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ESSENTIAL OILS OF LEAVES AND RHIZOMES OF *KAEMPFERIA GALANGA* LINN.

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ABSTRACT

Kaempferia galanga Linn. leaf and rhizome oils, obtained by hydrodistillation, were analyzed by gas chromatography mass spectroscopy (GC-MS). One hundred and eight components were identified in the leaf oil. The major components were linoleoyl chloride (21.42%), caryophyllene oxide (11.75%), cubenol (9.66%) and caryophyllene (5.60%). Eighty one components were identified in rhizome oil with the main components being 2-propenoic acid, 3-(4-methoxyphenyl),-ethyl ester (63.36%), ethyl cinnamate (6.31%), 4-cyclooctene -1-methanol (4.61%), caryophyllene oxide (4.37%) and limonene (3.22%). The compositions of both oils varied qualitatively and quantitatively.

Key words: Essential oil, GC-MS analysis, linoleoyl chloride, 2-propenoic acid, 3-(4-methoxyphenyl)-ethyl ester.

INTRODUCTION

Kaempferia galanga Linn. (Synonyms *Kaemferia rotunda Blanco*, *Kaempferia latifolia* Hornem.) from the Zingiberaceae family is commonly used as a spice ingredient and medicinal herb in South-East Asia, and is valued traditionally for their skin protectant action.

Its tubers are stimulant, expectorant, diuretic and carminative, coughs and asthma. The leaves are used in lotions and as a poultice for sore eyes, sore throat, swellings, rheumatism and fevers. Rhizome juice is applied by the Chakma of Rangamati district for toothache. In paralysis rhizome paste is applied on legs and arms. Rhizome paste is also applied on forehead in headache. Essential oil of rhizome possesses antifungal properties (Gani 2003). *Kaempferia galanga* has a peppery camphorous taste (Van Wyk and Ben-Erik 2005). Its alcoholic maceration has also been applied as liniment for rheumatism (Kanjanapothi *et al.* 2004). According to Burkill (1966), the rhizome is used in cosmetics. Smith and Stuart (1973) say that the rhizome is used in perfumery and also as a means to

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preserve clothes from insects. Smith and Stuart also (1973) say that the rhizomes are used as a wash for dandruff or scabs of the head. *K. galanga* rhizome contains about 1.5 to 2% essential oil, whose main components are ethyl cinnamate (25%), ethyl p-methoxycinnamate (30%) and p-methoxycinnamic acid. *K. galanga* is a good natural source of a biologically active easter compound ethyl p-methoxycinnamate. The antifungal action of ethyl p-methoxycinnamate is reported in the literature. Essential oil from the rhizomes was found active against gram positive and gram-negative microorganisms (Ibrahim *et al*. 2003, Norajit *et al*. 2007). Medicinal herbs are an indispensible part of traditional medicine. The rhizome of *K. galanga* finds an important place in indigenous medicine as an expectorant, diuretic and carminative (Achuthan and Jose 1997). It is also found to have anticancer (Xue and Chen 2002), antihypertensive (Othman *et al*. 2002) and larvicidal and repellent activity (Choochote *et al*. 1999). It is used for the treatment of various skin disorders, rheumatism, catarrhal infections and diabetes mellitus (Mangaly and Sabu 1991, Vagbhata and Hridayam 1971). Similarly major component, ethyl-trans- *p*-methoxycinnamate is present in both the varieties, its percentage varies (39 and 35%, respectively) (Indrayan *et al*. 2007). Philip *et al.* (1945) reported lower spleen indices in women than men in Southern Madras and the women of the region smeared themselves with galangal (*Kaempferia galanga*) before bathing. Kiuchi *et al.* (1987) reported that 3-caren-5-one found from *K. galanga*. There are no previous references in literature about these Bangladeshi oils. So this work has been undertaken to determine the chemical composition of leaf and rhizome oils of *K. galanga*. These features allow it to be identified for medicinal use and classified among the other ginger oils available in the international market.

MATERIALS AND METHODS

PLANT MATERIAL

The plant materials of *Kaempferia galanga* was collected from the plants grown in the campus of BCSIR Laboratory, Chittagong, during December 2007. The specimen was identified and one-voucher specimen (Y-984) was deposited in the herbarium of BCSIR Laboratory, Chittagong.

Extraction of essential oil

Samples of leaf was harvested from healthy, two-year-old plants. Freshly harvested leaves (500 g) and rhizome (200 g) were grounded in a blender separately. The grounded leaves and rhizome were subjected to hydrodistillation using a modified Clevenger-type glass apparatus for 4 h for isolation of oils separately. The oil samples were stored at 0°C in air-tight containers after drying

them over anhydrous sodium sulfate and filtered before Undertaking the GC-MS analysis.

GC-MS analysis

The essential oil from leaves and rhizomes of *Kaempferia galanga* were analyzed by GC-MS electron impact ionization (EI) method on GC-17A gas chromatograph (Shimadzu) coupled to a GC-MS QP 5050A Mass Spectrometer (Shimadzu); fused silica capillary column (30m x 0.25mm; 0.25 μm film thickness), coated with DB-5 (J&W); column temperature 100^{o}C (2 min) to 250^{o}C at the rate of 3^{o}C/min; carrier gas, helium at constant pressure of 90Kpa. Acquisition parameters full scan; scan range 40-350 amu.

Identification of the compounds

Compound identification was done by comparing the NIST library data of the peaks with those reported in literature , mass spectra of the peaks with literature data . Percentage composition was computed from GC peak areas on DB-5 column without applying correction factors.

RESULTS AND DISCUSSION

Essential oils from the leaves and rhizomes of *K. galanga* from Bangladesh were analyzed by GC-MS. The oil yields were 0.55% and 1.05%, respectively. The composition of the leaf and rhizome oil of *K. galanga* is shown in table 1 and 2. According to GC-MS analysis under the conditions described above, linoleoyl chloride was detected as the main component (21.42%) of the leaf. The remaining constituents were caryophyllene oxide (11.75%), cubenol (9.66%), caryophyllene (5.60%), 2-propenoic acid, 3-(4-methoxyphenyl)-, ethyl ester (5.56%), isoledene (4.91%), ethyl cinnamate (3.66%), borneol (2.86%), δ-cadinene (2.23%), δ-selinene (2.03%), Ylangene (1.98%), α-bulnesene (1.38%), seychellene (1.19%), α-caryophyllene (1.11%), pentadecane (1.10%) and 6-hexadecen-4-yne, (E)- (1.09%). On the other hand, rhizome oil contained 2-propenoic acid, 3-(4-methoxyphenyl),-ethyl ester (63.36%), ethyl cinnamate (6.31%), 4-cyclooctene -1-methanol (4.61%), caryophyllene oxide (4.37%), limonene (3.22%), borneol (2.46%), cubenol (1.67%) and nerolidyl acetate (1.05%). Results showed that the oils were complex mixture of numerous compounds, many of which were present in trace amounts. It is worth mentioning here that there is great variation in the chemical composition of leaves and rhizomes oils. Linoleoyl chloride and 2-propenoic acid, 3-(4-methoxyphenyl),-ethyl ester are the main common compounds in leaves and rhizomes' oils.

On the other hand, comparison of *K galanga* oils that reported herein with those reported from different places in the world showed that *K galanga* oil of Bangladesh is especially different from others. Besides, it is very interesting to note that *K galanga* essential oil constituents that reported from the leaf oil of different places showed different results in the content of some of the major and minor compounds. Linoleoyl chloride and 2- propenoic acid, 3-(4-methoxyphenyl), -ethyl ester, were reported herein as major constituents (*K galanga* oils) but from other parts of the world these compounds of the oil were reported either absent or present in trace amount. This confirms the variations which is not due to geographic divergence and ecological conditions but is due to different chemotype as reported from Bangladesh. On the basis of the above fact it may be concluded that *K galanga* of Bangladesh, may be utilized as a source for the isolation of natural Linoleoyl chloride and 2- propenoic acid, 3-(4-methoxyphenyl), -ethyl ester. The high concentration of Linoleoyl chloride and 2-propenoic acid, 3-(4-methoxyphenyl), -ethyl ester in leaf and rhizome oil makes it potentially useful in the medicines because they exhibit antinociceptive, anti-inflammatory (Sulaiman *et al*. 2008), carminative (Achuthan and Jose 1997), anticancer (Xue and Chen 2002), antihypersensitive (Othman *et al*. 2002), larvicidal and repellent activity (Choochote *et al*. 1999). Besides, they also have anti-microbial properties (Ibrahim *et al*. 2003, Norajit *et al*. 2007). It is worth noting that the oil of *K galanga* have been reported to be used in folk medicine in the treatment of skin disorders, rheumastism, asthma, diabetes and catarrhal.

TABLE 1. PERCENT COMPOSITION OF ESSENTIAL OIL OF LEAVES OF *KAEMPFERIA GALANGA*.

Peak No	Name of constituents	Percentage
1.	α-caryophyllene	1.11
2.	Camphor	0.13
3.	m-cymene	0.17
4.	α-pinene.	0.09
5.	Camphene	0.03
6.	β-phellandrene	0.04
7.	β-pinene	0.06
8.	β-myrcene	0.10
9.	Cyclooctanol	0.04
10.	α-phellandrene	0.12
11.	3-carene	0.09
12.	Limonene	0.58

13.	Eucalyptol	0.30
14.	Z-ocimene	0.02
15.	γ-terpinene	0.06
16.	1-undecanol	0.20
17.	2-carene	0.09
18.	Fenchone	0.09
19.	Linalool	0.20
20.	Nonanal	0.05
21.	α-campholenal	0.04
22.	trans-pinocarveol	0.17
23.	(+)-isomenthone	0.09
24.	Umbellulone	0.18
25.	Borneol	2.86
26.	Menthyl acetate	0.12
27.	4-terpineol	0.20
28.	Tridecanedial	0.12
29.	Myrtenal	0.78
30.	1-isobutyl-1-methylsiletane	0.06
31.	Decanal	0.25
32.	Methyl cyclobutyl(methyl)phosphinate	0.09
33.	Isothujol	0.09
34.	Z,E-2,13-octadecadien-1-ol	0.21
35.	Bornyl formate	0.09
36.	Isoamyl caproate	0.13
37.	Thujone	0.08
38.	2-dodecenal	0.07
39.	2,6-octadienal, 3,7-dimethyl-	0.18
40.	Bornyl acetate	0.33
41.	Neomenthol	0.11
42.	Carveol (fr.1)	0.04
43.	Carveol acetate	0.15
44.	Terpinyl acetate	0.15
45.	α-cubebene	0.36
46.	2-undecenal	0.06
47.	Ylangene	1.98
48.	α-bourbonene	0.23
49.	β-elemene,	0.45

50.	δ-selinene	2.03
51.	Caryophyllene	5.60
52.	Guaiene	0.29
53.	1,6,10-dodecatriene, 7,11-dimethyl-3-methylene-, (E)	0.67
54.	Seychellene	1.19
55.	Ethyl cinnamate	3.66
56.	9,12,15-octadecatrien-1-ol, (Z,Z,Z)-	0.54
57.	Cubenol	9.66
58.	α-muurolene	0.30
59.	Germacrene D	0.78
60.	Thujopsene-I3	0.62
61.	Valencene	0.27
62.	Pentadecane	1.10
63.	γ-selinene	0.24
64.	Thiepino[3,2-e]isobenzofuran-1,3-dione, 3a,10b-dihydro-3a,10b-dimethy	0.21
65.	α-selinene	0.21
66.	Isoledene	4.91
67.	δ-cadinene	2.23
68.	Ethanone, 1-(1,3a,4,5,6,7-hexahydro-4-hydroxy-3,8-dimethyl-5-azulenyl)-	0.71
69.	α-bulnesene	1.38
70.	Guaiene	0.31
71.	α-calacorene	0.20
72.	δ-cadinol,	0.40
73.	γ-elemene	0.30
74.	Dihomo-.gamma.-linolenic acid	0.54
75.	Caryophyllene oxide	11.75
76.	(-)-globulol	0.39
77.	Cyclohexanepropanal, 2,2-dimethyl-6-methylene-	0.27
78.	12-oxabicyclo[9.1.0]dodeca-3,7-diene, 1,5,5,8-tetramethyl-, [1R-(1R@,3E,7E,11R@)]-	0.74
79.	Alloaromadendrene oxide-(1)	0.98
80.	β-humulene	0.68
81.	2,3,3a,4,5,6,7,7a-octahydro-1H-	0.57

	cyclopenta[a]pentalen-7-ol	
82.	tau.-cadinol	0.57
83.	2-propenoic acid, 3-(4-methoxyphenyl)-, ethyl ester	5.56
84.	Nitrofurate	0.37
85.	Linoleoyl chloride	21.42
86.	Cycloisolongifolene, 8,9-dehydro-	0.19
87.	Hydrocotarnine	0.19
88.	Acetic acid N'-(3,4-dichloro-phenyl)-hydrazide	0.26
89.	Oleyl alcohol	0.30
90.	1-nonadecene	0.09
91.	Megastigma-4,6(Z),8(Z)-triene	0.26
92.	6-hexadecen-4-yne, (E)-	1.09
93.	Khusilol	0.05
94.	Octadecanoic acid, ethyl ester	0.07
95.	2,4a,8,8-tetramethyldecahydrocyclopropa[d]naphthalene	0.36
96.	2-pentadecanone, 6,10,14-trimethyl-	0.43
97.	Methyl (Z)-5,11,14,17-eicosatetraenoate	0.06
98.	14-methyl-8-hexadecyn-1-ol	0.07
99.	Farnesol	0.04
100.	Methyl palmitate	0.05
101.	Biformene	0.13
102.	Ethyl palmitate	0.17
103.	7-hexadecenal, (Z)-	0.04
104.	Phytol	0.16
105.	cis-vitamin A Aldehyde	0.12
106.	Linoleic acid ethyl ester	0.10
107.	3-tetradecanynoic acid	0.19
108.	β-iraldeine	0.10

TABLE 2.COMPOSITION OF ESSENTIAL OIL OF RHIZOME OF *KAEMPFERIA GALANGA*.

Peak. No.	Name of constituents	%
1.	℘-muurolene	0.11
2.	℘-terpinene	0.03
3.	12-oxabicyclo (9.1.0)dodeca, 3,7-diene, 1,5,5,8-tetramethyl	0.35
4.	13-tetradece -11yh -1-ol	0.29
5.	1-undecene	0.03
6.	2-cyclohexen-1-one, 2-Methyl-5-(1-methylethenyl)	0.21
7.	2-propenoic acid, 3-(4-methoxyphenyl),-ethyl ester	63.36
8.	3-octen-1-ol,(2)	0.02
9.	4,4,8-trimethyl tricyclo [6.3.1.0.(1.5) dodecane-2,7,-diol	0.17
10.	4-cyclooctene -1-methanol	4.61
11	4-terpineol	0.19
12.	5-nonanol, 5-methyl	0.11
13.	6-octenal, 3,7-dimethyl	0.04
14.	Allyl-3-methoxybenzoate	0.04
15.	Aromadendrene oxide	0.06
16.	β-cedren-9-L-ol	0.13
17.	β-elemene	0.07
18.	Benzone acid , 4-methoxy	0.04
19.	β-linalool	0.46
20.	Borneol	2.46
21.	Bornyl acetate	0.04
22.	Bornyl formate	0.03

23.	β-pinene	0.13
24.	Cadinene	0.12
25.	Calamene	0.19
26.	Camphene	0.24
27.	Carotol	0.18
28.	Carvacrol	0.08
29.	Carveol	0.12
30.	Carvyl acetate	0.03
31.	Caryophyllene oxide	4.37
32.	Cholestan-3-ol, 2-methylelene (3B,5a)	0.49
33.	cis-2-pinanol	0.07
34.	Cis-L-copaene -8-ol	0.11
35.	cis-sabinenehydrate	0.03
36.	Cubenol	1.67
37.	Cycloisolongifolene, 9,10-Dehydro	0.08
38.	Cyclopentanol, 1-(methylenecyclopropyl)	0.03
39.	Dihydrocarveol	0.14
40.	E-ocimene	0.02
41.	Ethyl cinnamate	6.31
42.	Eucalyptol	0.57
43.	Eucarvone	0.03
44.	Geranyl methyl ether	0.05
44.	Guaiacol	0.06
46.	Hydrindane	0.43
47.	Isolongifolene, 7,10-dehydro	0.37

48.	Isopulegol	0.47
49.	Isopulegol acetate	0.13
50.	Jasmone	0.33
51.	α-bisabolol	0.07
52.	α-calacorene	0.20
53.	Ledol	0.37
54.	Limonene	3.22
55.	Linalyl iso-valerate	0.03
56.	Longipinocarvone	0.26
57.	α-phellandrene	0.06
58.	α-pinene	0.15
59.	α-pinocarveol	0.05
60.	α-selinene	0.29
61.	m-cymene, 5-tert butyl	0.11
62.	Megastigmatrienone	0.14
63.	Methyl chavicol	0.05
64.	Methyl cinnamate	0.06
65.	m-methaxyomandelic acid	0.88
66.	Murolan-3,9(11) - diene-10-peroxy	0.20
67.	Nerolidyl acetate	1.05
68.	O-cymene	0.15
69.	γ-anisaldehyde	0.50
70.	γ-cymen-8-ol	0.08
71.	Pentadecane	0.04
72.	Phytol	0.18

73.	γ-methoxyhydrocinnamic acid	0.23
74.	Tetracyclo[6,3,2,0(2.5),0(1,8)] -trdecan-9-ol, 4,4,-dimethyl	0.73
75.	Thujone	0.03
76.	Thymol	0.05
77.	Thymoquinone	0.07
78.	Ylangene	0.09
79.	Z-ocimene	0.03
80.	β-elemene	0.07
81.	γ-muurolene	0.31

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