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REVIEW ARTICLE

The Pharmacological Activities of *Alpinia galangal* - A Review

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ABSTRACT

Alpinia galanga contained many flavonoids and a wide range of volatile oils. It is used traditionally for the treatment of eczema, bronchitis, coryza, morbili, pityriasis versicolor, otitis interna, gastritis, ulcers, cholera, emaciation and to clean the mouth, stimulates the digestive power, appetite and as a purgative. The different parts of the plant possessed many pharmacological effects including antibacterial, antifungal, antiviral, antiprotozoal, immunomodulatory, anti-oxidant effects**,** antidiabetic, antiplatelet, hypolipidemic and many other pharmacological effects. The present review will highlight the chemical constituents and the pharmacological and therapeutic effects of *Alpinia galangal.*

KEYWORDS

Alpinia galanga, Pharmacology, Constituents

INTRODUCTION

In the last few decades there has been an exponential growth in the field of herbal medicine. It is getting popularized in developing and developed countries owing to its natural origin and lesser side effects. *Alpinia galanga* belongs to the family Zingiberaceae has been used traditionally for the treatment of eczema, bronchitis, coryza, morbili, pityriasis versicolor, otitis interna, gastritis, ulcers and cholera[1]. The seed of A *galanga* is used for emaciation and to clean the mouth, stimulates the digestive power, appetite and as a purgative. The rhizome is generally used as a spice or source of essential oil. The flowers and young shoots are used as a vegetable or as a spice[1]. *Alpinia galanga* contained flavonoids and volatile oils[2-24]. The previous studies showed that *Alpinia galanga* possessed many pharmacological activities, including antibacterial, antifungal, antiviral, Antiprotozoal[25-43], immunomodulatory, anti-oxidant effect**,** antidiabetic, antiplatelet, hypolipidemic and many other pharmacological effects. The objective of the present review is to highlight the chemical constituents and the pharmacological and therapeutic effects of *Alpinia galanga*.

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Synonyms: *Amomum galangal*, *Alpinia viridiflora*, *Maranta galangal*, *Languas galangal*, *Languas vulgare*[1].

Common names: Sinhala: Aratta, Mahaaratta, Kaluwala; Indonesia : Langkuas (general); Malaysia : Lengkuas, Puar; Philippines: Languas (general), Pal-la (Mandaya); Burma Myanmar) : Padagogi; Cambodia : Rumdeng, Pras; Thailand : Kha, kha yuak(northern); Vietnam: Ri(eeF)ng; Tamil: Perarattai; Telugu: Peddadumparashtram; Marathi: Koshtkulayan; Malayalam: Arratta, peraratta.kol-inj; Gujarati: Kulinjan; Kanarese / Kannada: Ditrnparrasm; Sanskrit and Urdu: Barakulanjar, Kulanjan; French : Galanga; English : Greater Galangal; Arabic: Kholinjan Kabeer[1].

Family: Zingiberaceae

Distribution

It is found in Indonesia, India, China, and Arabic gulf areas, Malaysia, Egypt and Sri Lanka. It grows in open sunny places, forests and brushwood. It is commonly cultivated in the mid and low-country in Sri Lanka[1].

Traditional Use

Alpinia galanga has been used for the treatment of eczema, bronchitis, coryza, morbili, pityriasis versicolor, otitis interna, gastritis, ulcers, and cholera. The seed of A *galanga* is used for emaciation and to clean the mouth, stimulates the digestive power, appetite and acts as a purgative. The rhizome is generally used as a spice or source of essential oil throughout its distribution area. The flowers and young shoots are used as a vegetable or as a spice[1].

Physicochemical Parameters of *Alpinia galanga* %[1]

Ethanol extractive of rhizome 9.8-10.5 , water extractive of rhizome 11.3-13.6 , acid insoluble ash 3.8-5.8 , water soluble ash 4.3-5.9 and total ash 8.3-11.9.

Chemical Constituents

Many flavonoids were extracted from the plant, galangin (3, 5, 7-trihydroxyflavone) was the oldest flavonoid isolated from galangal root, it also contains alpinin. The rhizome also contains flavonoids, some of which have been identified as kaemperol, kaempferide, galangin, alpinin and quercetin[2-4]. However, a lot of chemical compounds were extracted from different parts of the plant[5-24]. The rhizome contained methyl cinnamate, p-methane-1,8- epoxy-acethoxychavicol acetate, alpinin, kaempferide, 3-dioxy 4-methoxy flavone, pinene, camphor, pineol, galangin, (rS)-l'-acetoxychavicol acetate, (I'S)-l'-acetoxyeugenol acetate, 1'-acetoxychavicol acetate, 1'-acetoxyeugenol acetate , D-camphor, chavicol, chavicol acetate, 1,8-cineole, 3-hydroxy-l,8-cineole glucopyranosides, (1R,2R,4S), (lS,2S,4R)-trans-2-hydroxy-1,8-cineole -D- glucopyranosides, (1R,3S,4S)- trans-3-hydroxy-l, 8-cineole -D-glucopyranoside, trans coniferyl diacetate, trans -p-coumaryl diacetate, di-(p-hydroxy-cis-styryl) methane, eugenol acetate, trans (3-faranesene, 7-hydroxy-3,5-dimethoxy flavone, 4-hydoxybenzyldehyde, 1'-hydroxychavicol acetate, p-hydroxycinammaldehyde, isorhamnetin, kaempferol, kaempferoI-4'-methylether, kaempferol-7'-methylether, methylcinnamate, methyleugenol, 3-carene, a-thu j ene a-pinene, p-pinene, camphene, myrcene, p-cymene, borneol, a-terpineol, 4-terpineol, fenchyl acetate, bornyl acetate, a-humulene and zerumbone. Two skeletal diterpenes, named galanga A and B , and 2 labdane type diterpenes, named galanolactone and (E) -(3), 12-labdiene-15,16-dial, were isolated from *A. galanga* together with (E)- B-epoxylabed-12-enel5,16-dial. One of the pungent principle of A. *galanga* rhizome was isolated and identified as l'-acetoxychavicol diaceta.

Leaf oil contains mainly myrcene, B-ocimene, a-pinene, borneol, B-caryophyIIene and B-bisabolene.

Flower oil contains a-pinene, sabinene, limonene, a- phyllandrene[14], 1,8-cineole, linalool, terpinen-4-ol, a-terpineol, methyleugenol, a-patchoulene,caratol, a-caryophyllene, a-bergamotene,(E,E), a-farnesene,nerolidol, a- bisabolol and benzyl benzoate. Fruits of A. galanga contain 1'-acetoxyeugenoi acetate and 1'-acetoxychavicol acetate. Seed contains 1'-acetoxyeugenoi acetate, 1'-acetoxychavicol acetate, caryophyllene oxide, caryophyllenol I, caryophyllenol H, pentadecane, 7-heptadecane, fatty acid methyl esters, galanga A, B, (E) and 8,17-epoxylabd-12-ene-15,16-diol.

Pharmacological Effects

Antimicrobial Activities

The essential oils of rhizome of A. galangal showed antimicrobial activity[25]. Thomas *et al*, found that ether and ethyl acetate extract of A. galangal exerted antibacterial activity[26]. Aqueous extract of *A. galanga* showed significant activity against *Klebsiella*

pneumonia, Escherichia coli, Pseudomonas aeruginosa, S. aureus and *Streptoccocus pyogenes* except *Staphylococcus epidermidis*[27].

Essential oil had shown significant activity against *Staphylococcus aureus, Streptococcus suis, Erysipelothrix rhusiopathiac, Pseudomonas aeruginosa, E. coli, Pasteurella multocida* and *Arcanobacterium pyogenes*, the effects were attributed to 1,8-cineole, 4-allyphenyl acetate and α-bisabolene[28.]

Oven-dried ethanol extract from *Alpinia galanga* flower was the most effective against *S. aureus* with inhibition zone of about 26–31 mm and the minimum inhibitory concentration (MIC) ranging from 0.352–0.547 mg/mL. No antimicrobial activity was observed on *E. coli* O157:H7 and *Salmonella*. Overall antimicrobial activity of oven-dried samples extracted with ethanol was the highest with inhibition zone of 8.94 mm and MIC of 1.457 mg/mL. In contrast, freeze-dried samples extracted with ethanol exhibited the lowest overall antimicrobial activity (7.05 mm and 2.470 mg/mL)[29].

The *Alpinia galanga* ethanolic extract had strong inhibitory effect against *S. aureus*. The minimum inhibitory concentration (MIC) of the galangal extract was 0.325 mg/ml and the minimum bactericidal concentration (MBC) was 1.3 mg/ml using the broth dilution method. Transmission electronmicroscopy demonstrated that the *Alpinia galanga* extract caused both outer and inner membrane damage, and cytoplasm coagulation. The disruption of the cytoplasmic membrane properties was determined by the releasing of cell materials including nucleic acids[30].

It has been shown that essential oils from both fresh and dried rhizomes of galangal have antimicrobial activities against bacteria, fungi, yeast and parasite. Terpinen-4-ol, one of the monoterpenes in the essential oil from fresh galangal rhizomes, contains an antifungal activity against *Trichophyton mentagrophytes*. Acetoxychavicol acetate, a compound isolated from an n-pentane/diethylether-soluble extract of dried rhizomes, was active against some bacteria and many dermatophyte species[31-32]

A. galanga have antifungal activity against fungi resist the common antifungal products like amphotericin B and ketoconazole[33]. It exerted a concentration-dependent inhibition of the growth of zoonotic dermatophytes and the yeast-like *Candida albicans*[34.]

Ethanolic extract of *A. galanga* possess phytotoxic activity against *Lemna minor* and significant antifungal activity against *Trichophyton longifusus*[35]. It also showed significant antifungal activity against *Candida albicans* and phytopathogenic fungi, *Colletotrichum musae* and *Fusarium oxysporum*, at a concentration of 10mg/ml[36.]

14 mg/ml of 1'-Acetoxychavicol acetate exerted antifungal activity against *Trichophyton mentagrophytes, Trichophyton rubrum, Trichophyton concentricum, Rhizopus stolonifer* and *Aspergillus niger*[32].

Methanolic extract of *A. galanga* and 1'*S*-1'-Acetoxychavicol acetate showed potent inhibitory activity against human immunodeficiency virus type-1 (HIV-1) and against human cytomegalovirus (HCMV)[37-38]. Chloroform extract of *Alpinia galanga* at a concentration of 1000ug/ml has shown good inhibition against *Entamoeba histolytica*. And a good activity against *Giardia intestinalis*, the minimum inhibitory concentration (MIC) was 125µg/ml[39-40].

Hexane, chloroform and ethyl acetate extracts (100 µg/ml) of *Alpinia galanga* rhizomes exhibited significant activity against promastigotes of *L. donovani in vitro*[41].

Antiprotozoan activity of *A. galanga* against *Paramecium caudatum* and *Paramecium caudatum*, and antitrypanosomal activity against *Trypanosoma cruzi* have been recorded[42-43].

Immunomodulatory and Anti-oxidant Effects

The flavonoid fraction of *Alpinia galanga* Linn. Extract significantly stimulated ($P < 0.001$) T cell proliferation and splenocyte proliferation in mice spleen at a dose of 100 mg/kg body weight

of mice. The aqueous fraction had a lower stimulatory effect than the flavonoid fraction. The antioxidant level of the spleen cells also increased following treatment with the flavonoid fraction[44]. Hot water soluble polysaccharide extract of *A. galanga* rhizome possesses a marked stimulating effect on the reticulo endothelial system (RES) and increased the number of peritoneal exudates cells and spleen cells of mice[45].

1'S-1'- acetoxychavicol acetate and 1'S-1'-acetoxyeugenol acetate from aqueous extract of rhizome inhibited the release of hexosaminidase and the antigen-IgE-mediated TNF-alpha and IL-4 production in passive cutaneous anaphylaxis reactions in mice[46].

1'-acetoxychavicol acetate and the related compounds in the rhizomes of *Alpinia galanga* exerted antioxidative activity[47]. The antioxidant activity of *Alpinia galanga* extracts and essential oil was determined using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) and oxygen radical absorbance capacity (ORAC) methods. The ethanolic extract showed the highest DPPH free radical scavenging ability as well as the highest ORAC value when compared to the water extract and the essential oil[48]. Ethanolic extract of *Alpinia galanga* showed a potent scavenging activity by DPPH method with the IC 50 value of 69.5±1.375 µg/ml, by lipid peroxidation method with the IC 50 value of 77±1.876 µg/ml, hydrogen peroxide radical scavenging activity with the IC 50 value 55±1.59 µg/ml, and ABTS radical scavenging method with the IC 50 value 0.086±1.10 µg/ml[49].

Antidiabetic Effects

The administration of powdered rhizome of *Alpinia galanga* to the normal rabbits produced significant decrease in blood glucose level[50]. However Srividya *et al* found that the ethanolic extract of *Alpinia galanga* exerted antidiabetic effects in rats. The glucose uptake by rat hemi diaphragm was significantly more in all groups tested compared to control. 400 mg/kg b.wt treated group showed marked increase in body weight. Fluid intake (ml/day) was also increased when compared to the diabetic control .Serum glucose level (mg/dl) was found to decrease gradually from the date of administration of the extract to the end of the study when compared to the diabetic control. 400 mg/kg bw in diabetic rats showed potent serum glucose reducing capacity than 200 mg/kg bw. Total protein level was found to increase in the extract treated group when compared to diabetic control. Serum triglyceride level was found to be decreased when compared with diabetic control as well as diabetes treated with glibenclamide. Total cholesterol was also found to decrease drastically on the administration of the extract when compared with the diabetic control. The ethanolic extract of *Alpinia galanga* was found to be effective in inhibiting the α-Glucosidase when compared to Acarbose[49].

Antiplatelet and Hypolipidemic Activity

Ethanolic extract of *A. galanga* 20mg/day for 4 weeks in rats exerted hypolipidemic activity, with a significant increase in the serum levels of high density lipoproteins (HDL) in rats[51]. *A. galanga* constituents exerted platelet activating factor (PAF) antagonists. Methanolic extract showed significant inhibitory effects on PAF with IC_{50} value of 5.5ug/ml in rabbit platelets[52].

Other Pharmacological Effects

The constituents of *Alpinia galanga* exerted antiulcer and antisecretory effects. 1'S-1'-Acetoxychavicol acetate and 1'S-1'-acetoxyeugenol acetate, isolated from seeds have markedly inhibited the ethanol-induced gastric mucosal lesions in rats. Ethanolic extract at a dose of 500mg/kg, was significantly reduce gastric secretion in pyrolic ligation and hypothermic restraint stress models in rats, a significant cytoprotective effect has been reported against 80% ethanol, 0.6M HCl, 0.2M NaOH, and 25% NaCl induced gastric cytodestruction[16, 53-54].

A significant analgesic effect in formalin test was produced by topical preparation containing methanolic extract of *Alpinia galanga* rhizome[55]. Acetoxychavicol acetate exhibited potent antioxidant activity, increased cell

apoptosis and decreased cytokine production by T helper cells[56-57].

A polyherbal formulation (JointCare B) containing *A. galanga*, exerted dose-dependent inhibition of inflammation in carrageenan induced paw and granuloma weight in croton oil-induced granuloma pouch model in rats[58].

In a randomized double-blind placebo controlled study, patients with osteoarthritis of the knee and moderate-to severe pain, the concentrated extract has been found significantly reduce symptoms of osteoarthritis[59].

Qureshi, *et al* reported that the methanolic extract of *Alpinia galangal* reduced the cytological and biochemical changes induced by cyclophosphamide in mice[60.]

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