Steam Distillation and Gas Chromatographic Analysis of Volatile Components of *Zingiber officinale*

***[1]Grace A. Akpanika, [2]Effiong E. Nkanor and [3]Gloria A. Ayoola**.

[1] Department of Pharmaceutical Chemistry, Faculty of Pharmacy, University of Calabar, Nigeria

[2] Department of Pharmacology, Faculty of Basic Medical Sciences, University of Calabar, Nigeria.

[3]Department of Pharmaceutical Chemistry, Faculty of Pharmacy, University of Lagos, Nigeria.

ABSTRACT

Background: The use of ginger in aromatherapy and humidification has become a common practice since the advent of Covid-19 pandemic. Even though ginger will not prevent or cure Covid-19 and other viral infections, there are evidences that ginger can give relief from nausea, cough, nasal irritation, fatigue and aches.

Methods: The oil of *Zingiber officinale* (ginger) from Calabar metropolis was extracted using steam distillation. Gas chromatography Mass Spectrometry was used to determine volatile compounds.

Results: 57 compounds were identified, Zingiberene (26.85%) being the most abundant. Other compounds identified included Sesquiphillandrene (22.12%), Curcumene (10.69%), Eucalyptus (2.80%), Eugenol (2.70%), B-Phellandrene (1.65%), Bisabollene (1.52%), Pinene (0.17%) and Camphor (0.13%).

Conclusion: The presence of these compounds is more likely to be responsible for the use of ginger in ethno medicine as in aromatherapy.

Key words **- Covid-19, GC-MS, Ginger, Steam distillation.**

1. INTRODUCTION

Ginger essential oil is derived from the root of *Zingiber officinale* rhizome. Ginger has found extensive use since ancient times as spice and in traditional medicine for the management of various disease conditions such as joint pains, epigastric pains, flatulence, sore throat, nasal congestions, chills, muscle aches, runny nose and fever. Ginger was extensively used by King Henry VIII in 1528 during the mysterious sweating sickness pandemic (sudor anglicus) that swept through Europe during his reign as King. In recent times, ginger hydroethanol extracts are used extensively as analgesics, anti-cancer, anti-diabetic, hepato-protective and nephro-protective agents [1]. Since the advent of Covid-19, the use of ginger especially in aromatherapy and humidification have become a common practice. Even though ginger will not prevent or cure Covid-19 and other viral infections, there are evidences that ginger can give relief from nausea, aches and respiratory congestions [2]. Numerous investigations have been carried out to isolate and characterize the bioactive compounds responsible for its pharmacological activities. Results indicate that ginger contains monoterpenoids, sesquiterpenoids, phenolic compounds and their derivatives, aldehydes, ketones, alcohols, esters that maybe responsible for their activities [3]. The aim of this work is to investigate the chemical composition of ginger oil responsible for its medical use as anti-inflammatory, analgesic, carminative, expectorant, anti-nausea, appetite-boosting agent.

Corresponding Author: E-mail: gakpanika@yahoo.com Phone: +2348034075133

2. MATERIALS AND METHODS

2.1 Materials

2.1.1. Equipment

Clavenger hydrodistillation apparatus, Shimadzu GC-MS system model QP2010, kenwood blender, BL 335, anhydrous sodium sulphate (Sigma-Aldrich).

1.1.2. Biological materials

Rhizomes of ginger were collected from Etim Edem Park in Calabar, Cross River State, Nigeria.

2.2 Methods

2.2.1. Extraction procedure

Essential oils are volatile and aromatic, the preferred method for essential oil extraction is steam distillation.
The rhizomes were washed to remove adhering soil particles, peeled and washed again in clean water. Rhizomes, 100 g were chopped into pieces, blended with 300 ml distilled water using a domestic kenwood blender, BL 335. The blended material was then macerated for 10 min before steam distillation using a clavenger hydrodistillation unit to extract essential oil [4]. A flask containing the homogenate was heated for 3 hours at 90^{o}C and the condensed vapour separated using a separator. The extracted oil was treated with anhydrous sodium sulphate to remove suspended and dissolved water. The percentage yield of the oil obtained was 0.364%. The extracted oil was stored in an amber bottle at 4^{o}C for future use.

2.2.2. GC-MS analysis

Sample was analyzed on a Shimadzu GC-MS system model QP2010, with medium polarity capillary column SLB-5 ms supelco column (Length 30.0 m x Thickness 0.20 mm x Diameter 0.20 mm) with helium gas as carrier gas. The column oven temperature was at 50^{o}C for 1 min and increased at a rate of 5^{o} min^{-1} to a final temperature of 150^{o}C. Injector and detector temperatures were maintained at 200 and 250^{o}C respectively, 0.2 µl of sample was injected using a splitless injection mode. Analytical conditions were as follows: Temperature program 50-200^{o}C, 5^{o}C min^{-1}, isothermal at 200^{o}C, Injector temperature 250^{o}C, Helium carrier gas velocity 30 cms^{-1}, Ion source temperature 200^{o}C, Ionization voltage 70 ev, Electron multiplier voltage 2600 v, Total run time was 18 min.

2. RESULTS

Identification of volatile oil compounds extracted from ginger was achieved using GC-MS (Figure 1). Fifty seven compounds were identified, these include: Zingiberene (26.85%), Sesquiphillandrene (22.12%), Curcumene (10.69%), Eucalyptus (2.80%), Eugenol (2.70%), B-Phellandrene (1.65%), Bisabollene (1.52%), Pinene (0.17%) and Camphor (0.13%).

3. DISCUSSION

In this study, the principal constituent was zingiberene, a sesquiterpene responsible for the characteristic scent of ginger. Zingiberene exhibits antiviral, antioxidant and antiseptic properties. The antioxidant property of zingiberene explains why ginger is refreshing and capable of reducing stress associated with free radical scavenging that damage cells by oxidation [5]. Sesquiphillandrene and eugenol present are also known to have antiviral and antibacterial properties. Their carminative property makes ginger very useful in expelling gas from the stomach and small intestine relieving flatulence and abdominal pain [6] The antiviral, antiseptic and bactericidal properties of ginger are enhanced by the presence of the peppery and minty B-Phellandrene [5]. Ginger is very useful in the treatment of hypertension. It contains Curcumene, a compound known to have hypotensive and anti-inflammatory properties [7]. Pinene and eugenol are potent bronchodilators with expectorant properties [8,9,10]. This is responsible for the use of ginger in asthma and cough. The decongestant property of B-Phellandrene and eucalyptus is also useful for the alleviation of

asthma and cough [10,11]. Ginger oil is used in cosmetic or topically to soothe redness in bacteria associated acne, aging and tanning because it contains Bisabollene which is known to exhibit anti-inflammatory and anti-allergy properties as well as exude a warm fruity aroma characteristic of the orients [12].

4. CONCLUSION

In conclusion, ginger is not only a dietary condiment used for flavouring but also a herb that have been in use over the years for medicinal purposes, treating various ailments. Its chemical analysis reveals the presence of diverse compounds that clearly defines its medicinal functions as seen in its extensive use in the recent Covid-19 pandemic.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions:

Grace Akpanika wrote the paper. Efiong Nkanor and Gloria Ayoola revised the paper. All authors have read and agreed to the published version of the manuscript. All authors are responsible for funding.

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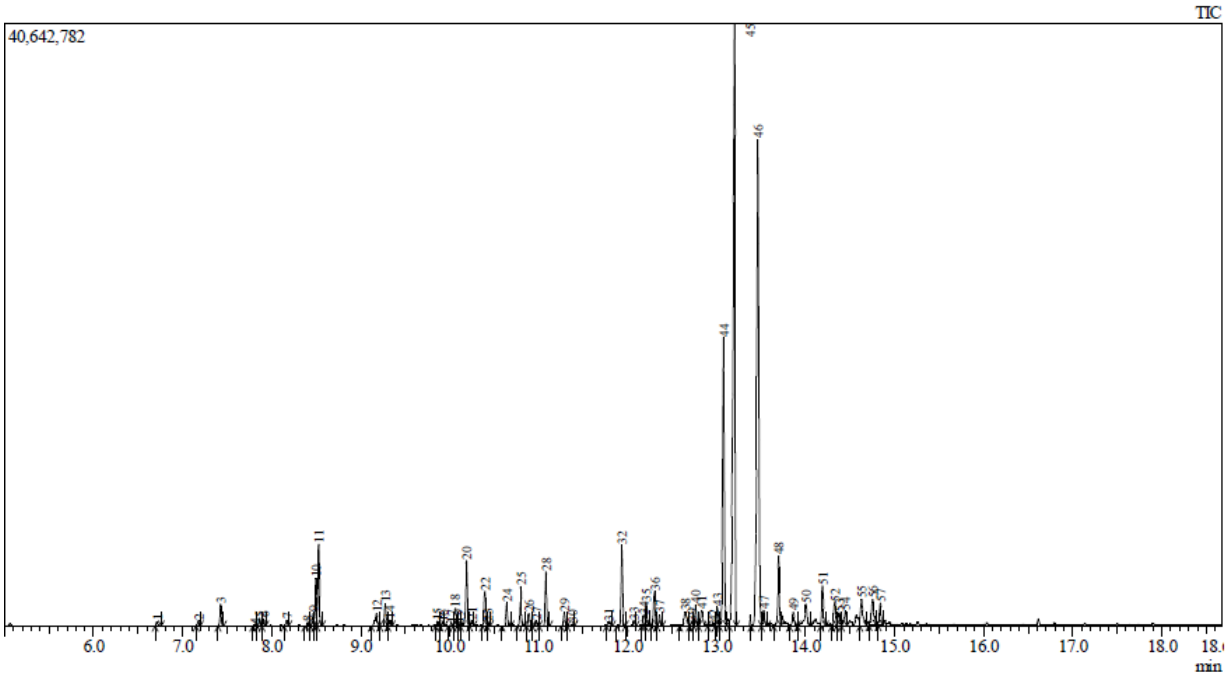

Figure 1: Shows the capillary gas chromatogram of ginger volatile components. Volatile compounds were identified as shown in table 1.

Table 1: Volatile compounds obtained from ginger oil

Peak Report TIC

Peak#	R.Time	Area	Area%	Height	Height%	A/H	Name
1	6.710	388532	0.16	286521	0.17	1.36	2-Heptanol
2	7.176	407868	0.17	340819	0.21	1.20	.alpha.-Pinene
3	7.426	1830743	0.77	1496483	0.91	1.22	Camphene
4	7.812	107901	0.05	95349	0.06	1.13	Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methyle
5	7.864	626092	0.26	533051	0.32	1.17	5-Hepten-2-one, 6-methyl-
6	7.909	563231	0.24	503672	0.31	1.12	.beta.-Myrcene
7	8.170	470682	0.20	414009	0.25	1.14	.alpha.-Phellandrene
8	8.402	222872	0.09	196235	0.12	1.14	1,3,8-p-Menthatriene
9	8.467	1134386	0.48	878844	0.53	1.29	D-Limonene
10	8.498	3924880	1.65	3228078	1.96	1.22	.beta.-Phellandrene
11	8.529	6674672	2.80	5526953	3.35	1.21	Eucalyptol
12	9.178	1484072	0.62	870779	0.53	1.70	Bicyclo[3.1.1]hept-3-en-2-one, 4,6,6-trimethyl-
13	9.276	1961700	0.82	1524538	0.93	1.29	1,6-Octadien-3-ol, 3,7-dimethyl-
14	9.325	482369	0.20	428876	0.26	1.12	3-Oxatricyclo[4.1.1.0(2,4)]octane, 2,7,7-trimet
15	9.860	358816	0.15	282689	0.17	1.27	6-Octenal, 3,7-dimethyl-, (R)-
16	9.925	300386	0.13	220464	0.13	1.36	Camphor
17	10.017	202576	0.09	166967	0.10	1.21	Bicyclo[2.2.1]heptan-2-ol, 2,3,3-trimethyl-
18	10.063	1368011	0.57	1176471	0.71	1.16	2,6-Dimethyl-1-nonen-3-yn-5-ol
19	10.100	148434	0.06	137307	0.08	1.08	Isobornyl acetate
20	10.188	5733941	2.41	4396516	2.67	1.30	endo-Borneol
21	10.250	432362	0.18	372158	0.23	1.16	Terpinen-4-ol
22	10.395	2796904	1.17	2344205	1.42	1.19	.alpha.-Terpineol
23	10.430	264992	0.11	234634	0.14	1.13	5-Tetradecen-3-yne, (E)-
24	10.640	1800069	0.76	1540261	0.93	1.17	Citronellol
25	10.798	3121232	1.31	2654387	1.61	1.18	2,6-Octadienal, 3,7-dimethyl-, (Z)-
26	10.890	955014	0.40	839701	0.51	1.14	Geraniol
27	10.969	382203	0.16	329138	0.20	1.16	trans-p-mentha-1(7),8-dien-2-ol
28	11.082	4271008	1.79	3652489	2.22	1.17	2,6-Octadienal, 3,7-dimethyl-, (E)-
29	11.288	1192424	0.50	883665	0.54	1.35	2-Undecanone
30	11.374	143288	0.06	111068	0.07	1.29	4-Methyl-2-hexanol
31	11.785	470110	0.20	238287	0.14	1.97	Cyclohexene, 4-ethenyl-4-methyl-3-(1-methyle
32	11.935	6421686	2.70	5424097	3.29	1.18	Eugenol
33	12.070	394244	0.17	351811	0.21	1.12	Geranyl acetate
34	12.179	875975	0.37	707563	0.43	1.24	1,2,4-Metheno-1H-indene, octahydro-1,7a-dim
35	12.206	1909707	0.80	1524281	0.93	1.25	Copaene
36	12.299	2671973	1.12	2308971	1.40	1.16	Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-met
37	12.357	876290	0.37	745005	0.45	1.18	1,3-Cyclohexadiene, 5-(1,5-dimethyl-4-hexeny
38	12.647	1967037	0.83	941777	0.57	2.09	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8
39	12.721	344839	0.14	234526	0.14	1.47	.beta.-copaene
40	12.763	1726122	0.72	1421827	0.86	1.21	cis-.beta.-Farnesene
41	12.831	1798697	0.75	1071246	0.65	1.68	Cyclohexene, 3-(1,5-dimethyl-4-hexenyl)-6-me
42	12.960	443226	0.19	224554	0.14	1.97	Humulene
43	13.007	1705855	0.72	1292799	0.78	1.32	Alloaromadendrene
44	13.076	25481861	10.69	19473901	11.82	1.31	Curcumene
45	13.200	63981967	26.85	40641483	24.67	1.57	Zingiberene
46	13.464	52701028	22.12	32841829	19.93	1.60	Sesquiphillandrene
47	13.529	1685183	0.71	1106973	0.67	1.52	(-)-.alpha.-Panasinsen
48	13.695	6150660	2.58	4769500	2.89	1.29	Nerolidyl acetate
49	13.861	1664976	0.70	949392	0.58	1.75	1,5-Cyclodecadiene, 1,5-dimethyl-8-(1-methyle
50	14.003	3084714	1.29	1467257	0.89	2.10	7-epi-cis-sesquisabinene hydrate
51	14.189	3630688	1.52	2718941	1.65	1.34	.alpha.-Bisabolol
52	14.325	2266767	0.95	1607814	0.98	1.41	7-epi-cis-sesquisabinene hydrate
53	14.375	1588513	0.67	908184	0.55	1.75	2-Naphthalenemethanol, 1,2,3,4,4a,5,6,7-octah
54	14.444	1804073	0.76	975070	0.59	1.85	Cycloheptane, 4-methylene-1-methyl-2-(2-meth
55	14.627	3475035	1.46	1800071	1.09	1.93	2-Naphthalenemethanol, decahydro-.alpha.,.alp
56	14.750	3279494	1.38	1784603	1.08	1.84	7-epi-cis-sesquisabinene hydrate
57	14.839	2114108	0.89	1554950	0.94	1.36	6,10-Dodecadien-1-yn-3-ol, 3,7,11-trimethyl-
		238266488		164753039	100.00		