SRI LANKAN MEDICINAL PLANT MONOGRAPHS AND ANALYSIS VOL - 7

ALPINIA CALCARATA

Lakshmi Arambewela
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Preface

Studies on medicinal plants of Sri Lanka have been carried out in the Herbal Technology Division of Industrial Technology Institute (former Ceylon Institute of Scientific and Industrial Research) for almost two decades. This monograph which is the seventh in this series incorporates information collected from literature surveys, researches and also experiences of the Herbal Technology Division staff. This monograph is intended for a varied reading public, herbal drug manufacturers who need to identify their herbal raw materials, Ayurvedic physicians who need some scientific information on medicinal plants, research workers requiring some quick background information on a plant, industrialists or entrepreneurs 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 the Herbal Technology Division for their contribution, the Information Service Center for providing information, Department of Plant Sciences and Department of Zoology of the University of Colombo for assisting in anatomical studies, Food Technology Division of the Industrial Technology Institute for helping in the analysis of powdered plant materials and the Microbiology Laboratory for photographing the slides. They also gratefully acknowledge the sponsor National Science Foundation for the research grant (RG / 2004 / TM / 01).

Herbal Technology Division
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P.O.Box 787
Colombo 07
Sri Lanka.

Alpinia calcarata Rosk.

Family

Zingiberaceae

Synonyms

Alpinia calcarata Rosk., *Alpinia erecta* Lodd. and Steud., *Alpinia bracheata* Rosk., *Alpinia cernua* Sims., *Renealmia calcarata* Haw., *Globba eracta* Retx., *Languas calcarata* Merr.[1]

Selected Vernacular Names

Sinhala- Heen aratta, Aratta[2,3]

English- Galanga, Small galanga[2]

Tamil- Amkolinji[2,3]

Sanskrit- Rasna[2]

Pharmacopoeia

Ayurveda Pharmacopoeia[4]

Distribution[1]

Considered as native to India. Occurs in Southern Malay Peninsula and Sri Lanka. It is common in village gardens in Sri Lanka.

Morphology[1]

Rhizomatous perennial herb with a non-tuberous rootstock, stems slender, about 75 cm tall; leaves simple, alternate, 25-32 cm long and 2.5-5 cm broad, lanceolate, acuminate, long-pointed, glabrous on both surfaces and shining on the upper surface, scantily hairy along the margin, petioles sheathing; flowers pinkish white, irregular, bisexual, in pendunculate, terminal, dense flowered panicles 8.5 cm long, two flowers together at each node, one opening earlier than the other, each bearing a pair of bracteoles, the inner one smaller than the outer, bracteoles oblong, papery white, each flower about 4 cm long, pedicels short, hairy; sepals 3, fused into a campanulate tube 1cm long, pubescent out side, glabrous inside, apices rounded; petals 3,

fused at base but segments free tinged with pink, segments oblong-spathulate, pubescent outside, lateral narrow; staminodes 3, fused at base with the stamen into a tube adnate to corolla, two basal staminodes reduced to minute filaments, the larger one petaloid, 3 cm by 2.3 cm ovate, yellow with vinous red streaks, emarginated, apex frilled and darker, glabrous and shining on both surfaces; stamen 1, anther tubular, style passing through, filament flat, 1.5 cm long, anther 0.8 cm long, style 3.5 cm long, tinged pink, hairy towards the apex, stigma swollen; ovary inferior, 3 mm long, strongly pubescent, 3-locular with ovules in each loculus on a central axis, capsules not seen.

Fig – 1. *Alpinia calcarata* plant

1. Inflorescence 2. Flower (longitudinal section) 3. Leaf 4. Rhizome

(Source-Jayaweera D.M.A., (1981). Medicinal plants (Indigenous and Exotic) used in Ceylon,Part V)

Plant Material of Interest

Rhizome

Official Drug

Powdered rhizome, rhizome oil and extract of rhizome[4].

Pharmacognostic Features*

Anatomy

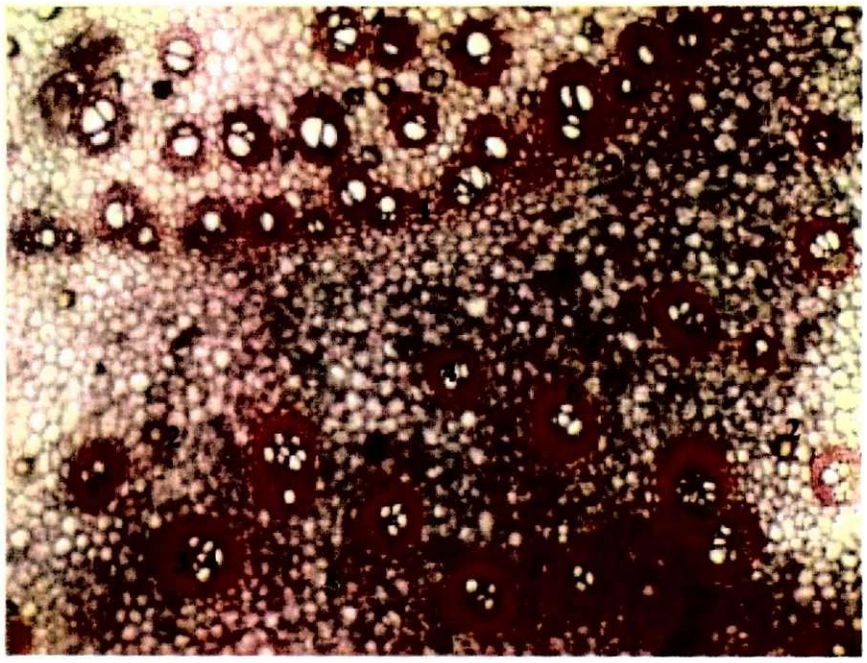

Fig – 2. Cross section of *Alpinia calcarata* rhizome (stained with safranine (10 x 10))
1. Endodermis 2. Oil secretion cells 3. Phloem 4. Xylem 5. Ground tissue 6. Sclerenchyma cells

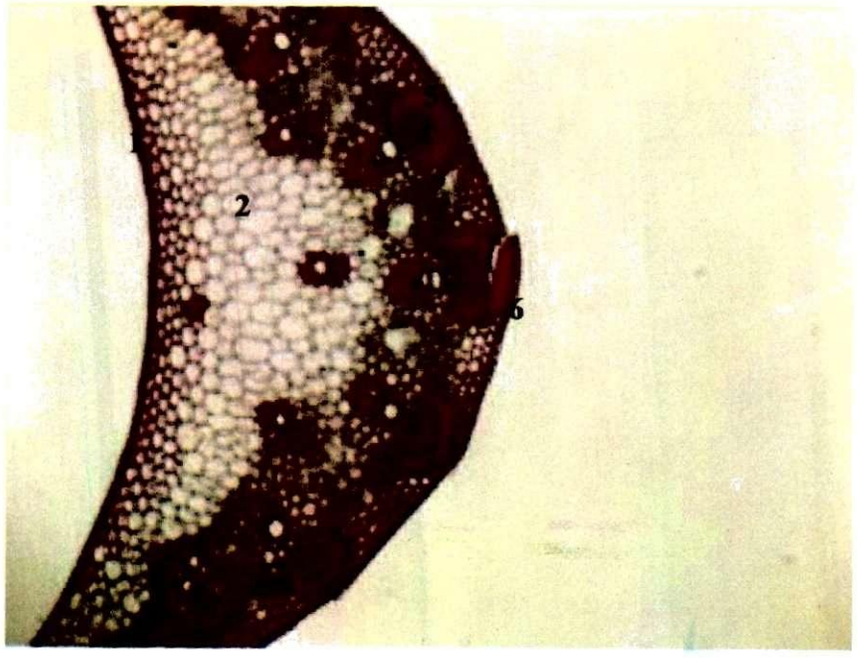

Fig – 3. Cross section of *Alpinia calcarata* leaf (stained with safranine (10 x 10))
1. Upper epidermis 2. Parenchyma cells 3. Xylem 4. Phloem 5. Sclerenchyma cells 6. Lower epidermis

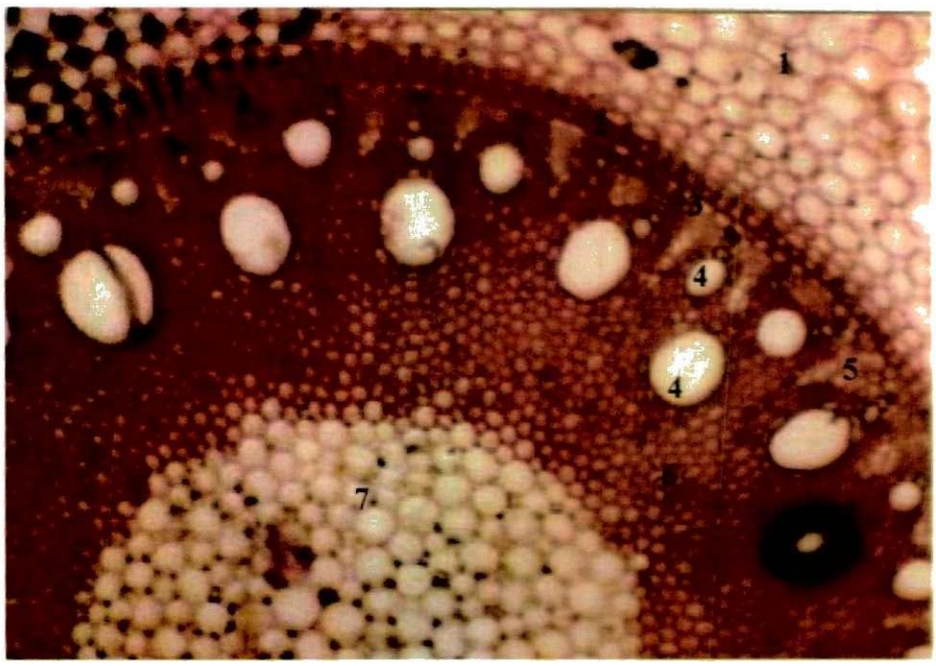

Fig – 4. Cross section of *Alpinia calcarata* root (stained with safranine (10 x 10))

1. Cork 2. Endodermis 3. Pericycle 4. Xylem 5. Phloem 6. Sclerenchyma cells 7. Pith

Powder analysis

Part analyzed - Rhizome

Organoleptic properties

Colour - Light brown.

Odour - Aromatic.

Taste - Bitter aromatic taste.

Microscopic characters

Parts of fibers, parenchyma cells, segments of thick walled vessels, tracheids, secretion cells, starch granules can be seen.

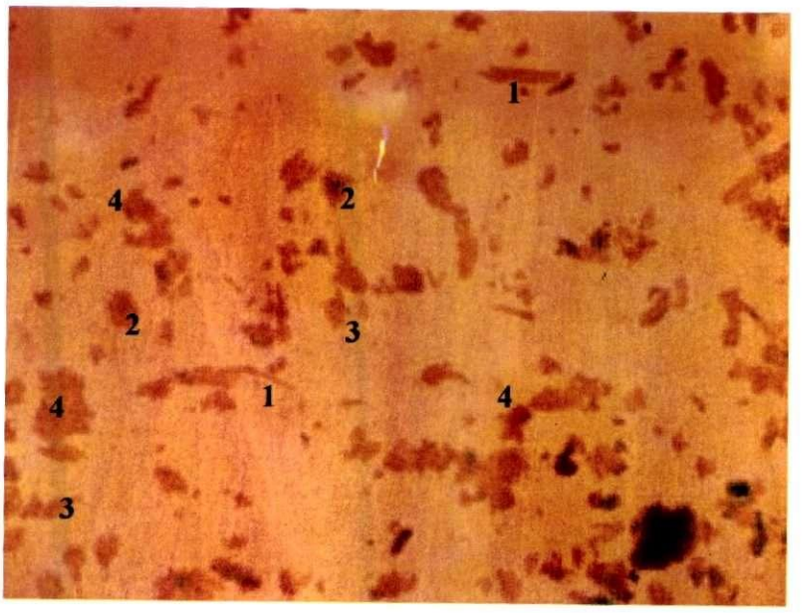

Fig – 5. Powdered *Alpinia calcarata* rhizome under the microscope (10 x 4)

1. Fibers 2. Parenchyma with oil secretion cell 3. Part of a tracheid 4. Parenchyma cells

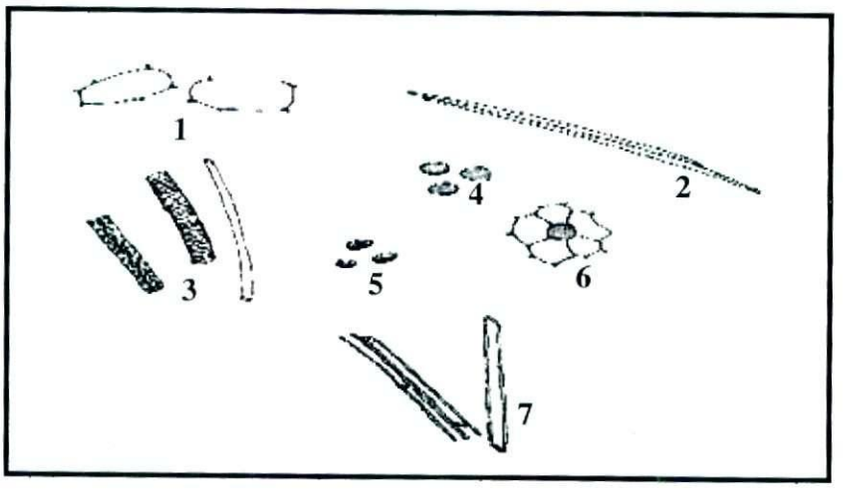

Fig – 6. Schematic diagram of powder microscopy

1. Parenchyma cells 2. Fibers 3. Xylem vessel segments 4. Oil secretion cells

5. Starch granules 6. Parenchyma cells with oil secretion cell 7. Tracheids

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* These analysis were carried out by the authors at Industrial Technology Institute and the Dept. of Plant Sciences and Dept. of Zoology of University of Colombo.

Physico-chemical Analysis[22]

Extractable matter

Crushed, air dried plant material (about 4 g) was weighed to a glass-stoppered conical flask. Solvent (100 mL) was added, weighed, shaken well and allowed to stand for 1h. It was then boiled for 1h and cooled. The weight was readjusted with specified solvent and filtered. Filtrate (25 mL) was taken, solvent was evaporated and oven dried at 105 °C for 6 h, cooled in a desiccator and weighed.

Total ash

Crushed, air dried plant material (about 4 g) was weighed to a previously ignited crucible. The material was ignited by gradually increasing the temperature to 550 °C until it was free from carbon. The crucible was cooled and weighed.

Acid insoluble ash

Hydrochloric acid (25 mL, conc. ~70 g/L) was added to the crucible containing total ash, covered with a watch glass and boiled gently for 5min. The insoluble matter was collected on an ashless filter paper and washed with hot water until the filtrate was neutral. The filter paper containing the insoluble matter was transferred to the original crucible and ignited to a constant weight.

Water soluble ash

Water (25 mL) was added to the crucible containing total ash, covered with a watch glass and boiled gently for 5min. The insoluble matter was collected on an ashless filter paper and washed with hot water. The filter paper containing the insoluble matter was transferred to the original crucible and ignited for 15 min. at a temperature not exceeding 450 °C. Water soluble ash is the calculated difference in weight between the total ash and the residue remaining after treatment of the total ash with water.

Moisture content of the samples was estimated and all the calculations were done on dry weight basis.

Table 1. Physico-chemical parameters of *Alpinia calcarata* rhizome**

Physico-chemical parameter	**Amount %**
1. Water extractable matter	19.8 - 21.8
2. Ethanol extractable matter	23.1 - 25.8
3. Total ash	8.5 - 9.8
4. Water soluble ash	7.2 - 8.2
5. Acid insoluble ash	0.36 - 0.48

(Results are expressed as percentages on dry weight basis)

Thin Layer Chromatographic Profile**

Alpinia calcarata water extract of rhizome

Sample preparation : *A. calcarata* rhizomes (4 g) were boiled for one hour with water (100 mL) and the extract was filtered and evaporated to dryness. Nine microliters (9 µL) of the diluted extract (95 mg in 5 mL) was spotted on TLC plate.

Absorbent : Silica gel GF_{254}

Solvent system : Ethyl acetate : Methanol : Chloroform (20 : 15 : 15)

Detection

Direct evaluation : UV_{254} nm. R_f values - 0.27, 0.48, 0.64, 0.84

Scanning : Densitometer at 254 nm (before spraying) and 450 nm (after spraying)

Spray reagent : Vanillin sulphate

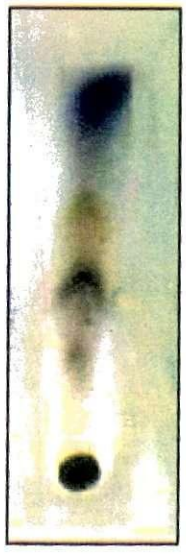


Fig – 7. TLC finger print profile of water extract of *Alpinia calcarata* rhizome

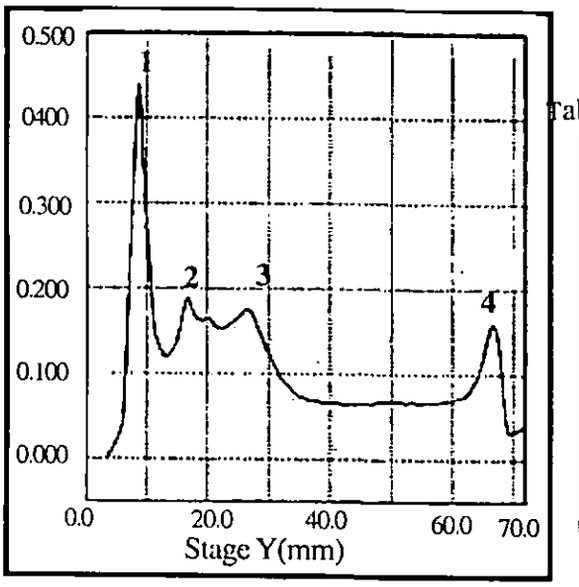


Table 2. Description of densitogram (fig-8)

Peak No.	Y(mm)	Relative Area (%)
1	8.76	27.21
2	16.84	13.51
3	26.63	27.65
4	66.57	15.24

Fig – 8. Densitogram of TLC finger print profile of water extract of *Alpinia calcarata* rhizome at 254 nm

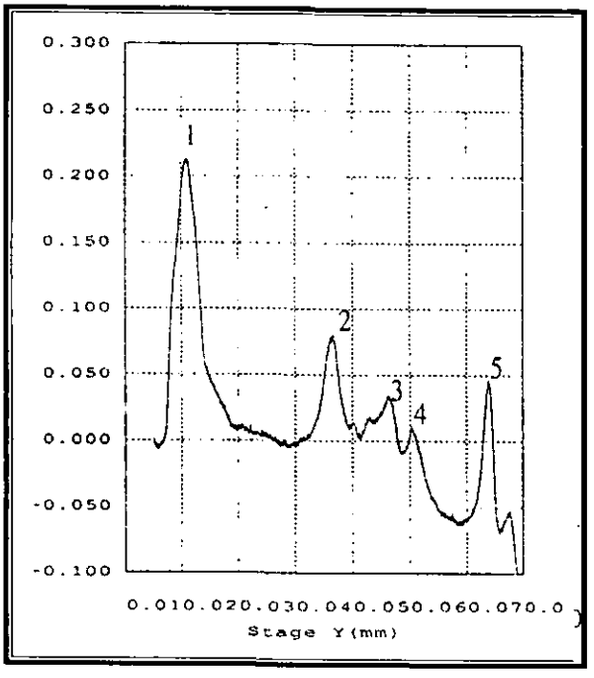


Table 3. Description of densitogram (fig-9)

Peak No.	Y(mm)	Relative Area (%)
1	10.92	54.67
2	36.58	15.71
3	46.30	5.17
4	50.43	2.87
5	63.90	19.14

Fig – 9. Densitogram of TLC finger print profile of water extract of *Alpinia calcarata* rhizome at 450 nm

***Alpinia calcarata* ethanol extract of rhizomes**

Sample preparation : *A. calcarata* rhizomes (4 g) were boiled for one hour with 95% ethanol (100 mL) and the extract was filtered and evaporated to dryness. Ten microliters (10 µL) of the diluted extract (0.1 g in 5 mL) was spotted on TLC plate.

Absorbent : Silica gel GF_{254}

Solvent system : Methanol : Chloroform : Cyclohexane : Hexane (1 : 1 : 2 : 2)

Detection

Direct evaluation : UV_{254} nm. R_f values - 0.19, 0.28, 0.38, 0.66, 0.93

UV_{366} nm. R_f values - 0.24, 0.34, 0.93, 0.96

Scanning : Densitometer at 254 nm (before spraying) and 450 nm (after spraying)

Spray reagent : Vanillin sulphate

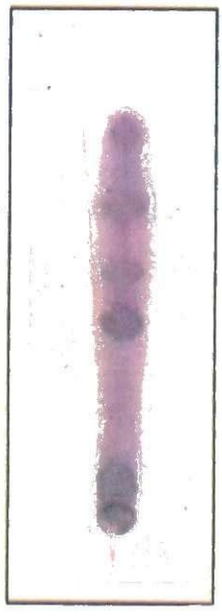


Fig – 10. TLC finger print profile of ethanol extract of *Alpinia calcarata* rhizome

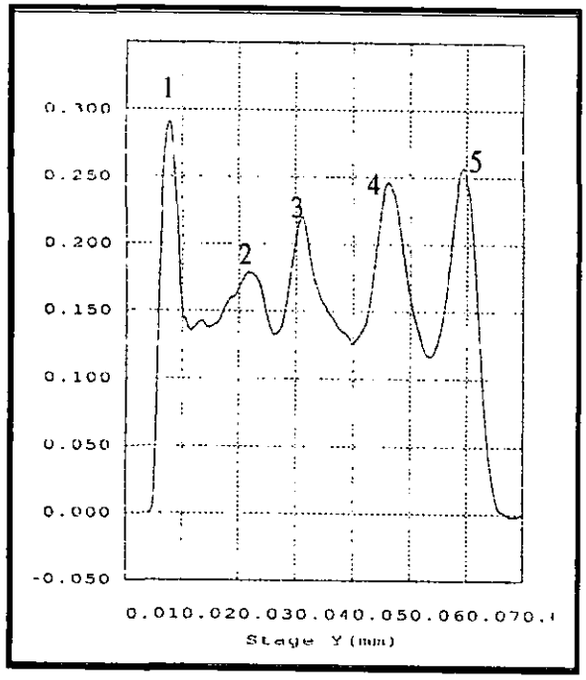


Table4. Description of densitogram (fig-11)

Peak No.	Y(mm)	Relative Area (%)
1	7.75	13.15
2	21.78	18.04
3	31.01	22.09
4	46.25	23.72
5	59.39	18.39

Fig – 11. Densitogram of TLC finger print profile of ethanol extract of *Alpinia calcarata* rhizome at 254 nm

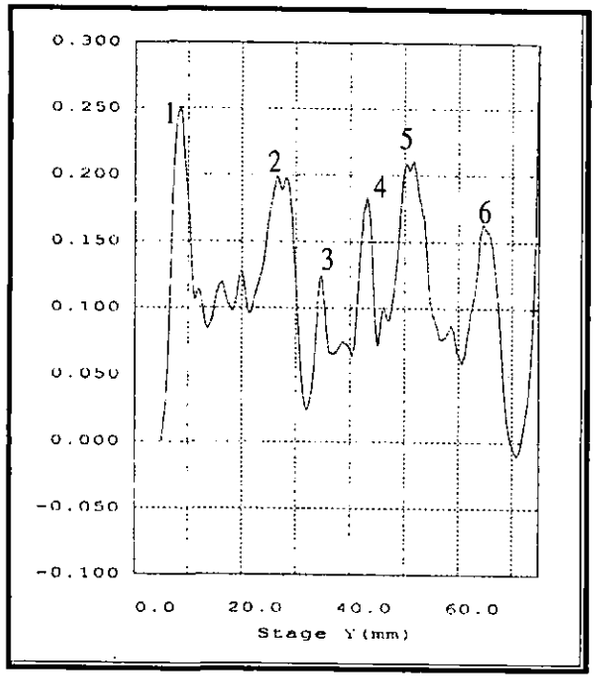


Table5 Description of densitogram (fig-12)

Peak No.	Y(mm)	Relative Area (%)
1	8.46	14.81
2	28.22	18.87
3	34.58	4.52
4	43.06	8.31
5	51.62	26.64
6	64.79	13.25

Fig – 12. Densitogram of TLC finger print profile of ethanol extract of *Alpinia calcarata* rhizome at 450 nm

High Pressure Liquid Chromatographic Profile**

Alpinia calcarata water extract of rhizomes

Sample preparation : *A. calcarata* rhizomes (4 g) were boiled for one hour with water (100 mL) and the extract was filtered and evaporated to dryness. The diluted extract (10 mg in 5 mL) was purified using Sep-pak C18 cartridge.

Injection volume : 20 μL

Apparatus : Shimadzu LC – 10 ADvp pumps and Shimadzu SPD – M 10 Avp uv / vis photodiode array detector.

Column : Inertsil 5U ODS – 2 reverse phase column, (250 mm x 2.6 mm).

Solvent system : Acetonitrile : Water (30 : 70)

Flow rate : 1 mL/min

Detection : 254 nm

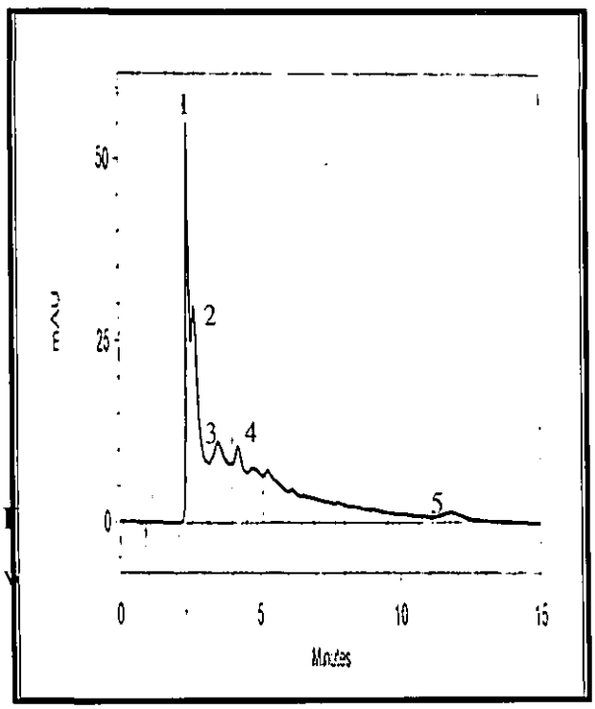


Table 7 Retention times of main peaks

Peak no.	Retention time(min)	Relative area %
1	2.44	14.65
2	2.68	19.60
3	3.50	14.83
4	4.23	8.74
5	11.82	2.85

***Alpinia calcarata* ethanol extract of rhizomes**

Sample preparation : *A. calcarata* rhizomes (4 g) were boiled for one hour with ethanol (100 mL) and the extract was filtered and evaporated to dryness. The diluted extract (22 mg in 5 mL) was purified using Sep-pak C18 cartridge.

Injection volume : 20 μL

Apparatus : Shimadzu LC – 10 ADvp pumps and Shimadzu SPD – M 10 Avp uv / vis photodiode array detector.

Column : Inertsil 5U ODS – 2 reverse phase column, (250 mm x 2.6 mm).

Solvent system : Methanol : Water (80 : 20)

Flow rate : 0.5 mL/min

Detection : 254 nm

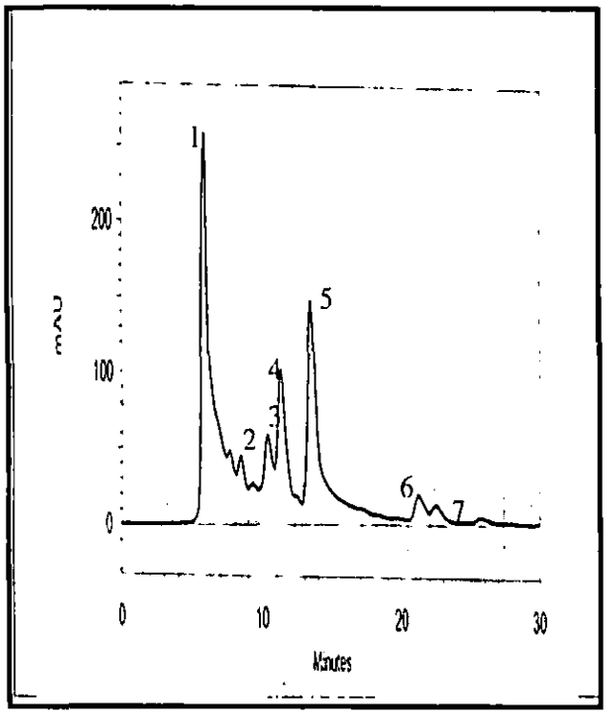


Fig – 13. HPLC finger print profile of ethanol extract of *Alpinia calcarata* rhizome

Table 6. Retention times of main peaks

Peak no.	Retention time(min)	Relative area %
1	5.87	32.65
2	8.45	4.66
3	10.37	7.33
4	11.29	12.16
5	13.47	27.02
6	21.21	2.78
7	22.45	2.22

**These analysis were carried out by the authors at Industrial Technology Institute.

Phytochemistry

Essential oil of *A. calcarata* grown in Sri Lanka is reported to contain the following chemical constituents[5,6].

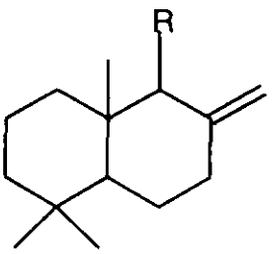
Rhizome oil - α-Pinene (5), β-Pinene (6), ρ-Cymene (7), 1,8-Cineol (8), Limonene (10), Camphene (11), Camphor (12), 4-Terpeneol (14), Borneol (15), α- Terpeneol (17), γ-Muurolene (18), Caratol (19), Fenchyl acetate (22), α-Eudesmol. Trace amount of Linalool (9), Fenchol (13), Fenchone (16), α-Cadinene and β-Caryophyllene.

Root oil - α-Pinene (5), β-Pinene (6), ρ-Cymene (7), 1,8-Cineol (8), Limonene (10), Camphene (11), Borneol (15), α-Terpeneol (17), Caratol (19), Fenchyle acetate (22), α-Cadinene, β-Caryophyllene, α-Eudesmol. Trace amount of Fenchone (16), Linalool (9).

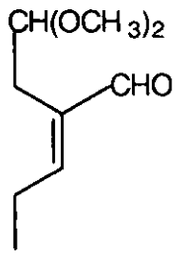
Leaf oil - α-Pinene (5), β-Pinene (6), ρ-Cymene (7), 1,8-Cineol (8), Limonene (10), Camphene (11), Camphor (12), 4-Terpeneol (14), Borneol (15), α- Terpeneol (17), γ-Muurolene (18), Caratol (19), Fenchyl acetate (22), α-Cadinene, α-Eudesmol and trace amount of Fenchone (16).

A. calcarata grown in China is reported to contain Calcaratarin A (1), Calcaratarin B (2), Calcaratarin C (3), Calcaratarin D (4) and Calcaratarin E, Coronarin D, Herniarin, Shyobunnone (23) and Zerumina in Rhizome oil[7,8].

Leaf oil of *A. calcarata* grown in India contains Protocatechuic acid (20), Quercetin, 4′-o-Methyl syringic acid and Vanillic acid (21)[9].

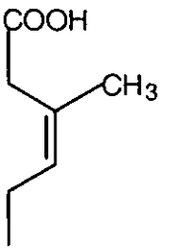


R=



(1) Calcaraatarin A

R=

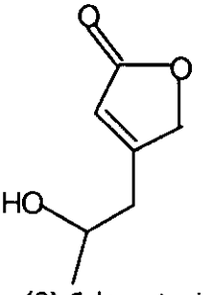


C

:) Calcaratarin B

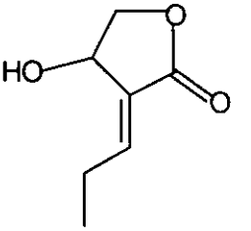
(2) Calcaratarin B

R=

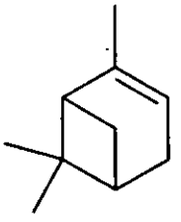


(2) Calcaratarin C

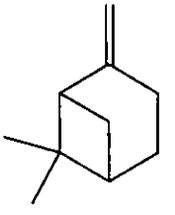
R=



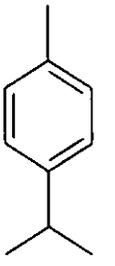
(2) Calcaratarin D



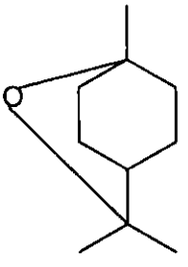
(5) α – Pinene



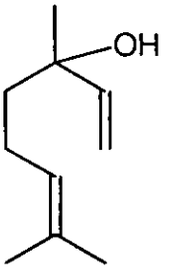
(6) β–Pinene



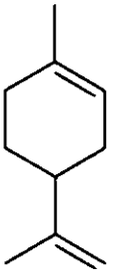
(7) ρ–Cymene



(8) 1,8 – Cineol

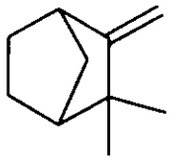


(9) Linalool

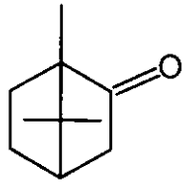


(10) Limonene

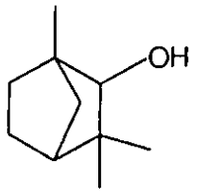
Fig – 15. Compounds present in *Alpinia calcarata*



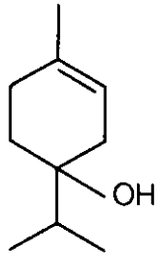
(11) Comphene



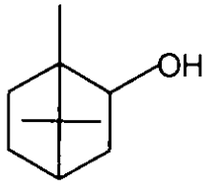
(12) Camphor



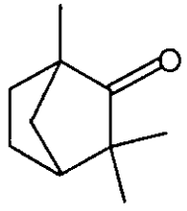
(13) Fenchol



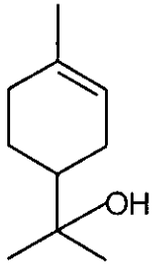
(14) 4-Terpineol



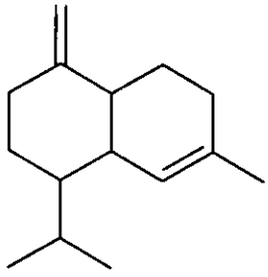
(15) Borneol



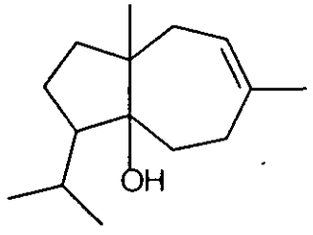
(16) Fenchone



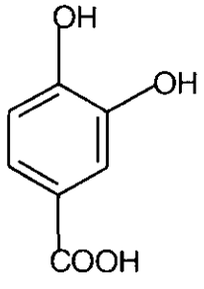
(17) α – Terpineol



(6) γ –Muurolene

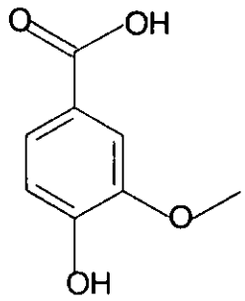


(19) Caratal

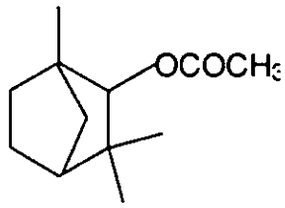


(20) Protocatechuic acid

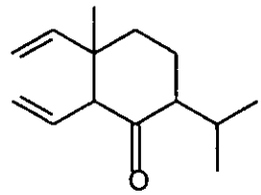
Fig – 16. Compounds present in *Alpinia calcarata*



(21) Vanillic acid



(23) α–Fenchyl acetate



(23) Shyobunone

Fig – 17. Compounds present in *Alpinia calcarata*

Gas Chromatographic Profile of Essential oil of *Alpinia calcarata* [5,6]

Method of distillation of oil

Dried crushed rhizomes (300 g), roots (250 g) and fresh leaves (250 g) were separately distilled for 4 h with water (2 L). A Clevenger-type oil arm was used to collect the oils of rhizomes (3.6 %), roots (0.57 %) and leaves (0.43 %). The oil contents are expressed on dry weight basis.

Identification of the peaks was done by using the retention time data, peak enhancement method using authentic compounds and by comparing the mass spectra with the spectra in the databank, and the recorded spectral data given in Eight Peak Index. The NMR date was obtained wherever possible.

Details of the gas chromatograph operating conditions

Chromatograph – Hewlett - Packard 5890 Series II

Detector – Flame ionization detector

Column – DB-5 MS capillary column (30 m x 0.25 mm id., 0.25 μm film)

Initial oven temperature – 40 °C

Final oven temperature – 280 °C

Program rate – 10 ° C/min

Injector temperature – 550 ^{0} C

Detector temperature – 550 ^{0} C

Carrier gas – Argon

Flow rate – 30 mL/min

Hydrogen flow rate – 25 mL/min

Air flow rate – 30 mL/min

Sample size – 1 µL

Attenuation – 6a..u.f.s.

Chart speed – 5 mm/min

The concentration of the compounds was determined by comparing the peak area of the compound with the total area of the peaks in the chromatogram.

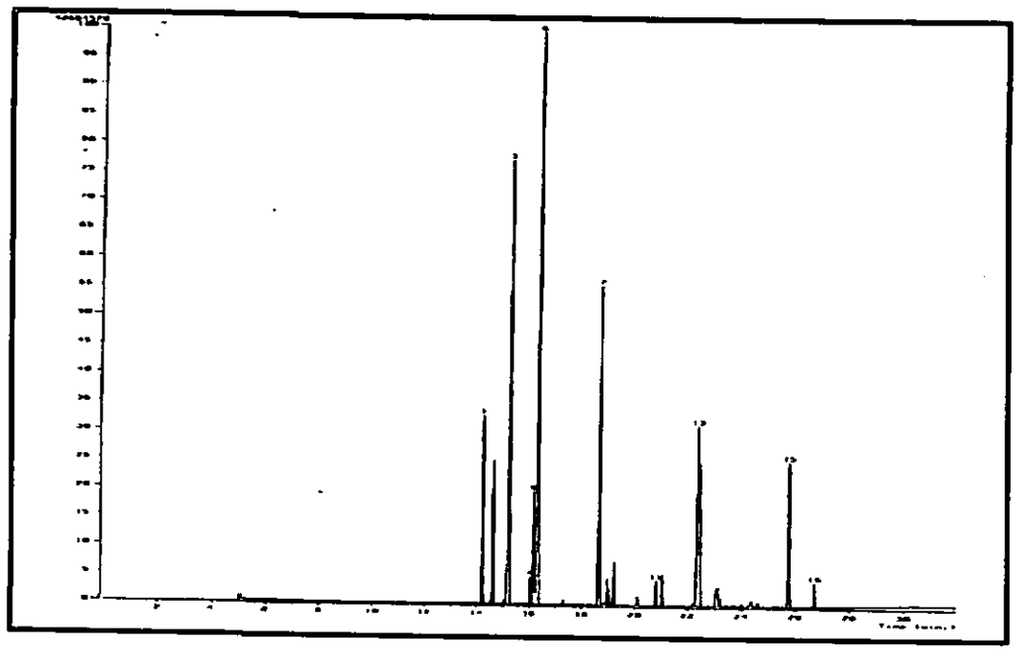


Fig - 18. Gas liquid chromatogram of *Alpinia calcarata* leaf oil

Table 8. Description of the Gas liquid chromatogram of *Alpinia calcarata* leaf oil

Peak No.	Compound	Relative area %
1	∝-Pinene	6.60
2	Camphene	5.12
3	β-Pinene	20.54
4	ρ-Cymene	0.96
5	Limonene	4.61
6	1,8-Cineole	24.71
7	Camphor	13.42
8	∝-Terpineol	1.31
9	γ-Muurolene	12.01
10	Caratol	5.42
11	∝-Eudesmol	0.76

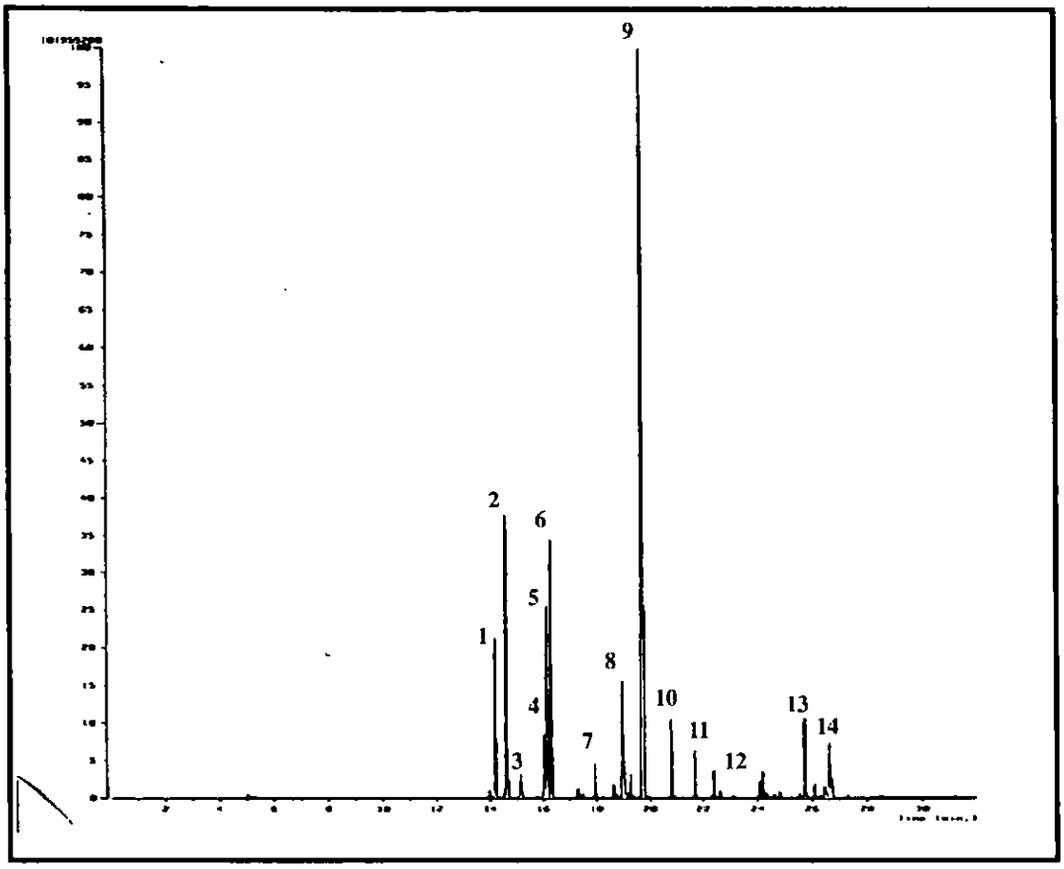


Fig – 19. Gas liquid chromatogram of *Alpinia calcarata* root oil

Table 9. Description of the Gas liquid chromatogram of *Alpinia calcarata* root oil

Peak No.	Compound	Relative area %
1	∝-Pinene	5.90
2	Camphene	13.29
3	β-Pinene	0.58
4	ρ-Cymene	2.32
5	Limonene	7.51
6	1,8-Cineole	11.09
7	Fenchol	1.07
8	Isoborneol	5.86
9	Fenchyl acetate	39.78
10	β-Caryophyllene	2.64
11	∝-Cadinene	1.54
12	γ-Muurolene	0.86
13	Caratol	2.88
14	∝-Eudesmol	2.54

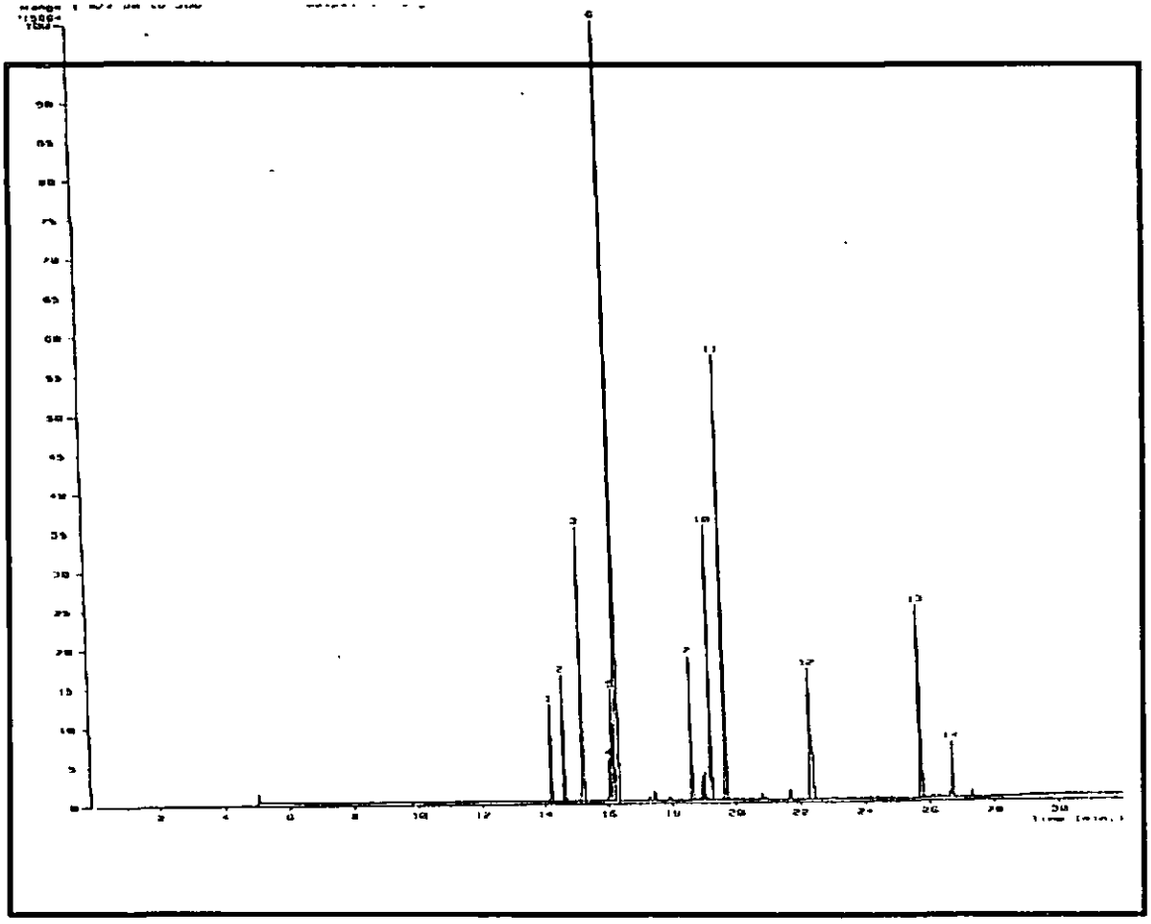


Fig – 20. Gas liquid chromatogram of *Alpinia calcarata* rhizome oil

Table 10. Description of the Gas liquid chromatogram of *Alpinia calcarata* rhizome oil

Peak No.	Compound	Relative area %
1	∝-Pinene	3.09
2	Camphene	4.09
3	β-Pinene	9.31
4	ρ-Cymene	1.36
5	Limonene	3.80
6	1,8-Cineole	33.32
7	Camphor	4.86
8	∝-Terpineol	9.01
9	Fenchyl acetate	14.44
10	γ-Muurolene	6.58
11	Caratol	6.76
12	∝-Eudesmol	1.66

Medicinal Uses

Uses described in Pharmacopoeia and in traditional systems of medicine

According to traditional systems of medicine, rhizomes of *A. calcarata* (Heen arathta) are used as a medicine for "vatadosa"[2,3,10,11].

Rhizome of this plant is used to treat rheumatoid arthritis. It is a major constituent of herbal formulations used against rheumatoid arthritis[1,10] and used as a fomentation on rheumatic joints[1].

Rhizomes are said to possess diuretic, aphrodisiac[2,3] and antitoxic[2,11] properties. It is used in polyuria, coughs, stomachic diseases[2], diabetes[3], colds, bronchial catarrh, asthma[2,3] respiratory ailments[2] and heart diseases[2,10]. They are also used to treat snake bites[2].

It improves the voice[2], prevents bad breath[2,3] and strengthens the nerves[3].

Uses in folk medicine

The boiled extracts of rhizomes are given for joint pains[3].

Alpinia rhizomes are used to treat snakebites[13].

Pieces of *A. calcarata* rhizomes are chewed to prevent unpleasant odour of mouth[3].

Small pieces of rhizomes are chewed and saliva is swallowed for stomachache, loss of appetite and to promote hunger[3].

A. calcarata rhizomes, long pepper and *Glycyrrhiza glabra* with bees' honey are used to treat bronchitis[3].

Fresh rhizomes of *A. calcarata* crushed and mixed with lemon juice are given against fungal infection of the skin[12].

Powdered rhizome of *A. calcarata* was used in the past to treat skin diseases[13].

For inflammation in joints, *A. calcarata* rhizomes are chopped with salt and applied on joints[13].

For cold with fever, the boiled extract of ginger, coriander, *Solanum xanthocarpum*, *Tinospora cordifolia* and rhizomes of *A. calcarata* are given[13].

Other Uses

It is grown as an ornamental plant in home gardens.

Ayurvedic / Traditional Medicinal Preparations

A. calcarata is used as a constituent of the following Ayurvedic preparations.

Chandra kalka, Buddharaja kalka, Yashodara kalka, Arkanantadi quatha, Grantandradi maha quatha, Bhargyadi quatha, Shatadi quatha, Kumaryasava, Mandanasava, Dasamula arishta, Devadarva arishta, Bala arishta, Narayana taila, Mahavatamegha taila, Siddhartaka taila[4].

Activity Studies

Anti-inflammatory activity

The use of *A. calcarata* to cure the inflammation of joints has been investigated and it was shown that the water extract of *A. calcarata* rhizomes has cured the formaldehyde induced joint inflammations in rats[10]. This was further experimented by clinical studies using human patients and confirmatory results were observed[10]. Hot water and hot ethanol extracts of *A. calcarata* possess significant and marked dose dependant anti-inflammatory activity. It was observed that the activity is due to prostaglandin inhibition and anti-histamine activities[14,15].

Anti-oxidant activity

Ethanol extract, water extract and essential oil of *A. calcarata* possess anti-oxidant activity[14,15].

Analgesic activity

The ethanol and hot water extracts of *A. calcarata* rhizomes are shown to possess analgesic activity. The results of some experiments showed that the extracts have marked dose-dependent antinociceptive activity and the effect was slightly higher in the ethanol extract than in the water extract[15,16].

Rhizomes of *A. calcarata* containing polyherbal preparation called "Maharasnadhi Quatha" was shown to possess anti-inflammatory, anti-oxidant and analgesic activities[17,18]. Studies have shown that *A. calcarata* may be the main component responsible for these properties[17].

Anti-microbial activity

Number of *in vitro* studies have been carried out to investigate the anti-microbial activity of *A. calcarata*. Ethanol and water extracts of the plant have been shown to possess antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*[14]. Studies revealed that the essential oil of *A. calcarata* rhizome was active against the following fungal species- *Fusarium* sps., *Curvularia* sps., and *Colletotrichum* sps[14]. The essential oil of *A. calcarata* has inhibited the growth of *Mycobacterium tuberculosis*[14].

Anthelmintic activity

The alcoholic extract of *A. calcarata* showed moderate activity against human *Ascaris lumbricoides in vitro*[20].

Cytotoxicity

Bis-Labdanic diterpenoids from *A. calcarata* showed cytotoxic activity against human KB cells *in vitro*[7].

Anti-diabetes activity

Anti-diabetes activity of hot water and hot ethanol extracts of *A. calcarata* rhizomes was studied using experimental rats. These two extracts significantly reduced the blood glucose levels and inhibited the glucose absorption by the lumen of the intestine in animal experiments [14,15].

Gastroprotective activity

It was demonstrated that hot water and hot ethanol extracts of *A. calcarata* rhizomes possess marked gastroprotective properties as evidenced by its significant inhibition of gastric lesions (in terms of length and number) induced by ethanol[14,15].

Insect repellant and insecticidal properties

Essential oil of *A. calcarata* has shown repellant properties against the American cockroach, *Periplanata americana*[21].

Essential oil of *A. calcarata* has a knock-down effect against ticks (*Ixodes pacifius)*[14].

Safety Evaluation

No toxicity effects have been observed when hot ethanol extract and hot water extract (doses of 1500 mg /kg per day for 42 consecutive days) of *A. calcarata* rhizomes were orally administered to rats. The results have shown that both extracts were well tolerated in terms of percentage weight gain, food and water intake, morbidity, haematology, serum analysis and organ weights except the spleen. Both extracts significantly increased the weight of the spleen which suggests lymphoproliferative activity[14,15].

Propagation

A. calcarata can be grown satisfactorily in soft, sandy soil. Propagation of the plant is carried out by root suckers. The root sucker should be cut with a sharp knife and planted on a planting bed containing sandy soil.

After about two weeks small plants should be planted 90 cm x 90 cm apart from each other. In the first month water should be supplied after every two days. Harvesting can be done within 9-12 months. Harvested rhizomes should be washed well and cut into pieces about 10 cm long. Then they are air dried. Dried rhizomes should be stored in gunny bags and kept in a dry place[3].

References

1. Jayaweera, D.M.A. (1981). *Medicinal plants (Indigenous and Exotic) used in Ceylon*, National Science Council of Sri Lanka. Part V.
2. *Osuturu Visituru*, (1994). Department of Auyrveda. Part I.
3. Perera, D.L. (Ed.), (2003). *Osu Turu Wagatuga*. Sri Lanka Conservation and Sustainable Use of Medicinal Plants, No.4, Woodland Avenue, Kohuwala.
4. *Ayurveda Pharmacopoeia*, (1976). Department of Ayurveda, Colombo, Sri Lanka. Vol. I, Part 2.
5. Arambewela, L.S.R., Kumaratunge, A. and Arawwawela, M. (2005). Volatile oils of *Alpinia calcarata* Rosc. grown in Sri Lanka. *Journal of Essential Oil Research* **17:** 124-125.
6. Kumaratunga, K.G.A. (2003). *Gas chromatagraphic and Antimicrobial studies on Alpinia calcarata and Piper betle from Sri Lanka*. M.Phil Thesis, University of Kelaniya, Sri Lanka.
7. Kong, L.Y., Qin, M.J. and Niwa, M. (2002). New cytotoxic bis-labanic diterpenoids from *Alpinia calcarata*. *Planta Medica* **68 (9):** 813-817.
8. Kong, L.Y., Qin, M.J. and Niwa, M. (2000). Diterpenoids from rhizomes of *Alpinia calcarata*. *Journal of Natural Product* **63 (7):** 939-942.
9. Merh, P.S., Daniel, M. and Sabnis, S.D. (1986). Chemistry and taxonomy of some members of the Zingiberales. *Current Science* **55(17):** 835-839.
10. Ranasingha, S.G. (1997). *Armavatayata Erehi Aratta*, Clinical and Experimental Studies on Anti-Arthritic Property of *Alpinia calcarata* Rosc. (Sri Lanka Rasna). S. Godage and Brothers, 676, Maradana Road, Colombo 10.
11. *Thalpatha Osumahima*, (2002). Department of Ayurveda, Bandaranaike Memorial Ayurveda Research Institute. Vol. I.
12. Pushpangadan, P. and Atal, C.K. (1984). Ethno-medico-Botanical investigations in Kerala I ,Some primitive tribals of Western Ghats and their herbal medicine. *Journal of Ethnopharmacology* **11(1):** 59-77.
13. Senarathna, D.W.J. (1987). *Osupala saha Atbehet*, Bandaranaike Memorial Ayurveda Research Institute.
14. Arambewela, L.S.R., *et al.* (2005). Report submitted to NSF on the Development of therapeutic products based on plant derived immunomodulatory and other bioactive compounds / extracts.

15. Arawwawala, L.D.A.M. (2005). *Bioactivities of Alpinia calcarata Rosc. rhizomes.* M.Phil Thesis, University of Peradeniya, Sri Lanka.

16. Arambewela, L.S.R., Arawwawala, L.D. and Rathnasooriya, W.D. (2004). Antinociceptive activities of aqueous and ethanolic extracts of *Alpinia calcarata* rhizomes in rats. *Journal of Ethnopharmacology* **95(2-3):** 311-316.

17. Thabrew, M.I., *et al.* (2001). Antioxident potential of two polyherbal preparations used in Ayurveda for the treatment of rheumatoid arthritis. *Journal of Ethnopharmacology* **76:** 285-291.

18. Thabrew, M.I., Dharmasiri, M.G. and Senaratne, L. (2003). Anti-inflammatory and analgesic activity in the polyherbal formulation Maharasnadhi Quather. *Journal of Ethnopharmacology* **85:** 261-267.

19. George, M. and Pandalai, K.M. (1949). Investigation on plant antibiotics. Part IV. Further search for antibiotic substances in Indian medicinal plants. *Indian Journal of Medical Research* **37:** 169-181.

20. Kaleysa Raj, R. (1975). Screening of indigenous plants for anthelmintic action against human *Ascaris lumbricoides*: Part II. *Indian Journal of Physiology and Pharmacology* **19:** 47-49.

21. Paranagama, P.A. and Ekanayake, E.M.D.S. (2004). Repellant properties from essential oil of *Alpinia calcarata* Rosc. against the American cockroach, *Periplanata americana. Journal of National Science Foundation,* Sri Lanka **32(1&2):** 1-12.

22. *Quality Control Methods for Medicinal Plant Materials*, (1998). World Health Organization, Geneva.