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Article

Estimation of Active Compounds in the Essential Oils of Selected Medicinal Plants (Ginger, Arugula, Mustard, and Rosemary)

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Abstract: This study examines the potent therapeutic properties of the essential oils extracted from ginger, arugula, mustard, and rosemary. Even with a wealth of study on essential oils, a thorough chemical profiling of these particular plants is still lacking. Gas Chromatography-Mass Spectroscopy (GC-MS) was used to identify and quantify the oils' chemical components. The objective was to present a thorough examination of the chemical components in order to gain a deeper understanding of their therapeutic effects. The potential health benefits of important components, like gamma-sitosterol in arugula and 9-12-Octadecenoic acid in ginger, were highlighted by the results. These discoveries may improve the way these oils are used in the pharmaceutical and other industries, improving patient outcomes and advancing product development.

Keywords: Ginger root oil, Rosemary leaves, Gamma-sitosterol, Gas chromatography, Mass spectroscopic

1. Introduction

Currently, medicinal plants occupy a dominant place in the agricultural industry and are the main source of pharmaceutical compounds and active ingredients used in pharmaceuticals These are also used as ingredients in the manufacture of pharmaceutical products species involved in the synthesis of several important chemicals [1] were recorded. Plants contain essential compounds such as carbohydrates, proteins and fats, as well as secondary compounds such as phenols, glycosides and volatile oils. These products are affected by a variety of factors, such as geographical conditions, climatic conditions, and methods of collection and storage [2]. These include volatile oils, also known as essential oils or aromatic oils. These are plant extracts with distinctive aromas, most of which are non-toxic. They are used as preservatives to prevent spoilage and spoilage of food due to microorganisms [3]. In addition, they are used in some foods or beverages as spices or flavor enhancers for nutrition as well as in the manufacture of perfumes and cosmetics [4].

Essential oils are extracted through various processes, including distillation. Their chemical composition can be determined by several methods, gas chromatography-mass spectrometry (GC-MS) being one of the most important. One of the major medicinal plants containing volatile oils is ginger which belongs to the Zingiberacea family. It is a flowering perennial herb belonging to the monocotyledonous group. The root is the used part of the plant, and its oil is used to treat high blood pressure, reduce cholesterol, prevent seizures, relieve acute migraines, prevent Alzheimer's disease, and is effective against cancer and certain heart diseases [17].

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Dhabhaie *et al*., (2012) determined active compounds in ginger root by GC-MS with ethanolic extract as solvent [16]. The site was occupied by α-giniberene 20.57%, followed by β-sesquiphellandrine 12.71%, α-farnesene 9.7%, cyclohexane 10.61%, cis-6-shogaol 7.45%, and α-curcumane 11.27%. Using methanolic extract as solvent, 40 compounds were identified. The highest percentage of compounds was α-giniberene 15.32%, followed by gingerol 13.78%, β-sesquiphellandrine 11.8%, α-farnesene 8.22%, and α-curcumane 8.11%. The plant arugula (Eruca sativa) is an annual herbaceous wintry weather crop belonging to the Brassicaceae own family. Its oil, extracted from seeds, is used medicinally to improve liver characteristic, boom sperm fertility, and decorate the effectiveness of the sexual hormones progesterone and estrogen [5].

Khoobchandani *et al*., (2010) analyzed arugula seed oil the use of GC-MS and diagnosed 25 compounds [6]. Eruic acid had the very best percent at 50.71%, observed by Oleic acid at thirteen.03%, Cis-eleven-Eicosadienoic at 12.41%, Linoleic acid at 6.57%, and Palmitic acid at 3.47%. El-Nwebye *et al*., (2023) also analyzed the active compounds in arugula seed oil the usage of GC-MS [7]. Eruic acid again had the best percent at forty.04%, accompanied by Oleic acid at 13.84%, Linoleic acid at 10.67%, and Linolenic acid at 9.68%. Another critical plant is Indian mustard (Brassica juncea), an annual herbaceous iciness plant also belonging to the Brassicaceae own family. Its seeds are used as spices, and the extracted oil is one of the most critical fit for human consumption oils. Medicinally, it's miles used to deal with again ache, rheumatism, rashes, and skin ulcers [8]. Aziz *et al*., (2020) recognized 10 compounds inside the petroleum ether extract of mustard seed oil using GC-MS. The most outstanding compounds have been 3β-cycloartenyl acetate at 34.77%, accompanied by way of 3-Methyl pentane at 25.26%, and Methyl cyclopentane at 15.44% [9].

Ashokkumar *et al*., (2021) analyzed the energetic additives in Indian mustard seed oil using GC-MS [10]. They discovered that three-Butenyl isothiocyanate had the very best attention at 84.36%, observed via Allyl isothiocyanate at 8.52%. Rosemary (Rosmarinus officinalis) is another crucial medicinal plant. It is a perennial, fragrant, evergreen herb belonging to the Lamiaceae own family. Its leaves are used to extract essential oils for numerous medicinal purposes, which include antibacterial, anticancer, antidiabetic, anti-inflammatory, antithrombotic, antioxidant properties, thirst reduction, and liver characteristic development [11, 12]. Ibrahim (2013) identified the active compounds in rosemary leaf oil, with α-Camphor being the amplest at 14.6%, accompanied by means of 1,8-cineole at 12.2%, Borneol at 10.6%, and Camphene at 7.2%.

Given the medicinal importance of the essential oils of ginger, arugula, Indian mustard, and rosemary, this look at changed into performed to determine the active additives of their important oils.

2. Materials and Methods

Plant Sample Extraction

The method described in [13] was used to extract henna leaves and the method mentioned in [14] was used to extract frankincense while oil was extracted from watercress and jojoba seeds according to AOAC (2000) [15].

GC-MS Analysis

GC-MS analysis was carried out on a gas chromatograph interfaced to a mass spectrometer (GCMS) instrument type GC MS QP210 Ultra, SHIMADZU, APAN supplied with capillary column DB-MS5(5% phenyl, 95% methyl polysiloxane) as stationary phase in addition to use helium gas (99.9%) employing the following conditions for gas Chromatography: Column Oven Temp.:50.0 °C, Injection Temp. :250.00 °C, Injection Mode :Split, Flow Control Mode :Pressure, Pressure : 90.0 kPa, Total Flow :79.2 mL/min, Column Flow :1.53

mL/min, Linear Velocity :44.8 cm/sec, Purge Flow :6.0 mL/min, Split Ratio :46.9 and for mass spectrometer: Ion Source Temp :200.00 °C, Interface Temp. :250.00 °C, Solvent Cut Time :4.00min, Detector Gain Mode :Relative, Detector Gain :0.84 kV +0.40 kV, Start Time :4.00min, End Time :41.71min, ACQ Mode :Scan, Event Time :0.40sec, Scan Speed :2000, Start m/z :35.00, End m/z :800.00.

3. Results and Discussion

From the table 1 and figure 1, the chromatogram of the essential oil obtained from the ginger roots presented 20 compounds. The highest percentage was recorded for the compound 9-1-Ocddivdecanioc with 18.65% at 21.14 minutes and the lowest percentage for 1-Heptatriacotanol with 0.83% at 33.94 minutes. In the chromatogram were presented Beta-Sitosterol with 12.90% at 34.59 minutes, 9-Octadecanic acid with 11.71% at 21.31 minutes, and 1,3-Cyclohexadiene with 6.35% at 10.59 minutes. The rest of the compounds have different appearance times and percentages, as it can be seen in table 1 and figure 1.

Table 1. Compounds of Essential Oil Extracted from Ginger Roots

Peak#	R.Time	Area	Area%	Name
1	3.049	425473	4.03	Octadecane, 2,2,4,15,17,17-hexamethyl-7,12-bis(3,5,5-trimethylhexyl)-
2	3.174	148394	1.41	Octadecanoic acid, 9,10-dihydroxy-, methyl ester, bis(trifluoroacetate)
3	10.359	385062	3.65	Benzene, 1-(1,5-dimethyl-4-hexenyl)-4-methyl-
4	10.595	669907	6.35	1,3-Cyclohexadiene, 5-(1,5-dimethyl-4-hexenyl)-2-methyl-, [S-(R*,S*)]-
5	10.712	174816	1.66	.alpha.-Farnesene
6	10.824	336898	3.19	.beta.-Bisabolene
7	11.044	554309	5.26	Rhodium, [1,2-bis(.eta.2-ethenyl)-4-ethenylcyclohexane]di-.mu.-chlo-rodi-
8	18.124	245344	2.33	Hexadecanoic acid, methyl ester
9	21.149	1967070	18.65	9,12-Octadecadienoic acid, methyl ester
10	21.319	1235593	11.71	9-Octadecenoic acid (Z)-, methyl ester
11	21.856	196905	1.87	Methyl stearate
12	22.844	203283	1.93	2,6,10-Dodecatrien-1-ol, 3,7,11-trimethyl-
13	24.607	176468	1.67	Glycidyl palmitate
14	27.534	274400	2.60	12-Hydroxy-3-keto-bisnor-4-cholenic acid
15	31.786	664642	6.30	Ergost-5-en-3-ol, (3.beta.)-
16	33.168	660658	6.26	Squalene
17	33.825	338157	3.21	1,2-Cinnolinedicarboxylic acid, 1,2,3,5,6,7,8,8a-octahydro-4-trimethylsi-lyloxy-, diethyl e
18	33.941	87771	0.83	1-Heptatriacotanol
19	34.491	441609	4.19	Heptacosane, 1-chloro-
20	34.594	1360580	12.90	.beta.-Sitosterol
		10547339	100.00	

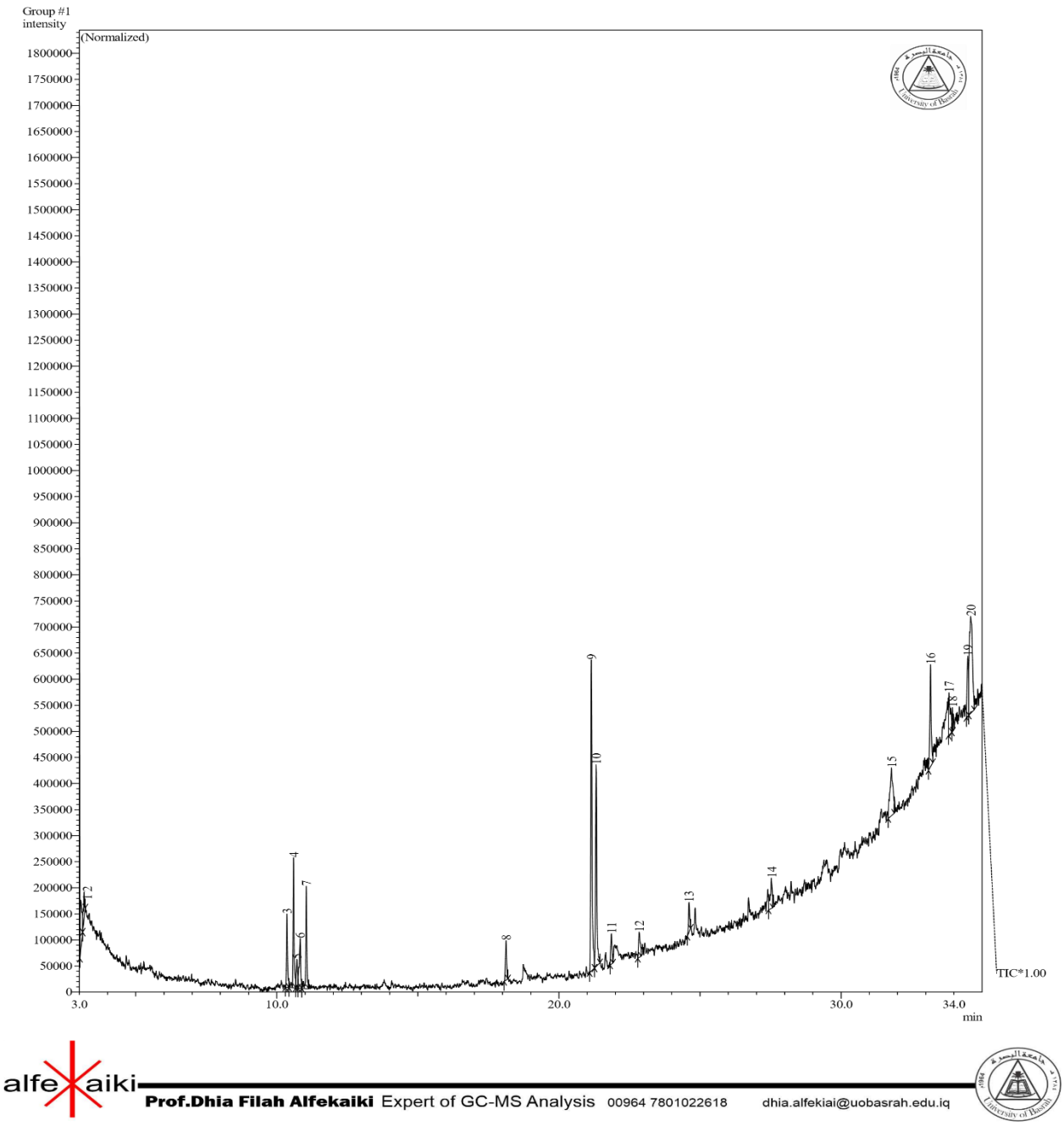

Figure 1. Compounds of Essential Oil Extracted from Ginger Roots by GC-MS

Table 2 and Figure 2 shows that 28 compounds have been diagnosed within the chromatogram of the critical oil extracted from arugula seeds. The compound gamma-Sitosterol ranked first with the highest percentage of thirteen.95% at 34.59 minutes, accompanied via three-hexanol with 8.04% at 3.17 minutes, 1-Heptatracotauol with 7.63% at 31.79 minutes, and Glacially palmitate with 6.85% at 24.60 minutes. The compound with the bottom percent became Cycloheptane, at 0.72% at 10.60 minutes. The different compounds varied of their appearance instances and percentages.

Table 2. Compounds of Essential Oil Extracted from arugula seeds

Peak#	R.Time	Area	Area%	Name
1	3.039	289433	1.73	Octadecane, 2,2,4,15,17,17-hexamethyl-7,12-bis(3,5,5-trimethylhexyl)-
2	3.169	302980	1.81	3-Hexanol
3	3.217	73579	0.44	Pentadecafluorooctanoic acid, tridecyl ester
4	4.648	792256	4.74	.alpha.-Pinene
5	4.778	262692	1.57	Camphene
6	5.415	102475	0.61	Dimethylmalonic acid, octadecyl 3-phenylpropyl ester
7	5.500	2123059	12.70	Eucalyptol
8	6.420	444535	2.66	Bicyclo[2.2.1]heptan-2-one, 1,7,7-trimethyl-, (1S)-
9	6.667	125118	0.75	endo-Borneol
10	9.682	165191	0.99	Caryophyllene
11	18.110	208960	1.25	Hexadecanoic acid, methyl ester
12	20.966	122949	0.74	9-Eicosenoic acid, (Z)-
13	21.133	423371	2.53	8,11,14-Eicosatrienoic acid, methyl ester
14	21.312	171024	1.02	7-Octadecenoic acid, methyl ester
15	21.960	214287	1.28	Oleic Acid
16	24.598	600654	3.59	Glycidyl palmitate
17	24.822	298789	1.79	9-Octadecenal, (Z)-
18	27.397	2303884	13.78	(Z)6,(Z)9-Pentadecadien-1-ol
19	27.529	1416901	8.48	Glycidyl palmitoleate
20	28.006	203564	1.22	Myristic acid glycidyl ester
21	28.229	407046	2.44	13-Docosenoic acid, methyl ester, (Z)-
22	32.306	748455	4.48	(9Z,12Z)-(E)-3,7-Dimethylocta-2,6-dien-1-yl octadeca-9,12-dienoate
23	32.417	901441	5.39	Succinic acid, cyclohexylmethyl neryl ester
24	32.778	2264661	13.55	.gamma.-Sitosterol
25	32.900	151522	0.91	5.alpha.-Cholestan-6.beta.-amine, N,N-dimethyl-
26	33.042	267059	1.60	Hexadecane, 1,1-bis(dodecyloxy)-
27	33.165	660730	3.95	trans-Farnesol
28	33.548	84071	0.50	Succinic acid, hept-2-yl dodec-9-yn-1-yl ester
29	33.746	165852	0.99	1-Heptatriacotanol
30	34.478	418527	2.50	Tetratetracontane
		16715065	100.00	

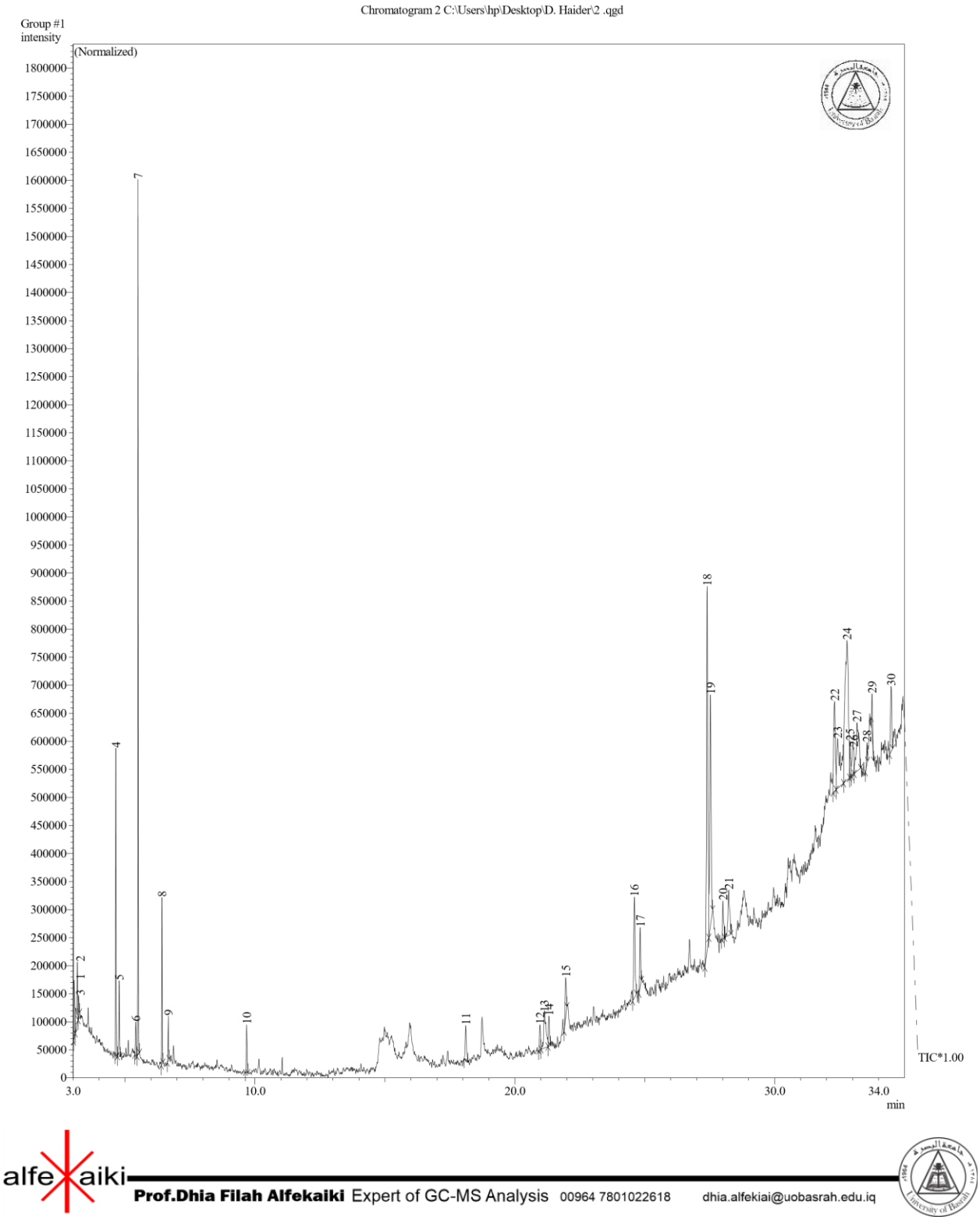

Figure 2. Compounds of Essential Oil Extracted arugula seeds by GC-MS

Table 3 and Figure 3 indicate the detection of 30 compounds from the chromatograms of essential oil extracted from Indian mustard seeds. The compound Hexadecane ranked first, giving the highest percentage of 19.15% at minute 33.0, followed by the compound 9-desoxo-9-x-acetoxy with a percentage of 17.48%. At minute 33.08, then the compound 1,37-Octatriacontadiene at a rate of 15.40% at minute 33.31, then the compound 9-Desoxo-9-x-acetoxy at a rate of 11.38% at minute 32.67, and the lowest percentage was Cyclohexasiloxane at 0.30% at minute 8.54. As for the rest of the compounds, they varied in time. Its appearance and proportion.

Table 3. Compounds of Essential Oil Extracted from mustard seeds

Peak#	R.Time	Area	Area%	Name
1	3.039	360355	1.10	Tritetracontane
2	3.171	936905	2.86	1-Hexadecanaminium, N,N,N-trimethyl-, octadecanoate
3	3.212	350135	1.07	Cyclopropanecarboxylic acid, 2-methylpentyl ester
4	3.581	1487275	4.55	Cyclotrisiloxane, hexamethyl-
5	4.754	643626	1.97	1-Butyl(dimethyl)silyloxypropane
6	4.861	1103444	3.37	Ethanol, 2-[(triethylsilyl)oxy]-
7	5.293	345545	1.06	Cyclotetrasiloxane, octamethyl-
8	6.716	113469	0.35	Cyclopentasiloxane, decamethyl-
9	8.549	99627	0.30	Cyclohexasiloxane, dodecamethyl-
10	11.048	182968	0.56	Pantothenic acid tritbdms
11	18.128	544081	1.66	Hexadecanoic acid, methyl ester
12	21.150	364852	1.12	9,11-Octadecadienoic acid, methyl ester, (E,E)-
13	21.325	178554	0.55	14-Octadecenoic acid, methyl ester
14	21.650	322618	0.99	Phytol
15	21.981	327418	1.00	8,11,14-Eicosatrienoic acid, (Z,Z,Z)-
16	22.041	437391	1.34	1,13-Tetradecadiene
17	24.612	546684	1.67	Glycidyl palmitate
18	26.725	922205	2.82	Oxirane, [(dodecyloxy)methyl]-
19	27.411	418039	1.28	2-Octylcyclopropene-1-heptanol
20	27.542	469722	1.44	Glycidyl (Z)-9-Heptadecenoate
21	28.032	163748	0.50	n-Heptyl hexanoate
22	29.977	631303	1.93	Oxirane, [(hexadecyloxy)methyl]-
23	32.442	157189	0.48	pentanamide, N-[4-[[[3-(didodecylamino)phenyl]amino]sulfonyl]phenyl]-4,4-dimethyl-3
24	32.500	264955	0.81	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol
25	32.673	3722884	11.38	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol
26	33.000	6264203	19.15	Hexadecane, 1,1-bis(dodecyloxy)-
27	33.086	5717261	17.48	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol
28	33.316	5038820	15.40	1,37-Octatriacontadiene
29	33.542	326708	1.00	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol
30	34.485	271642	0.83	Tetratetracontane
		32713626	100.00	

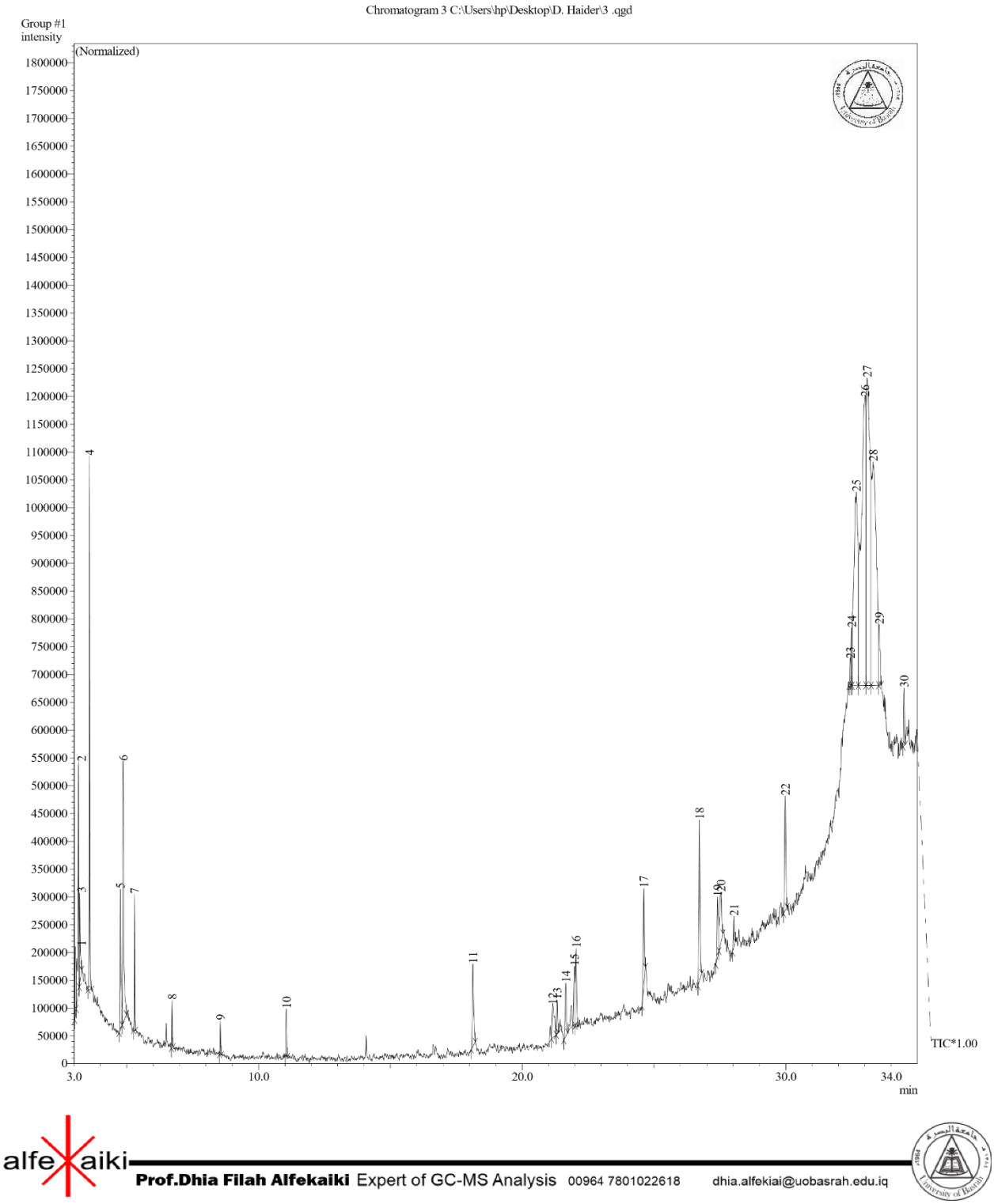

Figure 3. Compounds of Essential Oil Extracted mustard seeds by GC-MS

Table 4 and Figure 4 show the appearance of 28 compounds from the chromatogram of the essential oil extracted from the dried leaves of the Rosemary plant. The compound (Z)6, (Z)9-pentadecadien-1-01 had the highest percentage at 13.78% at minute 27.39, followed by gamma-sitosterol compound at 13.55% at minute 32.77, then Glycidyl palmitoleate compound at 8.48% at minute 27.52. The compound with the lowest percentage was Succinic acid at 0.50% at minute 33.54. The rest of the compounds varied in their appearance time and percentage.

Table 4. Compounds of Essential Oil Extracted from dry leaves of rosemary

Peak#	R.Time	Area	Area%	Name
1	3.039	289433	1.73	Octadecane, 2,2,4,15,17,17-hexamethyl-7,12-bis(3,5,5-trimethylhexyl)-
2	3.169	302980	1.81	3-Hexanol
3	3.217	73579	0.44	Pentadecafluorooctanoic acid, tridecyl ester
4	4.648	792256	4.74	.alpha.-Pinene
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6	5.415	102475	0.61	Dimethylmalonic acid, octadecyl 3-phenylpropyl ester
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17	24.822	298789	1.79	9-Octadecenal, (Z)-
18	27.397	2303884	13.78	(Z)6,(Z)9-Pentadecadien-1-ol
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20	28.006	203564	1.22	Myristic acid glycidyl ester
21	28.229	407046	2.44	13-Docosenoic acid, methyl ester, (Z)-
22	32.306	748455	4.48	(9Z,12Z)-(E)-3,7-Dimethylocta-2,6-dien-1-yl octadeca-9,12-dienoate
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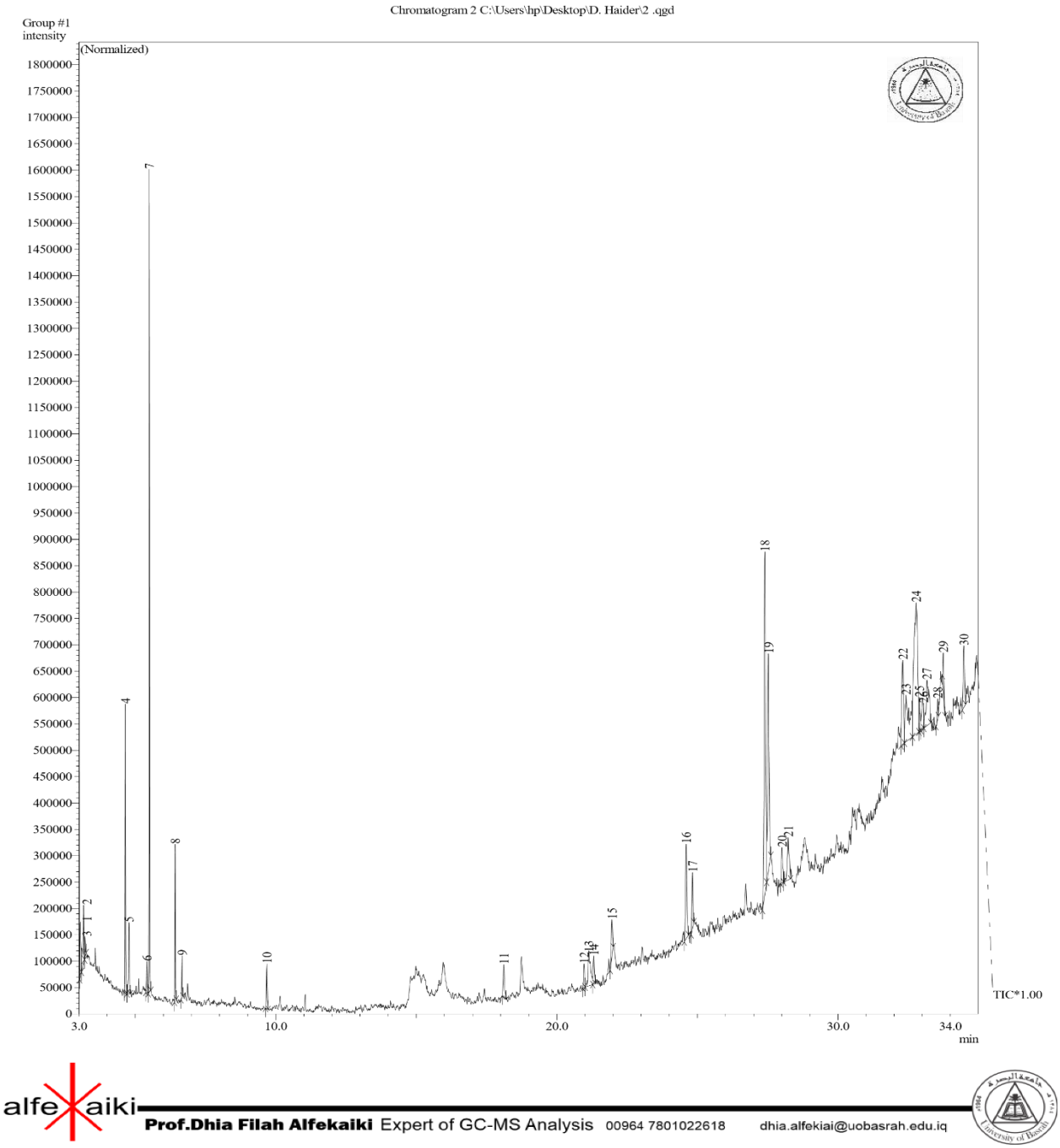

Figure 4. Compounds of Essential Oil Extracted dry leaves of rosemary by GC-MS

4. Conclusion

The presence or absence of active compounds inside the extracts of the studied flora various. This may be because of differences within the cutting-edge have a look at as compared to preceding research in phrases of extraction period, extraction technique, the part of the plant used, environmental factors, the time of plant series, and the growth season. All these factors make contributions to the variations inside the chemical composition of the plants.

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