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Alpinia calcarata Roscoe; A Pharmacological Update

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A B S T R A C T

Alpinia calcarata Roscoe (Family: Zingiberaceae), it is a rhizomatous perennial herb, which is commonly used in the traditional medicinal systems in Sri Lanka. *Alpinia calcarata* is cultivated in tropical countries, including India, Sri Lanka and Malaysia. Experimentally, rhizomes of *Alpinia calcarata* are shown to possess antibacterial, antifungal, anthelmintic, antinociceptive, anti-inflammatory, antioxidant, aphrodisiac, gastroprotective, and antidiabetic activities. Phytochemical screening revealed the presence of polyphenols, tannins, flavonoids, steroid glycosides and alkaloids in the extract and essential oil of this plant. Essential oil and extracts from this plant have been found to possess wide range pharmacological and biological activities.

Introduction

This review emphasizes on traditionally used clinically potential plant *Alpinia calcarata* Roscoe. *Alpinia calcarata* Roscoe (Zingiberaceae) is a rhizomatous plant widely used as systemic medicinal sources in Sri Lanka. The mature rhizomes are branched and dense with a light to dark brown color. The leaf of the plant is simple, alternate, 25-32 cm long, 2.5-5 cm broad. The flowers are irregular, bisexual and pendunculate. Terminal dense flowers are found in panicles 8.5 cm long. *A. calcarata* is cultivated in tropical countries including India, Sri Lanka and Malaysia.

Description¹

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 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 ovale, yellow with vinous red streaks, emarginated, apex frilled and darker, glabrous and shining on both surfaces; stamen J, 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.

Taxonomy²

Plant Parts³

Synonyms⁴

Alpinia calcarata Rosk., *Alpinia erecta* Lodd. and Steud., *Alpinia brachyata* Rosk., *Alpinia serrata* Sims., *Renealmia calcarata* Haw., *Globba erecta* Retz., *Languas calcarata* Mem

Selected

Vernacular Names⁵

Sinhala- Heen aratta, Aratta

English- Galanga, Small galangal

Tamil- Amkolinji

Sanskrit- Rasna

Physico-Chemical Analysis⁶

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 1 h 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

Phytochemistry⁷

Essential oil of *A. calcarata* reported to contain the following chemical constituents

α -Pinene, β -Pinene, p-Cymene, 1,8-Cineol, Limonene, Camphene, Camphor, 4-Terpeneol, Borneol, α -Terpineol, γ -Murolene (IS), Carotol, Fenchyl acetate, α -Eudesmol. Trace amount of linalool, Fenchol, Fenchone, α -Cadinene and β -Caryophyllene.

Medicinal Uses⁸

Uses described in Pharmacopoeia and in traditional systems of medicine. According to traditional systems of medicine, rhizomes of *A. calcarata* Rhizome of this plant is used to treat rheumatoid arthritis. It is a major constituent of herbal formulations used against rheumatoid arthritis and used as a fomentation on rheumatic joints'. Rhizomes are said to possess diuretic, aphrodisiac²⁻³ and anti-oxidant²¹¹ properties. It is used in polyuria, coughs, stomachic diseases², diabetes¹, colds, bronchial catarrh, asthma² respiratory ailments and heart diseases. They are also used to treat snake bites. It improves the voice², prevents bad breath²⁻¹ and strengthens the nerves.

Uses in Folk Medicine⁹

The boiled extracts of rhizomes are given for joint pains. *Alpinia* rhizomes are used to treat snakebites. Pieces of *A. calcarata* rhizomes are chewed to prevent unpleasant odour of mouth³. Small pieces of rhizomes are chewed and saliva is swallowed for stomachache, loss of appetite and to promote hunger¹. *A. calcarata* rhizomes, long pepper and *Glycyrrhiza glabra* with

bees' honey are used to treat bronchitis³. Fresh rhizomes of *A. calcarata* crushed and mixed with lemon juice are given against fungal infection of the skin¹². Powdered rhizome of *A. calcarata* was used in the past to treat skin diseases¹³. For inflammation in joints, *A. calcarata* rhizomes are chopped with salt and applied on joints¹³. For cold with fever, the boiled extract of ginger, coriander, Solatium xantiwearpum, *Tinospora cordifolia* and rhizomes of *A. calcarata* are given¹³.

Other Uses¹⁰

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 mahaquatha, Bhargyadi quatha, Shatadi quatha, Kumaryasava, Mandanasava, Dasamula arishta, Devadarva arishta, Bala arishta, Narayana taila, Mahavatamcgha taila, Siddharlaka taila

Activity Studies¹¹

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 rats¹⁰. This was further experimented by clinical studies using human patients and confirmatory results were observed¹⁰. Both 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.

Anti-Oxidant Activity¹²

Ethanol extract, water extract and essential oil of *A. calcarata* possess anti-oxidant activity^{14,15}.

Analgesic Activity¹³

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

Anti-Microbial Activity¹⁴

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*TM. Studies revealed that the essential oil of *A. calcarata* rhizome was active against the following fungal species- *Fusarium sps.*, *Curvularia sps.*, and *Colletotrichum sps.* The essential oil of *A. calcarata* has inhibited the growth of *Mycobacterium tuberculosis*.

Anthelmintic Activity

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

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,^{4,15}.

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

Pharmacological Activity (Literature Review)

The literature reveals that *Alpinia calcarata* has been exhaustively explored for its pharmacological activities.

Antimicrobial Activity¹⁵

Silvy Mathew *et al.*, conducted a study (February 2014) on the antimicrobial activity of the plant. The present study was designed to investigate the anti-microbial activity of four solvent extracts (Petroleum ether, Dichloromethane, Acetone and Methanol) of rhizome of *Alpinia calcarata* Roscoe. The rhizome of this plant is an important antimicrobial agent and a digestive stimulant. The plant extracts showed considerable activity against Ten tested strains viz., *Pseudomonas aeruginosa*, *Escherichia coli*, *Enterobacter aerogens*, *Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus faecalis*, *Vibrio cholerae*, *Salmonella paratyphi*, *Klebsiella pneumoniae* and *Proteus vulgaris* by using agar disc diffusion assay. This study reveals

that *Alpinia calcarata* has antimicrobial activity against gram positive and gram negative bacteria. Methanol extract showed inhibition against eight strains and showed highest inhibition zone (15 ± 0.3) against *Bacillus subtilis*. The minimum inhibitory concentration (MIC) of the *Alpinia calcarata* was ranging from 0.39 mg mL⁻¹ to 0.65 mg mL⁻¹.

Anti Oxidant Activity¹⁶

Arambewela L.etal., conducted a study(2005) on the antioxidant activity of the ethanolic and hot aqueous extract of the plant rhizomes. In this study the cold ethanolic extract(CEE), hot ethanolic extract(HEE) and hot water extract(HWE) of *Alpinia calcarata* rhizomes were investigated by TBARS(thiobarbituric acid reactive substance) assay DPPH0 (2,2-diphenyl-1-picryl hydrazyl) free radical scavenging assay. BHT(butylated hydroxytoluene) and vitamin E served as the positive control. Among the tested extracts higher antioxidant property was evident in CEE. In TBARS assay antioxidant potential of the CEE was comparable to that of BHT, the positive control. On the other hand in DPPH0 assay the free radical scavenging ability of CEE was lower than BHT

Anti Nociceptive Activity¹⁷

Arambewela L.etal., conducted a study(2004) on the Antinociceptive activities of aqueous and ethanolic extracts of *Alpinia calcarata* rhizomes in rats. Rhizomes of *Alpinia calcarata* Roscoe

(Zingiberaceae) possess several bio-activities and are used in traditional medicine of Sri Lanka. However, their antinociceptive activity has not been investigated so far. The aim of this study therefore, was to examine the antinociceptive activity of hot water extract (HWE) and hot ethanol extract

(HEE) of *Alpinia calcarata* rhizomes using rats and three models of nociception (tail flick, hot plate and formalin tests). Different concentrations of HWE (100, 250, 500, 750, 1000 mg/kg) and HEE (100, 250, 500, 750, 1000 mg/kg) were made and orally administered to rats and the reaction times determined. The results showed that the extracts have marked dose-dependent antinociceptive activity, when evaluated in the hot plate and the formalin tests but not in the tail flick test. The antinociceptive effect was slightly higher in HEE than that of HWE. The antinociceptive effect was mediated via opioid mechanisms.

Anti-Inflammatory Activity¹⁸

I Arambewela L.etal., conducted a study(2012) on the anti-inflammatory activity of the plant. *Alpinia calcarata* Roscoe (Family: Zingiberaceae) rhizomes are often used in Sri Lankan traditional systems of medicine as a remedy for bronchitis, cough, respiratory ailments, diabetics, asthma and arthritis. Generally drugs that are used for arthritis have antinociceptive and anti-inflammatory properties. However, validity of the anti-inflammatory activity has not been scientifically investigated so far. Therefore, the aim of this study was to investigate the anti-inflammatory potential of *Alpinia calcarata* rhizomes using hot water extract (AWE) and hot ethanolic extract (AEE). The anti-inflammatory activity of *Alpinia calcarata* was evaluated by use of the carrageenan-induced paw oedema model in rats. In addition, the mechanism/s by which *Alpinia calcarata* is mediated the anti-inflammatory activity was assessed by determining its effects on (a) membranestabilizing, (b) antihistamine and (c) prostaglandin synthesis inhibition activity. All the tested doses of AWE and AEE (250, 500, 750, and 1000 mg/kg) produced a significant ($P\leq 0.05$) inhibition of the

inflammation, most pronounced at 4h after the injection of carrageenan. The antiinflammatory effect induced by 500 mg/kg of AEE was superior than the reference drug, indomethacin at 4h. Inhibition of histamine and prostaglandin synthesis production is probable mechanisms by which *Alpinia calcarata* mediates its antiinflammatory action.

Anti-Inflammatory and Analgesic Activity¹⁹

Mizanur Rahman et al., conducted a study(2012) on the anti-inflammatory, analgesic and gc – ms analysis of essential oil of *Alpinia calcarata* rhizome. In the present study, essential oil isolated from *Alpinia calcarata* was analyzed and also assessed for acute toxicity, anti-inflammatory and analgesic activities in animals. The essential oil isolated from *Alpinia calcarata* was analyzed by using GC-MS on a combined GC-MS instrument. For evaluation of the antiinflammatory property “carrageenan induced paw edema model” served as acute model. “Acetic acid induced writhing response model” was used to assess analgesic activity in mice. The major components of essential oils isolated from *Alpinia calcarata* were Camphene (3.86%), Betamyrcene(4.39%), Eucalyptol(14.05%), Linalol(2.48%), Pyrazine(1.72%), L-camphor(7.90%) and Berneol(5.67%). Intraperitoneal injection of essential oil isolated from *Alpinia calcarata* significantly ($P<0.05$) suppressed the paw edema induced by carrageenan in two different dose levels studies namely 400mg/kg and 380mg/kg. Intraperitoneal injection of essential oil also significantly attenuated the acetic acid induced writhing response in three different dose levels studies namely 200 mg/kg (significant at $P<0.05$), 400mg/kg (significant at $P<0.01$) and 600mg/kg (significant at $P<0.01$). These studies suggest that essential oil isolated

from *Alpinia calcarata* might possess significant anti-inflammatory activity and analgesic effect and could be a potential source for treatment of different inflammatory diseases

Anti- Diabetic Activity²⁰

Ramya Rajasekar et al., proposed a study(2014) on the antidiabetic activity of the plant rhizomes. The study was to determine effect of *Alpinia calcarata* on glucose uptake in diabetic rats-an in vitro and in vivo model. Diabetes mellitus is a heterogeneous metabolic disorders characterized by abnormally high levels of blood glucose. The main objective of the present work is to study the effect of *Alpinia calcarata* on glucose uptake in streptozotocin (STZ) induced diabetic rats.

The diabetes was induced by single dose of STZ (45 mg/kg) in citrate buffer, while the normal control group was given the vehicle (citrate buffer) only. After induction of diabetes, the diabetic animals were treated with ethanolic extract of *Alpinia calcarata* (200 mg/kg) and glibenclamide (2 mg/kg) for 30 days. Blood glucose estimation was performed every week of the study. At the end of study period, animals were sacrificed for biochemical studies

Streptozotocin induced diabetic rats shows the altered levels of various biochemical profiles. Those levels were brought back to near normal upon treatment with ethanolic extract of *Alpinia calcarata* and standard drug glibanclamide. No significant changes were observed on treatment with plant

Safety Profile of *Alpinia calcarata* Roscoe²¹

Lakshmi Arambewela et al., conducted study(2011) on the safety profile of the plant. The aim of the present study was to

investigate whether *Alpinia calcarata* Roscoe (Family: Zingiberaceae) rhizomes have any toxic effects in rats. Wistar rats were used as the experimental model and orally administered hot water extract (HWE) and hot ethanolic extract (HEE) of *A. calcarata* rhizomes at a dose of 1500 mg/kg respectively for 42 consecutive days. Administration of the HWE or HEE to rats did not result in any chronic toxic effects as evident from their effects on (a) liver function (b) kidney function, (c) hematological parameters such as red blood

cell (RBC) count, white blood cell (WBC) count and hemoglobin (Hb) concentration (d) external morphology and wet weights of selected organs. Further, the HWE and the HEE did not appear to mediate any unacceptable effects on food and water intake, % weight gain, consistency of faeces and color of urine. In conclusion, the results of this study have revealed that the HWE and the HEE of *A. calcarata* at the doses tested do not produce any serious toxic side effects in rats.

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)

KINGDOM	Plantae
PHYLUM	MAGNOLIOPHYTA
CLASS	LILIOPSIDA
ORDER	ZINGIBERALES
FAMILY	ZINGIBERACEAE
GENUS	ALPINIA
SPECIES	<i>ALPINIA CALCARATA</i>



Fig - 1. *Alpinia calcarata* plant

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

Plant Parts



1. Leaf



2. Flower



3.Rhizome

Effects of Aqueous Extract of *Alpinia calcarata* Rhizomes on Reproductive Competence of Male Rats.²²

Ratnasooriya et al., conducted a study (2006) on the effect of aqueous extract of the plant rhizomes on reproductive competence of male rats. This study examined the effects of rhizomes of *Alpinia calcarata* Roscoe (Zingiberaceae) on male sexual competence and fertility, using a hot water extract (HWE) and rats. Different doses of HWE (150, 250 and 500 mg/kg) were orally administered to male rats and their sexual behaviour was monitored (for 15 min) 3 h later using receptive females. Fertility was determined in a separate group (with the highest dose) using a noncompetitive copulation test. In the sexual behaviour study, the HWE impaired the number of rats ejaculating and markedly prolonged the latency for ejaculation. Further, the number of rats mounting and intromitting, and the latencies for mounting and intromission were inhibited. Collectively, these observations indicate a strong aphrodisiac action. The other parameters remained unchanged indicating non-impairment in libido, sexual arousability, sexual vigour and sexual performance or penile erectile ability. However, a slight impairment was evident in sexual motivation (with the highest dose) in a partner preference test. In the fertility test, HWE induced profound oligozoospermia but fertility was uninhibited. The highest

dose of HWE also elevated the serum testosterone level and the number of spontaneous penile erections rapidly and markedly. Further, the HWE was nontoxic. It is concluded that *A. calcarata* rhizomes possess a strong and safe oral aphrodisiac activity.

Conclusion

Alpinia calcarata roscoe is an important plant for its various pharmacological activity and it would be worthwhile in continuing research to isolate the active compounds. The plant has been traditionally used in the treatment of rheumatoid arthritis. Rhizomes are said to possess diuretic and antioxidant properties. It is used in polyuria, coughs, stomachic diseases, diabetes, colds, bronchial disease, asthma and heart disease. The future aspects of the plant can be anti-asthmatic as it contains many of the phytochemicals and work has not been performed yet.

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