International Journal of Innovative Research and Review ISSN: 2347 – 4424 (Online)
An Online International Journal Available at http://www.cibtech.org/jirr.htm
2015 Vol. 3 (1) January-March, pp.99-106/Nag and Mandal
Review Article

IMPORTANCE OF EKANGI (*KAEMPFERIA GALANGA* L.) AS MEDICINAL PLANTS- A REVIEW

Sudipa Nag[1] and *Subrata Mandal[2]
[1]*Department of Botany, Botany Department, Rampurhat College, Rampurhat, Birbhum, West Bengal, India*
[2]*Department of Agronomy, Rathindra Krishi Vigyan Kendra, Visva-Bharati, Sriniketan, Birbhum, West Bengal, India, 731 236*
**Author for Correspondence*

ABSTRACT
Ekangi (*Kaempferia galanga* L. is an important medicinal plant of Zingiberaceae family is still considered as unutilized herbs in spite of having different pharmacological properties like antioxidant, antimicrobial, analgesic, anti inflammatory, sedative, vasorelaxant, nematicidal, mosquito repellent, larvicidal, antiprotozoal and wound healing activities. The most vital phytoconstituent isolated from Ekangi extracts found Ethyl-cinnamate and Ethyl-*p*-methoxycinnamate. Kaempferol, isolated from *K.galanga* rhizome was found effective to reduce the risk of pancreatic and lung cancer. Leaves and rhizomes of *K. galanga* are useful in treating rheumatism traditionally. Its nematicidal effects are more potential than chemical treatment. Different other phytoconstituents have also very effective pharmacological properties.

Keywords: *Phytoconstituents, Eharmacology, Anti Inflammatory, Ethyl-p-ethoxycinnamate, Ekangi*

INTRODUCTION
Kaempferia galanga Linn. commonly known as Cekor, Ekangi, Kencur or aromatic ginger is a stem less herb in Zingiberaceae family.

Indigenous medical practitioners used the rhizomes of it for treatment of Scariasis, bacterial infections, tumour and it is also applied externally for abdominal pain in women and used tropically for treatment of rheumatism (Hirschhorn, 1983).

In Thailand, the dried rhizome has been used as cardiotonic and CNS stimulant (Mokkhasmit *et al*., 1971), whereas an acetone extract has an effect on monoamine oxidase inhibition (Noro *et al.,* 1983).

The plant is native to Tropical Asia including Southern China, Thailand, Taiwan, Malaysia and India (Mitra *et al.,* 2007; Koh, 2009; Techaprasan *et al.,* 2010). Inspite of the findings that intra specific genetic variations are not observed in many *Kaempferia* sp., taxonomic identification is quite difficult due to the morphological similarities with in the vegetative part of Zingiberaceae (Techaprasan *et al.,* 2010).

Due to its valuable bioactive compounds *Kaempferia galanga* is famous for its medicinal as well as edible use.

Among the list of medicinal herbs and spices issued by International Organization, *Kaempferia galanga* is one of the medicinal herbs which are still underutilized and comparatively less known. Beside that this important medicinal herb is facing the threat of extinction. But many researchers have been reported on propagation of this herb by using *in vitro* multiplication methods (Chithra *et al*., 2005; Swapna *et al.,* 2004).

K. galanga is one of those precious medicinal herbs that are still included in unutilized herbs in spite of the variety of useful pharmacological properties it possess. Therefore, the importance of the plant *K. galanga* as a medicinal plant is to be documented and presented to the mass of people. Keeping in view the above statement a brief and up to date review about the medicinal values of *K. galanga* has been made in the following study.

Table 1: *Kaempferia galanga* L. in different languages

Bengali	Ekangi
Chinese (Cantonese)	Saan noih, Sa geung
Chinese (Mandarin)	Shan nai, San nai, Sha jiang
Danish	Lille Galanga
Dutch	Kentjoer
English	Resurrection lily, Sand ginger
French	Galanga camphré, Faux galanga
German	Kleiner Galgant, Gewürzlilie, Sandingwer
Greek	Kineszike piperoriza
Hindi	Abhuyicampa
Indonesian	Kencur; Kunci pepet, Kunir putih, Temu rapet
Japanese	Ban-ukon, Kenchoru
Korean	Sannae
Lao	Van hom
Lithuanian	Kvapusis imbierutis
Malay	Kunchor, Cekur, Cekur Jawa, Cengkur; Kunyit putih, Temu putih
Malayalam	Kaccholam, Chengazhinirkizhangu
Polish	Kentior
Russian	Maraba
Sanskrit	Bhucampaka
Sinhala	Ingurupiyali
Tagalog	Dusol; Gisol na bilog
Thai	Pro hom, Hom pro, Waan hom, Waan teen din; Wan phaen din yen, Waan nonlap, Waan haao non, Ueang din
Vietnamese	Cam dia la, Dia lien, Sa khuong, Ngai mau, Son nai, Tam nai

Figure 1: Different parts used for *Kaempferia galangal*
Courtesy: http://gernot-katzers-spice-pages.com/engl/spice_photo.html#kaem_gal

Medicinal Values

The rhizomes, root stocks and leaves of this plant are used in different way for different medicinal activities.

Antioxidant Activity

Antioxidant that can decrease free radical activity can prevent the oxidation of various molecules and may possibly have health promoting special effects in the interference of degenerative diseases (Young and Woodside, 2001).

The whole plant extracts have weak antioxidant activity (Chan *et al*., 2008; Meksee *et al.*, 2010). The anti oxidant activity is further reduced by drying using different thermal and non thermal drying methods, however, these decrease is prevented if the plant is subjected to freeze drying (Chan *et al.*, 2009). This antioxidant activity is mainly due to the total phenolic content and flavonoid including Luteolin and epidenin (Mustafa *et al*., 2010).

Table 2: Important phytoconstituents isolated from *K. galanga* extracts (Koh, 2009; Othman *et al.*, 2006; Sutthanont *et al.*, 2010)

S/N	Common name	IUPAC name
1	Ethyl-cinnamate	Ethyl 3-phenylprop-2-enoate
2	1, 8 – cineole	1,3,3- trimethyl-2-oxabicyclo[2.2.2]octane
3	Delta 3 Carene	(1*S*, 6*R*)-3,7,7- trimethylbicyclo[4.1.0]hept-3-ene
4	(+)Alpha Pinene	(1 *S*, 5*R*)-2,6,6-trimethylbicyclo[3.1.1]hept-2-ene
5	(-)Alpha Pinene	(1*S*,5*S*)-2,6,6-trimethylbicyclo[3.1.1]hept-2-ene
6	Camphene	(1*S*,4*R*)-2,2-dimethyl-3-methylenebicyclo[2.2.1]heptanes
7	Borneol	(1*S*,2*S*,4*R*)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-ol
8	Cymene	1-Methyl-4-(1-methylethyl)benzene
9	Alpha Terpineol	(*R*)-2-(4-methylcyclohex-3-en-1-yl)propan-2-ol
10	Alpha Gurjunene	1,1,4,7-tetramethyl-1 a,2,3,4,4a,5,6,7b-octahydro-1 *H*- cyclopropa[e]azulene
11	Germacrene	(*S*,1*E*,5*E*)-1, 5-dimethyl-8-(prop-1-en-2-yl)cyclodeca-1,5-diene
12	Cadinenes	(1S,4aR,8aR)-1-isopropyl-4,7-dimethyl-1,2,4a,5,6,8a- hexahydronaphthalene
13	Beta-Caryophyllen	(1*R*, 9*S*,*E*)-4,11,11-trimethyl-8-methylenebicyclo[7.2.0]undec-4-ene
14	Ethyl-*p*-methoxycinnamate	(*E*)-ethyl 3-(4-methoxyphenyl)acrylate
15	Kaempferol	3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4H-chromen-4-one
16	Kaempferide	3,5,7-trihydroxy-2-(4-methoxyphenyl)-4H-chromen-4-one
17	Cinnamaldehyde	(2*E*)-3-phenylprop-2-enal

Total phenolic content (TPC) of ethanolic extracts of leaves and rhizomes is found to be 146mg Galic acid equivalent (GAE)/ 100g and 57 mg GAE/ 100g respectively whereas the antioxidant activity of leaves and rhizome extracts is 77 mg Ascorbic acid (AA)/ 100g and 17mg AA/ 100g (Chan *et al.*, 2008). The rhizome extracts of *K. galanga* have shown good antioxidant activity, when studied in South India (Rao and Kaladhar, 2014). The *K. galanga* rhizome extracts have shown antioxidant activity of the tested plant extracts (IC 50= 490µg/ ml to 720µg / ml) is less compared to AA. It was interesting to note that methanolic extract of rhizome of natural plant of *K. galanga* was found significantly more effective as antioxidant than that of *in vitro* generated plant (Hanumantharaju *et al.*, 2010).

Table 3: Pharmacological activities of *K. galanga* extracts with possible mechanism of action

Pharmacological activity	Responsible active constituent	Possible mechanism of action
Analgesic and anti-inflammatory		Central mechanism involving opioid receptors and peripheral mechanism involving cyclooxygenase pathway (Ridtitid *et al*., 2008; Sulaiman *et al*., 2008)
Nematicidal activity	Ethyl-*trans*-cinnamate, ethyl-*p*-methoxycinnamate (Hong *et al*.,2011)	Mode of delivery of constituents is partly through steam phase. Mechanism is still unclear (Hong *et al*., 2011)
Mosquito repellent and larvicidal activity	Ethyl p-methoxycinnamate, ethyl-cinnamate, 3 carene, 2-propionic acid (Kim *et al*., 2008; Sutthanont *et al*., 2010)	Destruction of ionic regulation in the anal gills (Insun *et al*., 1999)
Vasorelaxant activity	Ethyl-cinnamate (Othman *et al*., 2006)	Inhibition of calcium influx into vascular cells, release of nitric oxide and prostaglandins from endothelial cells (Othman *et al*., 2002)
Antineoplastic activity	Ethyl-*p*-methoxycinnamate (Liu *et al*., 2010)	Translocation of phosphatidylserine of Hep G2 cells to cell surface, resulting in an increase in sub-G cell population (Liu *et al*., 2010)
Anti-oxidant activity	Total phenolic content and flavonoids including luteolin and apigenin (Mustafa *et al*., 2010)	
Anti microbial activity	Ethyl-*p*-methoxycinnamat (Kanjanapothi *et al*., 2004)	

Antimicrobial Activity

The methanolic extract of the rhizome contents ethyle p- methoxy transcinnamate which is cytotoxic to HELA cells. The rhizome extracts has been potentially active against bacterial infection (Vincent *et al*., 1992). The methanolic extract of the micropropagated plant rhizome was found to have significant zone of inhibition compared to that of natural plant against two gm(-)ve (*E.coli*, *Salmonella typhi*) and two gm (+)ve organisms (*Bacillus subtilis*, *Staphylococcus aureus*) compared with positive control ciprofloxacin and amoxicillin ((Hanumantharaju *et al.*, 2010). Kaempferol, a natural flavonoid isolated from *K.galanga* has been shown to reduce the risk of pancreatic and lung cancer (*Jun et al.*, 2006).

Analgesic and Anti-inflammatory Activity

K. galanga leaves show significant antinociceptive and anti-inflammatory effect in rats in a dose dependent manner (Sulaiman *et al.*, 2008). When it is given orally at a dose of 200 mg/kg, the anti-nociceptive effect if *K. galanga* rhizome extracts is more potent than aspirin usins 100 mg/kg, but lesser than morphine using 5 mg/kg subcutaneously (Ridtitid *et al.*, 2008). The capacity of the extracts to block abdominal constriction, hot plate and formaline test indicates that analgesic activity has both central

mechanism, involving opioid receptors, and peripheral mechanism that involves cyclooxygenase pathway (Ridtitid *et al.,* 2008; Sulaiman *et al.,* 2008). Leaves and rhizomes of *K. galanga* are used in traditional medicine to treat swelling, headache, stomachache, toothache and rheumatism (Mitra *et al*., 2007).

Sedative Activity

Inhalation of hexane extract of *K. galangal* at doses ranging from 1.5 to 10 g has shown considerable decrease in locomotor activity in rats. This sedative activity is due to ethyl trans-p-methoxycinamate and ethyl-cinnamate that inhibits locomotor activity in doses of 0.0014 and 0.0012 mg, respectively (Umar *et al.,* 2011).

Vasorelaxant Activity

Othman *et al.,* (2002), observed that extracts of *K. galanga* exhibited inhibition of calcium influx into vascular cells with maximum affect seen 5 to 10 min after injection to rat.

This vasorelaxant effect is reversed by pretreatment of aorta with methylene blue and indomethacin which indicates that the mechanism of this vasorelaxation may involve inhibition of calcium influx into vascular cells and release of nitric oxide and prostaglandins from endothelial cells. Extracts of *K. galanga* also exhibit significant anti-hypertensive activity (Zakaria, 1994).

Nematicidal Activity

According to Hong *et al.,* (2011), the mechanism of nematicidal effect is still unclear. But according to In-Ho *et al.,* (2006). *K. galanga* extracts have potent nematicidal effect. Crude extracts have shown 100% mortility in male, female and juvenile pine wood nematodes, *Bursaphelenchus xylophillus* at a dose of 1000µg/ ml.

Crude methanolic extracts of rhizomes has shown considerable nematicidal activity against *Meloidogyne incognita* juveniles and eggs that is greater than that of carbofuran and metham sodium but lesser than fosthiazate (Tae-Kyun *et al.,* 2010). Ethyl cinnamate and ethyl-p-methoxycinnamate isolated from *K. galanga* rhizome extracts are proven to be responsible for this killing effects on M. *incognita* juveniles and eggs.

Mosquito Repellent and Larvicidal Activity

According to many workers (Choochote *et al.,* 2007; Yang *et al.,* 2004) essential oils extracted from the rhizomes of *K. galanga* have shown considerable repellent and larvicidal activity against a number of mosquito species including *Aedes aegypti, Aedes togoi, Anopheles barbirostris, Anopheles aconitus,Culex quinquefasciatus* etc.

Sutthanont *et al*., 2010 found that the rhizome extract have shown remarkable larvicidal activity even against pyrethroid resistant strains of *Aedes aegypti*. Different phytoconstituents like ethyle-p-methoxycinnamate, ethyl-cinnamate, 3-carene, 2-propionic acid and pentadecane are responsible for the larvicidal activity (Kim *et al.,* 2008, Sutthanont *et al*., 2010).

Other Activities

Alcoholic extracts of *K. galanga* have considerable wound healing effect on incision, excision and dead space wounds with a remarkable reversal of dexamethasone induced delay in epithelialisation and wound breaking strength and also have antiprotozoal activity (Tara *et al*., 2006 and Koh, 2009).

CONCLUSION

From the above discussion, it is evident that *K. galanga* L. is a major plant species with many valuable medicinal properties. Although the rhizome is the major source of active principles, leaves are also being used in traditional medicine to treat swelling, headache rheumatism etc. *K. galanga* extracts have antioxidant, antimicrobial, analgesic, nematicidal, larvicidal, mosquito repellent sedative and woond healing activities.

Different phytoconstituents like ethyle-p-methoxycinnamate, ethyl cinnamate, 3-carene, 2-propionic acid, pentadecane etc. are responsible for these different medicinal as well as pesticidal activities. Increasing resistance in infectious organisms against conventional antibiotics is a major reason that prominates the use of herbs with immunomodulatory and antimicrobial potentials. There is an utmost need to diverse the cultivation of valuable medicinal plants.

REFERENCES

Chan EWC, Lim YY, Wong LF, Lianto FS, Wong SK, Lim KK, Joe CE and Lim TY (2008). Antioxidant and tyrosinase inhibition properties of leaves and rhizomes of ginger species. *Food Chemistry* **109** 477-483.

Chithra M, Martin KP, Sunandakumari C and Madhusoodanan PV (2005). Protocol for rapid propagation, and to overcome delayed rhizome formation in field established *in vitro* derived plantlets of *Kaempferia galanga* L. *Scientia Horticulturae* **104** 113-120.

Choochote W, Chaithong U, Kamsuk K, Jitpakdi A, Tippawangkosol P, Tuetun B, Champakaew D and Pitasawat B (2007). Repellent activity of selected essential oils against *Aedes aegypti*. *Fitoterapia* **78** 359-364.

Hanumantharaju N, Shashidhara S, Rajasekharan, PF and Rajendra CE (2010). Comparative evaluation of antimicrobial and antioxidant activities of *Kaempferia galanga* for natural and micropropagated plant. *International J Pharmacy and Pharmaceutical Sciences* **2**(4) 72-75.

Hirschhorn HH (1983). Botanical remedies of the former dutch east Indies (Indonesia). *Journal of Ethanopharmacology* **72** 123-156.

Hong TK, Kim SI, Heo JW, Lee JK, Choi DR and Ahn YJ (2011). Toxicity of Kaempferia galanga rhizome constituents to *Meloidogyne incognita* juveniles and eggs. *Nematology* **13** 235-244.

In-Ho C, Ju-Yong P, Sang-Chul S and Il-Kwon P (2006). Nematicidal activity of medicinal plant extracts and two cinnamates isolated from *Kaempferia galanga* L. (Proh Hom) against the pine wood nematode, *Bursaphelenchus xylophilus*. *Nematology* **8** 359-365.

Insun D, Choochote W, Jitpakdi A, Chaithong U, Tippawangkosol P, Jun SP, Ho SR, Duck HK and Ih SC (2006). Enzymatic preparation of Kaempferol from Green Tea Seed and Its antioxidant activity. *Journal of Agricultural and Food Chemistry* juveniles and eggs. *Nematology* **13** 235-244.

Kanjanapothi D, Panthong A, Lertprasertsuke N, Taesotikul T, Rujjanawate C, Kaewpinit D, Sudthayakorn R, Choochote W, Chaithong U, Jitpakdi A and Pitasawat B (2004). Toxicity of crude rhizome extract of *Kaempferia alanga* L. (Proh Hom). *Journal of Ethnopharmacology* **90** 359-365.

Kim NJ, Byun SG, Cho JE, Chung K and Ahn YJ (2008). Larvicidal activity of *Kaempferia galanga* rhizome phenylpropanoids towards three mosquito species. *Pest Management Science* **64** 857-862.

Koh HL (2009). *Guide to Medicinal Plants: An Illustrated Scientific and Medicinal Approach*. *SGP* (World Scientific) **9789812837103**.

Liu B, Liu F, Chen C and Gao H (2010). Supercritical carbon dioxide extraction of ethyl –p-methoxy cinnamate from *Kaempferia galanga* L. rhizome and its apoptotic induction in human HepG2 cells. *Natural Product Research* **24** 1514-1519.

Mekseepralard C, Kamkaen N and Wilkinson JM (2010). Antimicrobial and antioxidant activities of traditional Thai herbal remedies for aphthous ulcers. *Phytotherapy Research* **24** 1514-1519.

Mitra R, Orbell J and Muralitharan MS (2007). Agriculture — Medicinal Plants of Malaysia. *Asia Pacific Biotech News* **11** 105-110.

Mokkhasmit M, Swatdimongkol K and Satrawah P (1971). Study on toxicity of Thai Medicinal Plants. *Bulletin of the Department of Medical Sciences* **122**(4) 36-65.

Mustafa RA, Abdul HA, Mohamed S and Bakar FA (2010). Total phenolic compounds, flavonoids, and radical scavenging activity of 21selected tropical plants. *Journal of Food Science* **75** C28-C35.

Noro T, Miyase T, Kuroyanagi M, Ueno A and Fukushima S (1983). Monoamine oxidase inhibitor from the rhizomes of *Kaempferia*.

Othman R, Ibrahim H, Mohd MA, Awang K, Gilani AUH and Mustafa MR (2002). Vasorelaxant effects of ethyl cinnamate isolated from *Kaempferia galanga* on smooth muscles of the rat aorta. *Planta Medica* **68** 655-657.

Pitasawat B (1999). Possible site of action of *Kaempferia galanga* in killing Culex quinquefasciatus larvae. *Southeast Asian Journal of Tropical Medicine and Public Health* **30** 195-199.

Rao Narasingha and Kaladhar DSVGK (2014). Antioxidant and antimicrobial activity of rhizome extracts of *K. galangal*. *World Journal of Pharmacy and Pharmaceutical Sciences* **3**(5) 1180-1189.

Ridtitid W, Sae-Wong C, Reanmongkol W and Wongnawa M (2008). Antinociceptive activity of the methanolic extract of *Kaempferia galanga* Linn. In experimental animal. *Journal of Ethnopharmacology* **118** 225-230.

Sulaiman MR, Zakaria ZA, Daud IA, Ng FN, Ng YC and Hidayat MT (2008). Antinociceptive and anti-inflammatory activities of the aqueous extract of *Kaempferia galanga* leaves in animal models. *Journal of Natural Medicines* **62** 221-227.

Sutthanont N, Choochote W, Tuetun B, Junkum A, Jitpakdi A, Chaithong U, Riyong D and Pitasawat B (2010). Chemical composition and larvicidal activity of edible plant- derived essential oils against the pyrethroid-susceptible and -resistant strains of *Aedes aegypti* (Diptera: Culicidae). *Journal of Vector Ecology* **35** 106-115.

Swapna TS, Binitha M and Manju TS (2004). *In vitro* multiplication in *Kaempferia galanga* Linn. *Applied Biochemistry and Biotechnology* **118** 233-241.

Tae-Kyun H, Jae-Kook LEE, Jae-Won HEO, Soon-Il KIM, Dong-Ro C and Young-Joon AHN (2010). Toxicity of *Kaempferia galanga* rhizomederived extract and steam distillate to *Meloidogyne incognita* juveniles and eggs, and their effects on *Lycopersicon esculentum* germination and growth. *Nematology* **12** 775-782.

Tara SV, Chandrakala S, Sachidananda A, Kurady BL, Smita S and Ganesh S (2006). Wound healing activity of alcoholic extract of *Kaempferia galanga* in Wistar rats. *Indian Journal of Physiology and Pharmacology* **50** 384-390.

Techaprasan J, Klinbunga S, Ngamriabsakul C and Jenjittikul T (2010). Genetic variation of *Kaempferia* (Zingiberaceae) in Thailand based on chloroplast DNA (psbA-trnH and petA-psbJ) sequences. *Genetics and Molecular Research* **9** 1957-1973.

Umar MI, Mohammad Zaini Bin Asmawi, Amirin Sadikun, Rabia Altaf and Muhammad Adnan Iqbal (2011). Phytochemistry and medicinal properties of *Kaempferia galangal* L. (Zingiberaceae) extracts. *African Journal of Pharmacy and Pharmacology* **5**(14) 1638-1647.

Vincent KA, Molly Hariharan and Mary Mathew K (1992). Embryogenesis and plantlet formation in tissue culture of *K. galangal* - a medicinal plant. *Phytomorphology* **42**(3 and 4) 1992-1996.

Yang YC, Park IK, Kim EH, Lee HS and Ahn YJ (2004). Larvicidal Activity of Medicinal Plant Extracts Against *Aedes aegypti*, *Ochlerotatus togoi*, and *Culex pipiens* pallens (Diptera: Culicidae). *Journal of Asia-Pacific Entomology* **7** 227-232.

Young IS and Woodside JV (2001). Antioxidants in health and diseases. *Journal of Clinical Pathology* **54**(3) 176-186.

Zakaria M and Mustafa AM (1994). Traditional Malay Medicinal Plants. *Fajar Bakti, Kualalumpur* **129.**