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GC-MS Analysis of essential oils of *Curcuma longa* and *Mentha arvensis*

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Abstract: The goal of the current investigation is to use GC-MS analysis to comprehend the biomolecules found in turmeric and mentha essential oils. For this purpose, extraction of essential oils was carried out with the help of Clevenger's apparatus.Fifty volatile constituents were identified in *C. longa* essential oil in which Tumerone (32.70%), Curlone (19.10%),α-Zingiberene (5.35%), Cyclohexene-3(1,5dimethyl-4-hexenyl)-6-methylene (5.02%),Curcumene (3.74%), and Caryophyllene (3.09%) found as a major constituent.The Major constituents of *M. arvensis* essential oil were Carvone (50.59%), D-Limonene (22.65%), Caryophyllene (3.16%), Endo-Borneol (2.66%),Trans-Carveol (2.23%),Germacrene-D (1.97%),α-Pinene (1.62%), α-Bourbonene (1.44%), and Sabinene (1.08%).

Keywords: GC-MS, essential oil, turmeone, carvone.

INTRODUCTION

Most pharmaceuticals have historically been sourced from plants and other natural things. Essential oil is a secondary metabolite found in aromatic plants that has led to their usage in cooking and traditional medicine. Aromatic polypropanoids and mono- and sesquiterpenes combine to make essential oils. Traditional medicine uses *Curcuma* rhizome for a variety of conditions including the common cold, cough, internal injuries, inflammation, and wound healing. Furthermore, it finds application in cosmetics. *Curcuma's* essential oil is rich in terpenoids such monoterpenes, diterpenes, and other fragrant chemicals. Mint essential oil has become a popular additive to mouthwashes, breath mints, candies, gums, and toothpaste for its refreshing flavour. Mint has been used to relieve stomach aches and chest pain.

In the modern era, advancements have been made in every area of science and technology. There has been a rapid increase in the release of manufactured goods with a design focus. Almost eighty percent of people today use medicines derived from plants to treat illness and injury (SERMA). In recent years, Gas chromatography-Mass spectrometry (GC-MS) has emerged as a crucial technical platform for the profiling of secondary metabolites such as long-chain hydrocarbons, alcohols, acids, esters, alkaloids, steroids, amino and nitro compounds, etc in both plant and non-plant species (Gani [1], Fernie *et al.* [2], Kell *et al.* [3]). Therefore, the purpose of the current study was to analyze the chemical components through the extraction of essential oils and then separating and identifying the molecules using GC-MS.

MATERIALS AND METHODOLOGY

Extraction of essential oil (EO): Hydro-distillation employing Clevenger's equipment at room temperature was used to extract EO from the rhizome of *C. longa* and the leaves of *M. arvensis* (pudina). A liter of distilled water and the fresh plant material were placed in a round-bottom flask. Essential oils were extracted from plants by boiling them for around 5-6 hours, strained into dark bottles, and then treated with anhydrous sodium sulphate to remove any remaining traces of water. The refined oil was re-bottled in stealthy containers. These oil containers were kept at a temperature of 4°C.

GC-MS Analyses: GC-MS is an analytical technique for identifying low-molecular-weight molecules and volatile compounds. This technique can identify steroid, alkaloid, flavonoid, and fatty acid compounds found in medicinal plants. The GC-MS method was used to quantify the volatile nature of the herbal formulation's major constituents (Kasthuri *et al.* [4]). First, the chemicals in the complex mixture are separated by their retention times in a gas chromatograph, and then their structures are analyzed by means of mass spectrometry (MS).

GC-MS data was obtained on a Shimadzu GCMS-QP-2010 plus system using Omega SPTm column (30.0m x 0.25mm ID, film thickness 0.25um). Helium was used as carrier gas. Injector, Mass detector and Ion source temperatures were 270°C, 280°C and 250°C respectively. Column temperature programmed from 80°C (2 minutes hold), 80°C to 180°C at 4°C/min and 180°C to 230°C at 6°C/min withhold time of 6 minutes and 19 minutes, respectively. The flow rate of carrier gas was 1.21 ml/minute and split ratio was 1:80. EI source and mass range were 70eV and 40-850amu respectively. Compounds were identified by using Willey, NIST and Perfumery libraries.

RESULTS

Chemical compositions of *C. longa* essential oil by GC/GC-MS:A yellowish color oil was obtained from the rhizome of *C. longa.* The yield of the essential oil was 4ml / Kg plant material.The oil was analyzed by GC/MS and the results are shown in Table 1 & Fig.1. As shown 50 volatile constituents were identified, representing 100% of the total essential oil. Major constituents of *C. longa* essential oil were Tumerone (32.70%), Curlone (19.10%), α-Zingiberene (5.35%), Cyclohexene-3(1,5dimethyl-4-hexenyl)-6-methylene (5.02%), Curcumene (3.74%), Caryophyllene (3.09%), 2,6,10-Cyclotetradecatrien-1-one-3,7,11-trimethyl-14(1-methylethyl) (1.52%), 3-Methylbut-2-enoic acid, 4-nitrophenyl ester(1.05%), *trans*-Nuciferol (0.77%), Methyl -10,12-heptadecadiynoate (0.54%)and other constituents are present in trace amount as given in **Table 1.**

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Table (1): Compounds identified from essential oil of *C. longa* by GC-MS

Peak	Name of Compound	R. Time	Area%
1	Tricyclo[4.1.0.0(2,4)]heptane, 5(phenylthio)	6.05	0.04
2	α-Phellandrene	6.25	0.17
3	3,5Methanocyclopentapyrazole,3,3a,4,5,6,6-ahexahydro-3a, 4,4-trimethyl	6.32	0.05
4	α-Terpinolene	6.38	0.25
5	o-Cymene	6.46	0.06
6	Eucalyptol	6.56	0.61
7	α-Curcumene	7.13	3.74
8	p-Cymen-8-ol	8.03	0.06
9	Trans α-Bergamotene	10.79	0.05
10	Caryophyllene	11.30	3.09
11	β-Farnesene	11.65	0.22
12	Humulene	11.93	0.45
13	Benzene,1(1,5dimethyl-4 hexenyl) 4methyl	12.32	0.90
14	α-Zingiberene	12.64	5.35
15	α-Bisabolene	12.90	0.58
16	β-Sesquiphell-andrene	13.33	5.02
17	α-Farnesene	13.49	0.21
18	Trans α-Bergamotene	13.98	0.14
19	1-Methylene-2bhydroxymethyl-3,3-dimethyl-4b(3-methyl But -2-enyl) cyclohexane	14.15	0.25
20	Bicyclo[4.1.0]heptane, 7pentyl	14.27	0.07
21	1,2,3,1',2',3'-Hexamethyl bicyclopentyl-2,2'-diene	14.32	0.07
22	Tumerone	14.63	0.22
23	1,4Bis(4methylphenylcarbonyloxy) benzene	14.70	0.36
24	Trans-Sesquisabinene hydrate	15.00	0.32
25	Chamigran-7en-9-ol, 2,10-dibromo-3-chloro	15.15	0.19
26	Trans -Nuciferol.	15.43	0.77
27	Cis-sesquisabinene hydrate	15.67	0.41

28	5,10Pentadecadiyne, 1chloro	15.82	0.11
29	Spiro[4.5]dec-7-ene,1,8-dimethyl -4 (1methylethenyl)	16.18	0.51
30	Methyl-10,12-heptadecadiynoate	16.41	0.54
31	+α-Farnesene	16.48	0.23
32	p-Mentha [1(7),8] diene-2- hydroperoxide	16.80	0.18
33	Ar-tumerone	17.27	0.09
34	Tumerone	17.73	32.70
35	2-Methyl-6-(4-methylphenyl)-2-hepten-4-one	17.83	16.16
36	Cedrene	18.10	0.18
37	5,10-Pentadecadiyn-1-ol	18.17	0.28
38	Curlone	18.77	19.10
39	Acetic acid, trifluoro,2,6-dimethylphenyl ester	18.96	0.07
40	1,5-Diphenylhex-3-ene	19.28	0.09
41	2,6,10-Cyclotetradecatrien-1-one-3,7,11-trimethyl-14(1-methylethyl)	20.09	1.52
42	(6S)-2-Methyl-6-(4-methylphenyl)-2-hepten-4-one	20.47	1.02
43	3-Methylbut-2-enoic acid, 4-nitrophenyl ester	20.74	1.05
44	Catechol	20.86	0.23
45	Cyclohexanone,2,3,3trimethyl-2(3-methyl1,3butadienyl),(Z)	21.06	0.72
46	p- Mentha-[1(7),8]-diene-2-hydroperoxide	21.80	0.22
47	10,10-Dimethyl-2,6-dimethylenebicyclo[7.2.0]undecan-5-áol	21.92	0.12
48	3,4Dimethyl2,5diprop2enyl2,5dihydrothiophene-1,1-dioxide	22.46	0.70
49	2-Propenoic acid, 3-phenylpropyl ester	25.15	0.09
50	β-chamigrene	29.55	0.45
Total			100.00

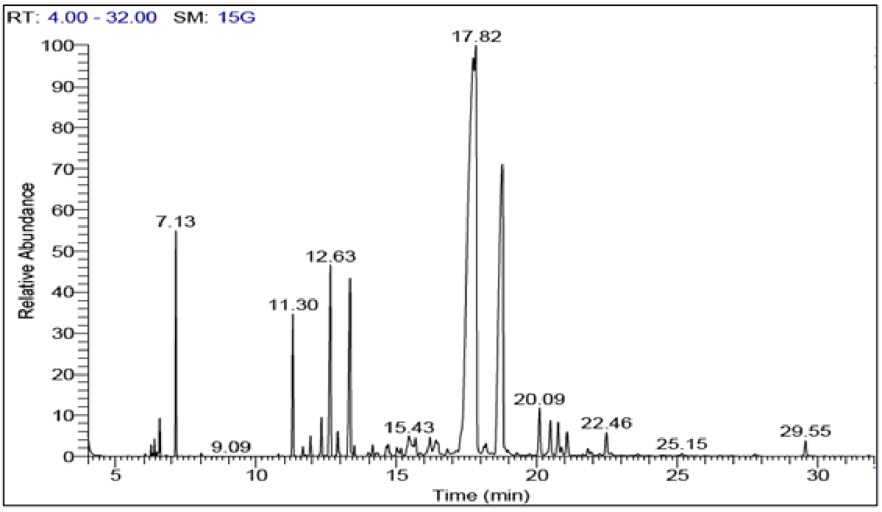

Fig. (1): Chromatograph of *Curcuma longa* essential oil

Chemical compositions of *M. arvensis* essential oil by GC/GC-MS:A pale yellow color oil was obtained from the fresh leaves of *Mentha arvensis.* The yield of the essential oil was 2ml / Kg plant material. The extracted oil was analyzed by GC/MS. The outcome is shown in **Table 2 & Fig. 2**. As shown 50 volatile constituents were identified, representing 100% of the total essential oil. Major constituents of *M. arvensis* essential oil were Carvone (50.59%), D-Limonene (22.65%), Caryophyllene (3.16%), Endo-Borneol (2.66%), Trans-Carveol (2.23%),Germacrene- D (1.97%),α-Pinene (1.62%), α-Bourbonene (1.44%),Sabinene (1.08%),p-Menth-8-en-2-one (1.06%), α-Farnesene (0.65%), Cismuurola-4 (14), 5-diene (0.55%), Humulene (0.48%) and other constituents are present in trace amount as presented in **Table 2**.

Table (2): Compounds identified from essential oil of *M. arvensis* by GC-MS

Peak	Name of Compound	R. Time	Area%
1	α-Pinene	6.63	1.22
2	Camphene	7.04	0.51
3	Sabinene	7.71	1.08
4	2,6,6-Trimethylbicyclo[3.1.1]hept-2-ene	7.82	1.62
5	α-Myrcene	8.16	1.17
6	3-Octanol	8.28	0.24
7	Cosmene	8.59	0.17
8	D-Limonene	9.38	22.65
9	(+)-α-Pinene	9.54	0.21
10	α-Ocimene	9.83	0.61
11	α-Terpinolene	11.07	0.14

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12	1,6-Octadien-3-ol,3,7dimethyl	11.37	0.19
13	2(1-Hydroxyethyl)-Hydroxymethylbenzene	12.03	0.17
14	Limonene oxide, trans	12.55	0.12
15	Endo-Borneol	13.43	2.66
16	3-Cyclohexen-1-ol,4-methyl-1(1-methylethyl)	13.73	0.29
17	α-Terpineol	14.13	0.22
18	O-Trifluoro-acetylisopulegol	14.22	0.29
19	p-Menth-8-en-2-one	14.31	1.06
20	Carveol	14.91	0.24
21	Trans-Carveol	15.26	2.23
22	Carvone	15.90	50.59
23	Piperitone	16.13	0.27
24	Carvone oxide, trans	16.31	0.11
25	1-methyl-4(prop-1-en-2-yl)7-oxabicyclo [4.1.0]heptan-2-one	16.65	0.19
26	Murolene	17.09	0.12
27	Bicyclo[3.1.1]hept-3-en-2-one-4,6,6trimethyl	18.36	0.24
28	2-Cyclohexen1ol,2-methyl-5(1-methylethenyl), acetate	18.85	0.08
29	α-Bourbonene	19.52	1.44
30	β-Elemene	19.65	0.23
31	2-Cyclopenten-1-one, 3-methyl-2-(2-pentenyl)	19.85	0.28
32	Caryophyllene	20.44	3.16
33	1HCyclopenta [1,3] cyclopropa[1,2]benzene,octahydro-7-methyl-3-methylene-4(1-methylethyl)	20.65	0.18
34	1,6-Cyclodecadiene,1-methyl-5-methylene-8(1-methylethyl)	21.05	0.29
35	Cis α-Farnesene	21.21	0.65
36	Humulene	21.29	0.48
37	Cismuurola-4(14),5-diene	21.51	0.55
38	1,6-Cyclodecadiene,1-methyl-5-methylene-8(1-methylethyl)	21.61	0.15

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39	Germacrene D	21.98	1.97
40	1,5-Cyclodecadiene-1,5-dimethyl8(1methylethylidene)	22.36	0.33
41	Ç-Muurolene	22.75	0.08
42	Catechol	22.96	0.41
43	α-Cadinene	23.31	0.10
44	4-epi-cubedol	24.25	0.09
45	Caryophyllene oxide	24.47	0.21
46	Cubenol	25.17	0.29
47	Muurolol	26.06	0.32
48	Ar-tumerone	26.23	0.23
49	Dihydro cis-α-copaene-8-ol	26.92	0.11
50	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	35.08	0.21
Total			100.00

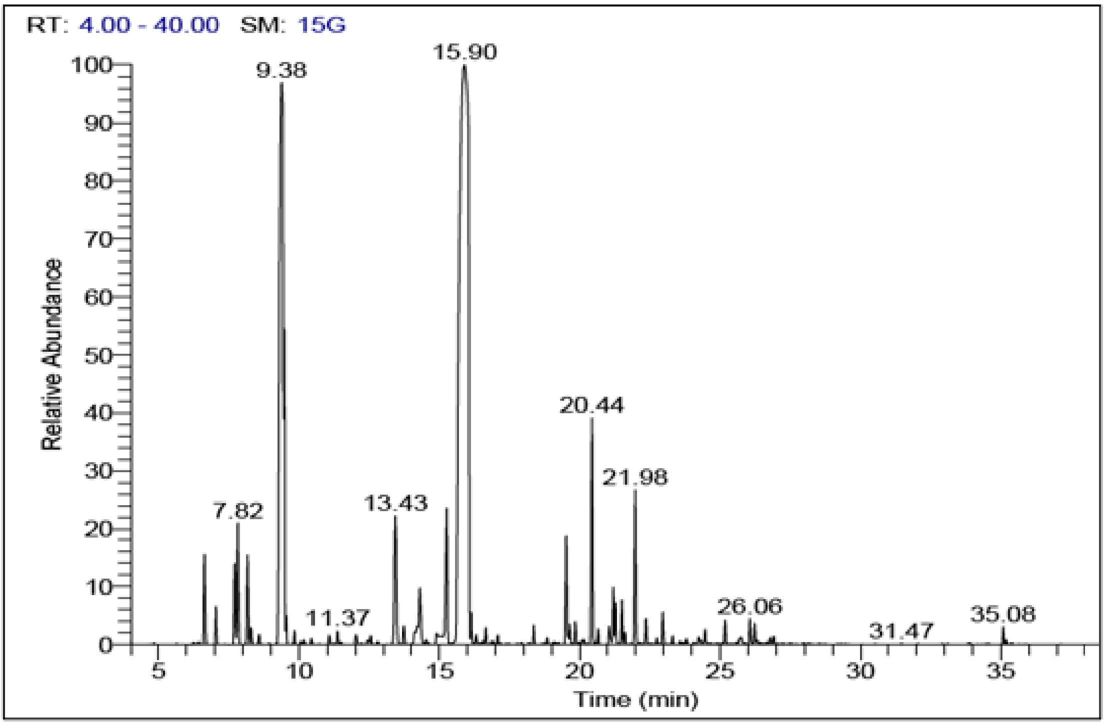

Fig. (2): Chromatograph of *Mentha arvensis* essential oil

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DISCUSSION

GC-MS combines the most effective separation technique (GC) with the most effective technology (MS) to substantially facilitate qualitative and quantitative study of volatile bioactive chemicals [5]. In present study, the major constituents of *Curcuma longa* oil were Tumerone (32.70%), Curlone (19.10%), α-Zingiberene (5.35%), Cyclohexene-3(1,5dimethyl-4-hexenyl)-6-methylene (5.02%), Curcumene (3.74%), Caryophyllene (3.09%), 2,6,10-Cyclotetradecatrien1one-3,7,11-trimethyl-14(1-methylethyl) (1.52%) and other constituents are present in trace amount. Mishra and Khan [6] analyzed *Curcuma longa* extract by GC-MS and identified 21 components in which Turmerone (29.12%) and Curlone (17.03 %) reported as a major component. Some other compounds have also been identified as follows: gamma-Atlantone (10.92%), Atlantone (4.52 %), Benzene, 1,4-dimethyl-2-(2-methylpropyl) (2.52 %), 2-Propenoic acid, 1,7,7- trimethylbicyclo-[2.2.1]-hept-2-yl ester, (2.43%).

Natta *et al.* [7] also extracted essential oils from *Zingiber officinale*, *Alpinia galanga*, *Curcuma longa*, *Boesenbergia pandurata* and *Amomum xanthioides* by hydrodistillation and analyzed the oils by GC-MS. They identified 15 compounds in turmeric oil. The obtained results showed that turmerone (50.0%) is the main compound which was followed by Curlone (12.9%), α-Farnesene (10.8%), α-Zingiberene (7.8%), ar-Turmeone (0.90%) respectively.

Hwang *et al.* [8] analyzed turmeric essential oil by GC–MS. Alpha-zingiberene (27.70–36.75 %), ar-turmerone (19.54–32.24 %), beta-sesquiphellandrene (13.14–18.23 %), alpha-turmerone (3.72–6.50 %), beta-turmerone (2.86–5.60 %) and beta-bisabolene (2.50-3.46 %) were identified. Sindhu *et al.* [9] also evaluated the essential oil of turmeric leaves by GC–MS and α-phellandrene, p-cymene and terpinolene have been identified as the major components of turmeric essential oil. Xu *et al.* [10] compared the essential oil yield of *C. longa* using three different methods (NADES-based MAHD, MAHD, and HD) and used gas chromatography-mass spectrometry (GC-MS) to analyze the essential oil. They identified 49 compounds, 14 of which were common in three different ways, including Caryophyllene, Curcumene, Valencene, and Germacrone.

In the present investigation, the major constituentss of *M. arvensis* essential oil were Carvone (50.59%), D-Limonene (22.65%), Caryophyllene (3.16%), Endo-Borneol (2.66%), Trans-Carveol(2.23%),Germacrene- D(1.97%),α-Pinene (1.62%)and other constituents were present in trace amount. Sharma *et al.* [11] analyzed the essential oil of *Mentha arvensis* from 3 different locations (Patiala, Fatehpur and Dhameta) of North, India. Essential oil was analyzed by GC-MC and the major components of *Mentha arvensis* L. collected from Patiala, were Carvone (60.59%), D-Limonene (19.34%), Germacrene (2.37%), Carveol (1.62%) and Dihydrocarveol (1.02%) whereas the major constituents of the Fatehpur oil were L-Menthone (29.41%), Menthol (21.33%), Isomenthone (10.8%), Eucalyptol (6.91%), α-Phellandrene (3.20%) and the major constituents of the *M. arvensis* oil collected from Dhameta were L-Menthone (27.1%), Menthol (20.25%), Pipetritione oxide (9.89%), Isomentheone (4.13%) and Thymol (1.49%). They concluded that the difference between these oil may be due to environmental factors and altitude.

Pandey *et al.* [12] also conducted a study on the chemical composition of the essential oils of *M. arvensis* and *Cymbopogon flexuosus*. Menthol (71.40%), *para*-menthone (8.04%), *iso*-menthone (5.42%) were identified as the major components of *M. arvensis* essential oil. Wenshen [13] conducted a study on the chemical constituents of *M. arvensis* essential oil by GC/MS method and 44 constituents were identified. Menthol, Menthone, Piperitone, Menthyl acetate, Germacrene-D and Limonene-1, 8-cineole were reported as the major constituents of the oil. Manh and Tuyet [14] analyzed the essential of *M. arvensis* L. by gas chromatography-mass spectrometry (GC-MS) and identified Menthol (66.04%), Menthyl acetate (22.19%), Menthone (2.51%), and Limonene (2.04%) as the main components.

CONCLUSION

The essential oil composition is influenced by a number of factors, including the extraction method, the conditions of the instrument, the plant part, the time of harvest, the sampling seasons, the geographical origin, etc., and these factors permit the selection of methods that facilitate the isolation of specific compounds.

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