A Comparative Study of the Chemical Composition of Essential Oils of *Cyperus rotundus* L. (Cyperaceae) Growing in Sudan

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Abstract

Essential oils are secondary metabolites obtained from various parts of plants. They have unique therapeutic benefits, and used in various forms such as lotions, ointment, lubricants, perfumes, fragrant bath perfumed water, massage and aromatherapy. Dried tuberous roots of *Cyperus rotundus* known as nutgrass is a source of aromatics used in perfumes and scents. The reported constituents of the essential oil of *C. rotundus* tubers vary with the source. Baring this in mind the present paper reports the results of investigation of the chemical composition of essential oils obtained from the plant growing in five Sudanese areas: Dongola (northern Sudan); Darfour (western Sudan); Aljazeera and Khartoum (central Sudan) and Sinnar (eastern Sudan). The essential oils of the plant samples were prepared by hydro-distillation technique and their chemical composition was investigated by GC-MS analysis. The results revealed the presence of one hundred and twenty eight compounds in Dongola sample; one hundred and eighteen compounds in Darfour sample; forty nine compounds in Sinnar sample; thirty eight compounds in Khartoum sample and eight compounds in Aljazeera sample. The common compounds detected in the prepared oils were Camphor, Cis-Verbenol, (1R) - (-) –Myrtenal, α-cubebene, Diepicedrene-1-oxide, α-Ylangene, α-Gurjunene, 9-Cedranone, 1-dodecanol, Rotundene, δ-Muurolene, β-Elemene, Caryophyllenol, β-Vetispirene, α-Longipinene, α-Calacorene with difference concentrations. These findings confirmed the effect of geographic location on the chemical composition and content of the prepared essential oils which could reflect on their biological activities.

Keywords: Chemical composition, essential oil, *Cyperus*, *rotundus*, geographic location, Sudan

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Introduction

Cyperus rotundus is a member of *Cyperaceae* family widely distributed in tropical, subtropical and temperate regions of the world namely Africa, southern Asia and India. It is a perennial weed commonly known as Nutgrass. The plant has creeping rhizomes, arising singly from the tubers. The tubers are externally blackish in colour and reddish white inside, with characteristic odors [1, 2]. It is a multipurpose plant, widely used in traditional medicine around the world to treat stomach ailments, wounds, boils and blisters [3-5]. The rhizomes are used in traditional medicine to cure a number of ailments and used as refrignant, demulcent, tonic, sedative, analgesic, antipyretic aphrodisiac, hypotensive agent, emmenagogue in uterine complaints; in treatment of colic, diarrhea, vomiting in children and flatulence, as an antidote to poison, promote the milk production, improve memory and the cognitive processes, and to improve the functions of the liver, spleen and pancreas [4, 5]. A number of pharmacological and biological activities have been reported for this plant [6]. such as; cytoprotective [7], antidiarrhoeal [8], affect of of CNS, antipyretic, analgesic, sedative [9,10], anti-cancer [11], anti-malarial [12], anti-*Candida* [13] anti-inflammatory [14], antidiabetic and control of glucose and lipids [15, 16], affect adipose tissue metabolism [14], tranquilizing activity, anticonvulsant, anti-obesity [17], antioxidant, antimutagenic, gastroprotective, antibacterial, cytotoxic and apoptotic activities [18- 23].

The previous phytochemical studies on *C. rotundus* revealed the presence of the alkaloids and flavonoids [24, 25], tannins, starch[26], steroid glycosides and furochromones,and [27], many novel sesquiterpenoids [28- 31]. The essential oil of the plant mainly composed of Cyperol, Cyperene, Rotundine, Cyperone, Copaene, Valerenal, Myrtenol, Pinene, Selinene and Caryophyllene [32, 33].

As part of our on-going research on the chemical composition of medicinal and aromatic plants growing in Sudan the present investigation reports the results of investigations on the chemical

composition of the essential oils prepared from the rhizomes of *Cyperus rotundus* collected in different locations in Sudan.

Materials and Methods

Plant Materials Collection and Preparation

Cyperus rotundus rhizomes were collected in five different locations in Sudan :Khartoum and Aljazeera (central Sudan); Darfour (western Sudan); Dongola (northern Sudan) and Sinnar (eastern Sudan).The collected samples were identified at the National Centre for Research, Medicinal and Aromatic Plants Research Institute (MAPRI), Khartoum, Sudan. The voucher specimens were deposited at the Pharmacognosy Department, Faculty of pharmacy, University of Medical Sciences and Technology (UMST), Sudan. The plant materials were dried and crushed by using mortar and pestle.

Preparation of the Essential Oils

One hundred grams of the dried crushed rhizomes were subjected to hydro- distillation for 4 h using Clavenger apparatus. The distilled essential oils were, stored in sealed vials at 4°C until analysis. The yield of the oils (v/w %) was calculated based on the plant dry matter.

GC-MS analysis of the Prepared Essential Oils

The essential oils were analyzed by gas chromatography coupled with mass spectrometry (GC-MS) using HP 6890 (GC) and HP 5973 (MSD). The samples were dissolved in dichloromethane and injected at 250 °C (Injector temperature) into a capillary column type HP-1, 30 × 0.25 mm × 0.25 µm, stationary phase (95 % diethyl-5% diphenylsiloxane), using helium as a carrier gas at a flow rate of 1 ml/min. The injected volume was 1 µl and the injection mode used was splitless. The oven temperature was programmed from 45–280 °C at the rate of 4 °C/min. Detector temperature was 250^{o}C. The MS was operated in the El mode at 70 eV. The mass and scan range was set at m/z.

Results and Discussion

The results of GC-MS of the prepared essential oils were shown in figures1, 2, 3, 4, and 5. GC-MS analysis of the prepared oils revealed the presence of one hundred and twenty eight; one hundred and eighteen; forty nine; thirty eight; and eight compoundsof oil samples in Dongola, Darfour, Sinnar, Khartoum and Aljazeera locations, respectively.

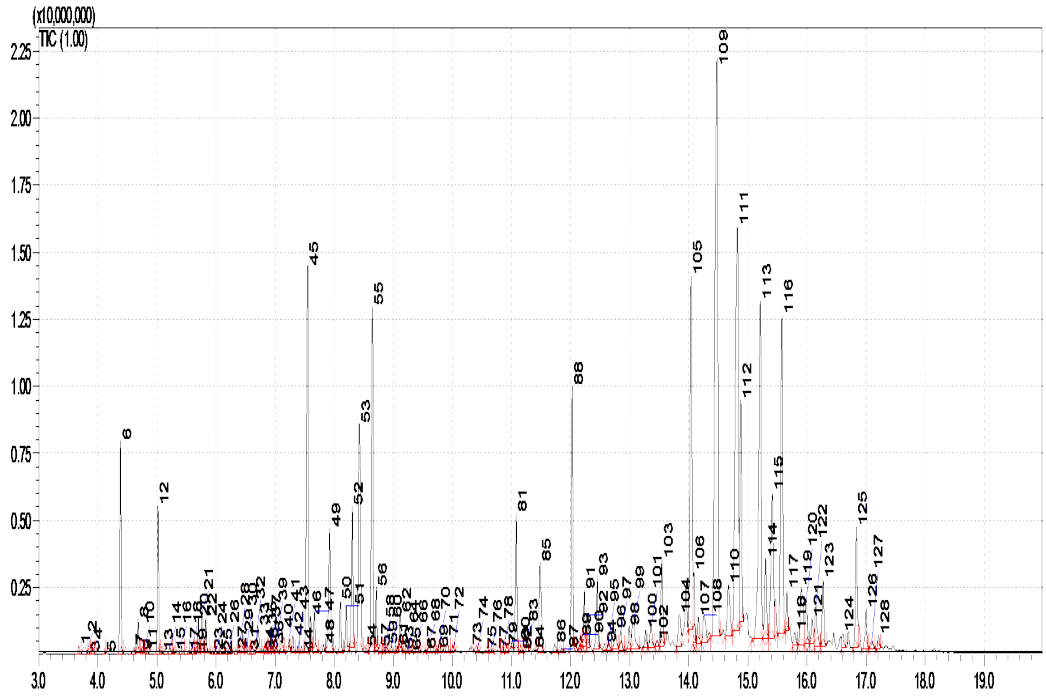


Figure 1: GC-MS Chromatogram of *Cyperus rotundus* rhizomes oil from Dongola.

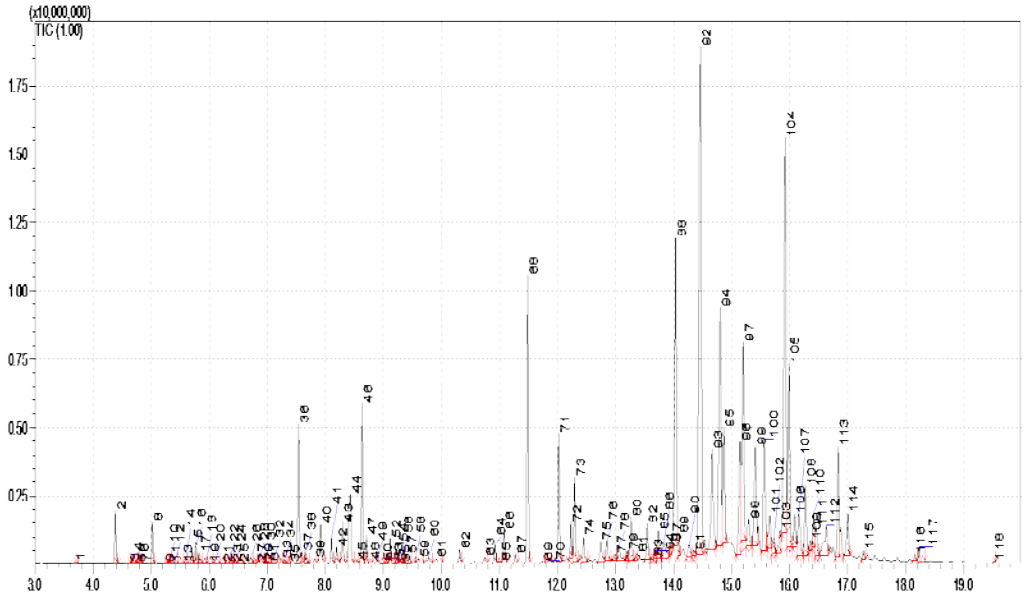


Figure 2: GC-MS Chromatogram of *Cyperus rotundus* rhizomes oil from Darfour.

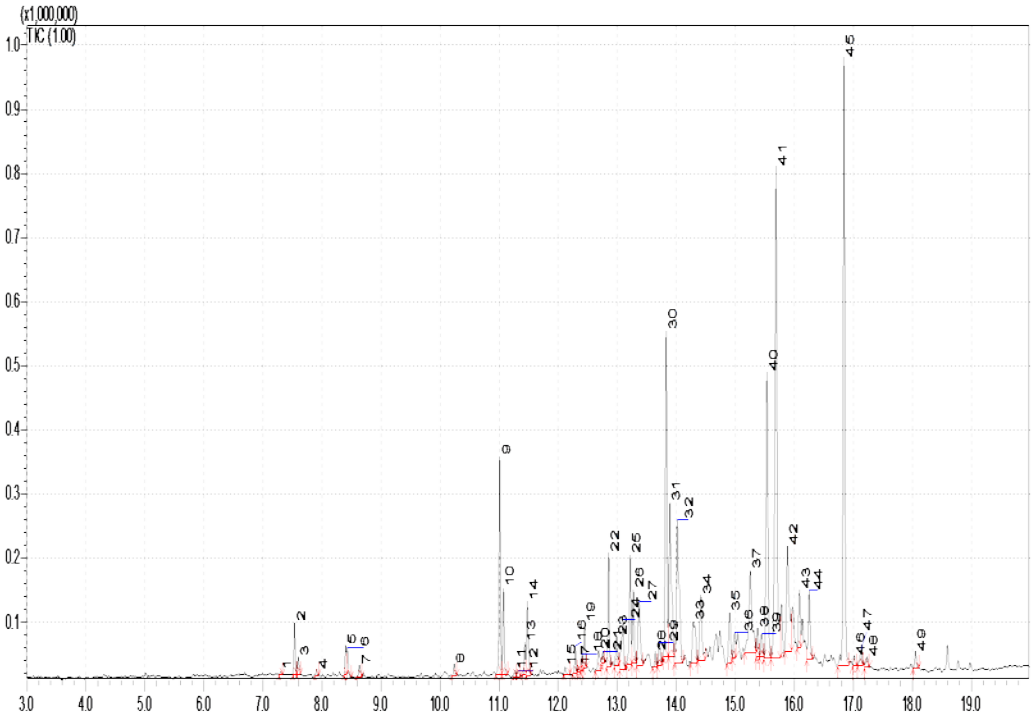


Figure 3: GC-MS Chromatogram of *Cyperus rotundus* rhizomes oil from Sinnar.

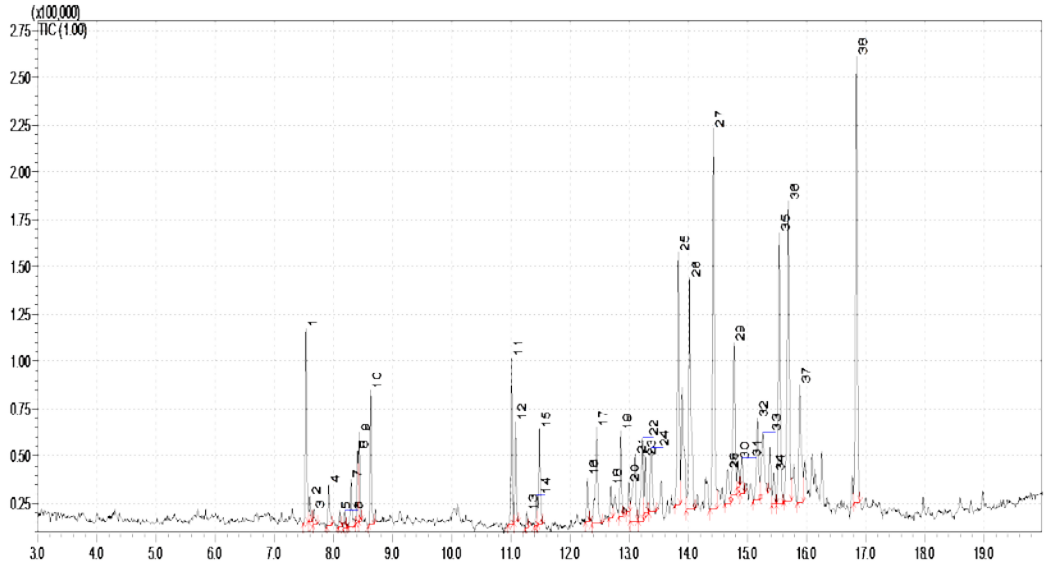


Figure 4: GC-MS Chromatogram of *Cyperus rotundus* rhizomes oil from Khartoum.

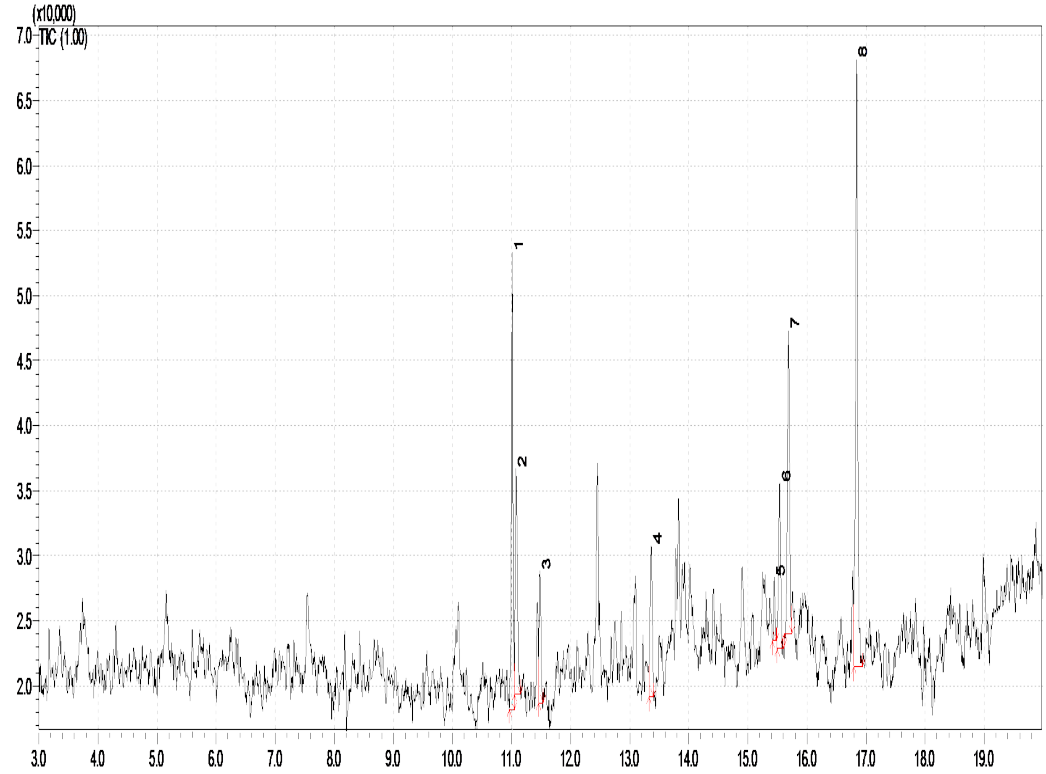


Figure 5: GC-MS Chromatogram of *Cyperus rotundus* rhizomes oil from Aljazeera.

The total components which have been identified in the five prepared essential oils were reported in table 1, 2 and figure 1. The components which have been identified were 78 accounting for 81.39% in Dongola sample ; 49 accounting for 79.38 % in Darfour sample; while in Sinnar sample 40 components accounting for 83.37% have been identified; in Khartoum sample, 32 components accounting for 91.39% were identified and finally in Aljazeera sample only 8 components accounting for 99.64 % have been identified.

The main components in Dongolla essential oil were Humulene epoxide 2 (13.43%), Globulol (9.88), Isoaromadenderene epoxide (6.50%), Longiverbenone (5.38%), Camphor (5.32%), trans-Pinocarveol (4.40%), (1R) - (-) –Myrtenal (3.90%), 4-Dodecan-1-ol (3.01%), α-Humulene epoxide(2.90%), α-pinene (2.16%), α-Terpinol (1.56%), β-Pinene (1.44%) **,** cyperene (1.43%), α-Cyperone (1.40%), cis-Thujopsene (1.11%).

In Darfour oil sample the main components were: α-Humulene epoxide (14.04%), 3,5,6,7,8,8α-Hexahydro-4,8α-dimethyl-6-(1-methylethenyl)-2(1H)-naphthalenone (10.04%), 9-Cedranone (6.78%), Aromadendrene epoxide (6.34%), Cyperene (4.66%), Isoaromadenderene epoxide (4.30%), Alloaenermadendr (3.88%), β –Muurolene (2.80%), Longiverbenone (2.74%), Aristolone (2.65%), 6-Isopropenyl-4,8a-dimethyl-1,2,3,5,6,7,8,8a-octahydro-naphthalen-2-ol (2.60%), Camphor (2.46%), trans-Pinocarveol (2.36%), 4-Dodecan-1-ol (2.00%), (1R) - (-) –Myrtenal (1.81%), Rotundene (1.39), Isocaryophyllene (1.16%), lsolongifolen-9-one (1.13).

Alloaenermadendr (14.82%), cyperene (14.14%), α-Calacorene (7.50%), Isocaryophyllene (7.49%), Caryphyllene oxide (5.35%), α-Ylangene (4.24%), α-Cyperone (4.20%), β-Vetispirene (2.45%), α-Longipinene (1.99%), Diepicedrene-1-oxide (1.82%), δ-Guaijene (1.73%), β-Copaene (1.70%), Copaene (1.63%), α-Humulene epoxide (1.62%), Caryophyllenol (1.46), Epiglobulol (1.37%) **,** 4-Nonenal (1.01%), were the main components in Sinnar oil sample.

The main components in Khartoum oil were 3,7-Guaiadiene (10.02%), Humulene epoxide 2 (9.84%), Guaia-3,7-diene (8.74%), Caryophyllenol (7.23%), Isocaryophyllene (6.63%) **,** β-Vetispirene (5.96%), Copaene (4.39%), Camphor (3.81%), 2,2,7,7-tetramethyltricyclo[6.2.1.0(1,6)]undec-4-en-3-one **(**3.74%**),** α-Ylangene (3.07%), δ-Muurolene

(2.84%), Carvone (2.59%), β-Elemene (2.53%), α-Calacorene (2.25%), cyperene (2.11%), α-cubebene (2.01%), α-Longipinene (1.79%), (1R) - (-) –Myrtenal (1.45%), Fenchone (1.29%), Ledol (1.24%), Diepicedrene-1-oxide (1.20%), Dehydrosabinene (1.16%), Fenchol (1.01%).

In Aljazeera oil sample, 3,7-Guaiadiene (30.48%), α-Ylangene (17.81%), 2,2,7,7-Tetramethyltricyclo[6.2.1.0(1,6)]undec-4-en-3-one (15.42%); α-cubebene (11.69%), Alloaenermadendr (8.44%); α-Calacorene (8.04%) cyperene (5.88%), Cadalin (1.88%), were the main components detected and identified.

The chemical composition of the essential oils prepared from samples collected in five Sudanese locations was quite different, confirming the effect of geographic location on the chemical composition and content of the essential oil which was compatible with the published literature about the variation of constituents in *C. rotundus* [(1)] and other plants [(34)] with the source, geographic location, chemotypes and seasonal variation.

The observed compositional difference between *C. rotundus* found in different Sudanese areas and the other of the world [(1, 35- 38)] could be due to climactic and environmental conditions, chemotypes, nutritional status of the plants, and other factors, which can influence essential oil composition

Comparing the present results with those previously reported in the literature on the essential oil compositions of the plant from different countries [(1, 35- 38)] showed that, there are many differences regarding the major constituents of the plant which further suggests the existence of more chemical diversity within the *C. rotundus* species.

Table 1: The number and percentage of essential oils Components of *Cyperus rotundus* rhizomes from five Sudanese areas (Dongola, Darfour, Sinnar, Khartoum and Aljazeera)

Oil sample	Number of Compounds and their Concentration (%)						
	Hydrocarbon	Oxygenated Hydrocarbon	Terpenoids				Total identified Compounds
			Monoterpenes	Oxygenated Monoterpenes	Sesquiterpenes	Oxygenated Sesquiterpenes	
Dongola	11Compounds (2.43 %)	29 Compounds (29.37 %)	6 Compounds (4.11 %)	9 Compounds (14.3 %)	15 Compounds (7.53%)	8 Compounds (23.65 %)	78 Compounds (81.39 %)
Darfour	8 Compounds (1.09 8%)	31Compounds (26.16%)	5 Compounds (1.14%)	10 Compounds (5.76%)	17 Compounds (17.31%)	9 Compounds (27.92%)	49 Compounds (79.38%)
Sinnar	5 Compounds (12.14%)	11Compounds (7.22%)	-	3Compounds (0.99%)	16 Compounds (50.74%)	5 Compounds (10.91%)	40 Compounds (83.37%)
Khartoum	6 Compounds (13.92%)	9 Compounds (12.04%)	-	3Compounds (5.5%)	9 Compounds (30.12%)	Compounds (21.07%)	32 Compounds (91.39%)
Aljazeera	2 Compounds (9.92%)	1Compound (15.42 %)	-	-	5 Compounds (74.3%)	-	8 Compounds (99.64%)

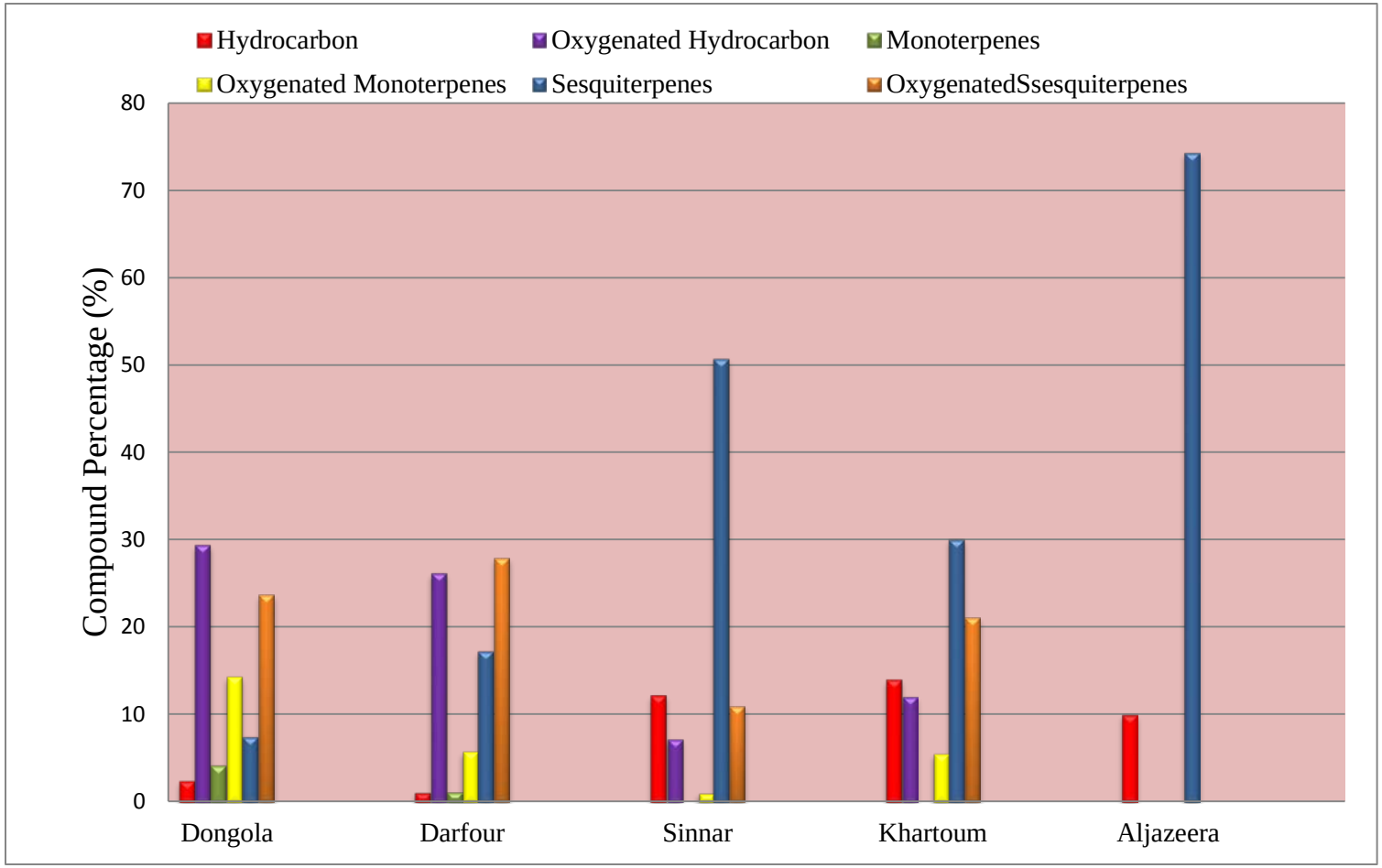
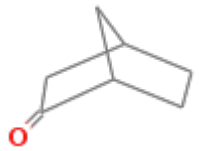
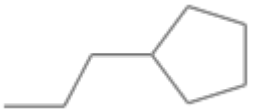
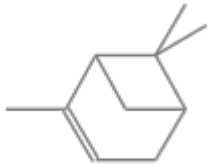
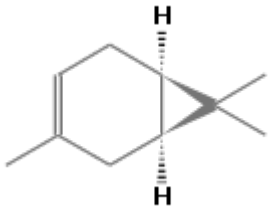
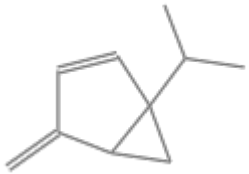
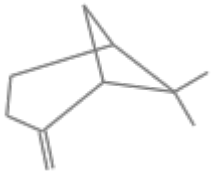
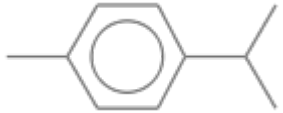
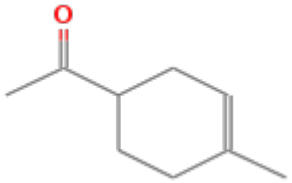
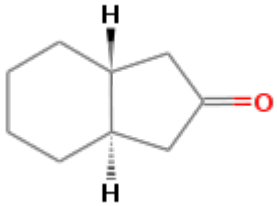


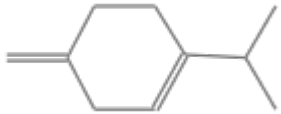
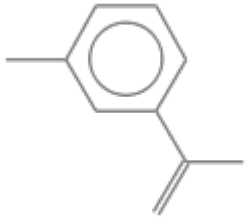
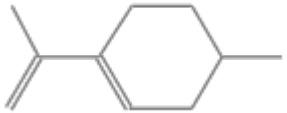
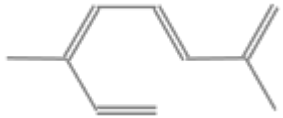
Figure 6: The percentage of essential oils Components of *Cyperus rotundus* rhizomes from five Sudanese areas (Dongola, Darfour, Sinnar, Khartoum and Aljazeera).

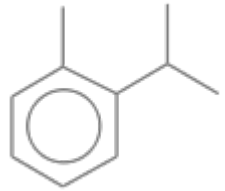
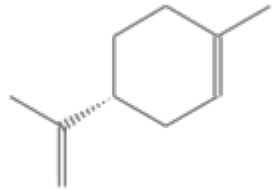
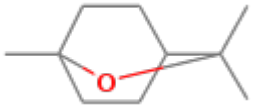
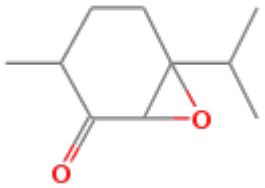
Table (2): The GC-MS Result of the essential oil of *C. rotundus* rhizomes collected from five Sudanese (Dongola, Darfour, Sinnar, Khartoum and Aljazeera) Areas

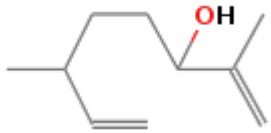
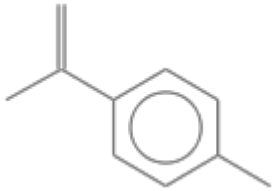
Peak NO	R.T	Compound name	M.W	Formula	Structure	Area %				
						Dongola	Darfour	Sinnar	Khartoum	Aljazeera
1	3.675	Norcampher	110	$C_7H_{10}O$		0.08				
2	3.675	2, 4-Heptadienal	110	$C_7H_{10}O$			0.03			
3	3.852	Propylcyclopentane	112	C_8H_{16}		0.01				
4	4.116	Unknown				0.01				

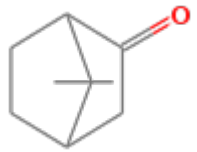
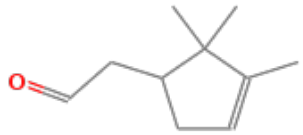
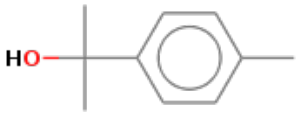
5	4.379	α-pinene	136	$C_{10}H_{16}$		2.16	0.76			
6	4.608	3-carene	136	$C_{10}H_{16}$		0.09	0.01			
7	4.678	2,4-Thujadiene	134	$C_{10}H_{14}$		0.34				
8	4.733	Unknown				0.02	0.02			
9	5.811	Unknown				0.03	0.01			
10	5.016	β-Pinene	136	$C_{10}H_{16}$		1.44	0.07			

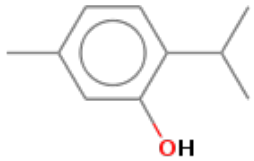
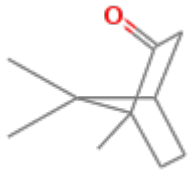
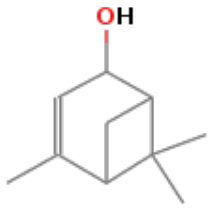
11	5.215	p-Cymene	134	$C_{10}H_{14}$		0.08	0.03			
12	5.289	Limona ketone	138	$C_9H_{14}O$		0.01				
13	5.289	trans-β-Hydrindanone	138	$C_9H_{14}O$			0.17			

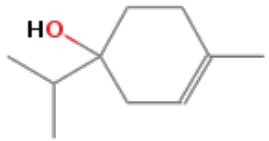
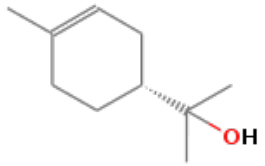
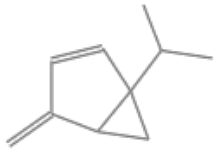
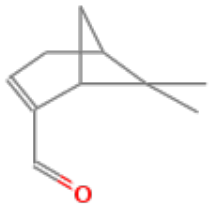
14	5.399	β-Terpinene	136	$C_{10}H_{16}$		0.01	0.03			
15	5.524	m-Cymenene	132	$C_{10}H_{11}$		0.02	0.01			
16	5.574	3,8-p-Menthadiene	136	$C_{10}H_{16}$		0.01				
17	5.659	Cosmene	134	$C_{10}H_{14}$		0.02	0.04			

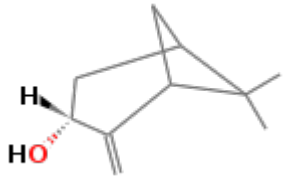
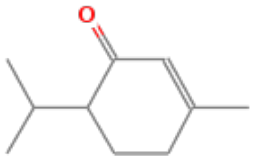
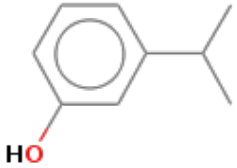
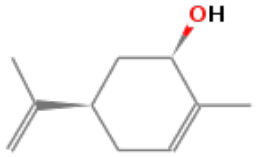
18	5.697	o-Cymene	134	$C_{10}H_{14}$		0.34	0.22			
19	5.765	D-Limonene	136	$C_{10}H_{16}$		0.41	0.27			
20	5.826	Eucalyptol	154	$C_{10}H_{18}O$		0.34	0.14			
21	5.933	Carvenone oxide	168	$C_{10}H_{16}O_2$		0.02				

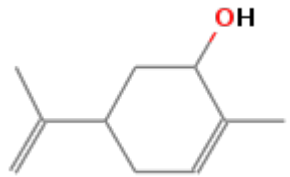
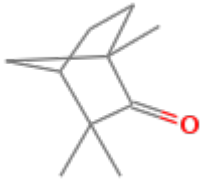
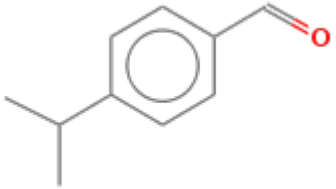
22	6.088	Unknown				0.26	0.03			
23	6.547	2,3-Dimethyl-1,7-octadien-3-ol	140	$C_9H_{16}O$		0.01	0.02			
24	6.649	Unknown				0.12	0.07			
25	6.706	p-Cymenene	132	$C_{10}H_{12}$		0.43	0.17			
26	6.805	4-Nonenal	140	C_9H_{16}		0.04	0.02	1.01		
27	6.912	Unknown				0.05	0.03			
28	6.957	Unknown				0.08	1.59			

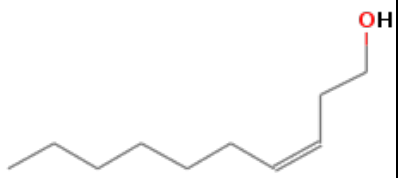
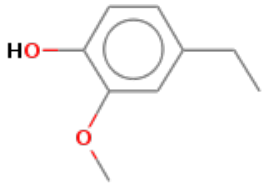
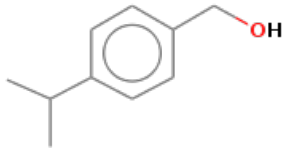
29	7.018	α-Fenchocamphone	132	$C_9H_{14}O$		0.06	0.02	0.24		
30	7.116	Fenchol	154	$C_{10}H_{18}O$		0.28	0.08		1.01	
31		Unknown				0.13	0.06			
32	7.295	α-Campholenal	152	$C_{10}H_{16}O$		0.19	0.07	0.08		
33	8.200	ρ-Cymene-8-ol	150	$C_{10}H_{14}O$		0.58	0.30			

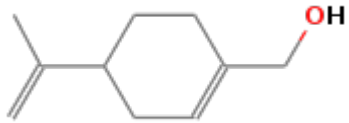
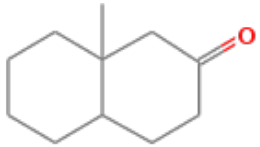
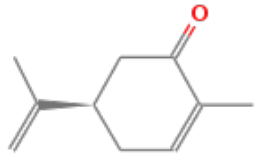
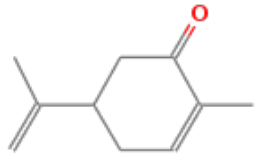
34		Thymol	150	$C_{10}H_{14}O$		0.03	0.29			
35	7.450	Unknown				0.02				
36	7.506	Camphor	152	$C_{10}H_{16}O$		5.32	2.46	0.56	3.81	
37	7.597	Cis-Verbenol	152	$C_{10}H_{16}O$		0.36	0.02	0.35	0.40	
38	7.664	Unknown				0.55	0.21			
39	7.921	Unknown				1.99	0.79			

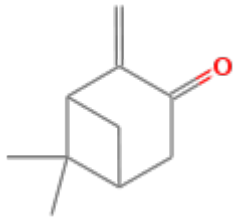
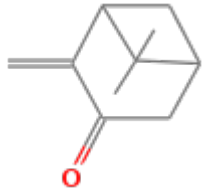
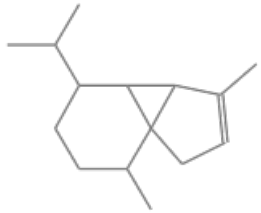
40	8.103	Terpinen-4-ol	154	$C_{10}H_{18}O$		0.61	0.63		0.26	
41	8.303	α-Terpinol	154	$C_{10}H_{18}O$		1.56	0.40			
42	8.303	Dehydrosabinene	154	$C_{10}H_{18}O$				0.11	1.16	
43	8.421	(1R) - (-) -Myrtenal	150	$C_{10}H_{14}O$		3.90	1.81	0.58	1.45	
44	8.536	Unknown				0.05				

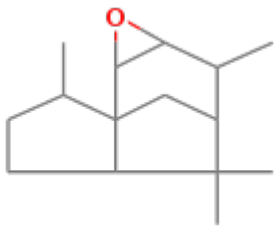
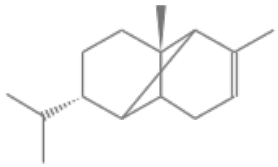
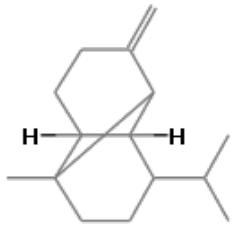
45	8.644	trans-Pinocarveol	152	$C_{10}H_{16}O$		4.40	2.36			
46	8.710	3-Carvomenthenone	152	$C_{10}H_{16}O$		0.61	0.04			
47	8.760	m-Cumenol	136	$C_9H_{12}O$		0.05	0.04		0.49	
48	8.842	cis-Carveol	152	$C_9H_{12}O_2$		0.01	0.39			

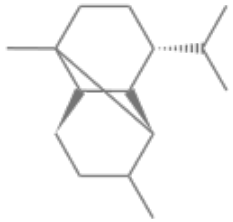
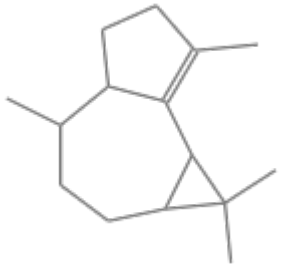
49	8.887	Carveol	152	$C_{10}H_{16}O$		0.08	0.60			
50		Cis- p-Mentha-2,8-dien-1-ol	152	$C_{10}H_{16}O$			0.06			
51		Fenchone	152	$C_{10}H_{16}O$		0.09	0.02		1.29	
52	9.066	Cuminal	148	$C_{10}H_{12}O$		0.09	0.08			

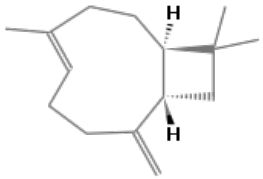
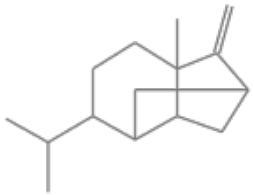
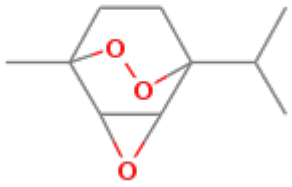
53	9.160	3-Decen-1-ol,(E)- (Z)-3-Decenol	156	$C_{10}H_{20}O$		0.03	0.02			
54	9.245	trans-p-Menth-2,8-dien-1-ol	152	$C_{10}H_{16}O$		0.03	0.12			
55	9.396	1-Decanol	158	$C_{10}H_{22}O$		0.21	0.16			
56	9.536	Unknown				0.02	0.01			
57	9.604	4-Ethylguaiacol	152	$C_9H_{12}O_2$		0.19	0.11			
58	9.743	Unknown				0.04		0.13		
59	9.777	Cuminol	150	$C_{10}H_{14}O$		0.12	0.16	0.27		

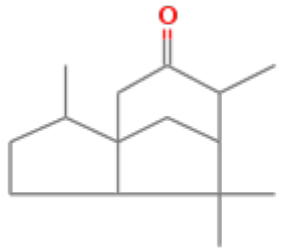
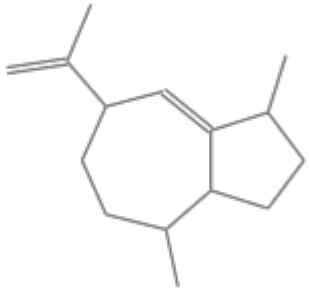
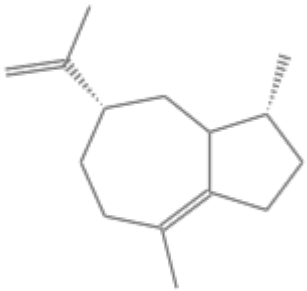
60	9.910	Isocarveol	152	$C_{10}H_{16}O_2$		0.22	0.01			
61	9.910	Unknown						0.66		
62	10.009	trans-10-Methyl-2-decalone	166	$C_{11}H_{18}O$		0.01				
63	10.312	Unknown				0.12	0.21			
64	9.114	(-)-Carvone	150	$C_{10}H_{14}O$		0.39	0.34	0.11		
65	10.564	Carvone	150	$C_{10}H_{14}O$					2.59	

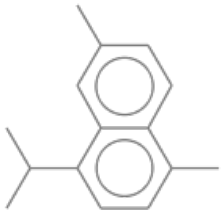
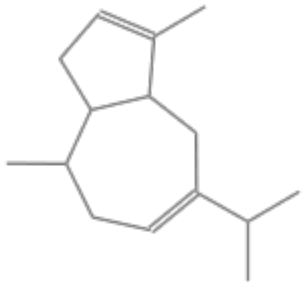
66	10.564	Pinocarvone	150	$C_{10}H_{14}O$		0.04				
67	10.564	α-Pinocarvone	150	$C_{10}H_{14}O$				0.27		
68	10.658	α-cubebene	204	$C_{15}H_{24}$		0.05	0.58	0.14	2.01	11.69
69		Unknown				0.02	0.92	4.66	2.52	

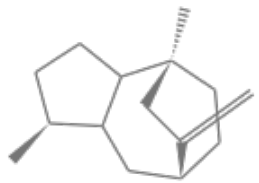
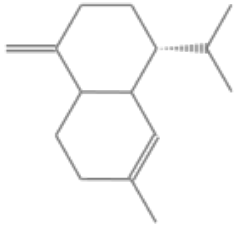
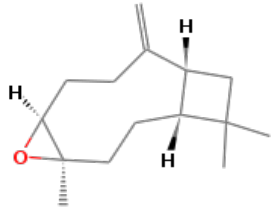
70		Diepicedrene-1-oxide	220	$C_{15}H_{24}O$		0.08	0.50	1.82	1.20	
71	11.011	α-Ylangene	204	$C_{15}H_{24}$		0.14	0.03	4.24	3.07	17.81
72	11.077	β-Copaene	204	$C_{15}H_{24}$		0.05	0.18	1.70		

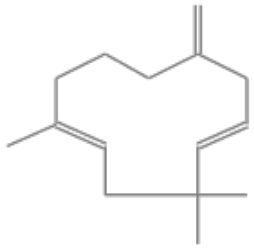
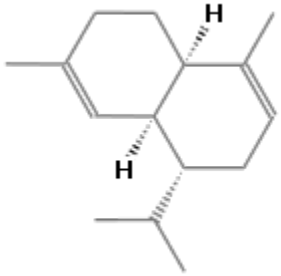
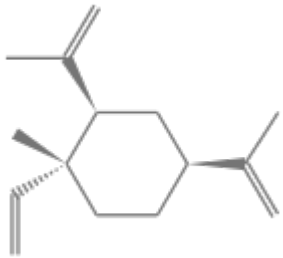
73	11.153	Copaene	206	$C_{15}H_{26}$		0.03	0.01	1.63	4.39	
74		α-Gurjunene	204	$C_{15}H_{24}$		0.21				
75	11.371	Unknown				0.06				
76	11.481	cyperene	204	$C_{15}H_{24}$		1.43	4.66	14.14	2.11	5.88

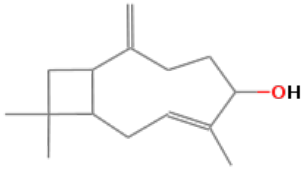
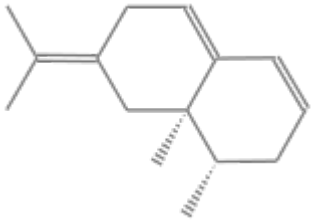
77	11.733	Caryophyllene	204	$C_{15}H_{24}$		0.14	0.05			
78		Isosativene	204	$C_{15}H_{24}$		0.05	0.05	0.09		
79	12.025	4-Dodecan-1-ol	184	$C_{12}H_{24}O$		3.01	2.00			
80	12.025	Ascaridole epoxide	184	$C_{10}H_{16}O_3$					0.28	

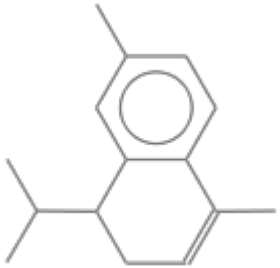
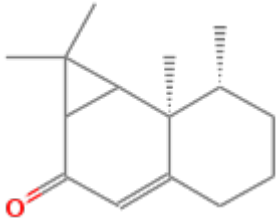
81		9-Cedranone	220	$C_{15}H_{24}O$		0.13	6.78	0.66	0.72	
82		γ-Gurjunene	204	$C_{15}H_{24}$		0.06	0.42			
83		δ-Guaijene	204	$C_{15}H_{24}$				1.73		

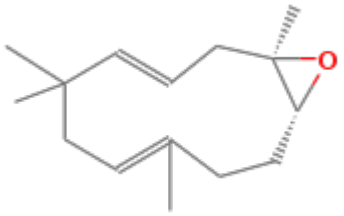
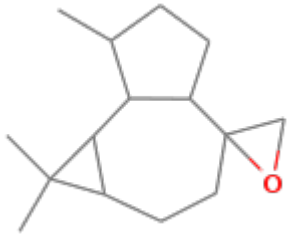
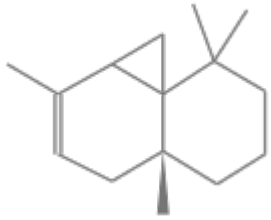
84		1-dodecanol	186	$C_{12}H_{26}O$		0.58	0.50	0.25	0.31	
85		1,8-Cyclotetradecadiyne	188	$C_{14}H_{20}$				0.62	0.57	
86		Cadalin	198	$C_{15}H_{18}$				0.56	0.75	1.88
87		3,7-Guaiadiene	204	$C_{15}H_{24}$				0.14	10.02	30.48

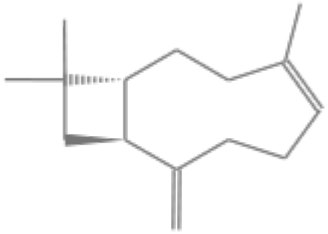
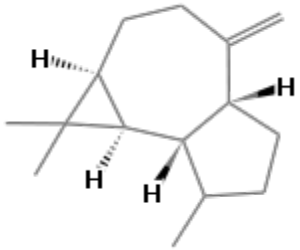
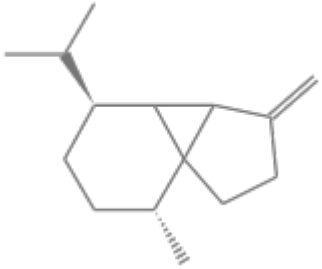
88	12.294	Rotundene	204	$C_{15}H_{24}$		0.33	1.39	0.52	0.91	
89	12.449	δ-Muurolene	204	$C_{15}H_{24}$		0.91	0.45	0.23	2.84	
90	12.580	Unknown				0.09				
91	12.638	Caryphyllene oxide	220	$C_{15}H_{24}O$		0.11	0.68	5.35		

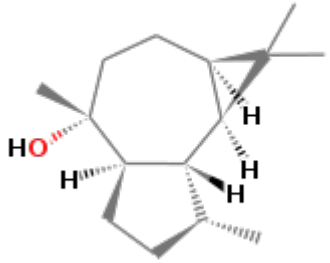
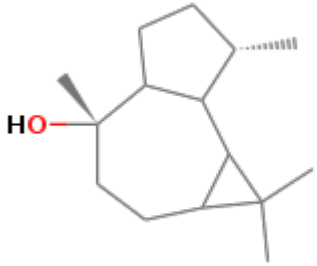
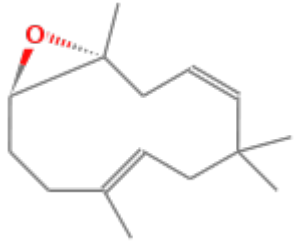
92	12.754	β –Muurolene	204	$C_{15}H_{24}$		0.31	2.80	0.89		
93	12.754	α-Muurolene	204	$C_{15}H_{24}$		0.27	0.35			
94	12.484	β-Elemene	204	$C_{15}H_{24}$		0.77	0.15		2.53	

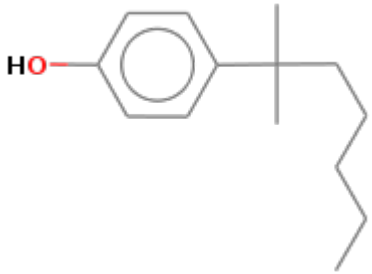
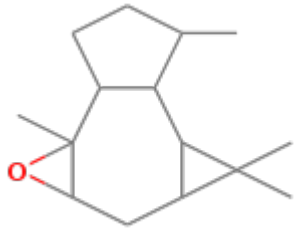
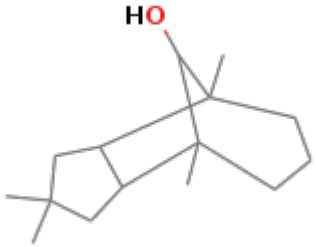
95	12.988	Caryophyllenol	220	$C_{15}H_{24}O$		0.28	0.21	1.46	7.23	
96	13.068	β-Vetispirene	202	$C_{15}H_{22}$		0.73	0.44	2.45	5.96	
97	13.271	α-Longipinene	204	$C_{15}H_{24}$		0.22	0.84	1.99	1.79	

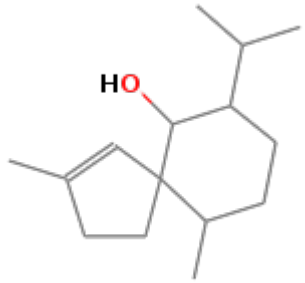
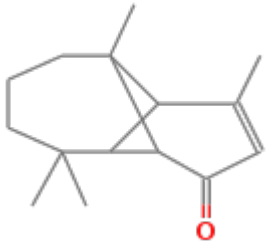
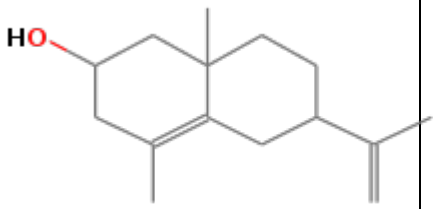
98	13.361	α-Calacorene	200	$C_{15}H_{20}$		0.39	0.16	7.50	2.25	8.04
99	13.545	Unknown				1.89	0.08			
100	14.038	Unknown				5.56				
101		Aristolone	218	$C_{15}H_{22}O$		0.36	2.65	0.38		
102	14.258	Unknown				0.63	0.13			

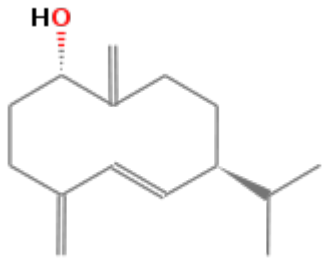
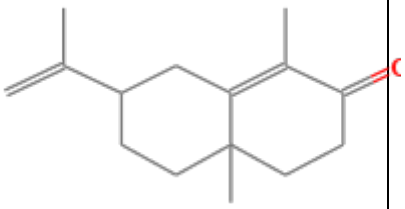
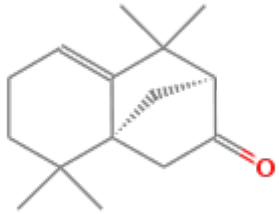
103	14.477	Humulene epoxide 2	220	$C_{15}H_{24}O$		13.43			9.84	
104		Aromadendrene epoxide	220	$C_{15}H_{24}O$			6.34		0.29	
105	14.671	cis-Thujopsene	204	$C_{15}H_{24}$		1.11	0.31	0.36		

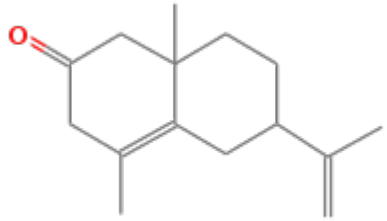
106	16.604	Isocaryophyllene	204	$C_{15}H_{24}$		0.22	1.16	7.49	6.63	
107		Alloaenermadendr	204	$C_{15}H_{24}$			3.88	14.82		8.44
108		β-cubebene	204	$C_{15}H_{24}$				0.63		

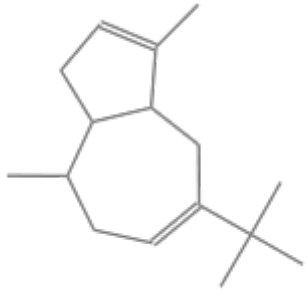
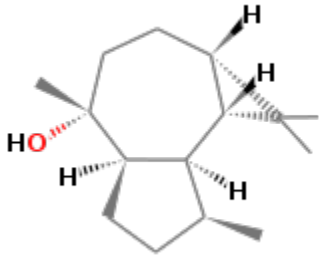
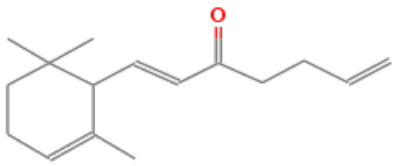
109	14.822	Globulol	222	$C_{15}H_{26}O$		9.88	0.10			
110	14.822	Ledol	222	$C_{15}H_{26}O$					1.24	
111		Unknown					0.59	2.26	1.73	
112	14.881	α-Humulene epoxide	220	$C_{15}H_{24}O$		2.90	14.04	1.62		

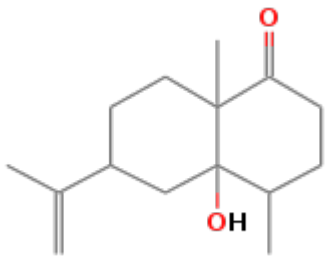
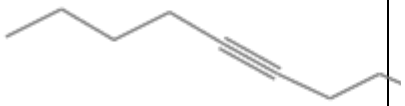
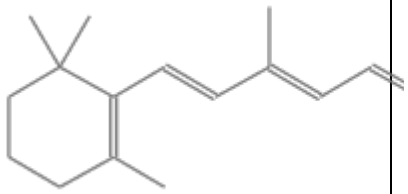
113		4(1,1-Dimethylhexyl)phenol	206	$C_{14}H_{22}O$			0.59			
114	15.209	Isoaromadenderene epoxide	220	$C_{15}H_{24}O$		6.50	4.30			
115		α-Caryophyllenol	222	$C_{15}H_{26}O$			0.62			

116		Gleenol	222	$C_{15}H_{26}O$			0.21			
117	15.301	Unknown				4.02		3.69	2.30	
118	15.576	Longiverbenone	218	$C_{15}H_{22}O$		5.38	2.74			
119		6-Isopropenyl-4,8a-dimethyl-1,2,3,5,6,7,8,8a-octahydro-naphthalen-2-ol	220	$C_{15}H_{24}O$		0.22	2.60			

120		germacra-4(15),5,10(14)-triene-1-α-ol	220	$C_{15}H_{24}O$			0.14		
121	15.905	α-Cyperone	218	$C_{15}H_{22}O$		1.40	0.69	4.20	
122		lsolongifolen-9-one	218	$C_{15}H_{22}O$			1.13		

123	17.211	3,5,6,7,8,8α-Hexahydro-4,8α-dimethyl-6-(1-methylethenyl)-2(1H)-naphthalenone	218	$C_{15}H_{22}O$		0.14	10.04			
124		2,2,7,7-Tetramethyltricyclo[6.2.1.0(1,6)]undec-4-en-3-one	218	$C_{15}H_{22}O$			0.02		3.74	15.42
125	15.987	Unknown				0.72	2.38			

126	16.085	Guaia-3,7-diene	218	$C_{16}H_{26}$		0.37	0.66	0.43	8.74	
127	16.150	Unknown				0.67				
128	16.271	Epiglobulol	222	$C_{15}H_{26}$ O		0.94	0.55	1.37		
129	16.999	Unknown				2.18	2.18		0.36	
130	17.098	Unknown				0.12	0.69			
131	17.211	Allyl ionone 1	232	$C_{16}H_{24}O$				0.73	0.59	

132		Corymbolone	236	$C_{15}H_{24}O_2$		0.24				
133	15.662	11-Hexadecyn-1-ol	238	$C_{16}H_{30}O$		0.47	0.80			
134		Retinal	284	$C_{20}H_{28}O$				0.74		
135		Unknown					0.02	3.95		
-	-	Total	-	-		100	100	100	100	100

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