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Alpinia galanga Willd.– An overview on phyto-pharmacological properties

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Plants have been one of the important sources of medicines even since the dawn of human civilization. Inspite of tremendous development in the field of allopathy during the 20th century, plants still remain one of the major sources of drug in the modern as well as traditional system of medicine throughout the world. *Alpinia galanga* Willd. (Family- Zingiberaceae) commonly known as galangal, is an important cultivated medicinal crop of India. It is well known official drug throughout the country as a holistic gift of nature for medicinal, culinary and cosmetic use. It has been found to possess various therapeutic activities, viz. anti-inflammatory, analgesic, antiallergic, antifungal, antidiabetic, antibacterial, antiulcer, immunostimulating, anticancer, antioxidant, antiamoebic, antidermatophytic and many more. The present paper is an overview on scientifically established and published phyto-pharmacological properties of the plant

Keywords: *Alpinia galanga*, Zingiberaceae, Galangal, Phytotherapeutic.

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Introduction

Plant and plant products are being used as a source of medicine since long. *Alpinia galangal* Willd. (Family- Zingiberaceae) is used in medication, culinary and cosmetics for centuries[1, 2]. It is widely used in dietary intake as well as in the traditional system of medicine, viz. Ayurveda, Unani, Chinese and Thai folk medicine[3]. It has a pungent, hot and spicy taste with an aromatic ginger like odour[4]. Rhizome has characteristic fragrance as well as pungency, therefore, it is widely used as a condiment for foods and local medicine in China and Thailand[5, 6]. It is official in various pharmacopoeias as well as scientifically reported to possess several therapeutic activities[7]. It is commonly known as Rasna and Sugandhmula in Sanskrit, Kullanjan in Hindi, Koshtkulinjan in Marathi, Arattai in Tamil and Galangal in English[8].

The plant is a perennial herb found commonly throughout the Western Ghats, Mysore, Goa, Malabar and Gujarat[9]; also found in other countries like Thailand, Indonesia, China and Malaysia[10]. Roots are adventitious, in groups, fibrous, persistent in dried rhizomes, about 0.5 to 2 cm long and 0.1 to 0.2cm in diameter and yellowish brown in colour. Rhizomes are cylindrical, branched, 2 to 8 cm in diameter, longitudinally ridged with prominent rounded warts (remnants of roots) marked with fine annulations; scaly leaves arranged circularly, externally reddish brown, internally orange yellow; odour pleasant and aromatic; spicy and sweet in taste.

The cultivation of the galangal as a spice is now carried out in many tropical areas of Asia. The herb is mostly propagated by rhizomes, grows best in shaded areas away from direct sunlight, it also requires well drained soils to grow in and is usually propagated by dividing and replanting the rhizomes during the spring. The four to six years old plants are harvested for their rhizomes at the end of the growing season. The rhizomes of the galangal are unearthed and collected in the early autumn and late summer in China, where the plant is extensively cultivated. Harvested rhizomes are carefully washed and cut into segments and then dried for storage and processing into herbal medicine[11-12] (Plate 1).

Traditional uses

In Ayurvedic system the rhizome is used to improve appetite, taste and voice. It is also useful in *vata*, bronchitis and diseases of the heart. In Unani system, rhizomes have been used as stomachic, aphrodisiac, tonic, diuretic, expectorant, carminative; useful in headache, rheumatic pains, sore throat, sour eructation, stuttering, pain in chest, diabetes, burning of the liver, tubercular glands and diseases of the kidney. The seeds are considered calefacient,

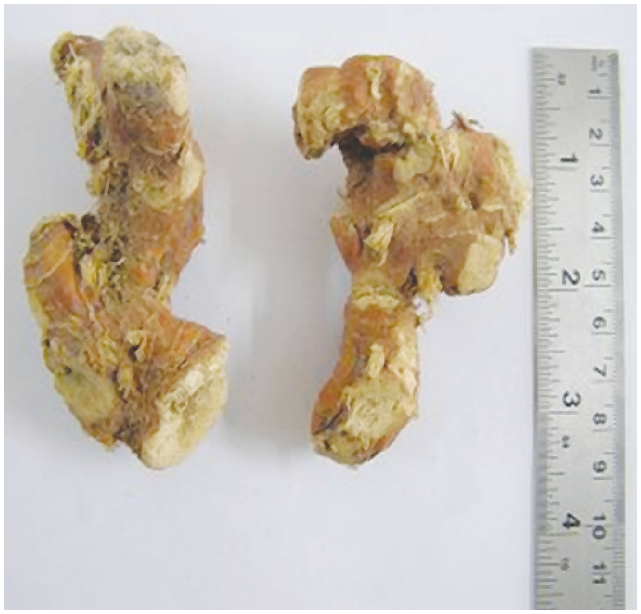

Plate1: Dried rhizomes of *Alpinia galanga*

stomachic, stenutatory, beneficial in colic, diarrhoea and vomiting in Chinese system. In Thai folk system the rhizomes of this plant are extensively used as carminative, antiflatulent, antifungal and anti-itching[13].

Chemical constituents

A. galanga has been thoroughly studied by various workers and a number of major as well as minor chemical constituents belonging to different classes of natural products have been isolated. In a study, 1'S'-1'-acetoxychavicol acetate, 1'S'-1'-acetoxyeugenol acetate, 1'S'-1'-hydroxychavicol acetate, trans-*p*-hydroxycinnamaldehyde, trans-*p*-coumaryl alcohol, trans-*p*-hydroxycinnamyl acetate, and trans-*p*-coumaryl diacetate have been isolated from rhizomes[14-18]. The pungent principal compound, 1'S'-1'-acetoxychavicol acetate has been reported to possess various biological activities such as antitumor, antiinflammatory, antifungal, antioxidative and xanthineoxidase inhibitory activity[18-25].

The GC–MS analysis showed that the main compounds of galangal extract are 1, 8-cineole, β-bisaboline and β-selinene**.** Whereas α-selinene, farnesene, 1,2-benzenedicarboxylic acid, germacrene B and pentadecane are the minor components[26]. 1, 8-Cineole is an oxygenated monoterpenes, while β-caryophyllene is a sesquiterpene. In addition, β-bisabolene and β-selinene are terpenes. Mallavarapu *et al*, also reported similar main compounds in galangal, i.e., 1,8-cineole, α-fenchyl acetate and camphor[27].

The rhizome also contains flavonoids, some of which have been identified as kaemperol, kaempferide, galangin and alpinin. Kaempferide, galangin and alpinin have also been isolated from galangal roots. The pale yellow oil with a pleasant odour is obtained from green rhizomes on distillation. The oil contains 48% methyl cinnamate, 20-30% cineole, α-pinene**,** β-pinene and camphor[28].

Galangin (3, 5, 7-trihydroxyflavone) is a flavonoid with multiple biological activities. It was originally found and characterized from galangal root in 1881. It has also been found in many other plants and is a constituent of bee propolis throughout the Mediterranean where it is considered to play an antimicrobial role[29]. Several recent studies with this flavonoid suggest that it may have a potent anti-cancer effect, specifically through inhibition of the detoxification enzyme CYP1A1 and modulation of the aryl hydrocarbon receptor[30, 31]. Unique aroma components i.e., hydroxy-1,8-cineole glucopyranosides, (1R,2R,4S) and (1S,2S,4R)-trans-2-hydroxy-1,8-cineole β-D-glucopyranosides and (1R,3S,4S)-trans-3-hydroxy-1,8-cineole β-D-glucopyranoside which are precursors of acetoxy-1,8-cineoles have been isolated from the rhizomes of greater galangal[32].

Three new 8-9′ linked neolignans, galanganal, galanganols A and B and a sesquineolignan, galanganol C, have also been isolated. The structures of new neolignans have been determined on the basis of physicochemical and chemical evidences[33]. Chemical structures of some important constituents are given in Plate 2.

Pharmacological activities

Anti-inflammatory and analgesic activities

Anti-inflammatory and analgesic effects of *A. galanga* in a variety of rheumatologic conditions have been studied by several authors. Yu *et al*, isolated *p*-coumaryl alcohol-γ-O-methyl ether (CAME) having phenylpropanoid structure, which selectively and substantially suppressed IFNγ production in CD4+ Th (T helper) cells[34]. Isolated chavicol analogues, viz. acetoxychavicol acetate (ACA) and hydroxychavicol acetate (HCA) have been comparably examined. In which ACA exhibited potent antioxidant activity, increased cell apoptosis and decreased cytokine production by Th cells; whereas, HCA suppressed

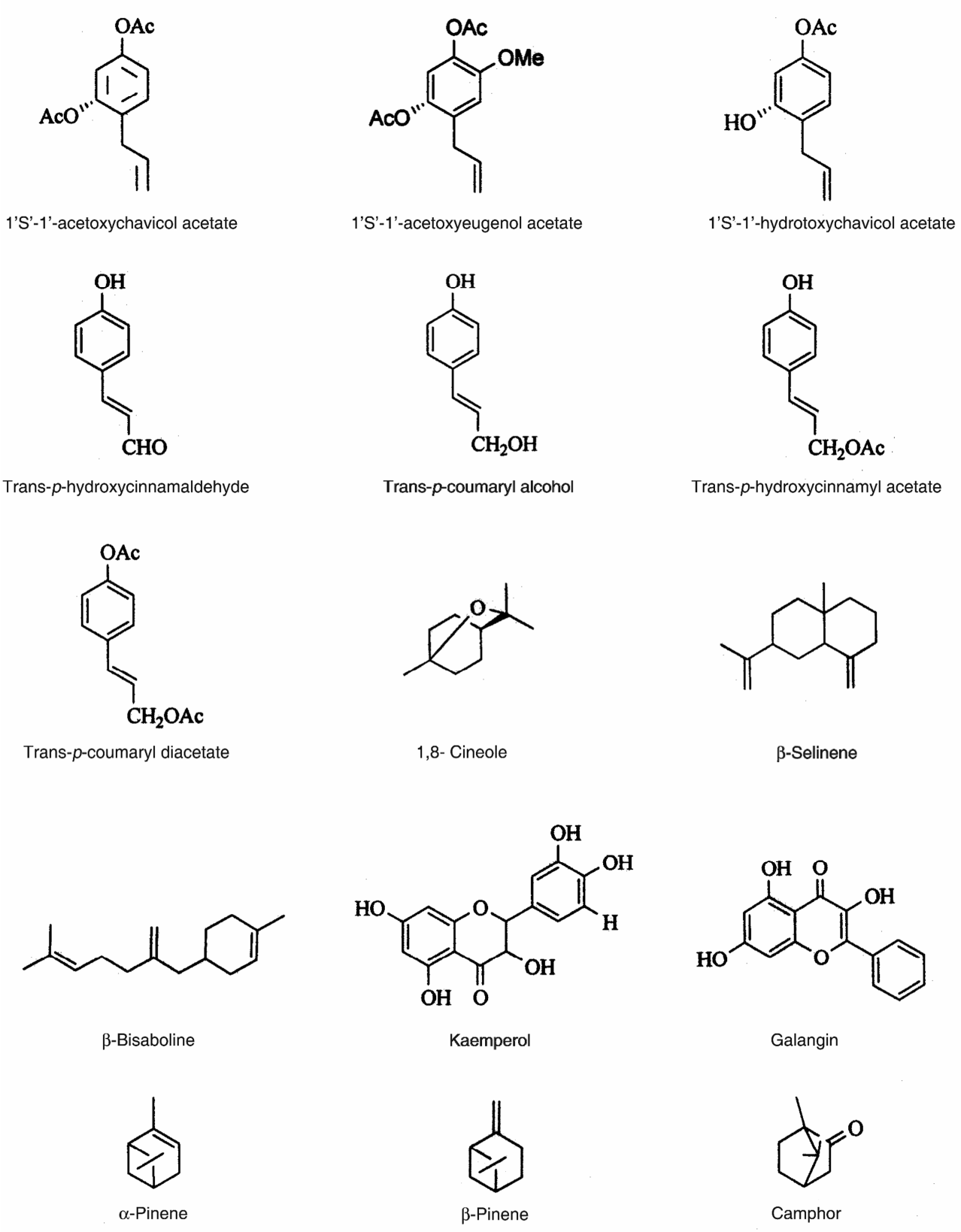

Plate 2: Chemical structures of some important constituents of *Alpinia galanga*

T-bet expression and might act as a beneficial therapeutics for treating inflammatory immune disorders caused by extravagant activation[35]. Joint Care B is a herbal formulation, containing *A. galanga*, has shown dose-dependent inhibition of carrageenan-induced paw inflammation and granuloma weight in croton oil-induced granuloma pouch model in rats[36]. Topical preparation containing methanolic extract of rhizome has shown significant analgesic effect in formalin test[37]. In randomized, double-blind, placebo controlled, multicenter study, conducted in two hundred sixty-one patients with OA (osteoarthritis) of the knee and moderate-to severe pain, highly concentrated extract has been found statistically significant on reducing symptoms of OA of the knee[38].

Hypoglycaemic activity

Akhtar *et al*, reported that administration of powdered rhizome to the normal rabbits, at dose levels of 3 and 4/kg produced significant decrease in blood glucose level. However, it could not produce hypoglycaemic effect in alloxan-induced diabetic rabbits[39].

Antiallergic activity

Alpinia galanga was found to be effective in treatment of allergy[40]. Isolated compounds, 1'S-1'-acetoxychavicol acetate and 1'S-1'-acetoxyeugenol acetate from aqueous extract of rhizome have shown to inhibit release of β-hexosaminidase and the antigen-IgE-mediated TNF-alpha and IL-4 production in passive cutaneous anaphylaxis reactions in mice[41].

Antimcrobial activity

Antiviral activity

Tewtrakul e*t al*, reported that methanolic extract of *A. galanga* showed potent inhibitory activity against human immunodeficiency virus type-1 (HIV-1) and human cytomegalovirus (HCMV)[42].

Antibacterial activity

The essential oils of rhizome are responsible for its antimicrobial activity[43]. Thomas *et al*, reported antibacterial activity of ether and ethyl acetate extract of *A. galanga*[44]. 1, 8-Cineole, has been reported to have an antibacterial activity against *Staphylococcus aureus*[45]. In a study performed by using broth dilution method, ethanol extract of galangal showed the strongest inhibitory effect against *S. aureus*[46]. Aqueous extract showed significant activity against *Klebsiella pneumonia*, *Escherichia coli*, *Pseudomonas aeruginosa*, *S. aureus* and *Streptoccocus pyogenes* except *Staphylococcus epidermidis*[47]. Essential oil had shown significant activity against *S. aureus, Streptococcus suis, Erysipelothrix rhusiopathiac, P. aeruginosa, E. coli*, *Pasteurella multocida* and *Arcanobacterium pyogenes*, with the maximum inhibitory dilution (MID), higher potential in antimicrobial activities was supposed to be due to the composition 1,8-cineole, 4-allyphenyl acetate and α-bisabolene[48].

Antifungal activity

A. galanga have shown pronounced inhibitory activities against a wide variety of human pathogenic fungi, including strains resistant to the common antifungal products like amphotericin B and ketoconazole[49]. Trakranrungsie *et al*, have reported concentration-dependent inhibition of the growth of zoonotic dermatophytes and the yeast-like *Candida albicans*[50]. Phytotoxic activity against *Lemna minor* (100%) as well as significant antifungal activity against *Trichophyton longifusus* (60%) in ethanolic extract was reported by Khattaka *et al*[51]. Isolated endophytic actinomycetes as *Streptomyces aureofaciens* CMUAc130 from the roots of *A. galanga*, showed significant antifungal activity against *Candida albicans* and phytopathogenic fungi, *Colletotrichum musae* and *Fusarium oxysporum*, at a concentration of 10mg/ml[52]. 1'-Acetoxychavicol acetate at a concentration of 14 mg/ml has shown significant activity against *Trichophyton mentagrophytes, Trichophyton rubrum, Trichophyton concentricum*, *Rhizopus stolonifer* and *Aspergillus niger*[24].

Antiamoebic activity

Chloroform extract at a concentration of 1000µg/ml has shown good inhibition against *Entamoeba histolytica* strains HTH-56:MUTM and HM1:IMSS[53]. However, it has shown highest activity against *Giardia intestinalis* with the minimum inhibitory concentration (MIC) at 125µg/ml with an IC_{50} 37.73 µg/ml[54].

Gastroprotective activity

Antisecreatory and cytoprotective action of *A. galanga* is responsible for its antiulcer activity. Ethanolic extract significantly reduced gastric secretion in pyrolic ligation and hypothermic restraint stressing rats at a dose of 500mg/kg, whereas, highly

significant cytoprotective effect has been reported against 80% ethanol, 0.6M HCl, 0.2M NaOH, and 25% NaCl induced cytodestruction[55]. 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[56]; former has shown antiulcer activity in Shay rats[57].

Anti-platelet activity

A. galanga acts as a potential source of platelet-activating factor (PAF) antagonists. In rabbit platelets, methanolic extract showed significant inhibitory effects on PAF with IC_{50} value of 5.5 µg/ml[58].

Antioxidant activity

A lot of scientific works have revealed that *A. galanga* and its isolates possess significant antioxidant activity. Essential oil of *A. galanga* has been reported to possess stronger antioxidant activity with IC_{50} value of 550 µg/ml[48]. Zaeoung *et al,* have reported significant free radical scavenging activity against 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical in methanolic and water extracts and volatile oils[59]. Antioxidant activity at neutral *p*H was higher than at acidic *p*H ranges. Ethanolic extract of galangal has been reported to possess strong superoxide anion scavenging activity, Fe^{2+} chelating activity and reducing power in a concentration dependent manner. However, it also possesses lipoxygenase inhibitor activity[60]. Dose-dependent antioxidant activity has been reported in dichloromethane (DCM) and methanol extract of rhizome of *A.galanga*[61].

Anticancer activity

A. galanga exhibited interesting cytotoxic activity. 1'S-1'-acetoxychavicol acetate acting as a major cytotoxic component, has shown a significant cytotoxic activity after 48h exposure, against COR L23 cells (lung cancer cell line) and MCF7 cells (breast cancer cell line) with IC_{50} 7.8µM and 23.9µM, respectively. Due to the relatively high amounts of 1'-acetoxychavicol acetate present in the Thai sample. Malaysian galangal showed weak activity as compared to Thai ones[62]. 1'S-1'-Acetoxychavicol acetate have been reported to act as an antiulcer and antitumor agents as well as an inhibitor of chemically induced carcinogenesis[63].

Immunostimulating effect

A study conducted by Bendjeddou *et al*, revealed that a 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[64].

Hypolipidemic effect

The ethanolic extract of *A. galanga* is reported to possess hypolipidemic activity in rats when 20mg/day extract for the period of 4 weeks was given to rats. This caused reduction in the serum and tissue levels of total cholesterol, triglycerides, phospholipids and significantly increased the serum levels of high density lipoproteins (HDL) in rats. Effect of extract on lipid profile exhibited the efficacy of *A. galanga* in lowering the risk of arteriosclerosis[65].

Conclusion

A. galanga, a perennial, aromatic, rhizomatous herbal drug used in both traditional as well as modern system of medicine to treat various physiological conditions. It is an important source of various types of compounds with diverse chemical structures as well as pharmacological activities. Further research in view of fulfilling the need of quality control aspects, standardization of the various constituents and extracts are needed. Also a very less pinpoint study related to various diseases has been done on this plant, therefore, there is a need to explore its maximum potential in the field of medicinal and pharmaceutical sciences for novel and fruitful applications.

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