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Review Article

Alpinia officinarum (Galangal): A Beneficial Plant

Munir Ahmed[1], Sakhawat Riaz[2*], Arslan Ahmad[2], Rimsha Farooq[1], Umber Mubeen[2], Muneer Hussain[3] and Nasir Hussain[4]

[1]School of Food Science and Engineering, Yangzhou University, China

[2]Department of Home Economics, Government College University Faisalabad, Pakistan

[3]Department of Eastern Medicine, Government College University Faisalabad, Pakistan

[4]Department of Food Science and Technology, Government College University Faisalabad, Pakistan

Abstract

Alpinia officinarum Hance rhizome have been traditionally used to cure a number of illnesses, piqueing the attention of the scientific community in this traditional medicinal plant. In this, we discussed its cultivation and constituents as well. In this work, the preparations and parts of the *Zingiberaceae* family plant species *A. officinarum* are characterized in terms of their phytochemical and therapeutic activities. Different plant components, many different techniques have been used to recover the entire plant, including the leaves, roots, rhizomes, and aerial parts, using solvents including methanol, ethanol, and ethyl acetate. These extracts' biological properties, fractions, and isolated compounds, including antioxidant, antibacterial, anti-inflammatory, anticancer, and anti-viral activity, have been examined.

Keywords: Galangal; *Alpinia officinarum*; Medicinal plant; Phytochemical; Therapeutic activities

Introduction

Galangal is a perennial plant in the *Zingiberaceae* family called *Alpinia officinarum* Hance. Beautiful foliage and a raceme of vibrant blooms are on it. The rhizome has a stronger flavor and scent and is less solid [1]. The less popular galangal is *Alpinia officinarum* Curtis. Southern China and several other Asian nations extensively plant *A. officinarum* Hance, a member of the *Zingiberaceae* family [1]. In earlier investigations, it was determined that the three main constituent categories that could be separated from the smaller galangal rhizomes were flavonoids, glycosides, and diarylheptanoids [3]. Subsequent research has connected these phytonutrients to pharmacological effects like anti-inflammatory, antioxidant, and anticancer activities. Though little information is now available on the bacteriolytic activity of plant rhizomes [4]. Herbal medication is widely used in underdeveloped countries, particularly in those with fragile local economies [5]. There is currently a significant desire for the usage of medicines derived from botanicals worldwide [6]. Along with stomach and respiratory problems, galangal is frequently prescribed for cramps, diarrhea, and respiratory problems. In place of antibiotics, galangal can be used to treat bacterial infections. Due to the fact that it has anti-inflammatory, antioxidant, anti-bacterial, and anti-tumor characteristics and is able to cure illness, gastrointestinal pain, and other conditions, this is effectively utilized as a therapeutic therapy for a variety of illnesses. The plant's tuber is frequently used as a treatment for diabetes mellitus, fever, and coughing [7].

Indonesia is the nation that produces and provides the most AG, and this plant is abundantly cultivated there. Other than Indonesia, a number of Asian nations, including as India, China, Malaysia, Egypt, Sri Lanka, and Thailand, also have AG growing areas [8]. Galangal also works well for treating fever, and irregular periods, and boosting male fertility. Originally, the rhizome of galangal was used in a number of remedies to treat ailments including arthritis, irritation, diabetes, including neurological problems as well as to prevent cancer and tumors [9]. Many scientists have conducted extensive research on the active components found in the different portions of *A. galanga*. In past studies, several active chemicals were effectively extracted and identified. The primary active ingredients of *A. galanga* include 1,8-cineol, fenchyl acetate, farnesene, bisabolene, bergamotene, pinene, and -1'-acetoxychavicol acetate. One of the distinguishing compounds of *Alpinia spp.* is 1, 8-cineole, which has been noted as the most prevalent chemical in the majority of investigations on *A. galanga* [10]. *Alpinia galanga* has been shown to exhibit considerable superoxide anion scavenging, metal chelating, and strong free radical scavenging action against DPPH radicals in both its aqueous and methanolic extracts. Additionally, the ethanolic of galanga has been shown to have potent antiseptic activity and may be able to effectively block the enzymes a-glucosidase and amylase. It was also believed that *Alpinia galanga* enhanced animal intellect [11].

Cultivation

Additionally, 300 of the more than 3000 essential oils produced by more than 2000 plants are notable from a commercial viewpoint. Because of their diverse range of pharmacologic and biological effects, including their antimicrobial properties, antioxidative, antimutagenic, hypoglycemic, virucidal, fungicidal, anti-inflammatory, and antimalarial actions, plant oils are broadly utilized in the pharmacy, agricultural, food, perfume, facelift, and sanitary industries [12-14]. Greater galangal is an annual shrub that is mostly grown like a spice in Asia under the name *Alpinia galanga* (L.) Willd [15]. The rhizome of *A. galanga* has been there for a very long time as a pickling spice pickling spices and food flavoring, as well as in Chinese, Ayurvedic, Thai, and Unani folk medicine to treat a variety of illnesses, such as stomach cramps, nausea, diarrhea, diabetes, microbial infections, chest infections, fever, headaches, sore throats, viral diseases, kidney problems, ulcers, arthritis [16].

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***Corresponding author:** Sakhawat Riaz, Department of Home Economics, Government College University Faisalabad, Pakistan, E-mail: sakhawt.sakhi@gmail.com

Lavender oil is listed in the "Catalogue of Cosmetic Raw Materials Used (2021 Edition)" which has been approved by both the China National Food & drug Commission and the European Commission's repository for data on skin creams and chemicals. In order to make creams, these substances are extracted from the *A. galanga* flower, stolons, leaf, and fruit [17]. Within lower troposphere, *A. galanga* normally blooms from to August, although it can grow during the entire tropical [18]. Spices, culinary ingredients, and cosmetic ingredients may all be made from its flower. However, there isn't any research on the *A. galanga* flower, but those that do only demonstrate the antibacterial, antimicrobial, and antioxidant properties of its hexane, ethanol, and methanol extracts [16].

Constituents and Bioactive Compounds of Galangal

According to reports, galangin can be found in various Asian herbal remedies and also in the roots of the herbs *Zingiber officinale* Roscoe and Leaf remove officinarum. Overview of the whole *Lamiaceae*, Alnus pendula Matsum, Plantago major L, and *Scutellaria galericulata* L families as well as the Betulaceae, which is regarded as its active ingredient [19], in addition to propolis [20]. Oriental civilizations have traditionally employed this organic flavone as a folk treatment to cure and/or prevent asthma, colds, stomach disorders, hypertension, and diarrhea. The aromatic ring hydrocarbon receptor is both a stimulant and an inhibitor of life forms. It inhibits cytochrome P450 function. Galangin may be used to treat vitiligo due to its anti-proliferative, anti-metastatic, anti-inflammatory, vasorelaxant, antiviral, antimicrobial, anti-allergic, inflammatory, and pro properties [21].

Flavonol is the genus of galangin, and its molecular formula is C15H10O5. 3,5,7-trihydroxy-2-phenyl, also known as 4H-1-benzopyran-4-one, is its chemical name, and its exact mass is 270.05282342. It also goes by the less well-known name of norizalpinin. It is a solid substance with a melting point between 214°C and 215°C with a colour that ranges from light to dark yellow. It disintegrates in dichloromethane, ethanol, DMSO, acetone, or ethanol but is insoluble in water (0.12 g/l). That becomes stable at a pH level that is slightly acidic and unstable at a pH level that is basic. Galangin, which has a somewhat acidic pH, has three phenolic hydroxyls. Galangin may be quantified in herbal goods by using it as an analytic reference standard because the majority of it is derived from various extracts [22], beeswax, bees [23], plus alcohol [24] analyzing samples with high-performance liquid chromatography. *Helichrysum auronitens* Sch.Bip., an Asteraceae plant, and *Alpinia galanga* Willd., a *Zingiberaceae* plant, both generate significant amounts of these flavonols (concentrations ranging from 2.63 to 11.1%) [25].

Phytochemistry Examples of acetoxycineoles include galangal acetate, hydroxy-1, 8-cineole glucopyranosides 1R, 2R, and 4S, the compound -trans-2-hydroxy-1, 8-cineole -D-glucopyranoside, and variants glucoside and sisterly arabinoside (cis and trans) Acetoxy-1, 1, 8-cineole-2 and 3- 1R, 3S, 4S Glucopyranoside trans-3-hydroxy-1-citral-8-D [10,26,27].

Two skeletal diterpenes from *A. galanga*, galanolactone and (E)-(17), 12-labdane, were also discovered in addition to (E)-(17)-epoxylabd-12-ene 15,16-dial. One of the aromatic compounds found in the rhizome of *A. galanga* was isolated and given the name 1'-acetoxychavicol diacetate [28]. The primary biomolecules isolated from *Alpinia galanga* are listed in Table 1 together with their biological functions.

Alpinia officinarum Solvent Extracts and Isolated Compounds

Tan et al. [29] used LC mass spectrometry and a particular reaction control mode to separate 12 polyphenols and 4 DAHs from a methanol extract of *A. officinarum* leaves. Chysin, pinocembrin, tectochrysin, apigenin, galangin, 3-hydroxymethylgalangin, acacetin, Kaempferol, kaempferide, quercetin, isorhamnetin, and rutin were among the 12 flavonoids (12). Yakuchinone A (13), oxyphyllacinol (14), hexahydrocurcumin (15), and hannokinol were the four DAHs (16). Scientists discovered 17 components in the different extracts or rhizomes of a three - month *A. officinarum* in research done [30]. The plant matter was eliminated using maceration and alcohol ultrasonic extraction. The LC-MS apparatus was performed after an aliquot was introduced. They were extracted from the *A. officinarum* dried rhizomes with methanol, and their *in vitro* bioactivity was assessed [31]. Table 2 and Figure 1, respectively, provide an outline of the actions of methanol extracts and isolated compounds in contrast to their constituents.

Ethyl acetate

Investigations of the methanol extract of *A. officinarum* rhizomes' *in vivo* anti-inflammatory and *in vitro* antioxidant abilities produced encouraging results. The components of the marker were separated from this extract [31]. The crushed and dried rhizomes of *A. officinarum* contained a significant amount of novel DAH compounds, according to Zhao & Liu [32,33]. The *in vitro* cytotoxic capability of every substance against several cancer cell lines was assessed. Table 3 and Figure 2 compile the functionalities of the molecules and chemicals that ethyl acetate separates separately.

Ethanol

Compounds 2, 5, 6, 9, and 22 were five flavonoids that Zhang et al. [34] extracted from the aerial portions of *A. officinarum* after ethanol extraction. A technique for extracting a pure extract from aerial sections using ethanol was reported in a Chinese patent. The extract would subsequently be refined using macroporous adsorptive resin [4]. Dry rhizomes of *A. officinarum* were crushed, and either a hot maceration technique or a cold maceration approach was used to extract the substance using 50% ethanol. It was discovered that the first approach had more phenol and flavonol than the second [35]. An *A. officinarum* ethanol extract prepared in 95% ethanol at 70°C for 6 hours was discovered to contain greater total antioxidant contents than just the water extract despite having poorer superoxide radicals' elimination efficiency when evaluated for antioxidants by using DPPH assay [36]. Table 4 and Figure 3 present a summary of the chemical structures and activity of test compounds and ethanol extracts, accordingly.

Health Benefits of Galangals

The onset and development of tissue damage and periodontal inflammation, which result in tissue disintegration and the production of a pro-inflammatory state in periodontitis, require sufficient hydroxyl radicals, also known as oxidative stress. This one is because it's possible that ROS might encourage the production of substances that cause inflammation, regulate apoptosis, and stimulate leukocytes, all of which could lead to the production of radicals. This results in a loop of inflammation and aggravated tissue damage. There is a progressively strong interest in using herbal remedies to treat and prevent problems including periodontal infections [37]. A study by Javid et al. [38], indicated that Consuming ginger reduced

Table 1: The major nucleotides taken out of Alpinia galanga and how they work.

The compound's name	kind of substance	Drug-related behavior	Reference
1,7-bis 4-hydroxyphenyl Bisdemethoxycurcumin and 1, 4, 6-heptatrien-3-one	Curcuminoid (natural phenols)	Inside the cell viability test, the aggressive melanoma A2058 was stopped from growing.	[45]
1'-acetoxychavicol acetate	Phenylpropanoid	triggers the apoptosis and death of myeloid leukemia cells. As a consequence, ACA-induced death signaling is mediated through the mitochondrial oxygen shock pathway. As a result of ACA-induced apoptosis, Caspase-9 is activated and mitochondrial membrane potential is decreased in NB4 cells. Additionally, ACA boosted caspase-8 activity, which prompted Fas-mediated death.	[55]
1'S-1'-acetoxyeugenol acetate	Phenylpropanoid	contribute to the class I allergic responses of the RBL-2H3 cells in the postoperative period.	[56]
p-hydroxycinnamaldehyde	Phenylpropanoid	Given that it affects human cells, this compound may be used to treat arthritis.	[57]
1'S-1'-acetoxychavicol acetate	Phenylpropanoid	*E. coli* becomes resistant as a result of its action as an active efflux inhibitor, providing it a new opportunity for the creation of pro medicines.	[58]
1'S-1'-acetoxychavicol acetate	Phenylpropanoid	The development of nuclear factor B is stopped via	[59]
1'S-1'-acetoxychavicol acetate	Phenylpropanoid	antiplasmin efficacy against multi-drug resistant strains.	[60]

Table 2: Synopsis of the studies using Alpinia officinarum methanol yields.

Parts of Alpinia officinarum	Extraction procedure	Defined substances	Observations	References
Leaves	Maceration and ultrasonic extraction	42370		[29]
portions of the air and	Maceration and ultrasonic extraction	1-5, 7-13, 15, 17-20	Compared to aerial parts, rhizomes exhibit greater compound contents.	[30]
Rhizomes	Maceration		antioxidant performance	[31]
Rhizomes	72 hours of r.t. methanol immersion		anti-cancer properties	[61]
Leaf and rhizome	100% methanol in lysis buffer for two hours		The anti-proliferative activity of rhizome extract is not as potent as that of leaf extract.	[62]
Roots	3 hours of extraction in 70% formaldehyde at 80°C		Antioxidant activity	[63]

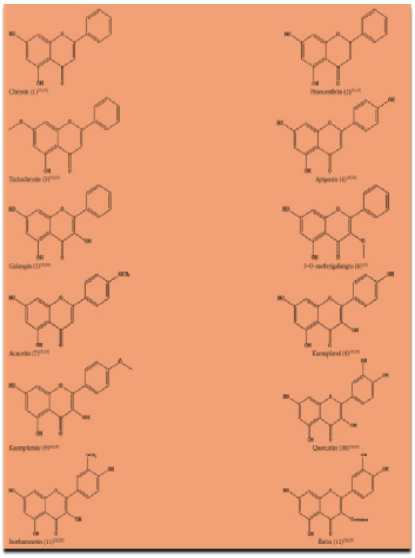

Figure 1: Alpinia officinarum extracts its components using methanol.

oxidative stress, enhanced inflammatory and periodontal conditions, and elevated blood levels of enzymatic antioxidants when combined with conventional periodontal therapy. The therapeutic properties of violet's active ingredients, such like paradol, shogaol, gingerol, as well as bisabolene, include the ability to control blood sugar, lessen inflammation, shield against cancer, and combat obesity [39]. Greater galangal, often referred to as *Alpinia officinarum*, is a large flowering plant that is extensively distributed in the tropical and subtropical areas of Southeast Asia. In western treatments, their rhizomes serve as a pro, painkiller, plus reactive agent [40]. Figure 4 depicts the view of the spices and herbs from a botanical standpoint.

This plant's rhizome would be used to brace the blood supply and cure edema, colds, and stomach problems in traditional Chinese medicine. Cholera, gastritis, otitis interna, ulcers, morbilli, pityriasis Versicolor, bronchitis, eczema, coryza, gastritis, mouth cleaning, and malnutrition are among the many conditions it is regularly often used to treat [41].

Antioxidant activity

It has been demonstrated that the particular phenylpropanoid compound 1'-Acetoxychavicol Acetate in *Alpinia galanga* possesses anti-oxidative, pungent, and fragrant properties. Linoleic acid's capacity as an antioxidant was also investigated. Although ACA had the greatest anti-oxidative action, related substances also demonstrated notable anti-oxidative activity. The antioxidant capabilities of galangal's ethyl acetate fraction. In comparison to acidic pH levels, *Alpinia galanga* extraction possesses antioxidative levels at neutral pH ranges [42].

Its oxidative ability of *Alpinia galanga*'s plant sources was assessed using the 2,2-diphenyl-1-picrylhydrazyl radical scavenging test and the 2,2'-azinobis-3-ethylbenzothiazoline-6-sulfonic acid oxygen radicals decolorization experiment. *Alpinia galanga* essential oil exhibits higher antioxidant activity, as per a research study, with IC50 values of 550 and 3721 g/ml, respectively.

By using total phenolic and vitamin C equivalent antioxidants of *Alpinia galanga*, the antioxidant properties of the leaves, stems, and roots were evaluated. It was highly important since the *Alpinia galanga* leaflets had a FIC value which was more than 20 times higher than that of the rhizomes. The greatest decrease of tyrosinase was seen [43]. The -carotene whitening process revealed that the antioxidant potential of galangal extracts and *Alpinia galanga* was 70.3% and 70.3%, respectively [44].

Table 3: Evaluation of effectiveness for ethyl acetate preparations of Alpinia officinarum.

Parts of Alpinia officinarum	Extraction type	classified substances	Observations	References
Rhizomes	Separation of solvent from methanol	5, 21	antioxidative and anti-properties	[31]
Rhizomes	Solvent separation from an extract of acetone	5, 9, 21-27	5, 24, 25, Nitric oxide generation is inhibited Anticancer activity: 5, 9, 21, 23, and 25 5, 9, 24: Inhibition of an	[56]
Rhizomes	Separation of solvents from ethanolic extract	28-31	Nothing was done to prevent cancer in action 29. 30: The selected capacity to combat cancer 31: Strong anticancer effectiveness	[64]

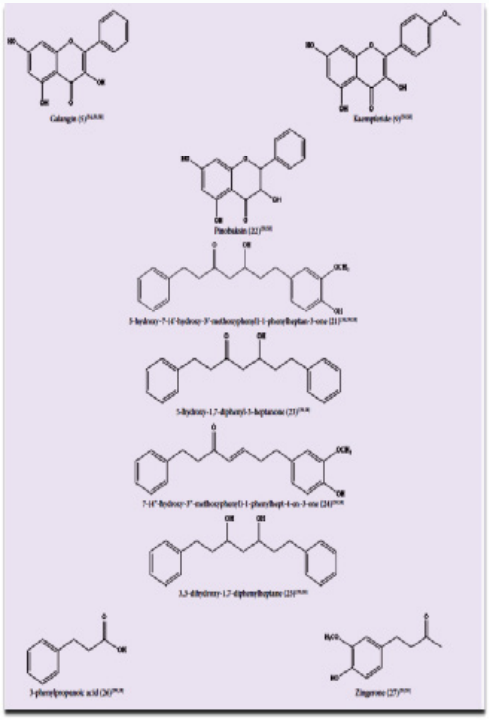

Figure 2: Ethyl acetate extracts from Alpinia officinarum include dissolved compounds.

Anti-cancer activity

In mouse Sarcoma 180 ascites, the pro properties of DL-1'-acetoxychavicol acetate (I) and DL-1'-acetoxyeugenol acetate (II) isolated from *Alpinia galanga* were investigated. Diterpene chemicals I (15- and 15-isomer) and II, extracted from the chemical's seeds, were also examined for their capacity to inhibit tumor growth [5].

The substances 1,7-bis 4-hydroxyphenyl-1,4,6-heptatrien-3-one and bisdemethoxycurcumin from the rhizomes of *A. galanga* efficiently inhibits the amount of carcinoma cells in an important cellular experiment, while their pharmacologic activities upon human tumor A2058 were examined. Studies on the B16-F10 cell line also showed that cellular tyrosinase activity and melanin levels were somewhat inhibited [45]. There in acute toxicity tests, hepatocytes from the *Alpinia galanga* MCF7 breast cancer and LS174T colon carcinoma were exposed to methanol extracts, aqueous extracts, or volatile oils from fresh rhizomes [46]. The manner wherein the human leukemic HL-60 and U937 cells perished after being exposed to 4'-hydroxycinnamaldehyde 4'-HCA from *Alpinia galanga*. 4'-HCA was hazardous to both cell cultures at a quantity consistent with the drug, according to the MTT Assay ($p<0.05$) [47].

Anti-diabetic activity

Alpinia galanga's hypoglycemic effects on rabbits are demonstrated using the herb's methanolic rhizome infusion. This significantly lowered the blood sugar level. Rats had been utilized to test the *Alpinia galanga* ethanolic rhizome preparation with glucose levels which is neither high nor average. Normoglycaemic, hyperglycaemic, and alloxan-induced diabetic rats (n=5) received a single oral dosage of EEAG (50, 100, or 200 mg/kg). EEAG treatment was contrasted to control glycemic rats at 12 hours and to diabetic group at 6 hours, a single dosage of EEAG (200 mg/kg) significantly ($p=0.05$) reduced blood glucose levels in fructose diabetic animals [48], Together with phenolic and methanol extracts, rhizome extract also has anti-diabetic and anti-inflammatory activities [49].

Anti-inflammatory activity

The effectiveness of the whole aqueous and full ethanolic extracts of the rhizomes from *Alpinia galanga* was evaluated using rat models of acute carrageenan-induced oedema, M1 and chronically cotton bead granuloma, and M2 sickness [48]. The 95% ethanolic extract of the rhizome of *Alpinia galanga* has been shown to have analgesic activity effects. The analgesic efficacy of EEAG at dosages of 200 mg/kg and 400 mg/kg administered orally was evaluated using the hot plate, formalin-induced paw licking, and acetic acid-induced writhing procedures. Yu et al. [50], added that studies have demonstrated the anti-inflammatory effects of p-coumaryl diacetate, a compound found in *Alpinia galanga*.

Carrageenan-related paw damage the effects of petroleum ether, chloroform, methanolic, and aqueous methanolic extracts on *Alpinia galanga* edema in Wistar rats were investigated. Ibuprofen was used as a positive control. One hour before the carrageenan injection, 500 mg/kg of these extracts were taken. The most effective inhibitor of carrageenan-induced rat paw edema was a methanolic extract of *Alpinia galanga* (79.51%) [51]. An ethanolic extract of the rhizome of *A. galanga* was used to examine the capacity of rats with sodium alginate pneumonia. With a P value of 0.005 in comparison to the control, *A. galanga* 100 mg, 200 mg, and 400 mg demonstrated significant activity in rats in each of the test groups [52].

Table 4: List of activity from Alpinia officinarum ethanol extracts.

Parts of Alpinia officinarum	Extraction procedure	Discovered substances	Observations	References
Aerial parts		2, 5, 6, 9, 22		[34]
Rhizomes	50% ethanol hot and cold maceration		Heat-treated ethanolic extract: Higher phenolic and flavonol content results in greater antioxidant and antibacterial action. ineffective against fungi	[35]
Rhizomes	6 hours of extraction in 95% ethanol at 70°C		a low level of antioxidant activity despite a high total phenolic and flavonoid content.	[36]

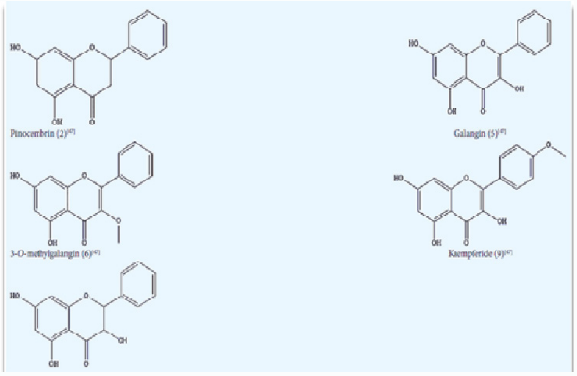

Figure 3: Ethanol extract/fraction from Alpinia officinarum, separated compounds.

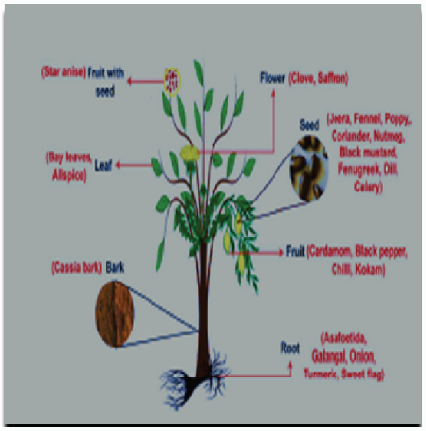

Figure 4: Spices as various plant components.

Anti-viral activity

1'-acetoxychavicol acetate is a component of both the HIV-derived protein Rev, which is required for HIV replication, and inhibitors for the nuclear export of such proteins (I). In order to create the compound 1'-acetoxychavicol acetate, a Methanolic extract of the fruits of *Alpinia galanga* was used. This drug prevents HIV-1 NL43 development in MT-4 cells. Evidently, this had no detrimental effect on the survival of MT-4 cells. [5]. Human cytomegalovirus, hepatitis C virus, and type 1 HIV proteases have all been shown to be susceptible to the antiviral actions of *Alpinia galanga* extracts in methanol and aqueous form. However, methanol extract inhibits the enzymes more potently than water extract [53,54].

1'-1'-acetoxychavicol acetate, which is made from rhizome extracts, exhibits anti-HIV effect by blocking Reverse *Alpinia galanga* Transport. The rev-export inhibitor from the medicinal plant made it evident how to synthesize the *Alpinia galanga* quinone methide intermediate and how important it is for demonstrating the inhibitory function [55-69].

Conclusion

Numerous scientific studies have revealed the enormous biological potential of the plant *Alpinia galanga* is a well-known herbal plant with the scientific name *Alpinia galanga* that is commonly used to cure many diseases and has a wide range of pharmacological qualities. *A. officinarum's* various fractions, solvent extracts, and separated, identifiable constituents have all been investigated for their phytoconstituents and biological effects. A few new compounds had been effectively isolated, and the majority of solvent extracts had demonstrated notable biological activity. The plant contains some compounds that exhibit diverse pharmacological and therapeutic activities. As a consequence of scientific research, in addition to supporting the traditional uses of *A. officinarum* in the treatment of a number of illnesses, it is now feasible to offer additional therapeutic possibilities, such as antioxidant, anti-inflammatory, anticancer, and antibacterial activities. To extract and identify the many compounds found in the plant that may one day be employed in numerous applications for human well-being, further analysis and research must be done.

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