSN 1391-4499
ISBN 955-590-024-8
Published by National Science Foundation

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PREFACE

The medicinal plants of Sri Lanka have been investigated in the Natural Products Development group for many years. This monograph which is the sixth in this series is the result of the literature surveys, researches and experiences of the Natural Products Development group of Industrial Technology Institute (Ceylon Institute of Scientific & Industrial Research). This is intended for varied reading public, the herbal drug manufacturers who need to identify and standardise their herbal raw materials, the Ayurvedic physicians who need some scientific information on medicinal plants, the research workers requiring a quick background on a plant, the industrialist or entrepreneur pondering on commercial ventures and the inquiring lay readers. We hope this monograph fulfils some requirements of each of them.

The authors wish to thank the members of Natural Products Development group for their contribution to this, the Information Service group for providing information, Dept. of Chemistry, University of Sri Jayawardenepura for the TLC scanning facility and Dept. of Botany, University of Colombo for photographs of slides. They also gratefully acknowledge the sponsor **National Science Foundation for research grant RG/98/IS/01.**

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PLUMBAGO INDICA

- Synonyms - *Plumbago rosea*
Plumbago coccinea
*Thela coccinea*¹
- Sinhalese name - Ruthnitol, Ratnetol¹
- Other names - English - Rosy-flowered Leadwort
Tamil - Cenkodiveli, Cithiramulam, Akkini, Sengodiveli, sengoduveli, Sengappugodiveli, Sittiramulam,
Hindi - Chitra, Lal-chita, rakta-chitra, Lal-chitarak,
Sanskrit - Agni, Atidipya, Chitraka, Chitranga, Chitravalli, Dahatea, Daruna, Dipika, Dvayagni, Hrasvagni, Kala, Kalamula, Mahanga, Marjana, Pathi, Pavaka, Raktachitra, Rakta-chitraka, Raktasikha, Sharbudhahvaya, Vahnimula, Vyala,
Bengali - Lalchitra,
Telugu - Errachitramulam,
Marati - Lal,
Kannada - Nelavarike,
Malay - Nilavaka,
Gujarati - Nat-ki-sana^{1,2}.
- Family - Plumbaginaceae
- Parts used - Leaves and roots
- Pharmacopoeia - Ayurveda Pharmacopoeia³
Sinhalese Materia Medica⁴
Indian Materia Medica⁵
- Official drugs - Concentrated decoctions, medicated wines, tablets³.

Uses in Traditional
Medicine

- The juice of the *Plumbago indica* root blisters the skin. It is used to cause abortion. The juice of the leaves and roots mixed with oil is employed as an application for rheumatism, paralysis and leprosy in Sri Lanka¹.

In South India, the dried root is valued as a remedy for secondary syphilis and leprosy. The vesicating property of the milky juice is made use of in certain type of leucoderma and scabies. A tincture of the root is used in dyspepsia, piles, flatulence, loss of appetite and other digestive complaints².

The roots are used in dyspepsia, colic, inflammations, cough, bronchitis, helminthiasis, haemorrhoids, elephantiasis, chronic intermittent fever, ring worm, hepatosplenomegaly, amenorrhoea, odontalgia, anaemia, skin diseases, diarrhoea, piles, anascarca and as an abortifacient⁶.

In Malaya the chewing of the root regularly with areca nut is said to cause abortion and is a vesicant and a powerful sialogogue².

In Java, the root is used in veterinary medicine for expelling worms in horses².

Plumbagin may be useful in the treatment of early cases of leucoderma and baldness of head².

Plumbagin has been prescribed for cancer in the Siddha system of medicine².

Other uses

- *Plumbago indica* is an attractive plant, frequently grown in gardens for its showy bright red flowers².

Distribution

- Probably native in South Asia and now cultivated throughout India and Sri Lanka¹.

Morphology

A perennial glabrous herb, more or less climbing with striated stems and with long succulent roots, leaves simple, alternate, exstipulate, ovate-elliptic, about 10 cm long, tapering into a short somewhat clasping petiole, entire, undulate, glabrous, thin, flowers regular, bisexual, in long purplish-red to scarlet, racemes, bracts shorter than calyx, sepals five, fused into a narrow, tubular, glandular calyx, pubescent with stalked glands, petals five, fused into a tubular salverform corolla, tube about 2.5 cm long, segments obovate, spreading, apiculate, stamens five, distinct, hypogynous, free from the corolla, filaments as long as the corolla tube, anthers exerted just beyond the throat, ovary superior, 5-carpellary, unilocular with basal placenta and one anatropous ovule, style 2.2 cm long, stigmas 5, fruit a membranous circumscissile capsule, enclosed by persistent calyx, the deciduous part often splitting into 5 valves from below¹.



Fig : 1 1. Leaf 2. Flower 3. Root

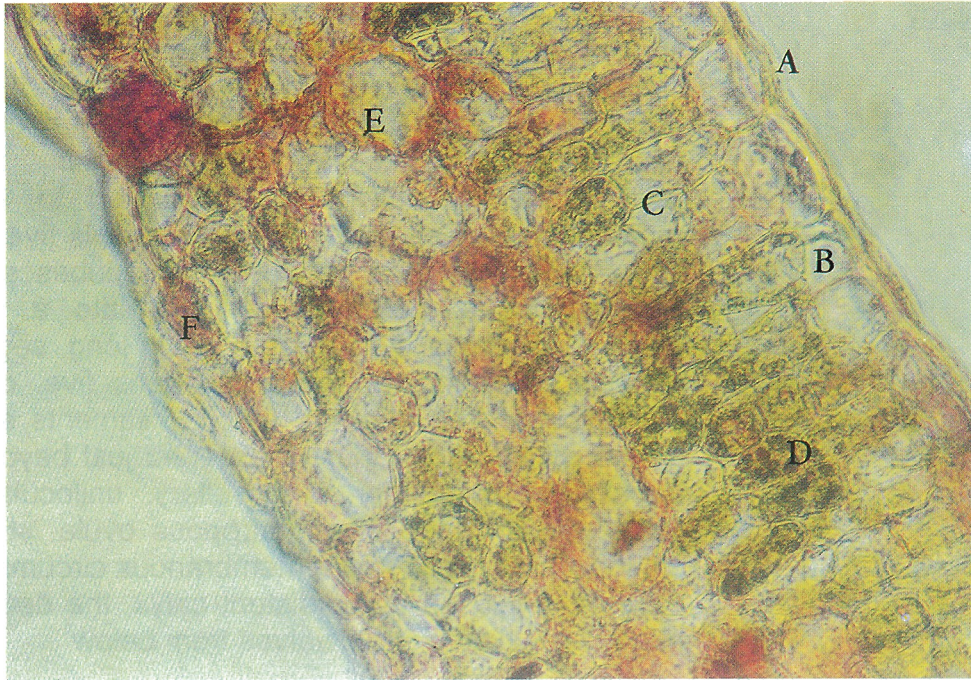


Fig 2 : Cross section of *Plumbago indica* leaf

- A. Cuticle B. Upper epidermis C. Palisade parenchyma cells
 D. Chloroplast E. Spongy parenchyma cells F. Lower epidermis



Fig 3 : Cross section of *Plumbago indica* stem

- A. Epidermis B. Cortex C. Chlorenchyma D. Phloem E. Xylem

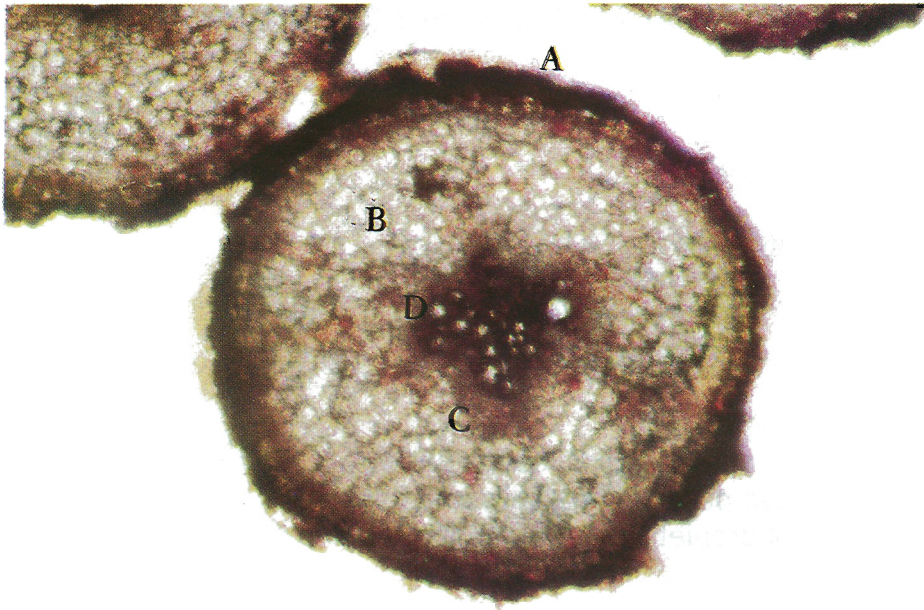


Fig 4 : Cross section of *Plumbago indica* root
A. Cork B. Cortex C. Phloem D. Xylem

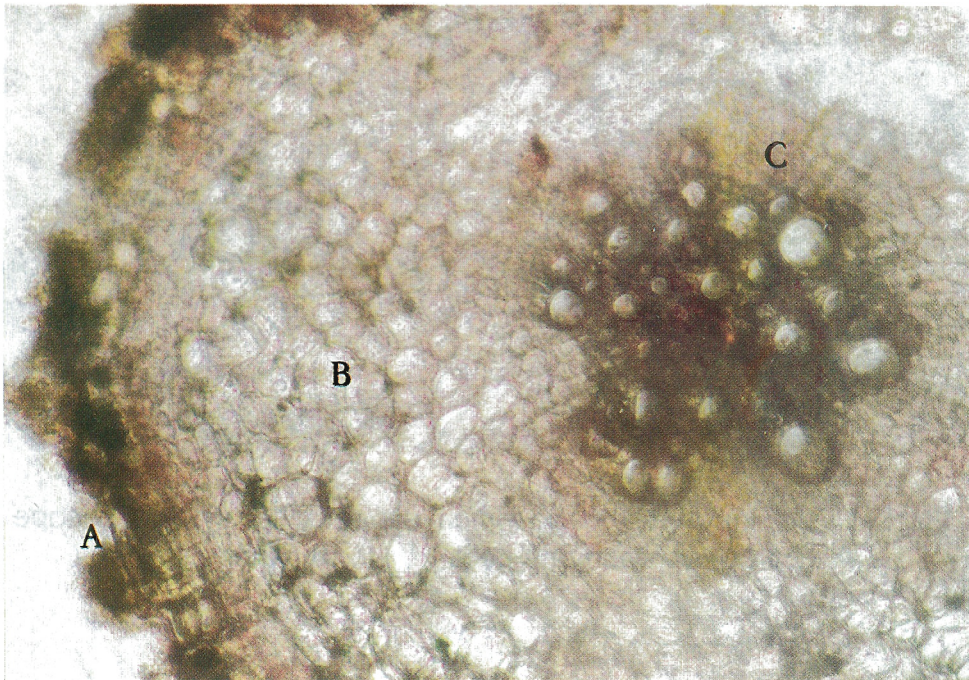


Fig 5 : Cross section of *Plumbago indica* root
A. Cork B. Cortex C. Vascular bundle

ANALYTICAL SPECIFICATION

Powder Analysis : Leaves

Macroscopic characters

Colour	-	Brownish black
Odour	-	Slightly pungent
Taste	-	Very slightly bitter

Microscopic character

The powder of *Plumbago indica* leaves shows-

Wilt irregular shape parenchyma cells and their parts.

Large numbers of droplet like granules that have come out from the cells.

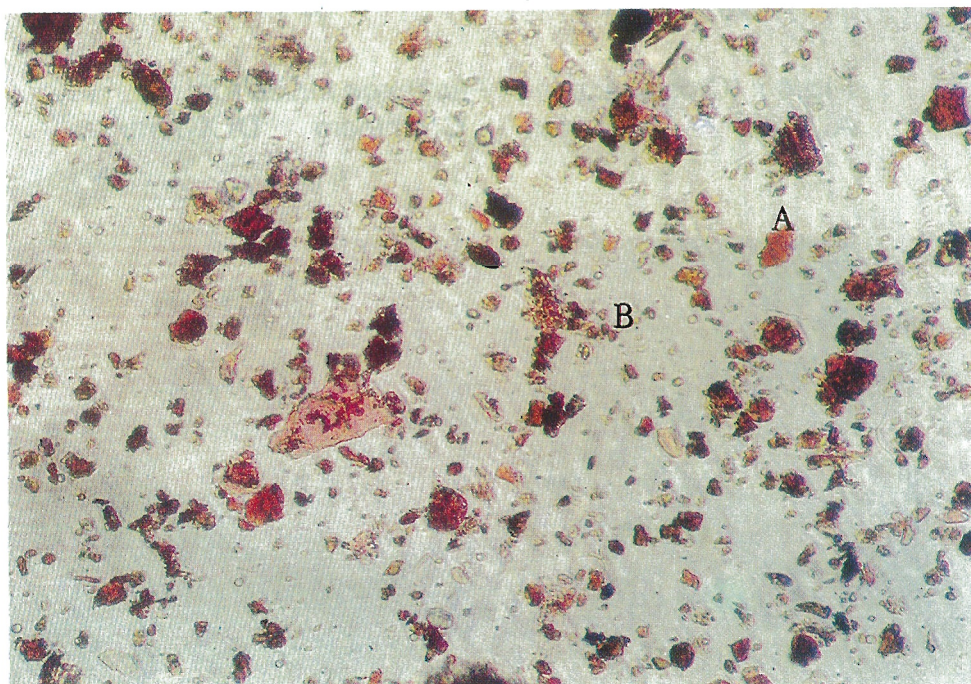


Fig 6 : Powder of *Plumbago indica* leaves under the microscope
A. Part of parenchyma cells B. Cell content

Powder Analysis : Roots

Macroscopic characters

Colour	-	Brownish black
Odour	-	Slightly pungent
Taste	-	Very slightly bitter

Microscopic character

The powder of *Plumbago indica* roots shows-

Thin walled parenchyma cells.

Fragments of thick walls of tracheids / vessels and parts of tracheids / vessel, with irregular shape parenchyma cells and their parts.

Large numbers of droplet like granules that have come out from the cells.

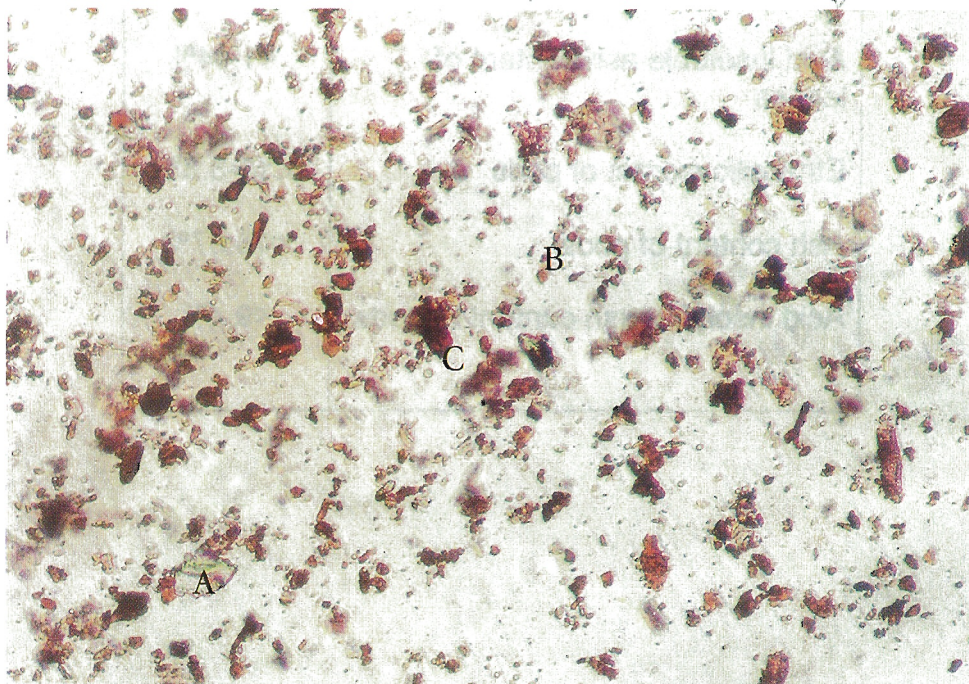


Fig 7 : Powder of *Plumbago indica* leaves under the microscope
A. Part of parenchyma cells B. Cell content
C. Fragment of thick cell wall

Table 1 : Physico – Chemical Analysis

Test	Limits
Ethanollic extract of leaves	1.5-3.5%
Ash content of aerial part	<19.5%
Acid insoluble ash content of leaves	<1.44%
Ethanollic extract of pods	1.13-3.3%
Ash content of pods	<16.87%
Acid insoluble ash content of pods	<9.4%

AGRONOMY

Some studies on agronomy of *Plumbago indica* are reported. Incropping of agricultural crops in the mature strands of *Hevea brasiliensis* is difficult. However many medicinal species are adapted to grow under very low light intensities. They are *Plumbago rosea*, *Strobilanthes heyneanus*, *Adhatoda vasica*. There are possibilities of using these species for inter cropping in mature strands of *Hevea* profitably without affecting the latex yield of rubber trees. Higher yields have resulted in plants grown under coconut compared to those in open area^{7,8}.

PHYTOCHEMISTRY

Plumbago indica aerial parts contain sitosterol, stigmasterol, campesterol, plumbagin (2-methyl-5-hydroxy-1-4-naphthoquinone), 6-hydroxyplumbagin, plumbaginol, fatty alcohol, tannin, flavonol, azalein, anthocyanin, capensinin^{9,10,11}

Plumbago indica roots contain naphthoquinone, droserone, elliptinone and zueylanone, plumbagin (2-methyl-5-hydroxy-1-4-naphthoquinone), 6-hydroxyplumbagin, binaphthoquinone roseanone, droserone, elliptinone, zeylanone^{12,13}

PHARMACOLOGY

Tumor growth inhibitory and radiosensitizing effects of the alcoholic root extract of *Plumbago rosea* was studied in experimental mouse tumors, S-180 solid tumor and Ehrlich ascites carcinoma *in vivo*. The results demonstrate that though *Plumbago rosea* extract may have only a weak antitumor effect, it may be a good candidate for use with radiation to enhance the tumor killing effect. The purified plumbagin more toxic than the extract^{14,15}.

Mouse melanoma cells treated with plumbagin, either alone or followed by 2Gy gamma radiation (RT), had following results: *Plumbago* alone produced a significant decrease in the cell count on days 3 and 4, whereas radiation treatment significantly enhanced the growth inhibitory effect when compared to radiation or *Plumbago* alone. These findings suggest the radiosensitizing effect of *Plumbago rosea* on mouse melanoma cells *in vitro*¹⁶.

The roots are acrid, astringent, thermogenic, anthelmintic, constipating, expectorant, anti-inflammatory, abortifacient, alterant, antiperiodic, carminative, digestive, sudorific, narcotic, gastric, nervous stimulant and rejuvenating¹⁷.

The ethonolic root extract of *Plumbago rosea* was studied for acute toxicity in mice and subacute toxicity in rats. The 24 h LD₅₀ values of the extract in mice were 239.88 mg and 1148.15 mg/kg body weight for intraperitoneal and oral routes, respectively. Oral administration of doses above 1250 mg/kg produced severe diarrhoea²².

Plumbagin -

Small doses of plumbagin, has a stimulant action on central nervous system, muscles, secretion of sweat, urine and bile²,
Blood pressure shows a slight fall²,
The peripheral vessels are found to dilate²,
Acts as a powerful irritant and has well marked antiseptic properties²,
Inhibits pathogenic fungi such as *Coccidioides immitis*, *Histoplasma capsulatum*, *Ctesnomycetes radians* and *Trichophyton ferrugineum*²,
Acts as an antimetabolite towards *Mycobacterium tuberculosis*²,
Induces antiimplantation¹⁸,
Abortifacient¹⁸,
Antioviulatory¹⁸,
Causes selective testicular lesions in dogs¹⁸,
Causes mitotic inhibition¹⁸,
Exhibits anticoagulant effect¹⁸,
Showed antigonadotrophic activity¹⁸,
In lower concentrations it behaves like a spindle poison but in higher concentrations. It exhibits radiomimetic nucleotoxic and cytotoxic effects¹⁸.
Showed anticancer effect on experimental tumors¹⁹.

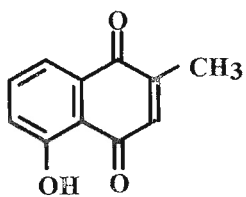
The antioxidant nature of plumbagin against lipid peroxidation induced by oxidants was investigated. It indicated that 1mM concentration of plumbagin prevented the oxidative tresses, induced lipid peroxidation in liver and heart homogenates of rats^{20,21}.

The synergistic effect of plumbagin and alkaloid isolated from *Plumbago indica* along with insecticides such as endosulphan, methyl parathion etc. Showed that plumbagin has higher synergistic effect with methyl parathion than in the presence of other insecticides¹⁷.

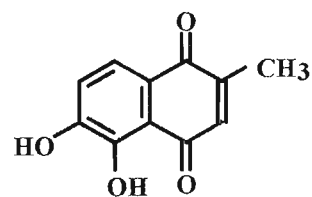
Plumbagin isolated from *P. indica* root bark was highly effective on third and fourth instar larvae of *Culex quinquefasciatus*²³.

Plumbagin and naphthoquinone derivative, obtained from *P. rosea*, *P. zeylanica*, *P. europea* have been reported to possess potent antifertility activity. Plumbagin has been reported to possess strong ant-progestational activity and devoid of any oestrogenic, anti-oestrogenic, progestational, androgenic and anti-androgenic activities²⁴.

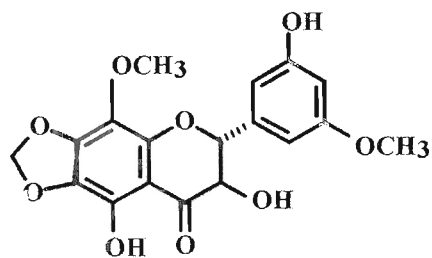
Crude extracts and partially purified as well as purified fractions were prepared from three Thai medicinal plants, namely, *Plumbago indica* Linn, *Acanthus ebracteatus* Vahl and *Rhinacanthus nasuthus* Kurz, and then tested for their mutagenic and antimutagenic potentials using the Salmonella / microsome mutagenicity test. All fractions tested were not mutagenic toward either strain TA98 or TA100. Furthermore, these fractions could markedly inhibit the activity of rat liver aniline hydroxylase, which is one of the cytochrome-P450-mediated reactions. These results therefore suggest that these Thai medicinal plants contain an antimutagen(s), which inhibits chemical mutagenesis by inhibiting the enzyme activities necessary for activation of indirect mutagens/carcinogens²⁵.



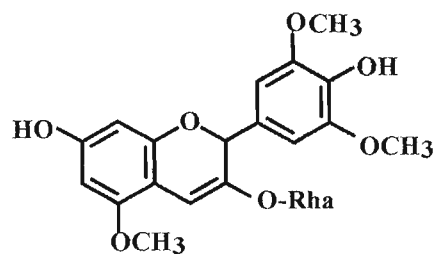
Plumbagin



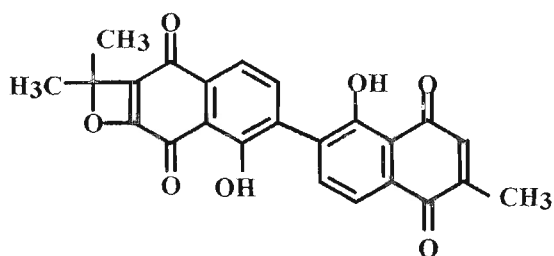
6-Hydroxy plumbagin



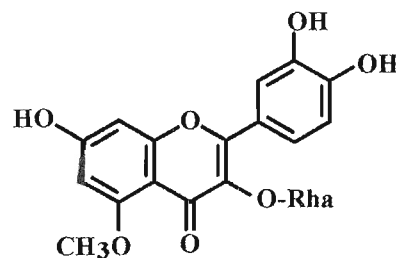
Plumbaginol



Capensinin



Binaphthoquinone roseanone



Azalein

Fig 8 Compounds present in *Plumbago indica*

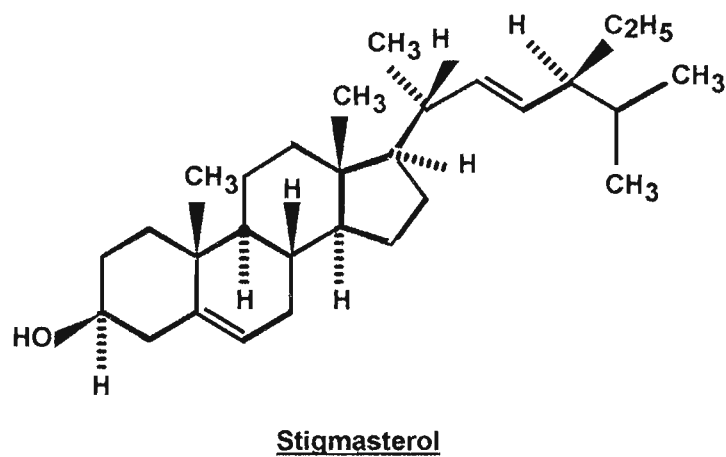
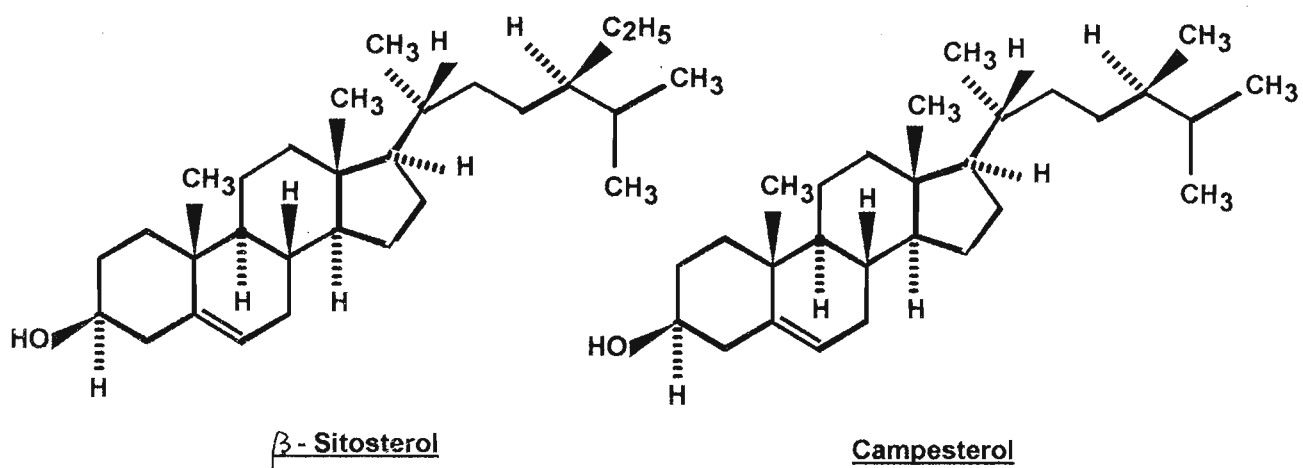


Fig 9 Compounds present in *Plumbago indica*

TLC PROFILE

Sample preparation

Sample detail

- *P. indica* leaves

Sample preparation

- *P. indica* leaves (5.0g) were extracted with ethanol and concentrated (28.5mg/10ml) 15 μ l of extract was applied to TLC plate.

Adsorbent

- Silica gel GF₂₅₄

Solvent system

- Benzene : ethyl acetate (3 : 7)

Detection

Direct evaluation

- UV₂₅₄nm, UV₃₆₆nm
Rf values (UV₂₅₄)
Extract : 0.03, 0.06, 0.39, 0.47
Rf values (UV₃₆₆)
Extract : 0.83, 0.22, 0.10, 0.06, 0.03

Scanning

- Densitometer

Spray reagent

- Vanillin – sulphuric acid

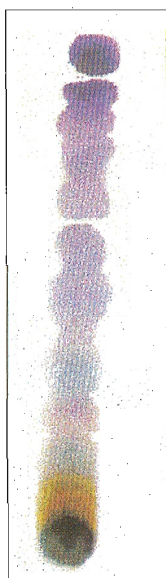


Fig : 10
TLC chromatogram of
P. indica leaves extract

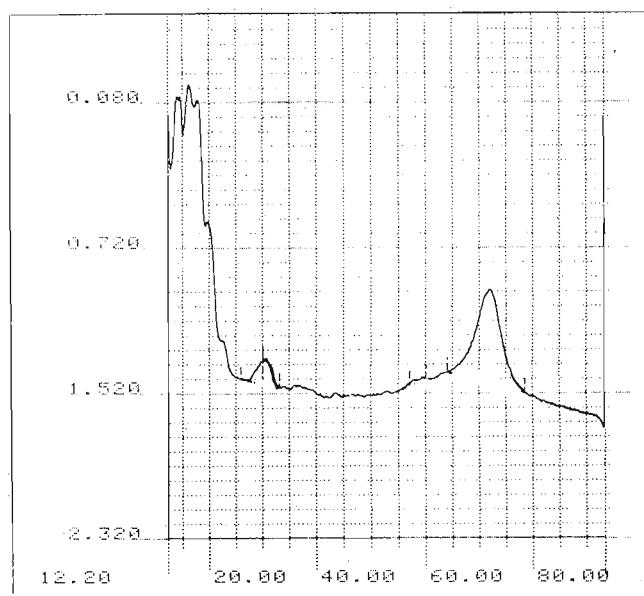


Fig : 11
TLC Densitometer finger print

TLC PROFILE

Sample preparation

- Sample detail - *P. indica* roots
- Sample preparation - *P. indica* roots (5.0g) were extracted with ethanol and concentrated (33.1mg/10ml) 15 μ l of extract applied to TLC plate.
- Adsorbent - Silica gel GF₂₅₄
- Solvent system - Benzene : ethyl acetate (3 : 7)
- Detection
- Direct evaluation - UV₂₅₄nm UV₃₆₆nm
Rf values (UV₂₅₄nm)
Extract : 0.01, 0.05, 0.08, 0.17, 0.27, 0.36, 0.46, 0.65, 0.74, 0.81
Rf values (UV₃₆₆)
Extract : 0.17, 0.10, 0.64, 0.74, 0.81
- Scanning - Densitometer
- Spray reagent - Vanillin – sulphuric acid



Fig : 12
TLC chromatogram of
P. indica roots extract TLC

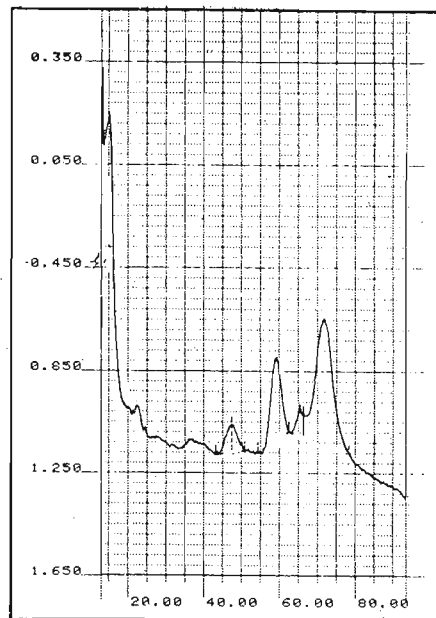


Fig : 13
Densitometer finger print

HP LC PROFILE

P. indica: Leaves

- Sample preparation - *P. indica* leaves (5.0g) were extracted with ethanol (9.4mg/10ml) and purified using Sep-pak C18 cartridge.
- Injection volume - 20 μ l
- Apparatus - Waters 501 HPLC pump.
SPD 10AV Shimadzu uv-vis detector.
- Column - μ BondapakTM RP18
- Solvent system - Methanol : water (1 : 1)
- Flow rate - 0.5ml/min
- Detection - 254nm

Description of the HPLC – Chromatogram

Table 2 : Retention time of main peaks

Peak no	Rt (min)
1	1.52
2	2.265
3	2.482
4	3.347
5	3.33
6	4.105
7	4.323
8	5.072
9	6.112
10	6.568
11	7.81
12	10.477
13	14.608

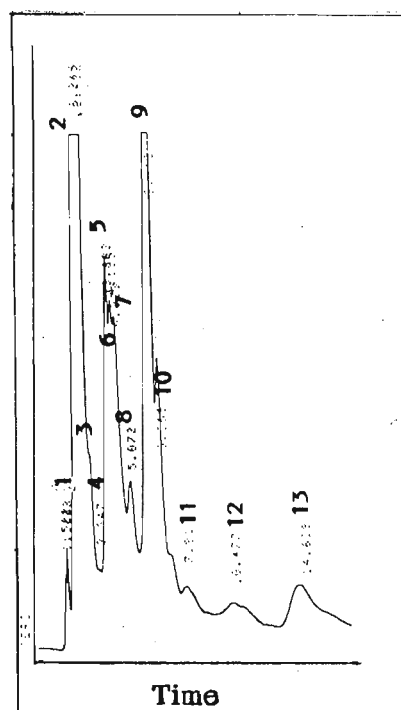


Fig : 14
HPLC chromatogram of leaves

HPLC PROFILE

P. indica : Roots.

- Sample preparation - *P. indica*_roots (5.0g) were extracted with ethanol (0.16mg/10ml) and purified using Sep-pak C18 cartridge.
- Injection volume - 20 μ l
- Apparatus - Waters 501 HPLC pump.
SPD 10AV Shimadzu uv-vis detector.
- Column - μ BondapakTM RP18
- Solvent system - Methanol : water (1: 1)
- Flow rate - 0.5ml/min
- Detection - 254nm

Description of the HPLC – Chromatogram

Table 3 : Retention time of main peaks

Peak no	Rt (min)
1	0.993
2	1.77
3	2.528
4	4.243
5	4.49
6	5.552
7	6.683
8	7.19
9	12.31

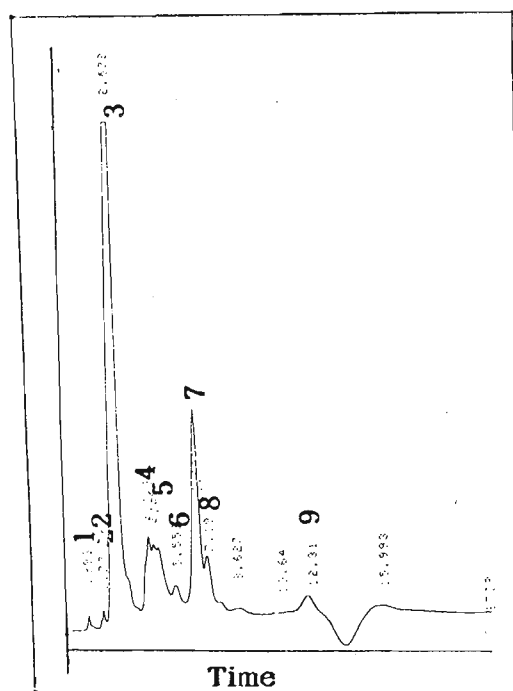


Fig – 15
HPLC chromatogram of root

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