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Analysis by gas chromatography-mass spectrometry of the essential oil of *Curcuma inodora* Blatt. (Zingiberaceae) from Southern India

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Abstract
The chemical investigation on volatile oil obtained by hydrodistillation of air dried leaves of *Curcuma inodora* Blatt. (Zingiberaceae) from Southern india done by GC and GC-MS. The major constituents of the above oils were beta.-Pinene (4.09%), Caryophyllene (31.33%), alpha-caryophyllene (5.97%), Benzofuran (21.29%), gamma.-Elemene (5.18%), alpha.-Bisabolol (2.32%), beta.-Elemenone (3.09%), Ethanone (2.76%), Phytol (3.19%), 1, 6-Cyclodecadiene (4.37%) and Cyclohexane (11.50%). This is the first report on the chemical compounds of the essential oil of this species.

Keywords: *Curcuma inodora* Blatt; Zingiberaceae; Essential oil composition; GC-MS; beta.-Pinene; Caryophyllene; Phytol; Cyclohexane

Introduction
The genus *Curcuma* L., with around 120 species distributed in tropical and subtropical Asia, consists of a rather homogenous group of rhizomatous perennials. In India about 29 species, distributed almost all states. The genus is easily recognized by its inflorescence, a spike with prominent spiral bracts, which laterally fuse or adnate to the peduncle and form pouches, each subtending a cincinnus of flowers, and a cluster of, often coloured, sterile, terminal bracts called 'coma'. The genus however is a taxonomically difficult one. It is a nightmare for plant hunters, herbarium technicians as well as taxonomists. Their occurrence as under growths in remote inaccessible forest areas and the extremely short period of flowering, hinders collection of materials with adequate character details. With their large size, fleshiness of rhizomes, tubers etc., they are difficult material for herbarium preparation. Consequently, most herbarium specimens are fragmentary and the treatment in most of the Floras, based as they are on these dried specimens, are truncated accounts (Skornickova *et al*., 2004) [8].
Curcuma inodora is an endemic species to peninsular India from Maharashtra extending up to North Karnataka. The specific epithet inodora (Latin) refers to the non-aromatic nature of the rhizome. Size and quantity of rhizomes are very low, hence isolated the volatile oil from the air dried leaves. This is the first report of the leaf oil composition of *C. inodora* from India. The main attraction of the plant *C. inodora* is its beautiful and attractive spike. The inflorescence with variously coloured and shaped comma bracts, and labellum shows range of colours from dark purple, white, yellow and golden. The plant produces two inflorescence in a year; one lateral and central. It is dormant during summer; starts sprouting by the end of April and fresh leaves appear. Hence named as hidden purple ginger. The species is closely related to *C. decipiens* Dalzell, and can be distinguished from it in the flowers equaling the bracts, 3-4 flowered cincinni, purple corolla and staminodes and labellum with a dark yellow band at the centre.

Materials and Methods
Shade dried aerial plant parts *Curcuma inodora* hydrodistilled separately in a Clevenger-type apparatus (Clevenger, 1928) [3] at 100 ^{o}C for 4 hours as prolonged extraction normally increases the yield (Gildemeister and Hoffman, 1961). Volatile oil was collected over water. The sample was cooled to room temperature and allowed to stand until oil layers were clear and finally the extracted oil was collected. The oils thus obtained were dried over anhydrous sodium sulfate and kept in refrigerator at 4 ^{0}C prior to analysis.

GC-MS analysis
GC was performed on a 6850 network GC system, Agilent technologies and MS was recorded on a 5975C VLMSD with triple axis detector Agilent technologies under the following

temperature conditions: 5 min at 60 ^{0}C, then rising at 5 ^{0}C/min to 110 ^{0}C, then 3 ^{0}C from 110^0-200 ^{0}C, then 5 ^{0}C/min to 220 ^{0}C and maintained at 220 ^{0}C for 5 minutes. Helium was used as the carrier gas and sample was injected in split mode.

Identification of Compounds: Compounds were identified by comparing the retention indices of the peaks on a RTX wax column with literature values, computer matching against the library spectra built up using pure substances and components of known essential oils and finally confirmed by comparison of mass spectra of peaks and retention indices with published data (Mc – Carron *et al*., 1995, Adams, 1989, Swigar and Silverstein, 1987, Ramaswamy *et al*., 1988) [6, 1, 9, 7]. The relative proportion of each individual component of the oil was expressed as a percentage relative to the total peak area.

Results and Discussion

Curcuma inodora is one of the most variable species we have ever come across the genus.Most remarkable is difference in colour of labellum. In present study we isolated the volatile oil from the leaves and subjected to GC-MS analysis. The major constituents of the above oils were beta.-Pinene (4.09%), Caryophyllene (31.33%), alpha-caryophyllene (5.97%), Benzofuran (21.29%), gamma.-Elemene (5.18%), alpha.-Bisabolol (2.32%), beta.-Elemenone (3.09%), Ethanone (2.76%), Phytol (3.19%), 1,6-Cyclodecadiene (4.37%) and Cyclohexane (11.50%).

Table 1: Percentage composition of the leaf oil of *Curcuma inodora* Blatt.

Components	Concentration (%)
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-, (1S)- beta.-Pinene	4.09
Cyclohexene, 4-ethenyl-4-methyl-3-(1-methylethenyl) -1-(1-methylethyl)-, (3R-trans)-	3.04
Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-,[1S-(1.alpha.,2.beta.,4.beta.)]-	11.50
Caryophyllene	31.33
gamma.-Elemene Cyclohexane, 1-ethenyl-1-methyl-2-(1-methylethenyl)-4-(1-methylethylidene)-	1.88
1,4,7,-Cycloundecatriene, 1,5,9,9-tetramethyl-, Z,Z,Z- alpha.-Caryophyllene	5.97
1,6-Cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl) -, [s-(E,E)]-	4.37
Benzofuran 5-Benzofuranacetic acid alpha.-methylene-, methyl ester	21.29
gamma.-Elemene	5.18
alpha.-Bisabolol	2.32
3,7-Cyclodecadien-1-one, 10-(1-methylethenyl)-,(E,E)- beta.-Elemenone	3.09
2-(Benzothiazol-2-ylamino)-3H-imidazol-4-ol Ethanone,	2.76
5-Hydroxy-3-methyl-1-indanone Phytol	3.19

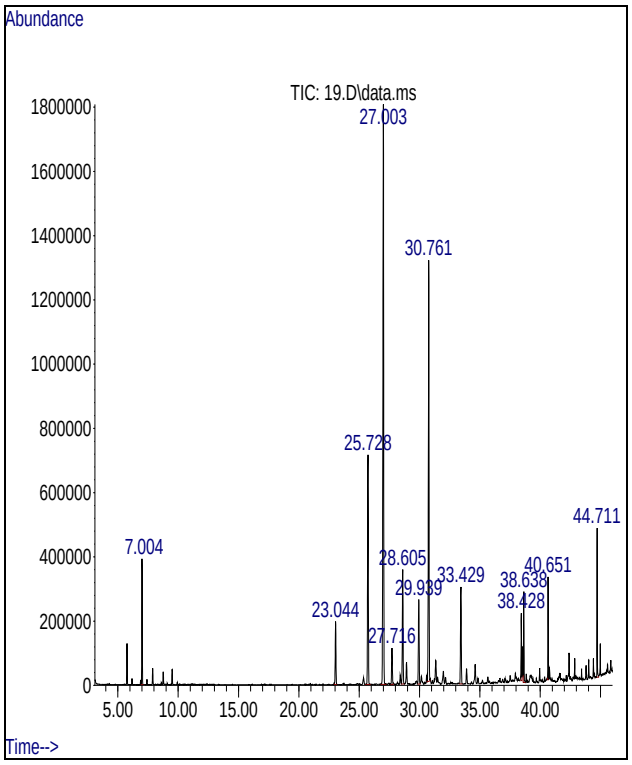
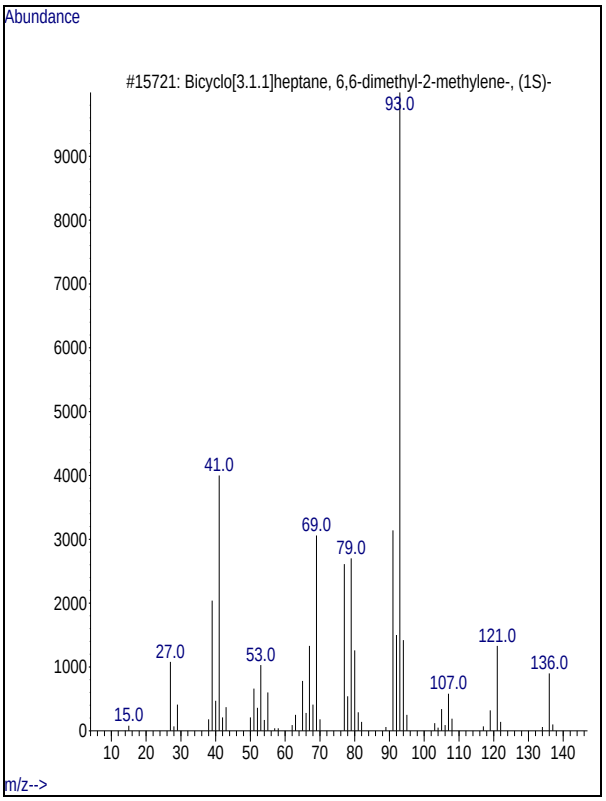
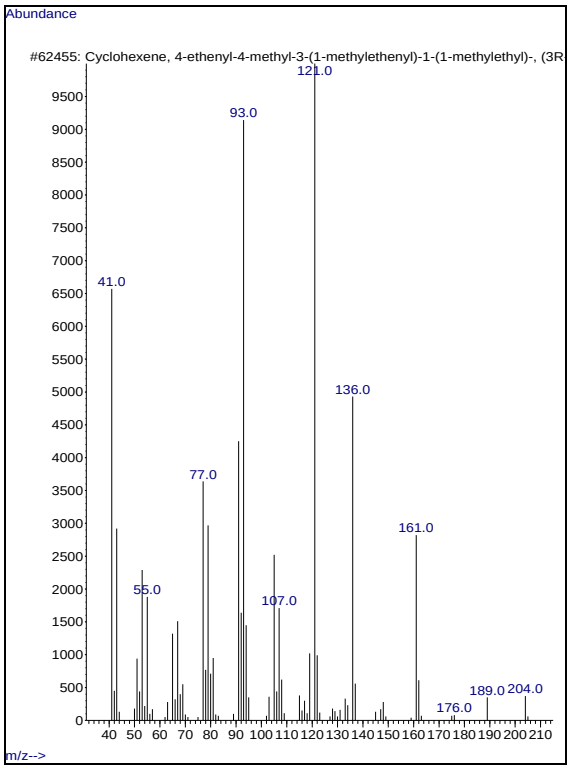


Fig 1: GC-MS ion chromatograms of volatile components from *C. inodora* leaf oil




Abundance
#62455: Cyclohexene, 4-ethenyl-4-methyl-3-(1-methylethenyl)-1-(1-methylethyl)-, (3R
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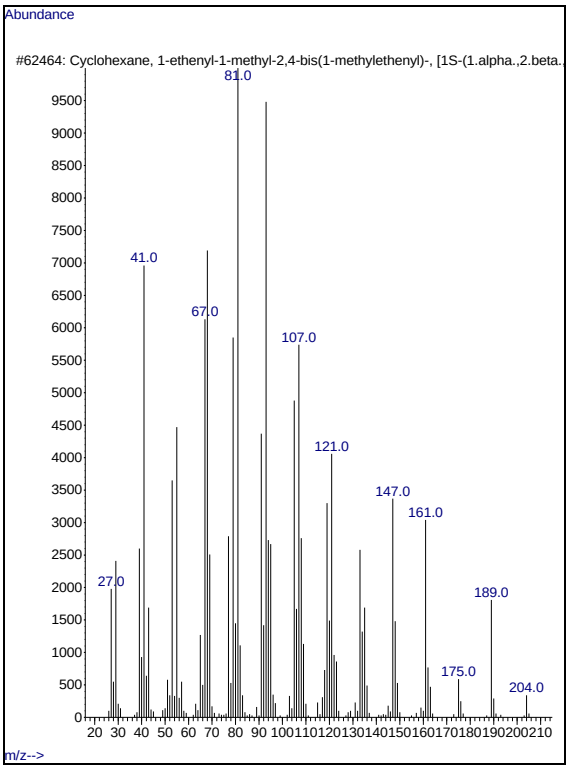
136.0
77.0
161.0
55.0
107.0
189.0
204.0
176.0
m/z-->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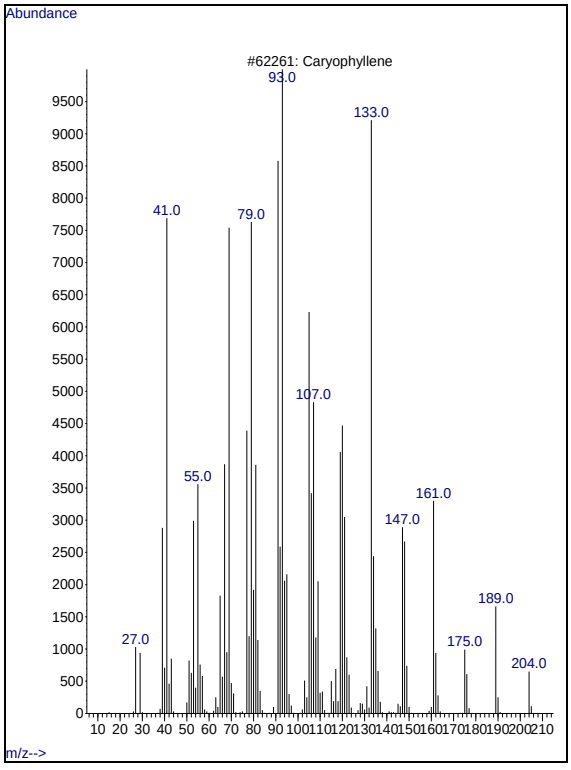
67.0
107.0
121.0
147.0
161.0
27.0
189.0
175.0
204.0
m/z-->


Abundance
#62261: Caryophyllene
93.0
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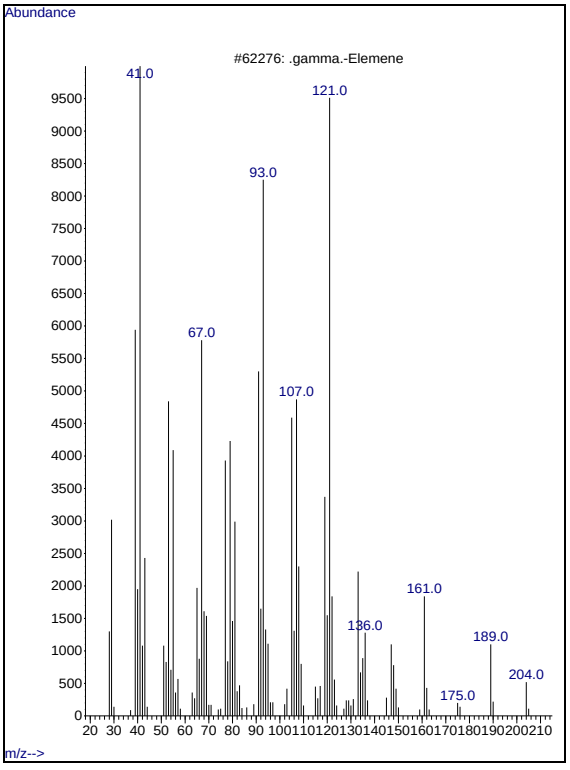
79.0
107.0
55.0
161.0
147.0
189.0
27.0
175.0
204.0
m/z-->


Abundance
#62276: .gamma.-Elemene
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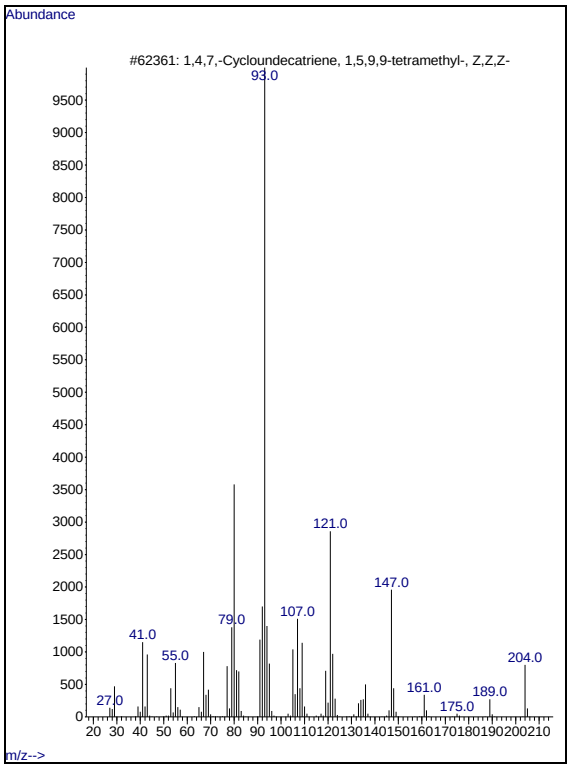
161.0
136.0
189.0
204.0
175.0
m/z-->


Abundance
#62361: 1,4,7,-Cycloundecatriene, 1,5,9,9-tetramethyl-, Z,Z,Z-
93.0
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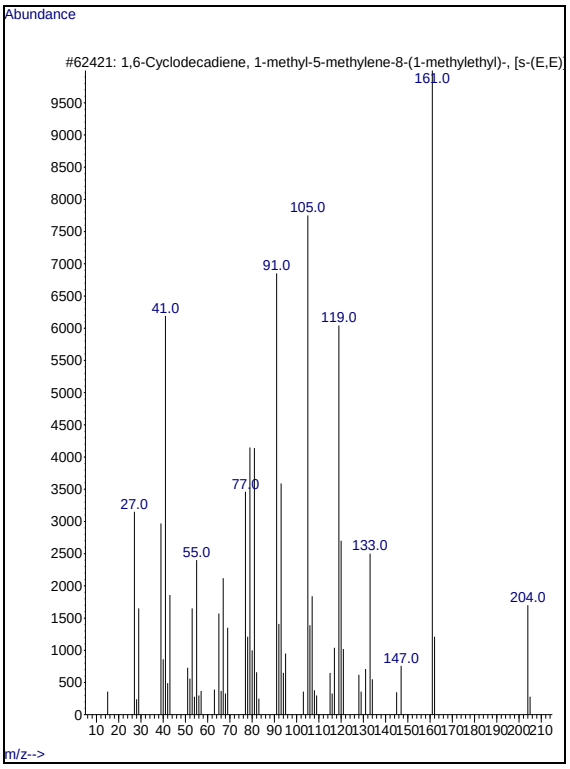
147.0
41.0
79.0
107.0
55.0
204.0
161.0
189.0
175.0
27.0
m/z-->


Abundance
#62421: 1,6-Cyclodecadiene, 1-methyl-5-methylene-8-(1-methylethyl)-, [s-(E,E)]
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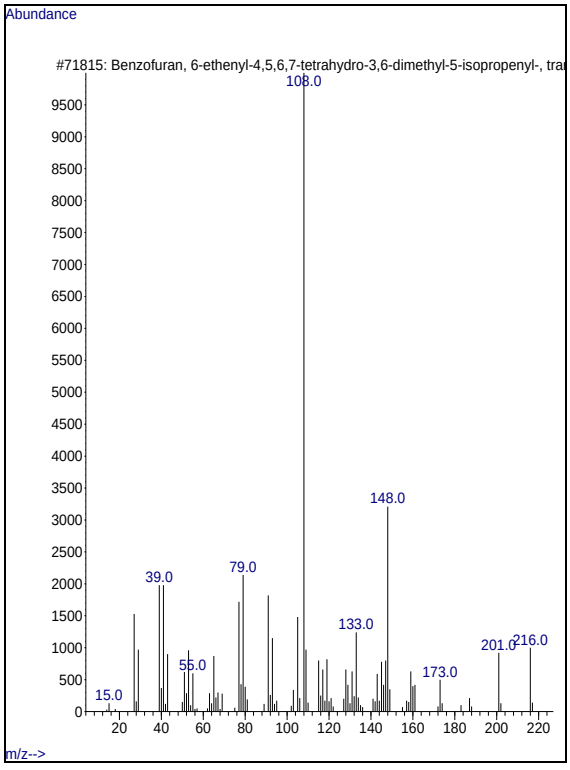
105.0
91.0
41.0
119.0
77.0
27.0
133.0
55.0
204.0
147.0
m/z-->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#71815: Benzofuran, 6-ethenyl-4,5,6,7-tetrahydro-3,6-dimethyl-5-isopropenyl-, trar
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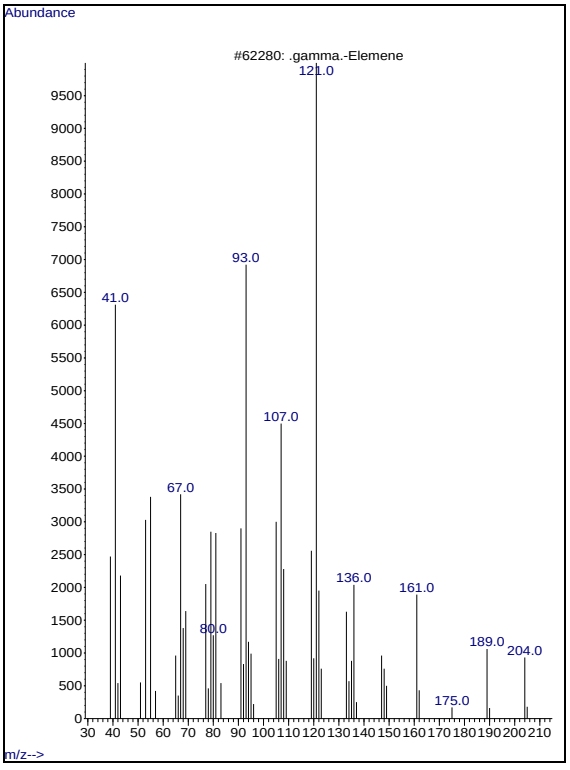
79.0
133.0
201.0
216.0
55.0
173.0
15.0
m/z-->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175.0
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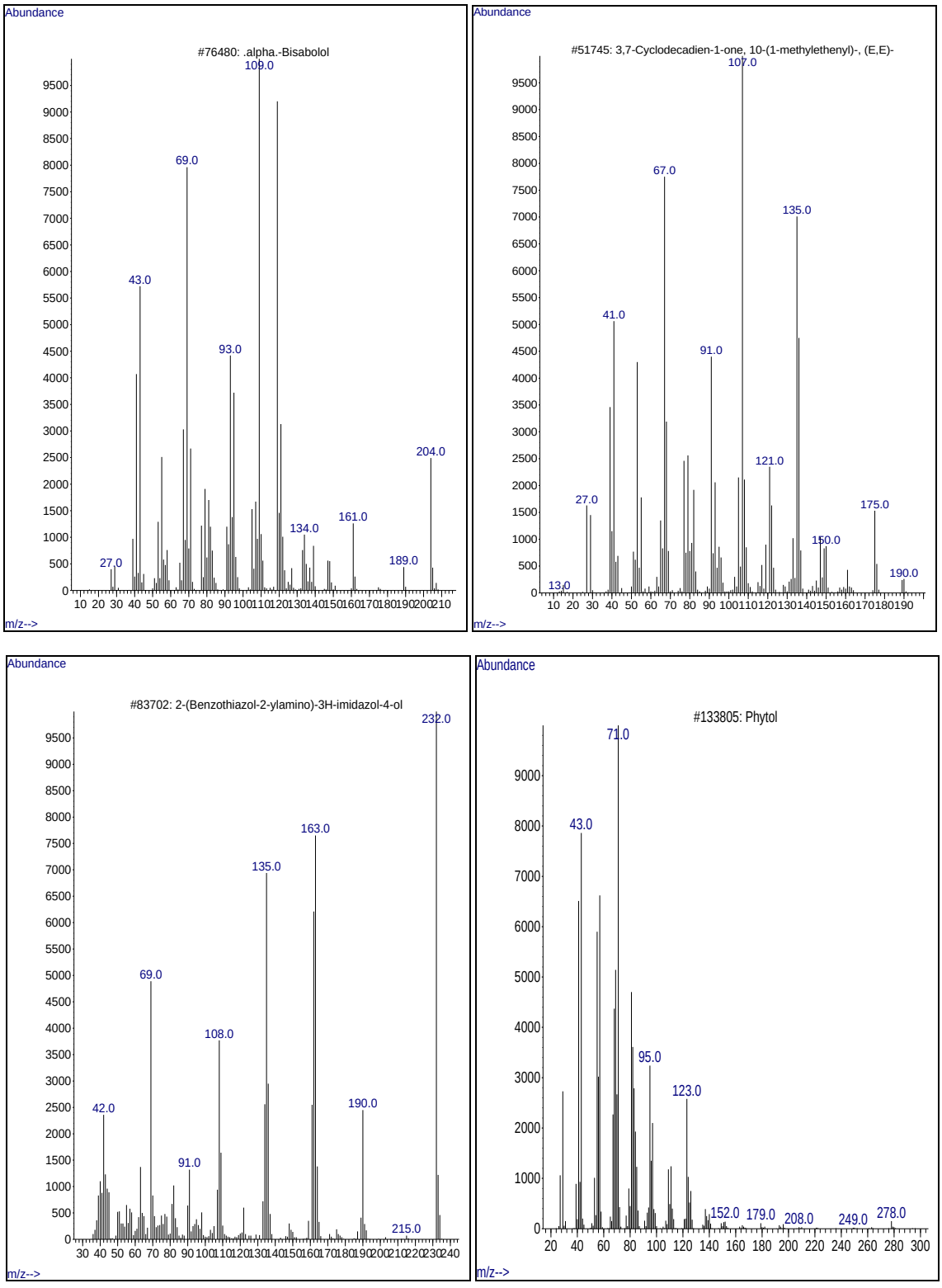

Fig 2: M.S Profile of volatile components from *C. inodora* leaf oil

A B

Fig 3A&B: Curcuma Inodora

Acknowledgements
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