Date : April 16, 2020

Certificate of Analysis – GC Profiling

Sample identification

Internal code : 20D09-PTH04
Customer identification : Peppermint U.S. Western - USA - PF010495R
Type : Essential oil
Source : *Mentha x piperita*
Customer : Plant Therapy

Analysis

Method: PC-MAT-007 - Analysis of the composition of an essential oil or other volatile liquide by FAST GC-FID (in French); identifications validated by GC-MS.
Analyst : Sylvain Mercier, M. Sc., Chimiste
Analysis date : April 16, 2020

Checked and approved by :

Alexis St-Gelais, M. Sc., chimiste 2013-174

Laboratoire PhytoChemia
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PHYSICOCHEMICAL DATA

Physical aspect: Faintly yellow liquid
Refractive index: 1.4626 ± 0.0003 (20 °C)

NF T 75-210:2007 & ISO 856:2006 - OIL OF PEPPERMINT - USA

Compound	Min. %	Max. %	Observed %	Complies?
β-Caryophyllene	1.0	2.5	2.3	Yes
Menthyl acetate	3.0	6.5	4.0	Yes
Pulegone	0.5	2.5	1.4	Yes
Menthol	36.0	46.0	42.6	Yes
neo-Menthol	2.5	4.5	3.4	Yes
Menthofuran	1.5	6.0	3.5	Yes
Isomenthone	2.0	4.5	3.0	Yes
Menthone	15.0	25.0	18.5	Yes
cis-Sabinene hydrate	0.5	2.3	0.8	Yes
Limonene	1.0	2.5	1.8	Yes
1,8-Cineole	4.0	6.0	4.4	Yes
Octan-3-ol	0.1	0.4	0.3	Yes
Refractive index	1.459	1.465	1.463	Yes

EUROPEAN PHARMACOPOEIA 9.0 - 07/2012:0405 - PEPPERMINT OIL

Compound	Min. %	Max. %	Observed %	Complies?
Carvone		1.0	0	Yes
Pulegone		3.0	1.4	Yes
Menthol	30.0	55.0	42.6	Yes
Menthyl acetate	2.8	10.0	4.0	Yes
Isomenthone	1.5	10.0	3.0	Yes
Menthofuran	1.0	8.0	3.5	Yes
Menthone	14.0	32.0	18.5	Yes
1,8-Cineole	3.5	8.0	4.4	Yes
Limonene	1.0	3.5	1.8	Yes
Total isopulegol		0.20	0.12	Yes
Refractive index	1.457	1.467	1.463	Yes

CONCLUSION

No adulterant, contaminant or diluent has been detected using this method. The oil complies with the ISO/AFNOR standard for American peppermint oil, and complies with the European pharmacopoeial standard for peppermint oil.

Analysis summary – Consolidated contents

New readers of similar reports are encouraged to read table footnotes at least once.

Identification	%	Classe
Isobutanol	0.01	Aliphatic alcohol
Isovaleral	0.02	Aliphatic aldehyde
2-Methylbutyral	0.01	Aliphatic aldehyde
Isoamyl alcohol	0.03	Aliphatic alcohol
2-Methylbutanol	0.03	Aliphatic alcohol
Hexanal	tr	Aliphatic aldehyde
Ethyl isovalerate	tr	Aliphatic ester
Ethyl 2-methylbutyrate	0.02	Aliphatic ester
(3*Z*)-Hexenol	tr	Aliphatic alcohol
Hexanol	0.01	Aliphatic alcohol
trans-2,5-Diethyltetrahydrofuran	0.02	Furan
Heptanal	0.01	Aliphatic aldehyde
α-Thujene	0.04	Monoterpene
α-Pinene	0.59	Monoterpene
3-Methylcyclohexanone	0.03	Aliphatic ketone
Camphene	tr	Monoterpene
Thuja-2,4(10)-diene	tr	Monoterpene
Sabinene	0.43	Monoterpene
β-Pinene	0.85	Monoterpene
Octen-3-ol	0.09	Aliphatic alcohol
Octan-3-one	0.02	Aliphatic ketone
Myrcene	0.21	Monoterpene
Octan-3-ol	0.30	Aliphatic alcohol
α-Phellandrene	0.01	Monoterpene
Pseudolimonene	0.01	Monoterpene
α-Terpinene	0.23	Monoterpene
para-Cymene	0.17	Monoterpene
Limonene	1.77	Monoterpene
1,8-Cineole	4.41	Monoterpenic ether
(*Z*)-β-Ocimene	0.31	Monoterpene
(*E*)-β-Ocimene	0.08	Monoterpene
γ-Terpinene	0.39	Monoterpene
cis-Sabinene hydrate	0.76	Monoterpenic alcohol
cis-Linalool oxide (fur.)	0.03	Monoterpenic alcohol
Octanol	tr	Aliphatic alcohol
Terpinolene	0.13	Monoterpene
trans-Sabinene hydrate	0.09	Monoterpenic alcohol
Linalool	0.33	Monoterpenic alcohol
2-Methylbutyl 2-methylbutyrate	0.08	Aliphatic ester
Amyl isovalerate	0.14	Aliphatic ester
Octen-3-yl acetate	0.03	Aliphatic ester
cis-para-Menth-2-en-1-ol	0.08	Monoterpenic alcohol
Octan-3-yl acetate	0.05	Aliphatic ester
allo-Ocimene	0.02	Monoterpene
trans-Sabinol	0.08	Monoterpenic alcohol
Isopulegol	0.12	Monoterpenic alcohol
Menthone	18.51	Monoterpenic ketone

Isomenthone	2.95	Monoterpenic ketone
Menthofuran	3.52	Monoterpenic ether
neo-Menthol	3.44	Monoterpenic alcohol
δ-Terpineol	0.10	Monoterpenic alcohol
Menthol	42.64	Monoterpenic alcohol
Terpinen-4-ol	1.07	Monoterpenic alcohol
Isomenthol	0.79	Monoterpenic alcohol
para-Cymen-8-ol	0.01	Monoterpenic alcohol
α-Terpineol	0.16	Monoterpenic alcohol
neoiso-Menthol	0.22	Monoterpenic alcohol
Myrtenal	0.03	Monoterpenic aldehyde
Myrtenol	0.05	Monoterpenic alcohol
trans-Isopiperitenol	0.01	Monoterpenic alcohol
Unknown	0.01	Unknown
Decanal	0.03	Aliphatic aldehyde
(3*Z*)-Hexenyl 2-methylbutyrate	0.03	Aliphatic ester
Pulegone	1.36	Monoterpenic ketone
(2*E*)-Hexenyl isovalerate	0.07	Aliphatic ester
Carvone	0.01	Monoterpenic ketone
Piperitone	0.56	Monoterpenic ketone
Decanol	0.03	Aliphatic alcohol
neo-Menthyl acetate	0.21	Monoterpenic ester
2-Ethylmenthone?	0.04	Aliphatic ketone
Dihydroedulan I	0.09	Terpenic ether
Menthyl acetate	3.99	Monoterpenic ester
Dihydroedulan II	0.06	Terpenic ether
Thymol	0.10	Monoterpenic alcohol
Isomenthyl acetate	0.19	Monoterpenic alcohol
Bicycloelemene	0.01	Sesquiterpene
Piperitenone	0.01	Monoterpenic ketone
α-Cubebene	0.02	Sesquiterpene
Menthofurolactone	0.02	Aliphatic alcohol
α-Copaene	0.05	Sesquiterpene
β-Bourbonene	0.37	Sesquiterpene
1,5-diepi-β-Bourbonene	0.04	Sesquiterpene
β-Cubebene	0.03	Sesquiterpene
β-Elemene	0.07	Sesquiterpene
(*Z*)-Jasmone	0.02	Jasmonate
Unknown	0.03	Unknown
Isocaryophyllene	0.04	Sesquiterpene
β-Caryophyllene	2.25	Sesquiterpene
β-Copaene	0.05	Sesquiterpene
trans-α-Bergamotene	0.03	Sesquiterpene
Isogermacrene D	0.04	Sesquiterpene
α-Humulene	0.10	Sesquiterpene
(*E*)-β-Farnesene	0.38	Sesquiterpene
Germacrene D	1.93	Sesquiterpene
Menthalactone	0.02	Monoterpenic lactone
Bicyclogermacrene	0.23	Sesquiterpene
Viridiflorene	0.02	Sesquiterpene
α-Muurolene	0.09	Sesquiterpene
γ-Cadinene	0.02	Sesquiterpene

δ-Cadinene	0.09	Sesquiterpene
Isocaryophyllene epoxide B	0.01	Sesquiterpenic ether
Spathulenol	0.04	Sesquiterpenic alcohol
Caryophyllene oxide isomer	0.01	Sesquiterpenic ether
Caryophyllene oxide	0.06	Sesquiterpenic ether
Viridiflorol	0.22	Sesquiterpenic alcohol
Isospathulenol	0.03	Sesquiterpenic alcohol
τ-Cadinol	0.01	Sesquiterpenic alcohol
τ-Muurolol	0.01	Sesquiterpenic alcohol
Unknown	0.01	Sesquiterpenic alcohol
α-Cadinol	0.02	Sesquiterpenic alcohol
Unknown	0.01	Oxygenated sesquiterpene
Consolidated total	**98.75%**	

tr: The compound has been detected below 0.005% of total signal.

Note: no correction factor was applied

About "consolidated" data: The table above presents the breakdown of the sample volatile constituents after applying an algorithm to collapse data acquired from the multi-columns system of PhytoChemia into a single set of consolidated contents. In case of discrepancies between columns, the algorithm is set to prioritize data from the most standard DB-5 column, and smallest values so as to avoid overestimating individual content. This process is semi-automatic. Advanced users are invited to consult the "Full analysis data" table after the chromatograms in this report to access the full untreated data and perform their own calculations if needed.

Unknowns: Unknown compounds' mass spectral data is presented in the "Full analysis data" table. The occurrence of unknown compounds is to be expected in many samples, and does not denote particular problems unless noted otherwise in the conclusion.

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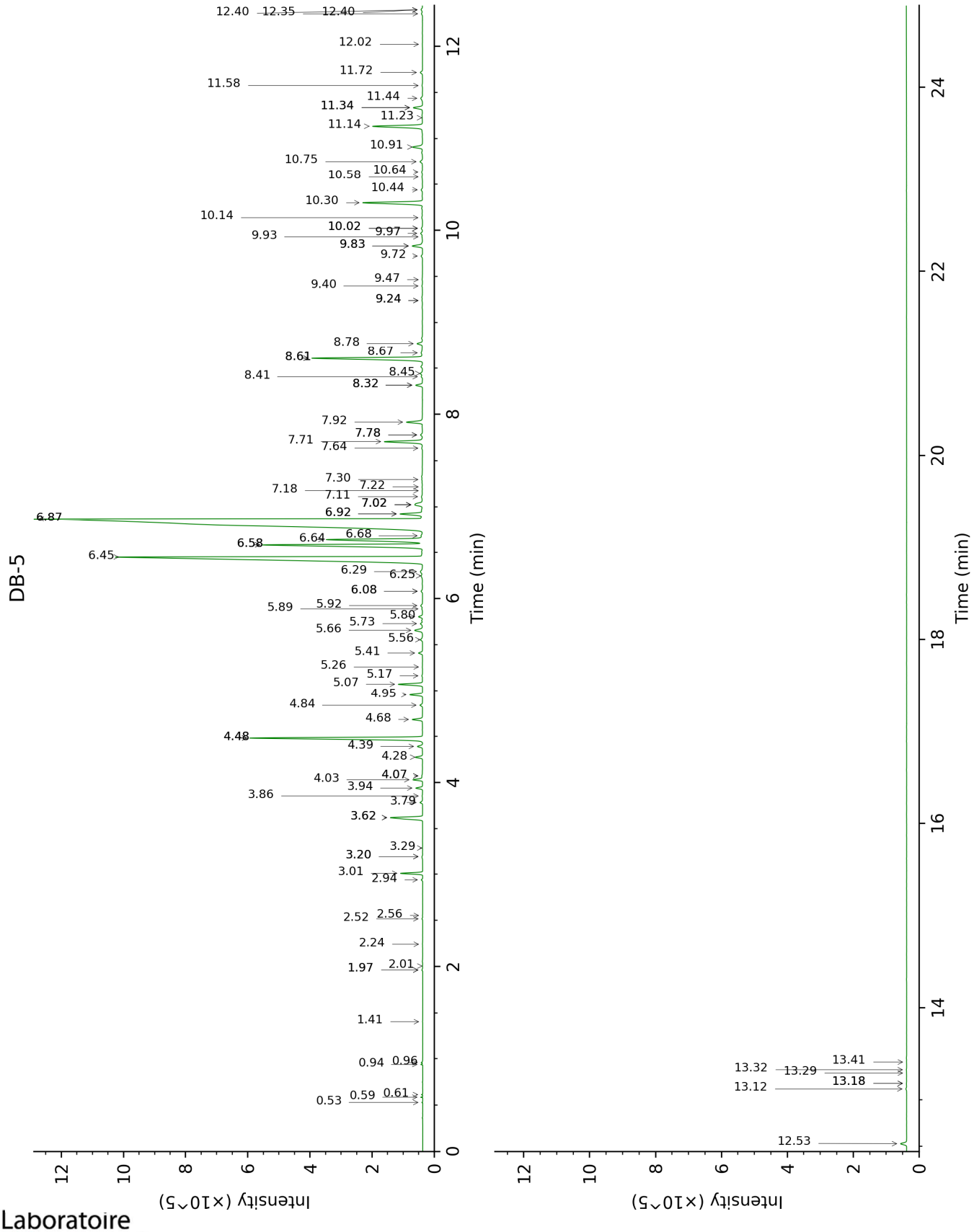
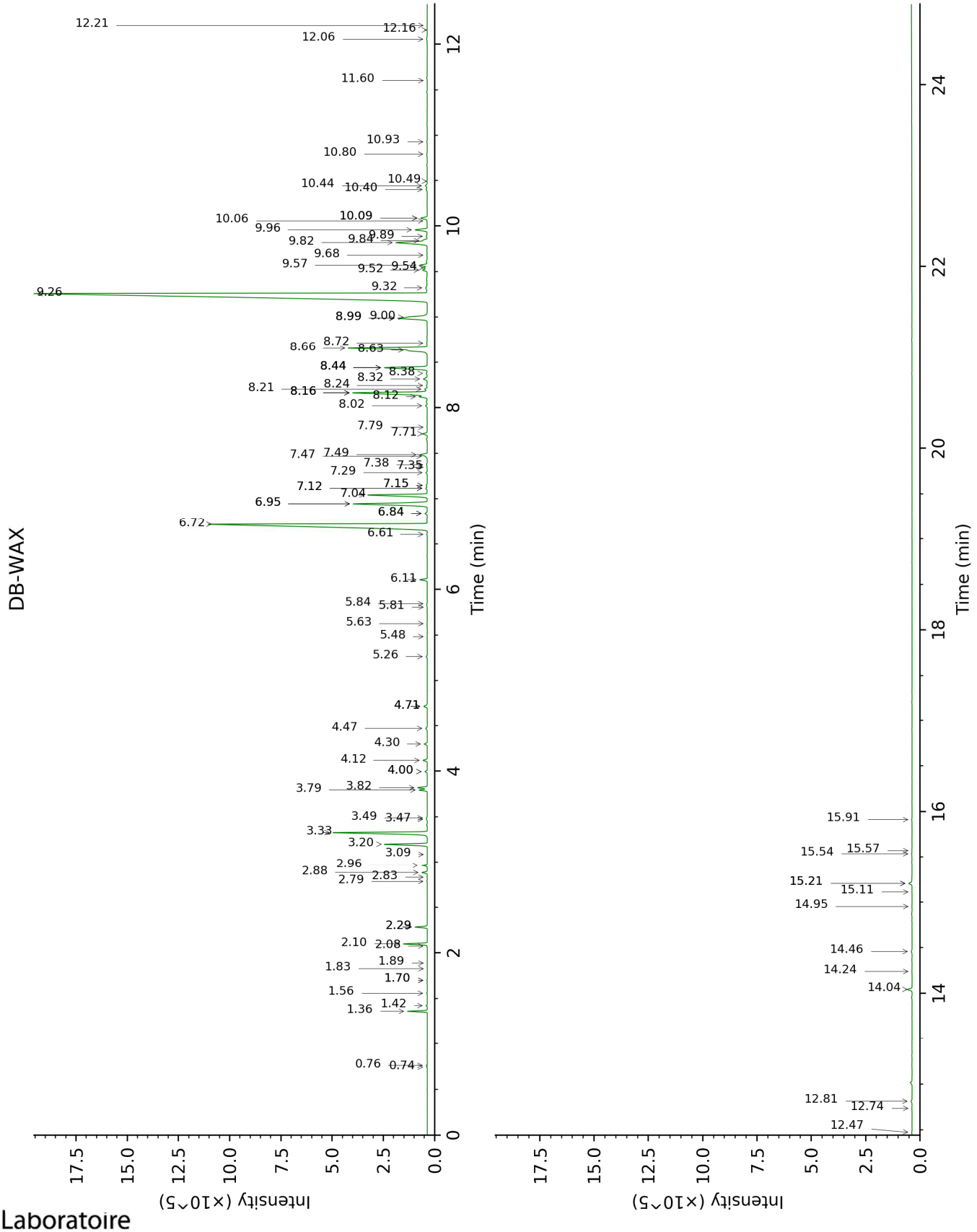

DB-5
12.40
12.35
12.40
12.02
11.72
11.58
11.44
11.34
11.23
11.14
10.91
10.75
10.64
10.58
10.44
10.30
10.14
10.02
9.97
9.93
9.83
9.72
9.47
9.40
9.24
8.78
8.67
8.61
8.45
8.41
8.32
7.92
7.78
7.71
7.64
7.30
7.22
7.18
7.11
7.02
6.92
6.87
6.68
6.64
6.58
6.45
6.29
6.25
6.08
5.92
5.89
5.80
5.73
5.66
5.56
5.41
5.26
5.17
5.07
4.95
4.84
4.68
4.48
4.39
4.28
4.07
4.03
3.94
3.86
3.79
3.62
3.29
3.20
3.01
2.94
2.56
2.52
2.24
2.01
1.97
1.41
0.96
0.94
0.61
0.59
0.53
Time (min)
Intensity (×10^5)
13.41
13.32
13.29
13.18
13.12
12.53
Time (min)
Intensity (×10^5)


DB-WAX
Time (min)
Intensity (×10^5)
12.21
12.16
12.06
11.60
10.93
10.80
10.49
10.44
10.40
10.09
10.06
9.96
9.89
9.84
9.82
9.68
9.57
9.54
9.52
9.32
9.26
9.00
8.99
8.72
8.66
8.63
8.44
8.38
8.32
8.24
8.21
8.16
8.12
8.02
7.79
7.71
7.49
7.47
7.38
7.35
7.29
7.15
7.12
7.04
6.95
6.84
6.72
6.61
6.11
5.84
5.81
5.63
5.48
5.26
4.71
4.47
4.30
4.12
4.00
3.82
3.79
3.49
3.47
3.33
3.20
3.09
2.96
2.88
2.83
2.79
2.29
2.10
2.08
1.89
1.83
1.70
1.56
1.42
1.36
0.76
0.74
15.91
15.57
15.54
15.21
15.11
14.95
14.46
14.24
14.04
12.81
12.74
12.47

FULL ANALYSIS DATA

Identification	Column DB-5			Column DB-WAX		
	R.T	R.I	%	R.T	R.I	%
Isobutanol	0.53	615	0.01	2.08	1063	0.01
Isovaleral	0.59	640	0.02	0.76	890	0.02
2-Methylbutyral	0.61	651	0.01	0.74	883	0.01
Isoamyl alcohol	0.94	736	0.03	3.49	1179	0.03
2-Methylbutanol	0.96	739	0.03	3.47	1178	0.03
Hexanal	1.41	802	tr	1.89	1045	tr
Ethyl isovalerate	1.96*	850	0.03	1.83	1039	tr
Ethyl 2-methylbutyrate	1.96*	850	[0.03]	1.70*†	1026	0.02
(3*Z*)-Hexenol	2.01	853	tr	5.81	1346	0.01
Hexanol	2.24	873	0.01	5.48	1323	0.01
trans-2,5-Diethyltetrahydrofuran	2.52	896	0.02	1.56	1012	0.02
Heptanal	2.56	899	0.01	3.09	1148	tr
α-Thujene	2.94	925	0.04	1.42	999	0.04
α-Pinene	3.01	930	0.59	1.36	991	0.58
3-Methylcyclohexanone	3.20*	942	0.04	4.71*	1268	0.17
Camphene	3.20*	942	[0.04]	1.70*†	1026	[0.02]
Thuja-2,4(10)-diene	3.29	948	tr	2.28*	1084	0.44
Sabinene	3.62*	970	1.29	2.28*	1084	[0.44]
β-Pinene	3.62*	970	[1.29]	2.10	1066	0.85
Octen-3-ol	3.79	981	0.09	6.84*	1421	0.12
Octan-3-one	3.86	986	0.02	4.00*	1217	0.09
Myrcene	3.94	991	0.21	2.88	1132	0.20
Octan-3-ol	4.03	997	0.30	6.11	1368	0.31
α-Phellandrene	4.07*	1000	0.03	2.78	1125	0.01
Pseudolimonene	4.07*	1000	[0.03]	2.83	1128	0.01
α-Terpinene	4.28	1013	0.23	2.96	1139	0.22
para-Cymene	4.39	1020	0.17	4.12	1226	0.17
Limonene	4.48*	1026	6.19	3.20	1157	1.77
1,8-Cineole	4.48*	1026	[6.19]	3.33	1167	4.41
(*Z*)-β-Ocimene	4.68	1039	0.31	3.82†	1204	[0.71]
(*E*)-β-Ocimene	4.84	1049	0.08	4.00*	1217	[0.09]
γ-Terpinene	4.95	1056	0.39	3.79†	1202	0.71
cis-Sabinene hydrate	5.07	1063	0.76	6.95*	1429	4.30
cis-Linalool oxide (fur.)	5.16	1069	0.03	6.61	1404	0.02
Octanol	5.26	1075	tr	8.24	1526	0.04
Terpinolene	5.41	1085	0.13	4.30	1238	0.13
trans-Sabinene hydrate	5.56	1094	0.09	8.02	1509	0.09
Linalool	5.66	1100	0.33	8.12	1517	0.35
2-Methylbutyl 2-methylbutyrate	5.73	1105	0.08	4.47	1251	0.08
Amyl isovalerate	5.80	1110	0.14	4.71*	1268	[0.17]
Octen-3-yl acetate	5.89	1116	0.03	5.84	1349	0.02
cis-para-Menth-2-en-1-ol	5.92	1118	0.08	8.20	1523	0.12
Octan-3-yl acetate	6.08*	1128	0.06	5.26	1308	0.05

allo-Ocimene	6.08*	1128	[0.06]	5.63	1333	0.02
trans-Sabinol	6.25	1139	0.08	9.89	1656	0.06
Isopulegol	6.29	1142	0.12	8.16*	1520	4.15
Menthone	6.45	1152	18.51	6.72	1412	18.40
Isomenthone	6.58*	1161	6.47	7.04	1436	2.95
Menthofuran	6.58*	1161	[6.47]	6.95*	1429	[4.30]
neo-Menthol	6.64†	1165	3.92	8.66†	1558	[4.51]
δ-Terpineol	6.68†	1167	[3.92]	9.54†	1628	[0.71]
Menthol	6.87*	1180	43.71	9.26	1605	42.64
Terpinen-4-ol	6.87*	1180	[43.71]	8.64†	1556	4.51
Isomenthol	6.92*	1183	0.80	9.00†	1584	[2.20]
para-Cymen-8-ol	6.92*	1183	[0.80]	11.60	1799	0.01
α-Terpineol	7.02*	1190	0.42	9.84	1652	0.16
neoiso-Menthol	7.02*	1190	[0.42]	9.52†	1626	0.71
Myrtenal	7.02*	1190	[0.42]	8.72	1562	0.03
Myrtenol	7.11	1196	0.05	10.93	1742	0.02
trans-Isopiperitenol	7.18	1200	0.01	10.49	1705	0.01
Unknown [m/z 43, 99 (84), 81 (46), 986 (43), 126 (36), 71 (28)... 170 (12)]	7.22	1203	0.01			
Decanal	7.30	1208	0.03	7.35	1459	0.02
(3*Z*)-Hexenyl 2-methylbutyrate	7.64	1231	0.03	7.15*†	1444	[0.13]
Pulegone	7.71	1236	1.36	8.99*†	1584	2.20
(2*E*)-Hexenyl isovalerate	7.78*	1241	0.07	7.29	1454	0.07
Carvone	7.78*	1241	[0.07]	10.06	1669	0.01
Piperitone	7.92	1251	0.56	9.96	1661	0.58
Decanol	8.32*	1279	0.23	10.80	1731	0.03
neo-Menthyl acetate	8.32*	1279	[0.23]	7.72	1486	0.21
2-Ethylmenthone?	8.41	1285	0.04			
Dihydroedulan I	8.44	1288	0.09	7.12*†	1442	0.13
Menthyl acetate	8.61*	1299	4.13	8.16*	1520	[4.15]
Dihydroedulan II	8.61*	1299	[4.13]	7.47	1468	0.06
Thymol	8.67	1303	0.10	15.21*	2134	0.15
Isomenthyl acetate	8.78	1311	0.19	8.32	1532	0.21
Bicycloelemene	9.24*	1338	0.02	7.12*†	1442	[0.13]
Piperitenone	9.24*	1338	[0.02]	12.16	1848	0.01
α-Cubebene	9.40	1349	0.02	6.84*	1421	[0.12]
Menthofurolactone	9.47	1354	0.02	12.06	1839	0.03
α-Copaene	9.72	1372	0.05	7.15*†	1444	[0.13]
β-Bourbonene	9.83*	1380	0.40	7.49	1469	0.37
1,5-diepi-β-Bourbonene	9.83*	1380	[0.40]	7.38	1461	0.04
β-Cubebene	9.93	1387	0.03	7.79	1491	0.02
β-Elemene	9.97	1390	0.07	8.44*	1541	2.24
(*Z*)-Jasmone	10.02*	1393	0.05	12.47	1875	0.02
Unknown [m/z 107, 121 (79), 119 (66), 91 (58), 136 (55), 105 (49)... 194 (1)]	10.02*	1393	[0.05]			

Isocaryophyllene	10.14	1402	0.04	8.16*	1520	[4.15]
β-Caryophyllene	10.30	1414	2.25	8.44*	1541	[2.24]
β-Copaene	10.44	1424	0.05	8.38	1536	0.06
trans-α-Bergamotene	10.58	1434	0.03	8.44*	1541	[2.24]
Isogermacrene D	10.64	1439	0.04	8.99*†	1584	[2.20]
α-Humulene	10.75	1447	0.10	9.32	1610	0.13
(*E*)-β-Farnesene	10.91	1459	0.38	9.57†	1630	[0.71]
Germacrene D	11.14	1476	1.93	9.82	1650	1.94
Menthalactone	11.23	1482	0.02	15.91	2205	0.02
Bicyclogermacrene	11.34*	1491	0.35	10.09*	1672	0.32
Viridiflorene	11.34*	1491	[0.35]	9.68	1639	0.02
α-Muurolene	11.44	1498	0.09	10.09*	1672	[0.32]
γ-Cadinene	11.58	1509	0.02	10.40	1697	0.07
δ-Cadinene	11.72	1520	0.09	10.44	1701	0.10
Isocaryophyllene epoxide B	12.02	1544	0.01	12.21	1852	0.01
Spathulenol	12.35	1570	0.04	14.46	2060	0.04
Caryophyllene oxide isomer	12.40*	1573	0.07	12.74	1899	0.01
Caryophyllene oxide	12.40*	1573	[0.07]	12.82	1906	0.06
Viridiflorol	12.53	1584	0.22	14.04	2020	0.22
Isospathulenol	13.12	1631	0.03	15.54	2167	0.02
τ-Cadinol	13.18*	1636	0.02	14.95	2108	0.01
τ-Muurolol	13.18*	1636	[0.02]	15.11	2124	0.01
Unknown cadinol analog II [m/z 95, 121 (73), 43 (57), 79 (43), 161 (43), 109)40)... 204 (35), 222 (2)]	13.29	1645	0.01	15.21*	2134	[0.15]
α-Cadinol	13.32	1648	0.02	15.57	2170	0.01
Unknown [m/z 82, 81 (92), 95 (76), 67 (69), 93 (68), 107 (68), 79 (63), 91 (61)... 220 (11)]	13.41	1655	0.01	14.24	2039	0.01
Total identified		**99.27%**			**98.59%**	
Total reported		**99.30%**			**98.60%**	

*: Two or more compounds are coeluting on this column
[xx]: Duplicate percentage due to coelutions, not taken into account in the consolidated total
†: Peaks apexes were resolved, but peaks overlapped and were summed for analysis
tr: The compound has been detected below 0.005% of total signal.

Note: no correction factor was applied
R.T.: Retention time (minutes)
R.I.: Retention index