Review 述评与综述

Current pharmacological and phytochemical studies of the plant *Alpinia galanga*

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Abstract: Traditional medicine systems consist of large numbers of plants with medicinal and pharmacological importance and hence represent an invaluable reservoir of new bioactive molecules. *Alpinia galanga* (family Zingiberaceae) is commonly known as galangal and has been used for its emmenagogue, aphrodisiac, abortifacient, carminative, antipyretic and anti-inflammatory qualities and used in the treatment of various diseases such as bronchitis, heart diseases, chronic enteritis, renal calculus, diabetes, rheumatism and kidney disorders. It was reported to contain, among other components, essential oils, tannins, phenol, glycosides, monoterpenes and carbohydrates. In the last few years, new compounds such as gallic acid glycoside, galangoisoflavonoid, β-sitosterol, galangin, alpinin, zerumbone and kampferide have been isolated from various parts of *A. galanga*. Therefore, the present review is aimed to summarize the information regarding *A. galanga* concerning the new phytoconstituents and pharmacological uses that have appeared in recent years.

Keywords: *Alpinia galanga*; rhizome; plant extracts; pharmacology; review

Since the rise of human civilization, plants have been used as one of the most important sources of medicines. *Alpinia galanga* (family Zingiberaceae) syn. *Languas galangal*[1], known as greater galangal in English, and either kulanjan[2] or barakulanjan[3] in Hindi, has been widely cultivated in Sri Lanka, India, Malaysia, Indonesia, Egypt and Saudi Arabia[4] and is found abundantly in Thailand[5]. The rhizomes are extensively used for flavouring food[6]. In India, most of the South Indian physicians of traditional Ayurveda and Siddha medicine systems use *A. galanga* to treat various kinds of diseases including diabetes mellitus[2]. In China and Thailand, it is used as a folk medicine for stomach health[7]. *A. galanga* has been used in traditional medicine systems for its carminative, emmenagogue, aphrodisiac, abortifacient, antipyretic, anti-inflammatory and antispasmodic activities[8]. *A. galanga* was also found to be beneficial in the treatment of bronchitis, heart diseases, chronic enteritis, renal calculus, diabetes and rheumatism, etc[1, 3, 9]. The young inflorescences and leaves are

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consumed as ulam or salad[10]. *A. galangal* possesses many therapeutic activities such as antifungal[10], antiulcer[6], antiflatulent, antiallergic[9], treating brain disorders[11], nerve tonic, and stimulant[12].

1 Phytochemistry

A. galanga has been studied by various researchers and a number of active constituents from the plant have been isolated and reported. Phenolic compounds such as flavonoids and phenolic acids are found abundantly in this plant[13]. The dominant components isolated from the rhizomes were galangoisoflavonoid[2], β-sitosterol diglucosyl caprate[14], methyleugenol, *p*-coumaryl diacetate, 1′-acetoxyeugenol acetate, *trans*-*p*-acetoxycinnamyl alcohol, *trans*-3, 4-dimethoxycinnamyl alcohol, *p*-hydroxybenzaldehyde, *p*-hydroxycinnamaldehyde, *trans*-*p*-coumaryl alcohol, galangin, *trans*-*p*-coumaric acid, and galanganol B[15]. The major phytoconstituents which have been isolated from the rhizomes are acetoxychavicol acetate (ACA) and hydroxychavicol acetate (HCA)[16]. Rhizomes are lowest in fat but richest in carbohydrate[3].

The chemical investigation of *A. galanga* has led to the isolation of b-caryophyllene (17.95%) and b-selinene (10.56%), terpinen-4-ol[7], 4-allylphenyl acetate and β-bisabolene, 5-hydroxymethyl furfural (59.9%), benzyl alcohol (57.6%), methylcinnamate (9.4%), 3-phenyl-2-butanone (8.5%) and 1, 2-benzenedicarboxylic acid (8.9%)[1]. A new phenylpropanoid, 4,4′[(2E, 2′E)-bis(prop-2-ene)-1,1′-oxy]-diphenyl-7,7′-diacetata[6], as well as *p*-coumaryl alcohol-γ-*O*-methyl ether (CAME) and *p*-coumaryl diacetate (CDA), has also been isolated from the plant[17, 18].

Volatile oil of plant from Sri Lanka contained zerumbone (44.9%) and those from Malaysia, India and Indonesia were found to be β-farnesene, myrcene and 1, 8-cineole, respectively[4, 19]. Bicyclo (4.2.0) oct-1-ene, 7-exoethenyl (58.46%), *trans*-caryophyllene (7.05%), α-pinene (14.94%) with camphene (2.15%), germacrene (1.78%) and citronellyl acetate (1.41%) were reported in *A. galanga* as major components[20].

2 Pharmacological activities

2.1 Anti-inflammatory and analgesic actions Several authors have studied the anti-inflammatory and analgesic effects of *A. galanga* in a variety of rheumatological conditions. Min *et al*[16] isolated chavicol analogues, namely, ACA and HCA from *A. galangal*, in which ACA exhibited potent antioxidant activity, increased cell apoptosis and decreased cytokines production by T helper cells; whereas, HCA suppressed T-bet expression. CAME, a phenylpropanoids from *A. galanga* suppressed interferon-γ production in $CD4^+$ T helper cells by decreasing T-bet expression[17]. *p*-Hydroxycinnaldehyde from *A. galanga* extract inhibited the interleukin-1β-stimulated cartilage matrix degradation[21, 22].

2.2 Anti-acetylcholinesterase activity Methanolic extracts of *A. galanga* showed acetylcholinesterase-inhibitory activity at a concentration of 100 μg/mL[12].

2.3 Anticancer and antimelanogenic potentials *A. galanga* extract at a dose of 300 μg/mL caused apoptosis of all cell lines including normal and p53-inactive fibroblasts, normal epithelial and tumour mammary cells and a lung adenocarcinoma cell line[23]. *A. galangal* and *Curcuma aromatica* extracts at non-cytotoxic concentrations (3.8 to 30.0 μg/mL) suppressed tyrosinase activity, mRNA levels and ultraviolet A (16 J/cm^2)-mediated melanin production[24].

2.4 Platelet-activating factor antagonist and hepatoprotective activity Methanolic extract from the rhizome of *A. galanga* at the concentration of 18.2 μg/mL showed 73.9% platelet-activating factor (PAF)-inhibitory activity[25]. *A. galanga* extract at 200 and 400 mg/kg caused significant reduction in the number of necrotic cells of the liver of rats with paracetamol-induced hepatotoxicity[26].

2.5 Antileishmanial activity Hexane, chloroform and ethyl acetate extracts of *A. galanga* rhizomes, exhibited significant *in vitro* activity against promastigotes of *Lesishmania donovani* due to the presence of phenylpropanoid compounds[15].

2.6 Antimicrobial activities

2.6.1 Antiplasmid activity 1′-Acetoxychavicol acetate from *A. galanga* showed antiplasmid activity against various multi-drug resistant bacteria. Crude acetone extract of the rhizomes of *A. galanga* exhibited antiplasmid activity against *Salmonella typhi*, *Escherichia coli* and vancomycin-resistant *Enterococcus faecalis* with an efficiency of 92%, 82% and 8%, respectively at 400 μg/mL subinhibitory concentration[9].

2.6.2 Antibacterial activity Indian gooseberry (*Phyllanthus emblica* Linn.) and galangal (*A. galanga*) extracts were investigated against *Staphylococcus aureus* for their antimicrobial activities. Minimal inhibitory concentration (MIC) values of Indian gooseberry and galangal extracts were found to be 13.97 and 0.78 mg/mL and the minimum biocidal concentration (MBC) values were 13.97 and 2.34 mg/mL, respectively. Extracts from *A. galanga* flowers showed the activity against *Micrococcus luteus*[10]. The ethanolic extracts of galangal were evaluated for antimicrobial quailities on *S. aureus* 209P and *E. coli* NIHJ JC-2 by using an agar disc diffusion assay. The extract had the strongest inhibitory effect against *S. aureus* with MIC at 0.325 mg/mL and MBC at 1.3 mg/mL using the broth dilution method[7]. Methanolic, acetone and diethyl ether extracts of *A. galanga* have been evaluated against pathogens such as *Bacillus subtilis* MTCC 2391, *Enterobacter aerogene*, *Enterobacter cloacae*, *Enterococcus faecalis*, *E. coli* MTCC 1563, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* MTCC 6642, *Salmonella typhimurium*, *S. aureus* and *Streptococcus epidermis* using the agar well diffusion method. Methanolic extract of the plant showed an excellent ability to fight all pathogens with MIC and MBC values ranging from 0.04 to 1.28 mg/mL and 0.08 to 2.56 mg/mL, respectively[1]. Also the hexane and ethanolic extracts of *A. galanga* showed strong antimicrobial functions against *S. aureus* and/or *Listeria monocytogenes*[27].

2.6.3 Antifungal activity and anti-amoebic activity Extracts of *A. galanga* were studied for their inhibitory activity against mycelial growth of *Phytophthora capsici* KACC 40157, *Rhizoctonia solani* KACC 40146, *Fusarium solani* KACC 40384, *Colletotrichum gloeosporioides* ATCC 32097, and *Botrytis cinera* KCTC 6973. The extracts showed inhibitory activity against all the five fungi[28]. Extract from *A. galanga* rhizome showed antifungal activity toward *Aspergillus niger*[10]. Crude ethanolic extract of the rhizome suppressed the growth of zoonotic dermaytophtes (*Microsporum gypseum* and *Trichophyton mentagrophyte*) and yeast-like *Candida albicans* in a concentration-dependent manner (0.5 to 256 mg/mL)[5]. Chloroform extract of *A. galanga* at a concentration of 1 000 μg/mL showed good anti-amoebic activity against *Entamoeba histolytica* strain HTH-56: MUTM and strain HM1: IMSS with 50% inhibitory concentration (IC_{50}) value of 55.2 μg/mL. The same extract showed the highest activity against *Giradia intestinalis* with MIC at 125 μg/mL with an IC_{50} at 37.73 μg/mL[29].

2.7 Antioxidant activity Different extracts (methanolic and aqueous) and volatile oils from rhizomes of *A. galanga* were assessed for free radical-scavenging activity against 1,1-diphenyl-2-picrylhydrazyl radical. Gas chromatography/mass spectroscopy analysis showed that *trans*-3-acetoxy-1,8-cineole was detected as a main compound in *A. galangal*, responsible for the antioxidant acivity. The novel compound, *p*-coumaryl-9-methyl ether, was isolated from methanol extract of *A. galanga*[18]. It was reported that *A. galanga* leaves and flowers showed the highest chelating and β-carotene-bleaching ability[10].

2.8 Apoptosis activity 4′-Hydroxycinnamaldehyde (4′-HCA) isolated from *A. galanga* was cytotoxic to human leukemic HL60 and U937 cell lines in a dose-dependent manner[30].

3 Conclusion

A. galanga is a rhizomatous medicinal plant of mammoth importance with a diverse pharmacological spectrum. Besides having the above mentioned pharmacological properties, it has been used as a constituent of many herbal formulations for the treatment of various diseases, in particular the respiratory diseases and rheumatism. The plant could be further exploited, in order to fulfil the need of quality-control aspects and standardization of various constituents and extracts.

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5 Conflict of interst statement

The authors declare that there are no conflicts of interests and no agency is involved for financial support for this research work.

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大高良姜的药理学及植物化学研究综述

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摘要:传统医学使用大量具有医用及药用价值的植物治疗疾病,因此是生物活性物质的一个宝库。姜科植物大高良姜通常被用作调经剂、催欲剂、堕胎药、驱风剂、退热剂和抗炎药等,可用于治疗支气管炎、心脏疾病、慢性肠炎、肾结石、糖尿病、风湿病及肾脏疾病。大高良姜含有精油、鞣酸、苯酚、苷类、单萜及糖类等。过去几年,有报道大高良姜各部位提取物中还含有没食子酸、生姜异黄酮、β-谷甾醇、高良姜素、良姜素、花姜酮、山萘素等。本文总结了近年来有关大高良姜的研究中新的植物化学成分及药理学的研究内容。

关键词:红豆蔻;根茎;植物提取物;药理学;综述