

Received: 05-05-2023 **Accepted:** 15-06-2023

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Chemical Composition of Essential Oils of Fresh Jordanian *Euphorbia Hierosolymitana* Boiss

¹ Areej M Al-Ghoul, ² Musa H Abu Zarga, ³ Mahmoud A Al-Qudah ^{1, 3} Department of Chemistry, Faculty of Science, Yarmouk University, Jordan ² Department of Chemistry, Faculty of Science, Jordan University, Jordan

Corresponding Author: Areej M Al-Ghoul

Abstract

Essential oils, in turn, have attracted the attention of researchers in recent years for their multiple biological activities, which target several diseases. In this paper, the flowering aerial parts of fresh *E. hierosolymitana* Boiss were collected from its natural habitat in the Jerash area, Jordan, in July 2017. The essential oil was obtained from the collected plant by using the hydrodistillation Clevenger method. The essential oil was analyzed by (GC-MS). GC/MS analysis of the hydro-distilled oil. 112 components

were identified. The identified compounds belonged to seven classes, which can be classified as; monoterpene hydrocarbons (MH), oxygen-containing monoterpenes (OM), sesquiterpene hydrocarbons (SH), and oxygen-containing sesquiterpenes (OS), diterpene hydrocarbons (DT), oxygenated hydrocarbons (OD), ester (E). The major components of the oil were found to be caryophyllene oxide (12.84%), α -chenopodiol (3.91%), benzene acetaldehyde (3.80%), heptanal (3.41%) and β -ylangene (3.12%).

Keywords: Euphorbiceae, Euphorbia Hierosolymitana, Essential Oil, Distillation, Volatile Compounds

1. Introduction

Many plants grow in Jordan, such as *Euphorbia hierosolymitana* Boiss, which belongs to the family Euphorbiaceae ^[1]. Milky or colored latex is found in most species of this family. Latex in certain species could have irritant, poisonous, or carcinogenic properties ^[2]. *Euphorbia hierosolymitana* Boiss grows in several areas in Jordan, such as Kerak, Shubak, Jerash, Tafila, Ajloun, Salt, and Irbid The common name of *Euphorbia hierosolymitana* Boiss in Jordan is *Halabloub* ^[3]. *Euphorbia hierosolymitana Boiss* is characteristic of a milky latex that "bleeds" from the stems or leaves when they are broken. This latex contains certain substances which cause diarrhea. The plant grows to the height of a small round shrub, and during the year it undergoes several changes of color. In summer the plant appears dry and grey due to the shedding of the leaves during the dry season. In early winter color becomes green, while in spring, during the flowering season, the color becomes yellow ^[4].

Essential oils have been used for thousands of years in several cultures for medicinal and health purposes. Essential oils are rich in aromatic compounds ^[5, 6]. In addition, Essential oils are a mixture of volatile constituents produced by the secondary metabolism of aromatic and other varieties of plants ^[7]. They can be obtained by several methods. Such as expression, fermentation, effleurage, or extraction but among all the methods, steam distillation and hydro distillation are commonly used ^[8, 9]. Essential oil possesses many biological activities ^[10]. For that essential oils have been used traditionally as medicinal agents ^[11, 12].

Since no previous investigation has been reported on the volatile components of this plant, the present study aimed to extract volatile compounds from *Euphorbia hierosolymitana* using the techniques of hydrodistillation using the Clevenger-type apparatus. The volatile compounds present in the distillates were analyzed by (GC-MS).

2. Experimental

2.1 Collection and Authentication of Plant

The flowering aerial parts of fresh *E. hierosolymitana* Boiss were collected from its natural habitat in the Jerash area, Jordan in July (2017) and it was identified by Prof. Jamil Lahham from Al-Yarmouk University. A voucher was deposited to the Yarmouk University Herbarium.

2.2 Oil Isolation

The oils were isolated from *E. hierosolymitana* Boiss. After the freshly collected plant was minced, it was immediately hydrodistilled for three hours using Clevenger-type apparatus to yield colorless to pale yellow oil as previously described ^[13]. The oil was dried over anhydrous sodium sulfate and immediately stored in GC-grade n-hexane at 4 °C until it was analyzed by gas chromatography/mass spectrometry (GC/MS).

2.3 Identification of Components

Chemical analysis of the essential oils was carried out using gas chromatograph-mass spectrometry (Agilent, Palo Alto, USA; 6890N gas chromatograph). The chromatographic conditions were as follows: column oven program, 60 °C (1 min, isothermal) to 246 °C (3 min, isothermal) at 3 °C/min, the injector and detector temperatures were 250 °C and 300

 $^{\circ}$ C, respectively. Helium was the carrier gas (flow rate 0.90 ml/min) and the ionization voltage was maintained at 70 eV.A HP-5 MS capillary column (30 m \times 0.25 mm i.d., 0.25 μ m film thicknesses) was used. Retention Indices (RIs) were calculated by injection of a series of n-alkanes (C₈-C₂₀) in the same column under the same conditions specified above for gas chromatography analysis.

Identification of the oil components was based on computer search using the library of the mass spectral data and by comparison of the calculated retention index with the available authentic standards and literature data.

3. Results and Discussions

The components of the essential oil were identified. The distilled essential oils from *E. hierosolymitana* Boiss (Figure 1) shows the total ion chromatogram of the essential oils from the plant.

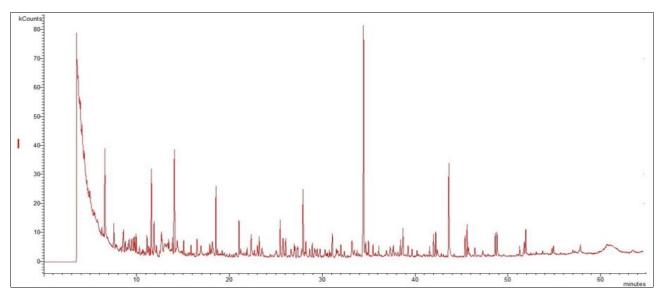


Fig 1: A representation of the obtained GC chromatogram with detection by the flame of oil from E. hierosolymitana Boiss

The main components of the essential oil, their percentages, and retention indices are presented in Table 1. GC/MS analysis of the hydrodistilled oil allowed the identification of 112 components that accounted for the total content. The identified components belonged to seven classes of compounds, which can be found in Table 2; monoterpene hydrocarbons (MH), oxygen-containing monoterpenes (OM), sesquiterpene hydrocarbons (SH), and oxygen-containing sesquiterpenes (OS), diterpene hydrocarbons (DT), oxygenated hydrocarbons (OD), ester (E). The major components of the oil were found to be caryophyllene oxide (12.84%), α -chenopodiol (3.91%), benzene acetaldehyde (3.80%), heptanal (3.41%) and β -ylangene (3.12%). The main compounds of the oil were chemically classified as follows, eight monoterpene hydrocarbons (4.95 %)

including α -pinene (1.04 %), verbenene (0.50%), β -pinene (0.56 %), cis-pinene (0.82 %) as major components. Twenty-nine Oxygenated monoterpenes were identified (17.68 %) including 2,2-dimethyl-2,4-ocradienal (5.55 %), linalool (0.54 %), cis-chrysathenol (0.73 %), γ -terpineol (0.63 %), pipertenone oxide (1.74 %) and trans-myrtand (1.57 %) as major components. There were fifteen sesquiterpene hydrocarbons (9.63 %) including β -ylangene (3.12 %), α -copaene (1.0 %), β -longipinene (0.57 %), longifolene (0.47 %), β -gurjunene (0.80 %) and epi-cedrane (0.61 %) as the most abundant components. Twenty-two oxygenated sesquiterpene compounds (24.98 %) were identified, among which caryophyllene oxide (12.84%), α -chenopodiol (3.90 %), drmenone (0.91 %), eudesm-(11)-en-4-01 (0.71 %) and valeranone (0.67 %) were detected.

Table 1: The main components of the essential oil, their percentages, and retention indices

#	$t_{\rm r}$	KI _{exp.}	KI _{the} .	Name of the compound	%A
1	3.848	812	811	Butyl acetate	1.00
2	4.101	828	828	Methyl pentanoate	0.99
3	6.574	900	902	Heptanal	3.41
4	7.561	939	932	α-Pinene	1.04
5	7.749	936	944	5-Methyl-3-heptanone	0.06
6	8.591	962	960	Benzaldehyde	1.86
7	8.812	968	969	Verbenene	0.50
8	8.966	973	979	trans-p-menthane	0.37

10 9,15 979 978 P-Patrice 0.56		0.125	050	0.70	a D:	0.55
11 9,34 988 990 Endo-2-Norborneul 0,13 12 9469 987 988 996 63-Penane 0,82 13 9,608 993 996 996 Mesirylene 0,67 15 9,830 1000 1000 1000 n-D-Decane 0,62 16 9,954 1003 1005 Gi-Debydroxy indooloxide 0,73 17 10,309 10/2 10/15 1,4-Circole 0,36 18 10,668 1000 1039 p-Cymene 0,15 19 10,761 10/23 10/26 1,2-4-Trimethyl betrzene 0,16 10 10/31 10/31 10/32 10/32 1,2-4-Trimethyl betrzene 0,16 10 10/31 10/32 10/32 1,2-4-Trimethyl betrzene 0,16 10 10/31 10/32 10/32 1,2-4-Trimethyl betrzene 0,19 20 1,1,1/31 10/31 10/32 10/32 1,2-4-Trimethyl betrzene 0,19 21 1,1,2,3 10/31 10/31 10/34 10/3	9	9.137	979	978	β -Pinene	0.56
12 9.469 987 995 3-Menthene 0.13 13 9.068 993 995 3-Menthene 0.13 14 9.703 996 996 Mestylene 0.67 15 9.830 1000 1000 n-Decane 0.62 16 9.954 1003 1008 cis-Delydroxy linalooloxide 0.73 17 10.309 1012 1015 1.4-Cincole 0.36 18 10.668 1020 1029 p-Cymene 0.15 19 10.761 1023 1026 1.2-4-Trimethyl hervane 0.16 19 10.761 1023 1026 1.2-4-Trimethyl hervane 0.16 10 10.761 1023 1026 1.2-4-Trimethyl hervane 0.16 12 11.288 1036 1088 Santolina alcohol 0.61 12 11.281 1036 1088 Santolina alcohol 0.61 12 11.281 1036 1088 Santolina alcohol 0.61 11.272 1077 1047 1.4-5-Chimene 0.19 12 11.281 1036 1056 0.5-Crossol 0.20 12 11.281 1057 1056 0.5-Crossol 0.20 12 12.488 1056 1056 0.5-Crossol 0.20 12 12.488 1056 1056 0.5-Crossol 0.25 12.678 1079 1058 0.5-Crossol 0.25 12.678 1079 1058 0.5-Crossol 0.25 13.131 1079 1082 0.5-Crossol 0.25 13.132 1079 1082 0.5-Crossol 0.25 13.132 1079 1082 0.5-Crossol 0.25 13.133 1019 1019 1020 Nonanone 0.36 13.13474 1090 1090 Nonanone 0.36 0.5-Totaloldryle 1.61 13.1473 1079 1079 1079 1.1aalool 0.54 13.13474 1090 1090 1090 Nonanone 0.36 13.13474 1090 1090 1090 Nonanone 0.36 13.13474 1090 1091 1097 1.1aalool 0.54 13.13474 1090 1091 1097 1.1aalool 0.54 13.13474 1090 1091 1097 1.1aalool 0.54 13.13474 1090 1090 1090 Nonanone 0.36 13.13474 1090 1090 1097 1.1aalool 0.54 13.13474 1090 1090 1090 1090 1090 1090 1090 1090 1090 1090 1090 1090 1090						
13 9,608 993 995 S.Menthene 0.13 14 9,703 996 1000 101	11	9.34	985	990	Endo-2-Norborneol	0.13
13 9,608 993 995 S.Menthene 0.13 14 9,703 996 1000 101	12	9.469	987	989	cis-Penane	0.82
14 9.703 996 996 Mesitylene 0.67 15 9.830 1000 1000 n-Decane 0.62 16 9.954 1003 1008 cis-Delydroxy linalooloxide 0.73 17 10.309 1012 1015 1.4-Cincole 0.36 18 10.668 1020 1029 p-Cymene 0.15 19 10.761 1023 1026 1.2-4-Timethyl benzene 0.15 20 11.002 1031 1037 2-Accyt-5-methyllurane 0.19 21 11.288 1036 1038 Santolina alcobal 0.61 22 11.442 1040 1044 Henzene Accidence 0.29 23 11.601 1044 1044 Henzene Accidence 0.29 24 11.727 1047 1047 E-β-Oximane 0.19 25 11.881 1056 1056 0-Cresol 2.08 25 11.881 1056 1056 0-Cresol 2.08 27 22.148 1056 1056 0-Cresol 2.08 28 12.688 1070 1056 A-Application 0.57 29 12.773 1073 1073 trus-landoof toxide 0.59 29 12.773 1073 1073 trus-landoof toxide 0.58 20 13.974 1090 1090 Nonanone 0.36 31 13.474 1090 1090 1092 Franchone 0.34 31 13.473 1070 1077 Linaloof 0.54 32 13.873 1100 1097 Linaloof 0.54 33 13.403 1104 1104 2.2-Dimethyl 3.4-Octadicnal 5.55 34 14.366 1111 117 Endo-Fenchol 0.54 35 15.890 1171 1123 truss-landoof 0.54 36 15.598 1138 1140 Nopisione 0.13 37 15.872 1145 1145 Cumphor 0.41 41 17.876 1191 1194 cis-Dibiydro-ar-leptine 0.49 41 17.876 1191 1194 cis-Dibiydro-ar-leptine 0.49 42 18.017 1191 1194 cis-Dibiydro-ar-leptine 0.49 43 18.176 1191 1194 cis-Dibiydro-ar-leptine 0.49 44 18.267 1191 1194 cis-Dibiydro-ar-leptine 0.49 45 18.181 1194 cis-Dibiydro-ar-leptine 0.49 47 1281 1291 1298						
15 9.830 1000 1008 cs-1-bydravy infanctoristic 0.73						
16 9.954 1003 1008 cis Dehydroxy Inalooloxide 0.73						
17 10,309 1012 1015 1,4-Cincole 0,36 10,70 1029 p-Cymen 0,15 10,761 1023 1023 1026 1,2-4-Trimethyl benzene 0,16 10,761 1023 1023 1025 1,2-4-Trimethyl benzene 0,16 10,10 10,1						
18 10.668 1020 1020 1026 1.2.44-lrimenty bearene 0.15	16	9.954	1003	1008	cis -Dehydroxy linalooloxide	0.73
18 10.668 1020 1020 1026 1.2.44-lrimenty bearene 0.15	17	10.309	1012	1015	1.4-Cineole	0.36
19 10.76 10.23 10.26 1.2.4+Trimethyl benzene 0.16						
20						
11.288						
22 11.442 1040 1044 Batylex-(2E)-enolate 0.29						
22 11.442 1040 1044 Batylex-(2E)-enolate 0.29	21	11.288	1036	1038	Santolina alcohol	0.61
23 11.601 1044 1044 1044 Benzene acetaldehyde 3.80						
24 11,727 1047 1047 1047 1056 6.0 Cressol 2.08 25 11,81 1050 1056 6.0 Cressol 2.08 26 12,147 1057 1057 1057 Bergamal 0.57 27 12,488 1065 1065 Actophenone 0.29 28 12,678 1070 1068 O-Tolualdelyde 1.61 29 12,773 1073 1073 trans-Linadol oxide 0.58 30 13,020 1079 1082 Fenctone 0.44 31 13,474 1090 1090 Nonanone 0.56 32 13,879 100 1097 Linadol 1097 Linadol 1097 33 14,053 1100 1097 Linadol 1097 Linadol 1097 33 14,053 1104 1104 12,2-Dimethyl-3,4-Ocatadienal 5.55 34 14,366 1111 1117 Endo-Fenchol 0.54 35 15,080 1127 1123 trans-Pinene hydrate 0.60 36 15,548 1138 1140 Nonjonone 0.13 37 15,872 1145 1145 Camphor 0.41 38 16,027 1149 1154 neo-3 *Thujanol 0.07 39 16,496 1160 1164 cis-Chrysathenol 0.73 41 17,876 1191 1192 2-Decanone 0.42 42 18,017 1194 1194 cis-Dihdro - Terpineol 0.49 43 18,176 1198 1198 7-Terpineol 0.63 44 18,267 1200 1205 Dedecane 0.38 45 18,518 1206 1205 2E,4E. Nonadienal 2.74 46 18,20 1210 1208 30-Dodecane 0.38 45 18,518 1206 1205 2E,4E. Nonadienal 2.74 48 20,634 1254 1253 Butyrophenone 0.07 49 21,028 1263 1262 trans-Phytrone 0.05 40 21,028 1263 1262 trans-Phytrone 0.07 41 12,004 1282 1291 0.08 0.09 0.09 42 12,038 1263 1262 trans-Phytrone 0.05 43 23,424 1254 1253 Butyrophenone 0.09 44 18,207 1201 1208 0.09 0.09 45 18,518 1206 1205 2E,4E. Nonadienal 2.74 46 18,200 1205 2E,4E. Nonadienal 2.74 47 19,220 1222 1229 Circunellol 0.18 48 20,634 1254 1253 Butyrophenone 0.07 50 21,218 126 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265 1265						
25 11.881 10.90 10.56 0 Cresol 2.08 26 12.147 10.57 10.57 Bergamal 0.57 27 12.488 10.05 10.65 0.65 Acetophenone 0.29 28 12.678 10.070 10.68 O-Tollandehyde 1.61 29 12.773 10.73 10.73 trans-Linalcol oxide 0.58 30 13.020 10.079 10.82 Fenchone 0.44 31 13.474 10.00 10.90 Nonumere 0.36 32 13.579 11.00 10.97 Linalcol 0.54 33 14.053 11.04 11.04 2.2-Dimethyl 3.4-Octadienal 5.55 34 14.566 11.11 11.17 Endo-Fenchol 0.54 35 15.080 11.27 11.23 trans-Pinneen hydrate 0.60 36 15.488 11.85 11.45 Nopinone 0.13 37 13.872 11.45 11.45 Endo-Fenchol 0.13 38 16.027 11.49 11.54 Endo-Fenchol 0.07 39 16.496 11.01 11.65 Camphor 0.41 41 17.876 11.01 11.02 Calcadienal 0.73 42 18.017 11.94 11.94 Calcadienal 0.73 43 18.176 11.94 11.94 Calcadienal 0.73 43 18.176 11.94 11.94 Calcadienal 0.73 43 18.176 11.94 11.94 Calcadienal 0.73 44 18.267 12.00 12.00 12.00 Dodecane 0.43 45 18.818 12.06 12.05 Calcadienal 0.74 46 18.820 12.00 12.00 Dodecane 0.38 47 19.220 12.22 12.29 Citronellol 0.18 48 20.634 12.54 12.53 Butyrophenone 0.06 49 21.028 12.63 12.64 12.55 Butyrophenone 0.07 50 21.218 12.67 12.71 2						
26						
27 12.488 1065 1065 1065 1065 0.5	25	11.881	1050	1056	o-Cresol	2.08
27 12.488 1065 1065 1065 1065 0.5	26	12.147	1057	1057	Bergamal	0.57
28 12.678 1070 1068 0-Tohaldehyde 0.58						
12.773						
30 13.020 1079 1082 Fenchone 0.44 31 13.474 1090 1090 Nonanone 0.36 32 13.879 1100 1097 Linalool 0.54 33 14.053 1104 1104 1104 2,2-Dimethyl -3,4-Ocatadienal 5.55 34 14.366 1111 1117 Endo-Fenchol 0.54 35 15.080 1127 1123 trans-Pimen bydrate 0.60 36 15.548 1138 1140 Nopinone 0.13 37 15.872 1145 1145 1145 Camphor 0.41 38 16.072 1149 1154 neo -3-Thujanol 0.07 39 16.496 1160 1164 cis-Chrysathenol 0.73 40 16.949 1170 1165 cis-Dihydro-a-Terpineol 0.49 41 17.876 1191 1192 2Decanone 0.43 42 18.017 1194 1194 cis-Dihdro carvone 0.19 43 18.176 1198 1198 1798 7-Terpineol 0.63 44 18.267 1200 1200 Dodecane 0.38 45 18.518 1206 1205 2E.4E-Nonadienal 2.74 46 18.720 1210 1208 iso-Dihydro carvole 0.34 47 19.220 1222 1229 Citronellol 0.18 48 20.634 1254 1253 Butyrophenone 0.06 49 21.028 1263 1262 trans-Myrtanol 1.57 50 21.218 1267 1271 2(1E)-propenyl phenol 0.65 51 21.904 1282 1263 Butyrophenone 0.06 52 22.343 1292 1298 Thymol 1.06 53 22.233 1308 1300 n-Tridecanone 0.27 55 23.202 1313 1319 2.34-Timethyl benzaldehyde 0.35 55 23.202 1313 1319 2.34-Timethyl benzaldehyde 0.35 56 23.482 1320 1319 139 2.34-Timethyl benzaldehyde 0.53 56 23.482 1320 1319 139 2.34-Timethyl benzaldehyde 0.05 56 27.98 140						
31 13.474 1090 1090 Nonanone 0.36						
31 13.474 1090 1090 Nonanone 0.36	30	13.020	1079	1082	Fenchone	0.44
33 1403 1104 1104 2.2.Dimethyl -3.4. Octadienal 5.55 34 14.366 1111 1117 Endo-Fenchol 0.54 35 15.080 1127 1123 trans-Pinen bydrate 0.60 36 15.548 1138 1140 Nopinone 0.13 37 15.872 1145 1145 1145 Camphor 0.41 38 16.077 1149 1154 neo -3- Thujanol 0.07 39 16.496 1160 1164 cis-Chrysathenol 0.73 40 16.949 1170 1165 cis-Dihydro -a-Terpineol 0.49 41 17.876 1191 1192 2- Decanone 0.43 42 18.107 1194 1194 cis-Dihdro carvone 0.19 43 18.176 1198 1198 1198 y-Terpineol 0.63 44 18.267 1200 1200 Dodecane 0.38 45 18.518 1206 1205 EA-K-Nonalienal 2.74 46 18.720 1210 1208 iso-Dihydro carvolo 0.34 47 19.220 1212 1229 Citronellol 0.18 48 20.634 1254 1253 Butyrophenone 0.06 49 21.028 1263 1262 trans-Myrtanol 1.57 50 21.218 1267 1271 2-(115)-propenyl phenol 0.53 51 21.904 1282 1291 1200 1.57 50 21.218 1267 1271 2-(115)-propenyl phenol 0.52 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n-Tridecanone 0.27 54 23.013 1308 1319 So-menthyl acetate 0.53 55 23.202 1313 1319 23.4+ Thimelyl benzalednyde 1.03 55 23.202 1313 1319 23.4+ Thimelyl benzalednyde 1.03 56 23.482 1320 1390 Cis-2,3-Pinanaediel 0.04 60 25.927 1381 1384 Modheph -2-ene 0.07 60 25.928 1301 1306 Ethyl decanoate 0.07 60 25.927 1381 1382 β-Manliene 0.04 60 25.927 1381 1382 β-Manliene 0.04 60 25.927 1381 1382 β-Copaene 0.07 61 26.052 1384 1484 1491 β-Corpaene 0.07 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β-Longipione 0.44 65 27.098 1403 1435 Gerana 0.44 66 27.298 1408 1408 1408 1408 1408 1408 14						
33 14.053 11.04 11.04 2,2-Dimethyl-3,4-Ocatadienal 5.55 34 14.366 1111 1117 Endo-Fenchol 0.54 35 15.080 1127 1123 trans-Pinene hydrate 0.60 36 15.548 1138 1140 Nopinone 0.13 37 15.872 1145 1145 Camphor 0.41 38 16.027 1149 1154 neo-3-Thujanol 0.07 39 16.496 1160 1164 cis-Chrysathenol 0.73 40 16.949 1170 1165 cis-Dihydro-α-Terpineol 0.49 41 17.876 1191 1192 2-Decanone 0.43 42 18.017 1194 1194 cis-Dihydro-α-Terpineol 0.63 44 18.267 1200 1200 Dodecane 0.38 45 18.518 1206 1205 2E.4.45 Nonadienal 2.74 46 18.720 1210 1208 iso-Dihydro carvool 0.34 47 19.220 1222 1229 Citronellol 0.18 48 20.634 1254 1253 Butyrophenone 0.06 49 21.028 1263 1262 trans Myrtanol 1.57 50 21.218 1267 1271 2-(15)-propenyl phenol 0.52 51 21.904 1282 1291 neo-iso-3-Thujyl acetate 0.35 52 22.343 1292 1298 Thympolenone 0.27 54 23.013 1308 1319 Iso-menthyl acetate 0.35 55 23.482 1330 1319 Iso-menthyl acetate 0.35 55 23.482 1330 1319 Iso-menthyl acetate 0.53 55 23.482 1330 1319 Iso-menthyl acetate 0.53 56 23.482 1320 1319 Iso-menthyl acetate 0.53 57 23.605 1323 1319 25.445 Printended 0.04 60 25.927 1381 1382 Butyrophenone 0.06 60 25.927 1381 1382 Butyrophenone 0.07 60 25.927 1381 1382 Butyrophenone 0.07 60 25.927 1381 1382 Butyrophenone 0.07 60 25.927 1381 1390 E.445 Decadenal 0.04 60 27.798 1401 1419 E. Caryophyllene 0.07 61 26.052 1384 1384 Modheph -2-ene 0.07 62 26.645 1399 1395 Ethyl decanoate 0.07 63 27.068 1401 1401 Byrophyllene 0.38 64 27.767 1419 1419 E. Caryophyllene 0.38 65 27.068 1401 1401 Byrophyllene 0.38 66 27.798 1423 1428 Byrophyllene 0.47 67 29.44 1451 1451 E.455 E.465 E.465						
34 14.366 1111 1117 Endo-Fenchol 0.54 35 15.080 1127 1123 trans-Pinene hydrate 0.60 36 15.548 1138 1140 Nopinone 0.13 37 15.872 1145 1145 1145 Camphor 0.41 38 16.072 1149 1154 neo-3-Thujanol 0.07 39 16.496 1160 1164 cis-Dihydro-a-Terpineol 0.73 40 16.949 1170 1165 cis-Dihydro-a-Terpineol 0.49 41 17.876 1191 1192 2-Decanone 0.43 42 18.017 1194 1194 cis-Dihdro carvone 0.19 43 18.176 1198 1198 7-Terpineol 0.63 44 18.267 1200 1200 Dodecane 0.38 45 18.518 1206 1205 E.4E-Nonadienal 2.74 46 18.720 1210 1208 iso-Dihydro-arvonol 0.34 47 19.220 1222 1229 Citronellol 0.18 48 20.634 1254 1253 Butyrophenone 0.06 49 21.028 1263 1262 trans-Myrtanol 1.57 50 21.218 1267 1271 2 - (1E)-propenyl phenol 0.52 51 21.904 1282 1291 neo-iso-3-Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n-Tridecanone 0.27 54 23.013 1308 1319 2.34+Trimethyl benzaldehyde 1.03 55 23.482 1320 1319 2.44-Trimethyl benzaldehyde 1.03 55 23.482 130 1319 2.54-Trimethyl benzaldehyde 1.03 56 23.482 130 1319 2.54-Trimethyl benzaldehyde 1.03 56 23.482 130 1319 2.54-Trimethyl benzaldehyde 1.03 56 23.482 130 1319 E.74-P-Decadienal 0.44 66 27.928 1431 1441 1441 B.84crol 0.07 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E. Caryophyllene 0.38 69 27.928 1434 1431 444 B.84crol 0.47 60 27.928 1434 1435 E. Caryophyllene 0.38 60 27.928 1443 1441 1441 B.84crol 0.47 60 27.928 1443 1455 E. Caryophyllene 0.42 70 28.117 1428 1428 B. Caryophyllene 0.42 71 28.240 1431 1431 B. Gardiene 0.47 72.346 1441 1441 B.84crol 0.47 73 29.244 1456 145						
35						
15.548 1138 1140 Nopinone 0.13						0.54
15.548 1138 1140 Nopinone 0.13	35	15.080	1127	1123	trans- Pinene hydrate	0.60
37 15.872 1145 1145 1145 16.027 1149 1154 1164 16.027 1149 1154 1164 16.027 1149 1154 1165 16.96 1160 1164 16.940 1170 1165 678-Dhlydro -a. Terpineol 0.49 1170 1165 678-Dhlydro -a. Terpineol 0.49 1170 1165 678-Dhlydro -a. Terpineol 0.49 1177 1194 1194 678-Dhlydro -a. Terpineol 0.49 1177 1194 1194 678-Dhlydro -a. Terpineol 0.49 1195 1194 1194 678-Dhlydro -a. Terpineol 0.63 18.176 1198 1198 7-Terpineol 0.63 18.172 1200 1200 0.60						
38 16.027 1149 1154						
39 16.496 1160 1164						
40 16,949 1170 1165 2- Decanone 0.43 41 17.876 1191 1192 2- Decanone 0.43 42 18.017 1194 1194 1194 cis-Dihdro carvone 0.19 43 18.176 1198 1198 y-Terpineol 0.63 44 18.267 1200 1200 Dodecane 0.38 45 18.518 1206 1205 2E.4E- Nonadienal 2.74 46 18.720 1210 1208 iso-Dihydro carveol 0.34 47 19.220 1222 1229 Citronellol 0.18 48 20.634 1254 1253 Butyrophenone 0.06 49 21.028 1263 1262 trans - Myrtanol 1.57 50 21.218 1267 1271 2 - (1E) - propenyl phenol 0.52 51 21.904 1282 1291 neo-iso-3- Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n- Tridecanone 0.27 54 23.013 1308 1319 So-menthyl acetate 0.53 55 23.202 1313 1319 2.3,4- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 22,4- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 22,4- Trimethyl benzaldehyde 1.04 57 23.605 1323 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 a-Copane 1.00 60 25.927 1381 1382 Butyrophenone 0.07 62 26.645 1399 1395 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.07 65 27.986 1403 1396 Ethyl decanoate 0.07 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Vangipinene 0.57 70 28.117 1428 1428 β- Copane 0.021 71 28.240 1431 1431 β- Gurjunene 0.30 72 28.641 1441 1441 Bakerol 0.45 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1461 1451 Cyclame 0.48 76 29.464 1461 1461 Cyclame 0.48 77 29.464 1461 1461 Cyclame 0.48 78 29.464 1461 1461 Cyclame 0.48 78 20.46 20.48 20.48 20.48 78 20.46 20.48 20.48 20.48						
1	39	16.496	1160	1164		0.73
1	40	16.949	1170	1165	cis- Dihydro –α- Terpineol	0.49
194 1194 1194 1194 1198 y-Terpineol 0.63						
44 18.267 1200 1200 1200 Dodecane 0.38 45 18.518 1206 1205 E3.4E. Nonadienal 2.74 46 18.720 1210 1208 iso-Dihydro carveol 0.34 47 19.220 1222 1229 Citronellol 0.18 48 20.634 1254 1253 Butyrophenone 0.06 49 21.028 1263 1262 trans - Myrtanol 1.57 50 21.218 1267 1271 2 - (1E) - propenyl phenol 0.52 51 21.904 1282 1291 neo-iso-3-Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n-Tridecanone 0.27 54 23.013 1308 1319 Iso - menthyl acetate 0.53 55 23.202 1313 1319 2.3.4-Trimethyl benzaldehyde 1.03 55 23.3482 1320 1319 22.4-E-Decadienal 0.44 57 23.605 1323 1320 cis - 2.3-Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1398 Ethyl geranate 0.53 64 26.985 1401 1401 β-Longipinene 0.57 65 27.068 1403 1398 Ethyl geranate 0.53 66 27.298 1408 1408 Longifolene 0.47 68 27.767 1419 1419 E-Caryophyllene 0.38 69 27.928 1428 1428 β-Copaene 0.07 70 28.141 1431 β-Curjapinene 0.37 71 28.240 1431 1431 β-Curjapinene 0.38 69 27.928 1428 1428 β-Copaene 0.01 71 28.240 1431 1431 β-Curjapinene 0.80 72 28.641 1441 1441 Bakerol 0.44 74 29.160 1454 1455 C-Methyl societical 0.42 75 29.244 1456 1456 C-Cyclame 0.61 76 29.464 1461 1461 C-Cyclame 0.47 76 29.464 1461 1461 C-Cyclame 0.48 76 29.464 1461 1461 C-Cyclame 0.48 77 28.464 24.461 24.61 24.61 24.61 24.61 78 29.464 24.61 24.61 24.61 24.61 24.61 78 29.464 24.61 24.61 24.61						
1.00 1.00						
45 18.518 1206 1205 1208 iso -Dihydro carveol 0.34 46 18.720 1210 1208 iso -Dihydro carveol 0.34 47 19.220 1222 1229 Citronellol 0.18 48 20.634 1254 1253 Butyrophenone 0.06 49 21.028 1263 1262 trans - Myrtanol 1.57 50 21.218 1267 1271 2 - (1E) -propenyl phenol 0.52 51 21.904 1282 1291 neo-iso -3 - Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n-rridecanone 0.27 54 23.013 1308 1319 Iso - menthyl acetate 0.53 55 23.202 1313 1319 23.4 - Trimethyl benzaldehyde 1.03 55 23.422 1320 1319 22.4E - Decadienal 0.44 57 23.605 1323 1320 cis -2,3 - Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 ac-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2 - ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.57 63 26.801 1403 1396 Ethyl geranate 0.57 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1396 Ethyl geranate 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 423 β- Ylangene 0.21 70 28.117 1428 1428 β- Copaene 0.21 71 28.240 1431 1441 441 Bakerol 0.47 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 cpi-Cedrane 0.61 74 29.160 1454 1455 C- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo-Clovene 0.38 76 29.444 1461 1461 Cyclamen aldebyde 0.48						
46	44	18.267	1200	1200	Dodecane	0.38
46	45	18.518	1206	1205	2E.4E- Nonadienal	2.74
48						
48 20.634 1254 1253 Butyrophenone 0.06 49 21.028 1263 1262 trans – Myrtanol 1.57 50 21.218 1267 1271 2 – (1E) – propenyl phenol 0.52 51 21.904 1282 1291 neo- iso -3- Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n- Tridecanone 0.27 54 23.013 1308 1319 Iso – menthyl acetate 0.53 55 23.202 1313 1319 22,34- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E,4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Pianaediol 0.22 58 25.744 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td></t<>						
49 21.028 1263 1262 trans – Myrtanol 1.57 50 21.218 1267 1271 2 – (1E) – propenyl phenol 0.52 51 21.904 1282 1291 neo- iso -3 - Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n- Tridecanone 0.27 54 23.013 1308 1319 Iso – menthyl acetate 0.53 55 23.202 1313 1319 23.4-Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E,4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maliene 0.14 61 26.645 13						
50 21.218 1267 1271 2 - (1E) - propenyl phenol 0.52 51 21.904 1282 1291 neo- iso - 3- Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n- Tridecanone 0.27 54 23.013 1308 1319 Iso - menthyl acetate 0.53 55 23.202 1313 1319 23.4- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E.4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Piananediol 0.22 58 25.474 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1	48				Butyrophenone	0.06
51 21.904 1282 1291 neo- iso -3- Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n- Tridecanone 0.27 54 23.013 1308 1319 Iso - menthyl acetate 0.53 55 23.202 1313 1319 22.4- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E.4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl decanoate 0.07 64 26.985 1401	49	21.028	1263	1262	trans – Myrtanol	1.57
51 21.904 1282 1291 neo- iso -3- Thujyl acetate 0.35 52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n- Tridecanone 0.27 54 23.013 1308 1319 Iso - menthyl acetate 0.53 55 23.202 1313 1319 22.4- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E.4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl decanoate 0.07 64 26.985 1401	50					0.52
52 22.343 1292 1298 Thymol 1.06 53 22.689 1300 1300 n-Tridecanone 0.27 54 23.013 1308 1319 Iso - menthyl acetate 0.53 55 23.202 1313 1319 23.4-Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E.4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
53 22.689 1300 1300 n-Tridecanone 0.27 54 23.013 1308 1319 Iso – menthyl acetate 0.53 55 23.202 1313 1319 2,3.4-Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E,4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 <						
54 23.013 1308 1319 Iso – menthyl acetate 0.53 55 23.202 1313 1319 2,3,4- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E,4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2-ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1404 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td></td<>						
55 23.202 1313 1319 2,3,4- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E,4E- Decadienal 0.44 57 23.605 1323 1320 cis - 2,7- Piananediol 0.22 58 25.474 1370 1370 Piperirenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
55 23.202 1313 1319 2,3,4- Trimethyl benzaldehyde 1.03 56 23.482 1320 1319 2E,4E- Decadienal 0.44 57 23.605 1323 1320 cis - 2,7- Piananediol 0.22 58 25.474 1370 1370 Piperirenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 <td>54</td> <td>23.013</td> <td>1308</td> <td>1319</td> <td>Iso – menthyl acetate</td> <td>0.53</td>	54	23.013	1308	1319	Iso – menthyl acetate	0.53
56 23.482 1320 1319 2E,4E- Decadienal 0.44 57 23.605 1323 1320 cis -2,3- Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Madiene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Car						
57 23.605 1323 1320 cis - 2,3 - Piananediol 0.22 58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β-Longipinene 0.57 65 27.068 1403 1398 Z-Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Copa						
58 25.474 1370 1370 Piperitenone oxide 1.74 59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 1428 β- Copaene						
59 25.738 1376 1371 α-Copaene 1.00 60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 1428 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td></t<>						
60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 β- Copaene 0.21 71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47						
60 25.927 1381 1382 β-Maaliene 0.14 61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 β- Copaene 0.21 71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47	59	25.738	1376	1371	α -Copaene	1.00
61 26.052 1384 1384 Modheph -2- ene 0.97 62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 1428 β- Copaene 0.21 71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1456 α- neo -Clovene						
62 26.645 1399 1395 Ethyl geranate 0.53 63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 1428 β- Copaene 0.21 71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1456 α- neo -Clovene 0.37 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
63 26.801 1403 1396 Ethyl decanoate 0.07 64 26.985 1401 1401 $β$ - Longipinene 0.57 65 27.068 1403 1398 Z - Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 $β$ - Ylangene 3.12 70 28.117 1428 1428 $β$ - Copaene 0.21 71 28.240 1431 1431 $β$ - Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1456 $α$ - neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldeh						
64 26.985 1401 1401 β- Longipinene 0.57 65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 1428 β- Copaene 0.21 71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde						
65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 1428 β- Copaene 0.21 71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
65 27.068 1403 1398 Z- Trimenal 0.48 66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 1428 β- Copaene 0.21 71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48	64	26.985	1401	1401	β - Longipinene	0.57
66 27.298 1408 1408 Longifolene 0.47 67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 β- Ylangene 3.12 70 28.117 1428 1428 β- Copaene 0.21 71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
67 27.346 1409 1409 Dodacanal 0.44 68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 β - Ylangene 3.12 70 28.117 1428 1428 β - Copaene 0.21 71 28.240 1431 1431 β - Gurjunene 0.80 72 28.641 1441 1441 1441 β - Gurjunene 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 α - neo -Clovene 0.37 76 29.464 1461 1461 α - neo -Clovene α - neo -Clovene 76 α -						
68 27.767 1419 1419 E- Caryophyllene 0.38 69 27.928 1423 1423 $β$ - Ylangene 3.12 70 28.117 1428 1428 $β$ - Copaene 0.21 71 28.240 1431 1431 $β$ - Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 $α$ - neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
69 27.928 1423 1423 $β$ - Ylangene 3.12 70 28.117 1428 1428 $β$ - Copaene 0.21 71 28.240 1431 1431 $β$ - Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 $α$ - neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
70 28.117 1428 1428 β - Copaene 0.21 71 28.240 1431 1431 β - Gurjunene 0.80 72 28.641 1441 <td>68</td> <td></td> <td></td> <td></td> <td></td> <td></td>	68					
70 28.117 1428 1428 β - Copaene 0.21 71 28.240 1431 1431 β - Gurjunene 0.80 72 28.641 1441 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
71 28.240 1431 1431 β- Gurjunene 0.80 72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
72 28.641 1441 1441 Bakerol 0.47 73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
73 28.920 1448 1455 epi- Cedrane 0.61 74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
74 29.160 1454 1455 Z- Methy isoeigenol 0.42 75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48	73	28.920	1448	1455	epi- Cedrane	0.61
75 29.244 1456 1456 α- neo -Clovene 0.37 76 29.464 1461 1461 Cyclamen aldehyde 0.48						
76 29.464 1461 1461 Cyclamen aldehyde 0.48						
77 29.758 1469 1468 Thujopsadiene 0.24						
	77	29.758	1469	1468	Thujopsadiene	0.24

			1		
78	30.291	1482	1483	γ- Curcumene	0.32
79	30.566	1488	1490	β- Selinene	0.14
80	30.761	1493	1493	iso- menthyl Lactate	0.28
81	30.867	1496	1496	2- Tridecanone	021
82	31.090	1501	1502	Decyl propanoate	1.37
83	31.522	1512	1512	Cameroonan -7- α- ol	0.35
84	31.611	1515	1514	trans- cyclo iso Longifol -5- ol	0.31
85	31.703	1517	1516	10- epiItalicene ether	0.20
86	31.999	1524	1518	Menthylisovalerate	0.48
87	32.387	1534	1529	trans- Calamenene	0.29
88	33.179	1555	1559	trans- Cadinene ether	1.23
89	33.461	1562	1564	Longicamphenylone	0.39
90	33.713	1568	1572	Caryophyllenyl alcohol	0.35
91	34.043	1577	1576	Pentyl salicylate	0.06
92	34.449	1587	1580	Caryophyllene oxide	12.84
93	34.704	1594	1597	cis-Arteannuic alcohol	0.73
94	34.998	1601	1601	Hexadecan	0.64
95	35.489	1615	1613	Tetradecanal	0.54
96	36.102	1631	1633	α- Acorenol	0.39
97	37.313	1664	1669	ar-Turmerone	0.59
98	37.578	1671	1675	Valeranone	0.67
99	38.158	1681	1685	5- neo- Cardranol	0.20
100	38.415	1694	1700	Eudesm -7(11) -en -4- ol	0.71
101	38.696	1702	1705	n- Heptadecane	1.56
102	39.224	1716	1718	2Z,6Z – Fernesol	0.49
103	39.647	1728	1727	Guaiol acetate	0.29
104	40.207	1744	1749	Oplopanone	0.62
105	41.993	1795	1793	Drmenone	0.91
106	42.229	1801	1800	Octadecane	1.35
107	43.627	1843	1855	α- Chenopodiol	3.91
108	45.382	1896	1896	Rimuene	0.90
109	45.615	1903	1900	Nonadecane	1.35
110	45.723	1913	1906	1,5- diene iso Pimara -9(11)	0.39
111	46.455	1936	1940	11- Acetoxy eujesman -4- α- ol	0.54
112	47.275	1961	1948	Isophytol	0.20
					1 2:-2

Table 2: The classes of compounds in the essential oil of *e. hierosolymitana* Boiss

Monoterpene hydrocarbons	4.94
Oxygenated Monoterpenes	21.48
Sesquiterpene hydrocarbons	9.63
Oxygenated sesquiterpenes	27.15
Diterpene hydrocarbon	1.29
Oxygenated diterpene	0.20
Ester	3.78
Others	5.16

4. References

- 1. Al-Eisawi DMH. Flora of Jordan Checklist, revised Edition 1. The University of Jordan Press, Amman, Jordan, 2013.
- 2. Bruyns P, Mapaya R, Hedderson T. A new subgenaric classification for Euphorbia (Euphorbiaceae) in southern Africa based on ITS and pspA-trnH sequence data. Taxon. 2006; 55:397-420.
- 3. Alghoul A, Abu Zarqa M, Alqudah M. Chemical constituents of Euphorbia hierosolymitana Boiss. Jordan Journal of Chemistry, 2020.
- Al-Ghoul A. Isolation and Identification of the Chemical Constituents of Euphorbia Hierosolymitana and Bassia Eirophora and Their Antioxidant Activity. Unpublished PhD dissertation. The University of Jordan. Amman, 2019.
- Mahato N, Sharma K, Koteswararao R, Sinha M, Baral E. Citrus essential oils: Extraction, authentication and application in food preservation. Crit Rev Food Sci Nutr. 2019; 59:611-625.

- 6. Tongnuanchan P, Benjakul S. Essential oils: Extraction, bioactivities, and their uses for food preservation. Journal of Food Science. 2014; 79:R1231-R1249.
- 7. Bassole I, Juliani H. Essential oils in combination and their antimicrobial properties. Molecules.2012; 17:3989-4006.
- 8. Burt S. Essential oils: Their antibacterial properties and potential applications in foods-a review. International Journal of Food Microbiology. 2004; 94:223-253.
- 9. Tajkarimi M, Ibrahim S, Cliver D. Antimicrobial herb and spice compounds in food. Food control. 2010; 21:1199-1218.
- 10. Alessandro P, Paola A, Gianluigi B, Roberto V. Some Biological Activities of Essential Oils. Med Aromat Plants. 2013; 2(5):1-4.
- 11. Angnes S. Isolation, chemical characterization and evaluation of insecticide property of essential oil Piper amplumKunt, in Masters IDissertação (chemistry) R.U.o. Blumenau, Editor. Blumenau-SC, 2005, p88.
- 12. Almeida F, Ramos M, Amorim E, Albuquerque U. A comparison of knowledge about medicinal plants for three rural communities in the semi-arid region of northeast of Brazil. Journal of Ethnopharmacology. 2010; 127:674-684.
- 13. A-qudah M, Al-ghoul A, Trawenh I, Al-Jaber H, Al shboul T, et al. Antioxidant Activity and Chemical Composition of Essential Oils from Jordanian Ononis Natrix L and Ononis Sicula Guss. Journal of Biologically Active Products from Nature. 2014; 4:52-61.