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Pharmacology of an Endangered Medicinal Plant *Alpinia galanga:* A Possible Treatment for covid-19

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ABSTRACT

Traditional system of medicine consists of huge number of plants with various medicinal and pharmacological importances and hence represents a priceless thank of latest bioactive molecules. galangal (Linn.) is one of these, found everywhere the planet. it's commonly referred to as 'Kulanjan'. Different parts of this plant are traditionally claimed to be used for the treatment of anti-fungal, antitumor, anti-diuretic, disease of heart, rheumatic pains, dyspepsia, fever, diabetes etc. Therefore, this review aimed to compile and comprehensive information of galangal with special emphasis on its various scientifically documented pharmacological activities, traditional and folk medicine uses along side its role in biofuel industry. this review will highlight the pharmacological and therapeutic effects of Alpinia galangal. Galangal (Zingiberaceae) is one sort of herbal plant that's widely grown in india. Various countries cultivate this medicinal plant, including India. This medicinal plant features a sort of benefits and even be used as a treatment for several diseases. Although the galangal rhizome is that the most generally used and studied a part of the plant, the flower on the galangal also can provide additional advantages, like antioxidant and antimicrobial properties. Therefore, this study aimed to demonstrate galangal for the longer term prospects against SARS-CoV-2. In summary, this study suggests that lengkuas could be useful as a treatment for COVID-19, although further studies might be conducted to verify the results of computational studies.

Keywords: galangal, COVID-19, Medicinal Plant, pharmacology, SARS-CoV-2

INTRODUCTION

Medicinal plants and derived medicine are widely utilized in traditional cultures everywhere the planet and that they are getting increasingly popular in modern society as natural alternatives to synthetic chemicals[1].In the previous couple of decades there has been an exponential growth within the field of herbal medicine. it's getting popularized in developing and developed countries due to its natural origin and lesser side effects[2]. At this juncture, the fashionable 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. quite 70% of India's 1.1 billion Populations still use these non-allopathic systems of drugs[3]. India possesses almost 8% of the estimated biodiversity of the planet 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 drugs, and remains widely used and practiced. About 30% of the currently used therapeutics is of natural origin[5]. galangal is additionally referred to as Greater galangal in English and Kulanjan in Hindi. Most of the South Indian physicians of traditional Ayurveda and Siddha medicine system use galangal to treat various sorts of disease including diabetes mellitus[6]. The optimum time for harvesting galangal decided 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 simplest for realizing maximum rhizome (45.4 t/ha) and oil (127.4 liters/ha) yields, and for obtaining oil of excellent quality (27.1% cineole [eucalyptol]). a considerable quantity of oil (127.4 liters/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 quite 48 tillers per clump and 13 leaves per tiller within the experimental location[7]. within the previous couple of decades there has been an exponential growth within the field of herbal medicine. it's getting popularized in developing and developed countries due to its natural origin and lesser side effects. galangal belongs to the Zingiberaceae has been used traditionally for the treatment of eczema, bronchitis, coryza, morbili, pityriasis versicolor, labyrinthitis, gastritis, ulcers and cholera. The seed of A galanga is employed for emaciation and to wash the mouth, stimulates the digestive power, appetite and as a purgative. The rhizome is usually used as a spice or source of volatile oil. The flowers and young shoots are used as a vegetable or as a spice[1]. galangal contained flavonoids and volatile oils[8-29]. The previous studies showed that galangal possessed many pharmacological activities, including antibacterial, antifungal, antiviral, Antiprotozoal[30-48], immunomodulatory, anti-oxidant effect, antidiabetic, antiplatelet, hypolipidemic and lots of other pharmacological effects. the target of this review is to spotlight the chemical constituents and therefore the pharmacological and therapeutic effects of galangal.

TAXONOMY

Kingdom - Plantae
Order - Zingiberales
Family - Zingiberaceae
Subfamily -Alpinioideae
Genus - Alpinia
Species - A. galangal

GEOGRAPHICAL DISTRIBUTION

It's found in Indonesia, India, China, and Arabic gulf areas, Malaysia, Egypt and Sri Lanka. It grows in open sunny places, forests and brushwood. it's commonly cultivated within the mid and low-country in Sri Lanka[49]. The plant is distributed in Himalaya and Southern region of Western Ghats in India[50]. it's often cultivated in Konkan and North Kanara[51].

TRADITIONAL USE

Galangal has been used for the treatment of eczema, bronchitis, coryza, morbili, pityriasis versicolor, labyrinthitis, gastritis, ulcers, and cholera. The seed of A galanga is employed for emaciation and to wash the mouth, stimulates the digestive power, appetite and acts as a purgative. The rhizome is usually used as a spice or source of volatile oil throughout its distribution area. The flowers and young shoots are used as a vegetable or as a spice[49].The rhizome of the plant is employed as carminative, digestive tonic, anti-emetic, antifungal, antitumor, Anti-helmintic, anti-diuretic, anti-ulcerative, anti-dementia5. The extract of rhizome shows anti-tubercular activity, hypothermia, bronchial catarrh, tonic, stomachic and stimulant[50]. it's also used as pungent, bitter, heating, stomachic, improve appetite, disease of heart, aphrodisiac tonic, expectorant, use in heal, ache, lumbago, rheumatic pains, pain, diabetes, burning of liver, renal disorder, disinfectants[52] . The rhizome is additionally used as anti-microbial, anti-bacterial, anti-inflammatory and flavoring agent[53]. The seeds are used as cardiotonic, diuretic, hypotonic, gastric lesions, antiplatelet, anti-tumor, anti-fungal[54]. The tubers of this plant is employed as carminative, irritant action, pertussis in children, bronchitis, anti-asthma, dyspepsia, fever and DM[55].

MORPHOLOGY

Alpinia galangal in commonly referred to 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, ligules 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 quite 1 cm long, broadly elliptic, shortly 2-lobed at the apex, with a pair of subulate glands at the bottom of the apex, with a pair of subulate glands at the bottom of claw. Fruit the dimensions of the tiny cherry, orange red[56].

PHARMACOLOGICAL ACTION

During past several year years, galangal is gaining lot of interest consistent with researchers' point of view. Recently many pharmacological studies are conducted on galangal. A summary of the findings of those studies performed is presented below:

ANTIMICROBIAL ACTIVITY

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*[57]. 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[58]. 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[59]. Antimicrobial activity of essential oils from fresh and dried rhizomes of *Alpinia galanga* was investigated. 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[60]. The antifungal activities of aroma components from *Alpinia galanga* against some fungi in the Saprolegniaceae was studied. The toxicity to goldfish (*Carassius auratus*) and platyfish (*Xiphophorus maculates*) 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[61]. A study 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 galangal.* 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 galangal*[62]. 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*[63]. 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[64]. Antiplasmid activity of 1'-acetoxychavicol acetate from *Alpinia galanga* against multi-drug resistant bacteria was reported. 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[65]. Antimicrobial activity of various extracts of *Alpinia galanga* were screened against the common food borne bacteria such as Escherichia coli, Salmonella enteriditis, 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[66]. 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 Staphilococcus aureus ATCC Salmonella typhimurium ATCC Salmonella enteritidis* and *Pasteurella multocida was studied*. 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*, *Staphilococcus aureus ATCC*, *Salmonella typhimurium ATCC* and *Salmonella enteritidis* at 8 mg/cc and to *Pasteurella multocida* at 16 mg/cc[67]. Hexane, ethyl acetate, acetone or methanol extract of the rhizome of *Alpinia galanga* shows the Anti-*Phytopthora 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[68].

ANTI INFLAMMATORY

Antiallergic principles from Alpinia galanga rhizome was reported. 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[69]. Evaluation of the anti-inflammatory potential of rhizome of Alpinia galanga Linn. Was carried out. The anti-inflammatory 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[70]. The Anti-inflammatory and analgesic activity of the topical preparation of Alpinia galanga willd from methanolic extract was reported . 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 anti-inflammatory 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 anti-inflammatory effect of SN at 4-5% was similar to the effect of Piroxicam gel at 3 h after Carrageenan injection[71]. Antidiabetic and anti-inflammatory activities from the phenolic and methanolic extract of rhizome of Alpinia galangal was reported[72] . The effects of p hydroxycinnamaldehyde from Alpinia galanga acetone extracts on human chondrocytes was reported. 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[73].

HEPATOTOXICITY

The Paracetamol hepatotoxicity in rats treated with crude extract of Alpinia galanga was reported. 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[74].

ANTI- HIV

Anti human immunodeficiency virus type 1 replication by blocking Reverse Transport from 1'S-1' acetoxychavicol acetate isolated from Alpinia galanga rhizomes extract[75].

IMMUNOMODULATOR

Study 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[76]

ANTI DIABETIC

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[77]. Antidiabetic and anti-inflammatory activities from the phenolic and methanolic extract of rhizome of Alpinia galangal was reported[80] .

ANTI-OXIDANT

A study of Antioxidant activities and antioxidative components in extracts of Alpinia galanga (L.) & it states 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[78]. The antioxidant activity of methanol extracts of Alpinia galanga leaves were evaluated for total phenolic content was studied. 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[79].

ANTI-ULCER

A study 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*[80]. A study 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 anti-inflammatory, antineoplastic, digestive and tonic[81].
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[82].

ANTIVIRAL ACTIVITY AGAINST SARS-COV-2

Medicinal plants in the Zingiberaceae family include Alpinia, Kaempferia, Curcuma, and so on, which contain compounds often used as herbal treatments. The use of herbal treatments increased rapidly during the COVID-19 pandemic, a study reported the potential inhibitory effect of Alpinia, Caesalpinia, Citrus, and Curcuma against SARS-CoV-2, so that the development may provide novel treatment and prevention strategies for COVID-19 treatment. One of the phytocomponents of Alpinia galanga has been predicted as a possible potent antiviral agent against SARS-CoV-2[83].

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. In summary, Alpinia *galanga* is commonly used as a medication for many illnesses. This study suggests that Alpinia *galanga* might be useful as a treatment for COVID-19, although further studies could be conducted to confirm the results of computational studies.

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