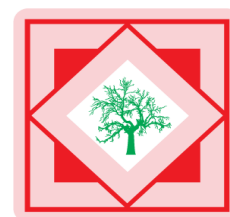




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***Alpinia galanga* – An Important Medicinal Plant: A review**

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ABSTRACT

Traditional system of medicinal consists of large number of plants with various medicinal and pharmacological importances and hence represents a priceless tank of new bioactive molecules. Alpinia galanga (Linn.) Pierre is one amongst these, found all over the world. It is commonly known as 'Kulanjan', and has been recognized in different traditional system of medicines for the treatment of various diseases of human beings. Different parts of this plant are traditionally claimed to be used for the treatment of ailments including anti-fungal, anti-tumor, Anti-helminthic, anti-diuretic, anti-ulcerative, disease of heart, rheumatic pains, chest pain, dyspepsia, fever, diabetes, burning of liver and kidney disease to list of few. Therefore, the present review aimed to compile up to date and comprehensive information of Alpinia galanga with special emphasis on its photochemistry, various scientifically documented pharmacological activities, traditional and folk medicine uses along with its role in biofuel industry.

Keywords - Kulanjan, Sugandha Vacha, Rasna, Greater galangal.

INTRODUCTION

Medicinal plants and derived medicine are widely used in traditional cultures all over the world and they are becoming increasingly popular in modern society as natural alternatives to synthetic chemicals [1]. 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 [2].

At the present juncture, the modern conventional healthcare is burdened with great problems of unsafe medicines, chronic diseases, resistant infections, auto immune disorders and degenerative disorders of ageing, despite great scientific advances. More than 70% of India's 1.1 billion

populations still use these non-allopathic systems of medicine [3]. India possesses almost 8% of the estimated biodiversity of the world with around 0.126% million species [4].

The World Health Organization (WHO) estimated that approximately 80% of world population relies mainly on traditional medicines, mostly plant drugs in their health care. Today, Ayurveda coexists with modern system of medicine, and is still widely used and practiced. About 30% of the currently used therapeutics is of natural origin [5].

Alpinia galanga is also known as Greater galangal in English and Kulanjan in Hindi. Most of the South Indian physicians of traditional Ayurveda and Siddha medicine system use *Alpinia galanga* to treat various kinds of disease including diabetes mellitus [6]. The optimum time for harvesting *Alpinia galanga* was determined in Kerala, India during 1995-1999. Treatments consisted of harvesting at 3 month-intervals from 6 to 48 months after planting. Harvesting the crop at 42 months after planting was the best for realizing maximum rhizome (45.4 t/ha) and oil (127.4 litres/ha) yields, and for obtaining oil of good quality (27.1% cineole [eucalyptol]). A substantial quantity of oil (127.4 litres/ha) was obtained from the roots (19.5 t/ha) 39 months after planting. The shoot yield (40.5 t/ha) and shoot oil yield (70.61 h/a) were highest at 18 months after planting. *A. galanga* reached a maximum height of 129.4 cm with more than 48 tillers per clump and 13 leaves per tiller in the experimental location [7].

TAXONOMY

Kingdom	-	Plantae
Order	-	Zingiberales
Family	-	Zingiberaceae
Subfamily	-	Alpinioideae
Tribe	-	Alpinieae
Genus	-	Alpinia
Species	-	<i>A. galanga</i>

BOTANICAL DISTRIBUTION

Hindi	-	Kulanjan
Kannada	-	Dhumarasmi
Bengali	-	Kulingjan
Gujrati	-	Kulinjan
Malyalam	-	Arattha, Kol-inji, Pararatta
Tamil	-	Pera-rattai
Kannad	-	Dhoomraasmi
Telugu	-	Pedda-dhumpa
Marathi	-	Kulinjan
Sanskrit	-	Mahabaracach, Sugandha Vacha, Rasna
English	-	Greater galangal

GEOGRAPHICAL DISTRIBUTION

The plant is distributed in Himalaya and Southern region of Western Ghats in India [8]. It is often cultivated in Konkan and North Kanara [9].

MORPHOLOGY

Alpinia galangal is commonly known as Greater galangal. Its root stocks are tuberous and slightly aromatic. Leaves are oblong-lanceolate, acute, glabrous, green above, paler beneath, with slightly callus white margins, sheaths are long and glabrous, ligule are short and rounded. Flowers greenish white, in dense flowered, 30 cm Panicles; bracts ovate-lanceolate. Calyx tubular, irregularly 3-toothed. Corolla lobes oblong, claw green, blade white, striated with red, rather more than 1 cm long, broadly elliptic, shortly 2-lobed at the apex, with a pair of subulate glands at the base of the apex, with a pair of subulate glands at the base of claw. Fruit the size of the small cherry, orange red [10].

PHYTOCHEMISTRY

Chemical investigations of the *Alpinia galanga* by jadu, S.B. *et al* (2009) reported the isolation of galangoflavonoid from the rhizomes by column chromatography and eluted with ethyl acetate-methanol (9:1) to yield a compound, galangoflavonoid (AG 11) and the structure of the compound was elucidated by various spectral techniques (UV, IR, ¹H NMR, ¹³C NMR, and MS) [11].

Ye Ying BaoAn (2006) isolated 1'S-1'-acetoxychavicol acetate (ACE) from the rhizomes of *Alpinia galangal* [12].

Matsuda H. *et al* (2003) were isolated nine known phenylpropanoids and p-hydroxybenzaldehyde (1'S-1'-acetoxychavicol acetate and 1'S-1'-acetoxyeuginol acetate) from the rhizome of *Alpinia galangal* [13].

Kkubota k. *et al* (1998) reported four isomers of acetoxycineoles (trans and cis)-2-and 3-acetoxy-1, 1, 8-cineoles from the isolated plant of rhizome. Their structures were confirmed by comparing the retention indices by GC and the mass spectra with those of synthesized compound [14].

Yang Xion Gen and Eilerman R.G. (1999) were isolated and identified 1'-acetoxychavicol acetate (galangal acetate) from rhizome of *Alpinia galanga*. The identification was done by the Gas Chromatography Analysis [15].

Jadu S.B. *et al* (2009) were isolated β-Sitosterol diglucoside (AG-7) and β-sitsteryl Arabinoside (AG-8), from the rhizome of *Alpinia galanga* and characterized by their spectral value [16].

Zhu X.L. (2009) were isolated by the Silica gel and Sephadex LH-20 column chromatography and spectroscopic techniques were employed to elucidate their structures. The phenylpropanoids (4,4'[2E,)-bis (prop-2-ene)-1, 1'-diphenyl-7, 7'-diacetate [17].

Someya, y. *et al* (2001) were isolated and identified three hydroxy-1,8-cineole glucopyranosides, (1R, 2R, 4S)-and (1S, 2S, 4R)-trans-2-hydroxy-1,8-cineole β-D-glucopyranoside, and (1R, 3S, 4S)-trans-3-hydroxy-1, 8-cineole β-D-glucopyranoside, which are possible precursors of acetoxy-1,8-cineole, from the rhizome of the *Alpinia galanga*. Their structures were analyzed by FAB-MS and NMR spectrometry, and the absolute configuration of each aglycone was determined by using a GC-MS analysis with a capillary column coated with a chiral stationary phase. The composition of the diastereomers of (1R, 2R, 4S)-and (1S, 2S, 4R)-trans-2-hydroxy-

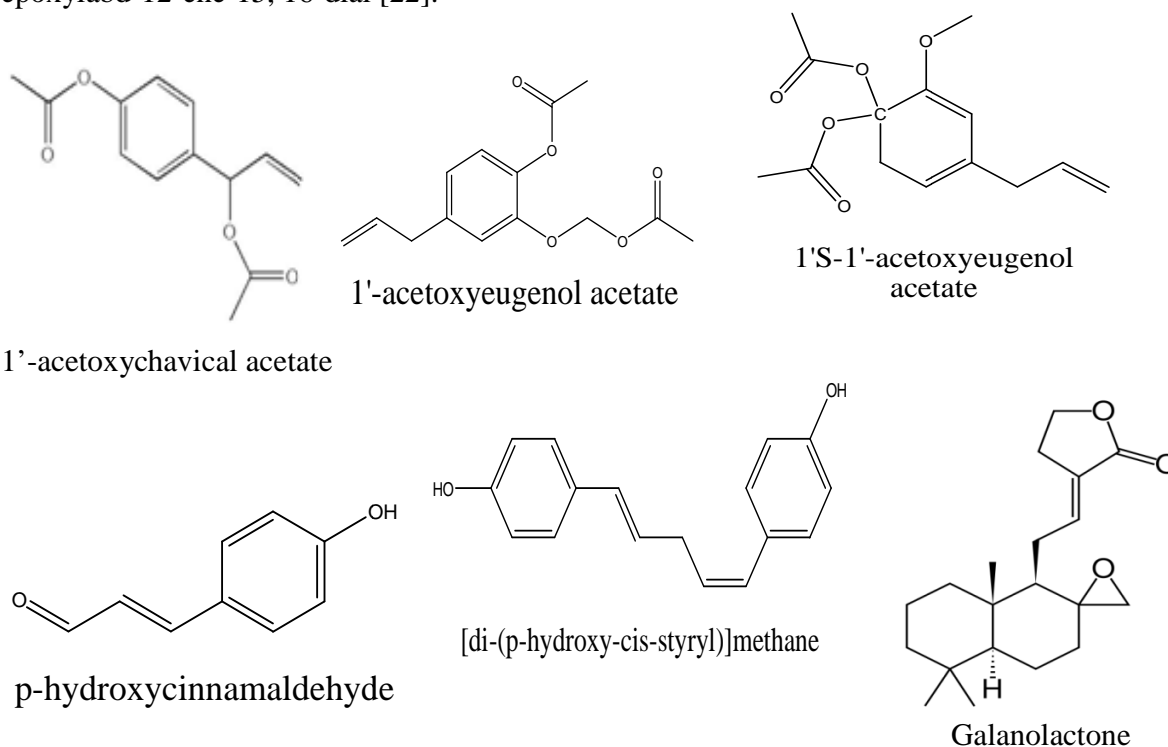
1,8-cineole β -D-glucopyranosides in the rhizome was determined as 3:7 by GC-MS analysis after preparing the trifluoroacetate derivatives of the glycosides [18].

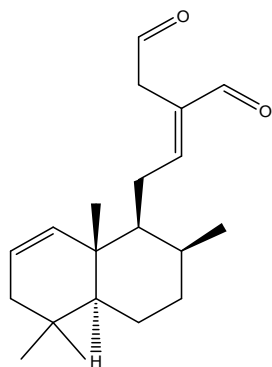
Barik, B.R. (1987) were isolated first time in nature and the latter is a new chemical component from the chloroform extract of the rhizome of the *Alpinia galanga* i.e. p-hydroxycinnamaldehyde and [di-(p-hydroxy-cis-styryl)] methane [19].

Taechowisan, T., (2006) were isolate some endophytic actinomycetes (120) from the roots of the *Alpinia galanga*. The identification of these endophytes was based on their morphology and amino acid composition of the whole-cell extract. Most isolated were classified as *Streptomyces* sp. (82). With the remainder belonging to *Nocardia* sp. (11), *Microbispora* sp. (3), *Micromonospora* sp. (2). Eight isolated were unclassified and 14 were lost during subculture [20].

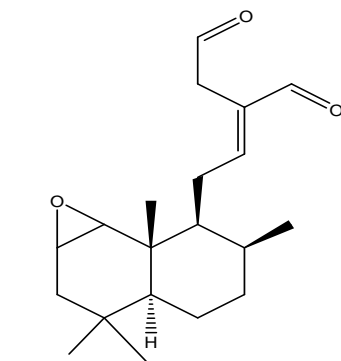
Taechowisan, T. & Lumyong, S. (2003) were isolated AB of 59 endophytic actinomycetes, from roots of *Alpinia galanga* and tested against *Candida albicans* and phytopathogenic fungi, *Colletotrichum musae* and *Fusarium oxysporum* [21].

Haraguchi, H. *et al* (1996) were isolated an Antimicrobial diterpene from the rhizome of *Alpinia galanga*. Its structure was elucidated from by spectral data and identified as (E)-8 beta, 17-epoxylabd-12-ene-15, 16-dial [22].

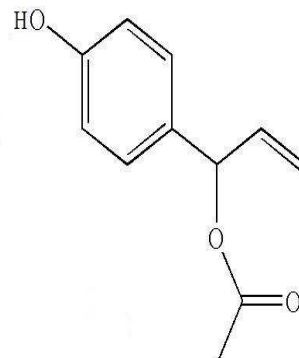




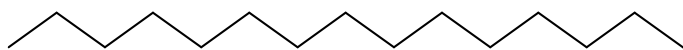
12-labddien-15,16-dial



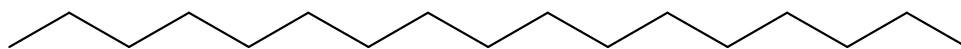
(17)-epoxylabd-12-en-15,16-dial



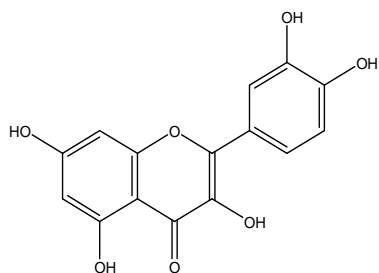
1'-hydroxychevicol acetate



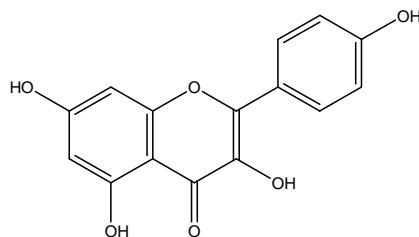
Pentadecane



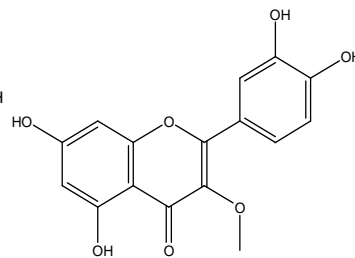
7-heptadecane



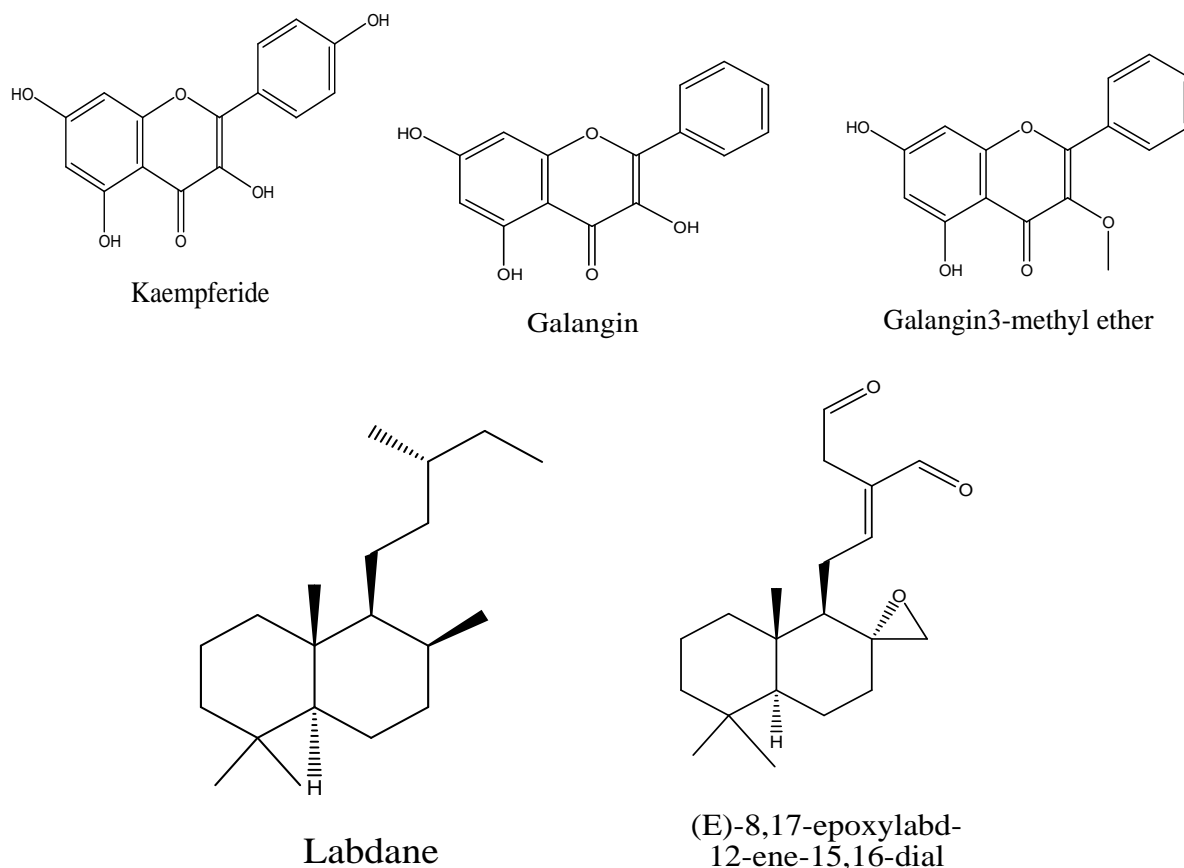
Quercetin



Kaempferol



Quercetin-3-methyl ether



Biological and Pharmacological Action

During past several year years, *Alpinia galanga* is gaining lot of interest according to researchers' point of view. Recently many pharmacological studies have been conducted on *Alpinia galanga*. A summary of the findings of these studies performed is presented below:

Antimicrobial Activity

Elsamma Thomas Shanmugam, J. & Rafi, M. M. (1996) reported Antibacterial activity of plant belonging to Zingiberaceae family (*Alpinia galanga*). The ether and ethyl acetate extracts were screened for their antibacterial activity in vitro against different multi-resistant Gram positive and Gram negative bacteria isolated from hospitalized patients. *Alpinia galanga* showed the best activity; its ether extract was more potent than the ethyl acetate extract. Both types of extracts of *Alpinia galanga* had significant effects on *Staphylococcus aureus* and *Klebsiella pneumonia* [23].

Haraguchi, H. *et al* (1996) studied an antimicrobial diterpene, was isolated from *Alpinia galanga*. Antifungal activity from the competition for incorporation of unsaturated fatty acids in cell growth. Antifungal activity was reversed by unsaturated fatty acids. *Alpinia galanga* a medicinal plant used to treat colic, dysentery, food poisoning and skin diseases [24].

Taechowisan, T. and Lumyong, S. (2003) studied endophytic actinomycetes activity of from roots of *Alpinia galanga* against phytopathogenic fungi and tested against *Candida albicans* and

phytopathogenic fungi, *Colletotrichum musae* and *Fusarium oxysporum*, The strain identified as *Streptomyces aureofaciens* CMUAc130 was the most effective in antifungal activity amongst those investigated [25].

Vuong Thi Thuy Quynh and Duszkievicz-Reinhard, W. (2004) investigated antimicrobial activity of essential oils from fresh and dried rhizomes of *Alpinia galanga*. The essential oils from dried *A. galanga* rhizomes were more effective against the tested microorganisms, *Staphylococcus aureus*, *Bacillus subtilis*, *Streptococcus faecalis* [*Enterococcus faecalis*], *Escherichia coli*, *Proteus vulgaris*, *Salmonella enteritidis*, *Saccharomyces cerevisiae* and *Aspergillus niger*, (the MIC values ranged from 1.25 to 12,5 micro l/ml) than the fresh ones (2.5-20 micro l/ml). The drying method affected the antimicrobial activity [26].

Chukanhom, K. *et al* (2005) studied the antifungal activities of aroma components from *Alpinia galanga* against some fungi in the Saprolegniaceae. The toxicity to goldfish (*Carassius auratus*) and platyfish (*Xiphophorus maculatus*) was also investigated. *Saprolegnia parasitica* NJM 8604, *S. diclina* NJM 0236, *Achlya bisexualis* NJM 9905, *A. diffusa* NJM 0011, and two isolates (NJM 9701 and NJM 0219) of *Aphanomyces piscicida* were used in this study. The fungistatic concentrations of linalool, geranyl acetate and 1,8-cineole against the hyphae of the strains used were 2000 to 500, 2500 to 250 and 5000 to 3000 micro g/ml, respectively, while the fungicidal concentrations of each chemical against the strains were 1250 to 1000, over 2000 and 4000 to 2000 micro g/ml [27].

Hong Song Jen & Chang Chung Hsing. (2006) studied reports a case of localized contact dermatitis and subsequently generalized erythema multiforme-like eruptions after topical application of herbal remedies [Taiwan]. Patch tests showed there was an allergen in fresh and dried *Alpinia galanga*. The patient, a 54-year-old woman, had used a preparation containing dried *A. galanga* as a liniment for her chronic low back and neck pain. Erythema multiforme-like generalized allergic contact dermatitis caused by *Alpinia galanga* [28].

Oonmetta-aree, J. (2006) reported the ethanol extracts of the Zingiberaceae family *Alpinia galanga* (galangal) were evaluated for antimicrobial action on *Staphylococcus aureus* 209P and *Escherichia coli* NIHJ JC-2 by using an agar disc diffusion assay. The galangal extract had the strongest inhibitory effect against *S. aureus* [29].

Trakranrungsie, N. *et al* (2008) studied Crude ethanolic extracts of *Alpinia galanga* rhizomes (Zingiberaceae) were tested against selected zoonotic dermatophytes (*Microsporum canis*, *Microsporum gypseum* and *Trichophyton mentagrophyte*) and the yeast-like *Candida albicans*. A broth dilution method was employed to determine the inhibitory effect of the extracts and compared to those of ketoconazole and griseofulvin [30].

Latha, C. *et al* (2009) reported antiplasmid activity of 1'-acetoxychavicol acetate from *Alpinia galanga* against multi-drug resistant bacteria. They said that the crude acetone extract of the rhizomes of *Alpinia 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 micro g/ml SIC [31].

Sunilson, J. A. J. *et al* (2009) studied antimicrobial activity of various extracts of *Alpinia galanga* were screened against the common food borne bacteria such as *Escherichia coli*, *Salmonella enteritidis*, *Clostridium perfringens*, *Staphylococcus aureus*, *Campylobacter jejuni*, *Bacillus cereus* and fungi such as *Saccharomyces cerevisiae*, *Hansenula anomala*, *Mucor mucedo*, *Candida albicans* using disc diffusion method. All the extracts showed significant antibacterial and antifungal properties.[32]

Yamsakul, P. *et al* (2009) studied the comparison of antimicrobial potential of variety of extraction of *Alpinia galanga* extract such as hexane, ethyl acetate, ethanol and the essential oil respectively that against swine pathogenic bacteria compose of *Escherichia coli* ATCC *Staphylococcus aureus* ATCC *Salmonella typhimurium* ATCC *Salmonella enteritidis* and *Pasteurella multocida*. The results showed that essential oil of *Alpinia galanga* have the best antibacterial and bactericidal activities with minimum inhibition concentration (MIC) and minimum bactericidal concentration (MBC) to *Escherichia coli* ATCC, *Staphylococcus aureus* ATCC, *Salmonella typhimurium* ATCC and *Salmonella enteritidis* at 8 mg/cc and to *Pasteurella multocida* at 16 mg/cc [33].

Pompimon, W. *et al* (2009) studied hexane, ethyl acetate, acetone or methanol extract of the rhizome of *Alpinia galanga* shows the Anti-*Phytophthora capsici* activities and potential use as antifungal in agriculture of *Alpinia galanga*. The studies were conducted to investigate the antifungal activity and their potential use as fungicides in agriculture of crude extracts and purified compounds derived from plants used *Alpinia galanga* were selected and percolated. The extracts were purified and elucidated their chemical structures. Disc mycelial growth inhibition was applied in order to determine their anti-*Phytophthora capsici* activity and a field study was conducted in Thailand to determine their potential use in controlling fungal infection in chili plants compared to commercial fungicides such as captan and control *Trichoderma virens*. All crude extracts inhibited mycelial growth of the fungus and had similar efficacy. The ED₉₀ was equal to 300 ppm [34].

Antiinflammatory

Matsuda, H. *et al* (2003) reported Antiallergic principles from *Alpinia galanga* rhizome. The 80% aqueous acetone extract of the rhizomes of *Alpinia galanga* was found to inhibit release of beta -hexosaminidase, as a marker of antigen-IgE-mediated degranulation in RBL-2H3 cells [35].

Satish, R. and Dhananjayan, R. (2003) studied Evaluation of the antiinflammatory potential of rhizome of *Alpinia galanga* Linn. The antiinflammatory properties of total alcoholic extract (TAE) and total aqueous extract (TAQ) from *Alpinia galanga* rhizomes were evaluated in acute (carrageenan-induced paw oedema; M1) and sub-acute (cotton-pellet-induced granuloma; M2) rat models [36].

Nagashekhhar, M. and Shivaprasad, H. N. *et al* (2006) reported the Anti-inflammatory and analgesic activity of the topical preparation of *Alpinia galanga* willd from methanolic extract. The anti-inflammatory activity was evaluated against Carrageenan-induced oedema in rats and in a formalin test. Piroxicam gel and methyl salicylate ointment were studied as positive controls for antiinflammatory and analgesic activities, respectively. The degree of inhibition of oedema

by preparations containing the extract at 1-5% w/w significantly varied from that of the control. The antiinflammatory effect of SN at 4-5% was similar to the effect of Piroxicam gel at 3 h after Carrageenan injection [37].

Jaju Shivkanya *et al* (2009) reported Antidiabetic and anti-inflammatory activities from the phenolic and methanolic extract of rhizome of *Alpinia galangal* [38].

Phitak, T. *et al* (2009) reported the effects of *p*-hydroxycinnamaldehyde from *Alpinia galanga* acetone extracts on human chondrocytes. Osteoarthritis (OA) is the most common form of arthritis and affects millions of people worldwide. Patients have traditionally been treated with non-steroidal anti-inflammatory drugs (NSAIDs), but these are associated with significant side effects [39].

Hepatotoxicity

Hemabarathy, B. and Siti Balkis Budin Feizal, V. (2009) reported the Paracetamol hepatotoxicity in rats treated with crude extract of *Alpinia galanga*. This study was conducted to observe the hepatoprotective effect of the crude extract of *Alpinia galanga* at 200 and 400 mgkg⁻¹ against paracetamol induced hepatotoxicity in rats [40].

Anti- HIV

Ye Ying Li BaoAn (2006) reported Anti human immunodeficiency virus type 1 replication by blocking Reverse Transport from 1'S-1'-acetoxychavicol acetate isolated from *Alpinia galanga* rhizomes extract [41].

Immunomodulator

Bendjeddou, D. *et al* (2003) reported Immunostimulating activity of the hot water-soluble polysaccharide extracts of *Alpinia galanga*. *Alpinia galanga* (L.) Willd. (family Zingiberaceae) were tested for their immunostimulating activity in mice [42].

Anti Diabetic

Akhtar, M. S. *et al* (2002) studied hypoglycaemic activity of *Alpinia galanga* rhizome and its extracts in rabbits the investigation was carried out to study effects of *Alpinia galanga* rhizome on blood glucose levels. In normal rabbits, powdered rhizome and its methanol and aqueous extracts significantly lowered the blood glucose [43].

Jaju Shivkanya *et al* (2009) reported Antidiabetic and anti-inflammatory activities from the phenolic and methanolic extract of rhizome of *Alpinia galangal* [38].

Anti-Oxidant

Kubota, K. *et al* (2000.2001) reported antioxidative activity of 1'-acetoxychavicol acetate and its related compounds in the rhizomes of *Alpinia galanga* during [44].

Mahae, N. and Chaiseri, S. (2009) studied Antioxidant activities and antioxidative components in extracts of *Alpinia galanga* (L.) & they said 50% ethanol in water was studied for its antioxidant activity and composition in comparison with two other samples based on a water extract and the essential oil. The antioxidant activities were 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 [45].

Wong, L. F. *et al* (2009) studied the antioxidant activity of methanol extracts of *Alpinia galanga* leaves were evaluated for total phenolic content. The AOA were investigated using 1,1-diphenyl-2-picrylhydrazyl (DPPH), reducing power (RP), ferrous ion chelating as well as beta -carotene bleaching assays. They also said *Alpinia galanga* leaves and flowers showed highest chelating and beta -carotene bleaching abilities. Extracts from *Alpinia galanga* flowers showed the largest zone of inhibition of *Micrococcus luteus*. Only the extract from *Alpinia galanga* rhizome showed antifungal activity toward *Aspergillus niger*. The antimicrobial activities were screened by using disc diffusion method [46].

Anti-Ulcer

Al-Yahya, M. A. *et al* (1990) reported Gastric antisecretory, antiulcer and cytoprotective properties of ethanolic extract of *Alpinia galanga* Willd. in rats. They said rhizomes of *A. galanga* are used widely in Arabian and Unani systems of medicine to treat stomach disorders. The ethanolic extract also significantly reduced gastric secretion and showed marked cytoprotective activity; it is suggested that these properties may be responsible for the antiulcer activity of *Alpinia galangal* [47].

Qureshi, S. *et al* (1994) reported treatment on cytological and biochemical changes induced by cyclophosphamide in mice by the effect of *Alpinia galanga* from the ethanolic extract. The rhizomes of *Alpinia galanga* are used as a spice and in traditional medicine to treat dyspepsia, gastralgia, sea sickness, and abdominal colic, and as an antiinflammatory, antineoplastic, digestive and tonic [48].

Dadang Riyanto, S. and Ohsawa, K. (1998) reported Lethal and antifeedant substance from rhizome of *Alpinia galanga* Sw. (Zingiberaceae). Extracts from *A. galanga* showed insecticidal activity and were screened further to isolate the active compound. The active compound was identified as 1'-acetoxychavicol acetate, which had a molecular formula of C₁₃H₁₄O₄. Several Zingiberaceae species were screened for compounds which show insecticidal effects. Extracts from rhizomes of *Alpinia galanga* were tested as an antifeedant [49].

Traditional Uses of *Alpinia Galanga*

The rhizome of the plant is used as carminative, digestive tonic, anti-emetic [1], anti-fungal, anti-tumor, Anti-helminthic, anti-diuretic, anti-ulcerative, anti-dementia [5]. The extract of rhizome shows anti-tubercular activity, hypothermia, bronchial catarrh, tonic, stomachic and stimulant [50].

It is also used as pungent, bitter, heating, stomachic, improve appetite, disease of heart, aphrodisiac tonic, expectorant, use in heal, ache, lumbago, rheumatic pains, chest pain, diabetes, burning of liver, kidney disease, disinfectants [51]. The rhizome is also used as anti-microbial, anti-bacterial [52], anti-inflammatory and flavouring agent [53].

The seeds are used as cardiogenic, diuretic, hypotonic, gastric lesions, antiplatelet, anti-tumor, anti-fungal [54]. The tubers of this plant is used as carminative, irritant action, whooping cough in children, bronchitis, anti-asthma, dyspepsia, fever and diabetes mellitus [55].

CONCLUSION

The extensive literature survey revealed that *Alpinia galanga* is important medicinal plant with diverse pharmacological spectrum. The plant shows the presence of many chemical constituents which are responsible for varied pharmacological and medicinal property. The evaluation needs to be carried out on *Alpinia galanga* in order to uses and formulation of the plant in their practical clinical applications, which can be used for the welfare of the mankind.

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