Date : April 12, 2022

Certificate of Analysis – GC Profiling

Sample identification

Internal code : 22D07-PTH06
Customer identification : Black Pepper - India - B40109R
Type : Essential oil
Source : *Piper nigrum*
Customer : Plant Therapy

Analysis

Method: PC-MAT-014 ISO - Analysis of the composition of an essential oil or other volatile liquid by FAST GC-FID (in French); identifications validated by GC-MS.
Analyst : Sylvain Mercier, M. Sc., Chimiste 2014-005
Analysis date : April 11, 2022

Checked and approved by :

Alexis St-Gelais, Ph. D., Chimiste 2013-174

Notes: This report may not be published, including online, without the written consent from Laboratoire PhytoChemia. This report is digitally signed, it is only considered valid if the digital signature is intact. The results only describe the samples that were submitted to the assays.

Méthode certifiée ISO 17025:2017 Certified method

Laboratoire PhytoChemia

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PHYSICOCHEMICAL DATA

Physical aspect: Faintly yellow liquid
Refractive index: 1.4836 ± 0.0003 (20 °C; method PC-MAT-016)

CONCLUSION

No adulterant, contaminant or diluent has been detected using this method.

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Analysis summary – Consolidated contents

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

Identification	%	Class
Isovaleral	tr	Aliphatic aldehyde
2-Methylbutyral	tr	Aliphatic aldehyde
Toluene	tr	Simple phenolic
Hashishene	0.01	Monoterpene
Tricyclene	0.02	Monoterpene
α-Thujene	0.84	Monoterpene
α-Pinene	9.72	Monoterpene
Camphene	0.23	Monoterpene
α-Fenchene	0.02	Monoterpene
3,7,7-Trimethylcyclohepta-1,3,5-triene	0.02	Monoterpene
β-Pinene	8.19	Monoterpene
Sabinene	9.13	Monoterpene
Dehydro-1,8-cineole	0.01	Monoterpenic ether
Myrcene	1.36	Monoterpene
2-Carene	0.01	Monoterpene
α-Phellandrene	1.52	Monoterpene
Pseudolimonene	0.04	Monoterpene
Δ3-Carene	9.99	Monoterpene
α-Terpinene	0.16	Monoterpene
meta-Cymene	0.04	Monoterpene
para-Cymene	0.71	Monoterpene
β-Phellandrene	1.03	Monoterpene
Limonene	9.99	Monoterpene
(*Z*)-β-Ocimene	0.01	Monoterpene
(*E*)-β-Ocimene	0.08	Monoterpene
Unknown	0.03	Monoterpene
γ-Terpinene	0.32	Monoterpene
cis-Sabinene hydrate	0.11	Monoterpenic alcohol
Isoterpinolene	0.13	Monoterpene
Terpinolene	0.42	Monoterpene
para-Cymenene	0.02	Monoterpene
α-Pinene oxide	0.01	Monoterpenic ether
trans-Sabinene hydrate	0.08	Monoterpenic alcohol
Linalool	0.45	Monoterpenic alcohol
trans-para-Mentha-2,8-dien-1-ol	0.04	Monoterpenic alcohol
cis-Limonene oxide	0.02	Monoterpenic ether
cis-para-Mentha-2,8-dien-1-ol	0.03	Monoterpenic alcohol
trans-Limonene oxide	0.01	Monoterpenic ether
trans-Verbenol	0.02	Monoterpenic alcohol
meta-Mentha-4,6-dien-8-ol	tr	Monoterpenic alcohol
1,4-Dimethyl-4-acetylcyclohexene	0.01	Monoterpenic ketone
Borneol	0.01	Monoterpenic alcohol
cis-Sabinol	0.02	Monoterpenic alcohol
Terpinen-4-ol	0.46	Monoterpenic alcohol
meta-Cymen-8-ol	0.01	Monoterpenic alcohol

Unknown	0.02	Unknown
para-Cymen-8-ol	0.03	Monoterpenic alcohol
Myrtenal	0.05	Monoterpenic aldehyde
α-Terpineol	0.01	Monoterpenic alcohol
Unknown	0.01	Oxygenated monoterpene
Myrtenol	0.02	Monoterpenic alcohol
trans-Isopiperitenol	0.04	Monoterpenic alcohol
Unknown	0.02	Oxygenated monoterpene
Verbenone	0.01	Monoterpenic ketone
Car-2-en-4-one?	0.03	Monoterpenic ketone
trans-Carveol	0.02	Monoterpenic alcohol
Nerol	0.01	Monoterpenic alcohol
cis-Carveol	0.01	Monoterpenic alcohol
Cuminal	0.01	Monoterpenic aldehyde
Carvone	0.01	Monoterpenic ketone
Car-3-en-2-one	0.01	Monoterpenic ketone
Unknown	0.02	Unknown
trans-Ascaridole glycol	0.02	Monoterpenic alcohol
Bornyl acetate	0.01	Monoterpenic ester
Cuminol	0.01	Monoterpenic alcohol
2-Undecanone	0.02	Aliphatic ketone
Car-3-en-5-one	0.02	Monoterpenic ketone
para-Menth-5-en-1,2-diol isomer II	0.01	Monoterpenic alcohol
Methyl geranate	0.01	Monoterpenic ester
δ-Elemene isomer	0.07	Sesquiterpene
δ-Elemene	2.20	Sesquiterpene
Bicycloelemene	0.03	Sesquiterpene
α-Cubebene	0.22	Sesquiterpene
Cyclosativene I	0.07	Sesquiterpene
Cyclosativene II	0.03	Sesquiterpene
α-Ylangene	0.02	Sesquiterpene
α-Copaene	2.39	Sesquiterpene
cis-β-Elemene	0.03	Sesquiterpene
β-Bourbonene	0.01	Sesquiterpene
β-Cubebene	0.21	Sesquiterpene
β-Elemene	0.83	Sesquiterpene
Isocaryophyllene	0.15	Sesquiterpene
α-Gurjunene	0.03	Sesquiterpene
β-Caryophyllene	27.18	Sesquiterpene
β-Copaene	0.16	Sesquiterpene
γ-Elemene	0.01	Sesquiterpene
trans-α-Bergamotene	0.23*	Sesquiterpene
α-Guaiene	0.23*	Sesquiterpene
Unknown	0.02	Unknown
Unknown	0.04	Sesquiterpene
α-Humulene	1.60	Sesquiterpene
allo-Aromadendrene	0.03	Sesquiterpene
(*E*)-β-Farnesene	0.08	Sesquiterpene
γ-Gurjunene	0.05	Sesquiterpene
trans-Cadina-1(6),4-diene	0.09	Sesquiterpene
γ-Muurolene	0.06	Sesquiterpene
Germacrene D	0.40	Sesquiterpene

β-Selinene	1.17	Sesquiterpene
ar-Curcumene	0.08	Sesquiterpene
trans-Muurola-4(15),5-diene	0.04	Sesquiterpene
Viridiflorene	0.13	Sesquiterpene
α-Selinene	0.81	Sesquiterpene
epi-Cubebol	0.13	Sesquiterpenic alcohol
Epizonarene	0.06	Sesquiterpene
α-Muurolene	0.44	Sesquiterpene
Germacrene A	0.03	Sesquiterpene
β-Bisabolene	0.06	Sesquiterpene
γ-Cadinene	tr	Sesquiterpene
Cubebol	0.17	Sesquiterpenic alcohol
7-epi-α-Selinene	0.07	Sesquiterpene
trans-Calamenene	0.08	Sesquiterpene
Zonarene	0.08	Sesquiterpene
δ-Cadinene	1.04	Sesquiterpene
trans-Cadina-1,4-diene	0.02	Sesquiterpene
α-Calacorene	0.02	Sesquiterpene
(*E*)-α-Bisabolene	0.06	Sesquiterpene
Germacrene B	0.07	Sesquiterpene
α-Elemol	0.02	Sesquiterpenic alcohol
Isocaryophyllene epoxide B	0.04	Sesquiterpenic ether
Dihydrocaryophyllen-5-one?	0.02	Sesquiterpenic ketone
(*E*)-Nerolidol	0.06	Sesquiterpenic alcohol
Caryophyllene oxide	0.64	Sesquiterpenic ether
Caryophyllene oxide isomer	0.12	Sesquiterpenic ether
Globulol	0.01	Sesquiterpenic alcohol
Unknown	0.01	Oxygenated sesquiterpene
Ledol	0.02	Sesquiterpenic alcohol
Humulene epoxide II	0.05	Sesquiterpenic ether
α-Corocalene	0.02	Sesquiterpene
Unknown	0.03	Oxygenated sesquiterpene
Alismol	0.25	Sesquiterpenic alcohol
Caryophylladienol II	0.01	Sesquiterpenic alcohol
τ-Muurolol	0.05	Sesquiterpenic alcohol
α-Muurolol	0.18	Sesquiterpenic alcohol
cis-Calamenen-10-ol	0.01	Sesquiterpenic alcohol
trans-Calamenen-10-ol	0.01	Sesquiterpenic alcohol
(3*Z*)-Caryophylla-3,8(13)-dien-5β-ol	0.16	Sesquiterpenic alcohol
Phytone	0.01	Terpenic ketone
Phytol	0.01	Diterpenic alcohol
Consolidated total	**98.25%**	

*: Individual compounds concentration could not be found due to overlapping coelutions on columns considered
[xx]: Duplicate percentage due to coelutions, not taken into account in the consolidated total
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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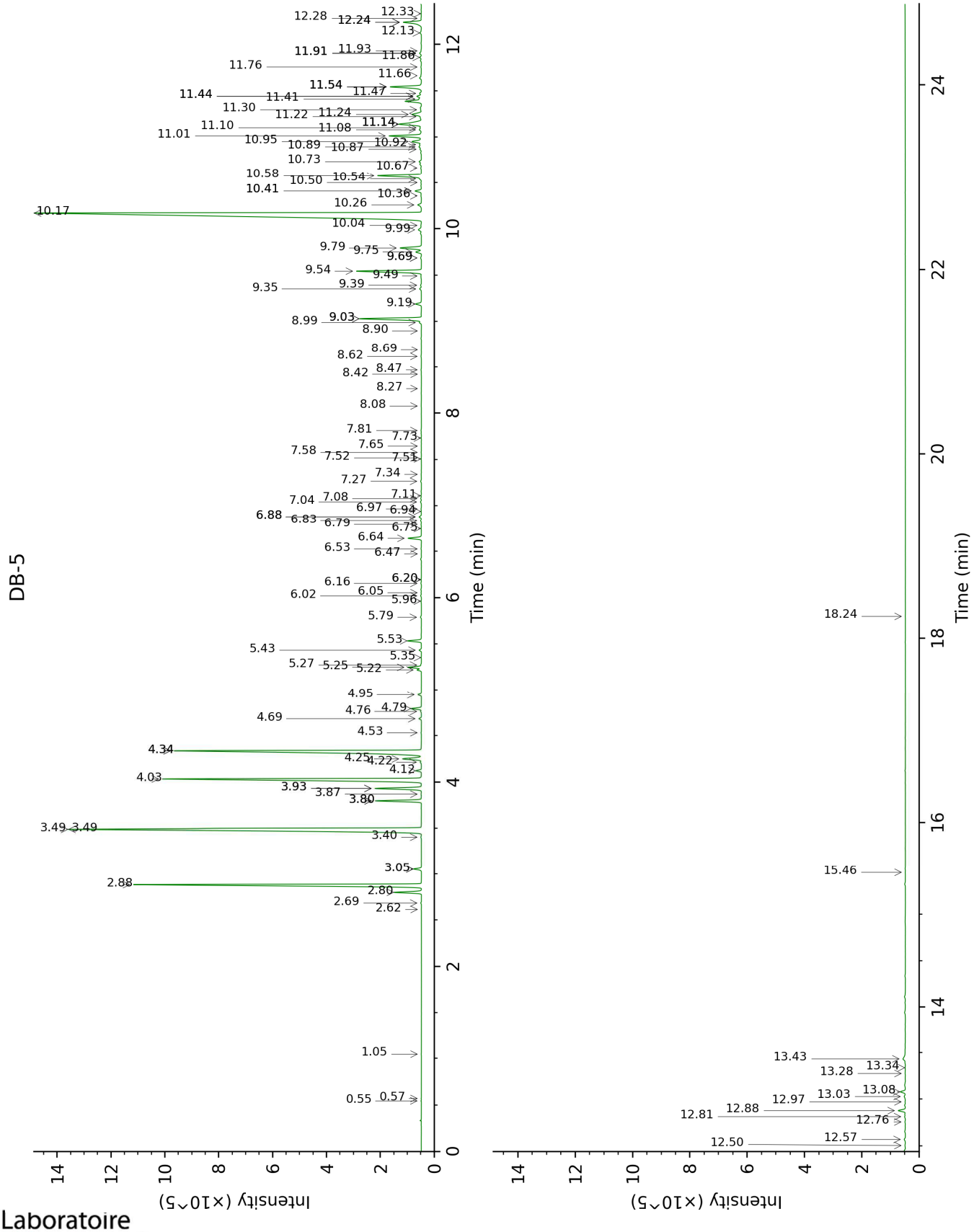
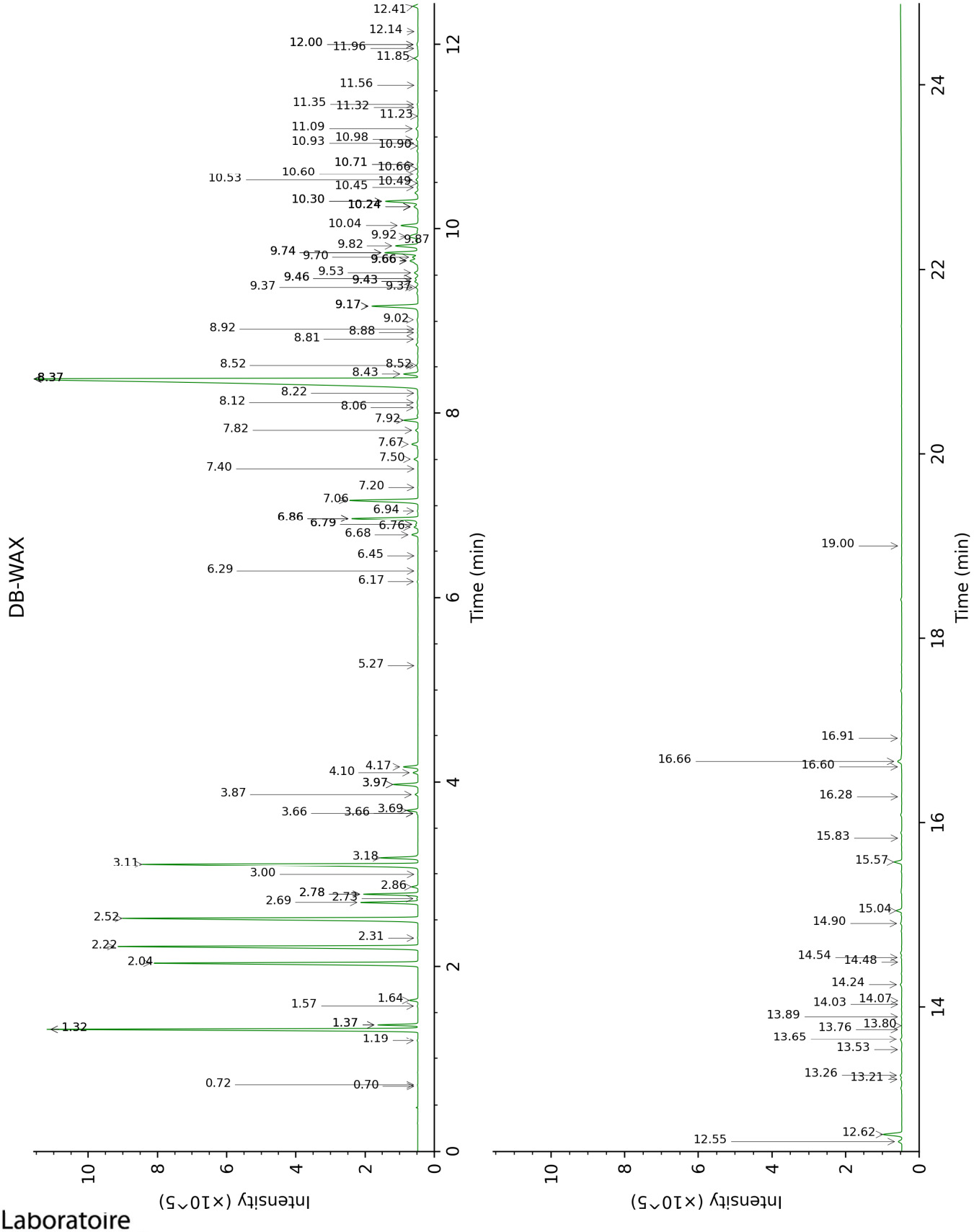

DB-5
Time (min)
Intensity (×10^5)
12.28
12.24
12.33
12.13
11.91
11.93
11.88
11.76
11.66
11.54
11.47
11.44
11.41
11.30
11.22
11.24
11.10
11.08
11.14
11.01
10.95
10.89
10.87
10.92
10.73
10.67
10.58
10.50
10.54
10.41
10.36
10.26
10.17
10.04
9.99
9.79
9.75
9.69
9.54
9.49
9.35
9.39
9.19
8.99
9.03
8.90
8.62
8.69
8.42
8.47
8.27
8.08
7.81
7.73
7.65
7.58
7.52
7.51
7.27
7.34
7.04
7.08
7.11
6.97
6.94
6.88
6.83
6.79
6.75
6.64
6.53
6.47
6.16
6.20
6.02
6.05
5.96
5.79
5.53
5.43
5.35
5.27
5.25
5.22
4.95
4.69
4.76
4.79
4.53
4.34
4.25
4.22
4.12
4.03
3.93
3.87
3.80
3.49
3.49
3.40
3.05
2.88
2.80
2.69
2.62
1.05
0.55
0.57
Time (min)
Intensity (×10^5)
18.24
15.46
13.43
13.28
13.34
12.97
13.03
13.08
12.81
12.88
12.76
12.50
12.57



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FULL ANALYSIS DATA

Identification	Column DB-5			Column DB-WAX		
	R.T	R.I	%	R.T	R.I	%
Isovaleral	0.54	642	tr	0.72	887	tr
2-Methylbutyral	0.57	652	tr	0.70	882	tr
Toluene	1.05	758	tr	1.37*	1002	0.85
Hashishene	2.62	912	0.01	1.32*	995	9.71
Tricyclene	2.69	917	0.02	1.19	974	0.02
α-Thujene	2.80	925	0.84	1.37*	1002	[0.85]
α-Pinene	2.88	930	9.72	1.32*	995	[9.71]
Camphene	3.05*	942	0.24	1.64	1029	0.23
α-Fenchene	3.05*	942	[0.24]	1.57	1022	0.02
3,7,7-Trimethylcyclohepta-1,3,5-triene	3.40	966	0.02	2.78*	1135	1.40
β-Pinene	3.49*	971	17.31	2.04	1069	8.19
Sabinene	3.49*	971	[17.31]	2.22	1087	9.13
Dehydro-1,8-cineole	3.80*	992	1.37	3.00	1152	0.01
Myrcene	3.80*	992	[1.37]	2.78*	1135	[1.40]
2-Carene	3.87	997	0.01	2.31	1096	0.01
α-Phellandrene	3.93*	1001	1.53	2.69	1128	1.52
Pseudolimonene	3.93*	1001	[1.53]	2.73	1131	0.04
Δ3-Carene	4.03	1008	9.99	2.52	1114	9.97
α-Terpinene	4.12	1013	0.16	2.86	1141	0.17
meta-Cymene	4.22	1019	0.04	3.97*	1228	0.74
para-Cymene	4.25	1022	0.71	3.97*	1228	[0.74]
β-Phellandrene	4.34*	1027	10.97	3.18	1167	1.03
Limonene	4.34*	1027	[10.97]	3.11	1161	9.99
(*Z*)-β-Ocimene	4.53	1039	0.01	3.66*	1205	0.03
(*E*)-β-Ocimene	4.69	1049	0.08	3.87	1220	0.08
Unknown [m/z 93, 91 (54), 92 (31), 77 (29), 79 (17), 43 (13), 41 (10), 136 (9)]	4.76	1054	0.03	3.66*	1205	[0.03]
γ-Terpinene	4.80	1056	0.32	3.69	1207	0.32
cis-Sabinene hydrate	4.95	1065	0.11	6.76†	1429	0.20
Isoterpinolene	5.22	1083	0.13	4.10	1238	0.14
Terpinolene	5.25	1084	0.42	4.16	1243	0.42
para-Cymenene	5.27	1086	0.02	6.17	1386	0.03
α-Pinene oxide	5.35	1091	0.01	5.27	1322	0.01
trans-Sabinene hydrate	5.43	1096	0.08	7.82	1507	0.08
Linalool	5.53	1102	0.45	7.92	1516	0.44
trans-para-Mentha-2,8-dien-1-ol	5.79	1119	0.04	8.81	1584	0.03
cis-Limonene oxide	5.96	1130	0.02	6.29	1394	0.01
cis-para-Mentha-2,8-dien-1-ol	6.02	1134	0.03	9.37*	1629	0.08
trans-Limonene oxide	6.05	1136	0.01	6.45	1406	0.01
trans-Verbenol	6.16	1142	0.02	9.43*	1634	0.11

meta-Mentha-4,6-dien-8-ol	6.20*	1145	0.01	9.17*	1612	1.65
1,4-Dimethyl-4-acetylcyclohexene	6.20*	1145	[0.01]	7.20	1461	0.01
Borneol	6.47	1163	0.01	9.66*	1652	0.43
cis-Sabinol	6.53	1166	0.02	10.70*	1739	0.03
Terpinen-4-ol	6.64	1173	0.46	8.42	1554	0.45
meta-Cymen-8-ol	6.75	1180	0.01	11.32	1792	0.01
Unknown [m/z 43, 135 (73), 59 (46), 93 (39), 91 (35), 81 (32)...]	6.79	1183	0.02			
para-Cymen-8-ol	6.83	1186	0.03	11.35	1795	0.03
Myrtenal	6.88*	1189	0.08	8.52*	1562	0.07
α-Terpineol	6.88*	1189	[0.08]	9.66*	1652	[0.43]
Unknown [m/z 67, 41 (99), 109 (98), 43 (97), 81 (94), 91 (93)...152 (12)]	6.94	1192	0.01			
Myrtenol	6.97	1194	0.02	10.70*	1739	[0.03]
trans-Isopiperitenol	7.04	1199	0.04	10.24*	1700	0.17
Unknown [m/z 109, 91 (100), 81 (88), 94 (75), 119 (74), 96 (73), 41 (63)... 150 (2)]	7.08	1201	0.02	10.66	1735	0.02
Verbenone	7.11	1203	0.01	9.46*	1637	0.10
Car-2-en-4-one?	7.27	1214	0.03	9.37*	1629	[0.08]
trans-Carveol	7.34	1219	0.02	11.23	1784	0.02
Nerol	7.51	1230	0.01	10.90	1756	0.01
cis-Carveol	7.52	1231	0.01	11.56	1813	0.01
Cuminal	7.58	1235	0.01	10.45	1717	0.03
Carvone	7.65	1239	0.01	9.87	1670	0.04
Car-3-en-2-one	7.73	1245	0.01	10.24*	1700	[0.17]
Unknown [m/z 43, 97 (69), 107 (46), 41 (28), 55 (21), 109 (20)...]	7.81	1250	0.02	10.93	1759	0.02
trans-Ascaridole glycol	8.08	1268	0.02	14.03	2041	0.01
Bornyl acetate	8.27	1281	0.01	8.12	1530	0.05
Cuminol	8.42	1291	0.01	14.07	2045	0.01
2-Undecanone	8.47	1294	0.02	8.52*	1562	[0.07]
Car-3-en-5-one	8.62	1304	0.02	11.96	1848	0.02
para-Menth-5-en-1,2-diol isomer II	8.69	1309	0.01	14.24	2062	0.05
Methyl geranate	8.90	1324	0.01	9.66*	1652	[0.43]
δ-Elemene isomer	8.99	1330	0.07	6.79*†	1431	[0.20]
δ-Elemene	9.03*	1333	2.22	6.86*	1436	2.27
Bicycloelemene	9.03*	1333	[2.22]	6.94	1443	0.03
α-Cubebene	9.19	1344	0.22	6.68	1423	0.21
Cyclosativene I	9.35	1356	0.07	6.79*†	1431	[0.20]
Cyclosativene II	9.39	1359	0.03	6.86*	1436	[2.27]
α-Ylangene	9.49	1366	0.02	6.86*	1436	[2.27]
α-Copaene	9.54	1369	2.39	7.06	1451	2.38

cis-β-Elemene	9.69*	1379	0.03	8.22	1538	0.03
β-Bourbonene	9.69*	1379	[0.03]	7.40	1476	0.01
β-Cubebene	9.75	1384	0.21	7.67	1496	0.22
β-Elemene	9.79	1387	0.83	8.37*	1550	28.15
Isocaryophyllene	9.99	1401	0.15	8.06	1526	0.04
α-Gurjunene	10.04	1404	0.03	7.50	1484	0.14
β-Caryophyllene	10.17	1414	27.18	8.37*	1550	[28.15]
β-Copaene	10.26	1421	0.16	8.37*	1550	[28.15]
γ-Elemene	10.36	1428	0.01	8.92	1593	0.02
trans-α-Bergamotene	10.41*	1432	0.23	8.37*	1550	[28.15]
α-Guaiene	10.41*	1432	[0.23]	8.37*	1550	[28.15]
Unknown [m/z 41, 97 (78), 69 (77), 43 (71), 125 (67), 55 (56)... 168 (39)]	10.50	1439	0.02	16.91	2338	0.01
Unknown [m/z 139, 69 (60), 41 (51), 43 (47), 119 (41)... 204 (1)]	10.54	1442	0.04			
α-Humulene	10.58	1444	1.60	9.17*	1612	[1.65]
allo-Aromadendrene	10.67	1451	0.03	8.88	1590	0.02
(*E*)-β-Farnesene	10.73	1456	0.08	9.46*	1637	[0.10]
γ-Gurjunene	10.87	1466	0.05	9.02	1601	0.05
trans-Cadina-1(6),4-diene	10.89	1468	0.09	9.17*	1612	[1.65]
γ-Muurolene	10.92	1470	0.06	9.43*	1634	[0.11]
Germacrene D	10.95	1472	0.40	9.66*	1652	[0.43]
β-Selinene	11.01	1477	1.17	9.74*	1659	1.16
ar-Curcumene	11.08	1482	0.08	10.53	1724	0.07
trans-Muurola-4(15),5-diene	11.10	1483	0.04	9.70	1656	0.19
Viridiflorene	11.14*	1486	1.17	9.53	1642	0.13
α-Selinene	11.14*	1486	[1.17]	9.82	1666	0.81
epi-Cubebol	11.14*	1486	[1.17]	11.85	1839	0.13
Epizonarene	11.22	1492	0.06	9.74*	1659	[1.16]
α-Muurolene	11.24	1494	0.44	9.92	1674	0.43
Germacrene A	11.30	1498	0.03	10.24*	1700	[0.17]
β-Bisabolene	11.41	1506	0.06	10.04	1683	0.59
γ-Cadinene	11.44*	1509	0.17	10.24*	1700	[0.17]
Cubebol	11.44*	1509	[0.17]	12.42	1889	0.17
7-epi-α-Selinene	11.47	1511	0.07	10.30*	1705	1.11
trans-Calamenene	11.54*	1517	1.20	11.09	1772	0.08
Zonarene	11.54*	1517	[1.20]	10.24*	1700	[0.17]
δ-Cadinene	11.54*	1517	[1.20]	10.30*	1705	[1.11]
trans-Cadina-1,4-diene	11.66	1526	0.02	10.49	1721	0.02
α-Calacorene	11.76	1534	0.02	12.00*	1852	0.06
(*E*)-α-Bisabolene	11.86	1542	0.06	10.60	1730	0.04
Germacrene B	11.91*	1545	0.07	10.98	1762	0.07
α-Elemol	11.91*	1545	[0.07]	13.89	2028	0.02
Isocaryophyllene epoxide B	11.91*	1545	[0.07]	12.00*	1852	[0.06]

Dihydrocaryophyllen-5-one?	11.93	1547	0.02	12.14	1865	0.01
(*E*)-Nerolidol	12.13	1562	0.06	13.65	2004	0.07
Caryophyllene oxide	12.24*	1572	0.82	12.62	1908	0.64
Caryophyllene oxide isomer	12.24*	1572	[0.82]	12.55	1901	0.12
Globulol	12.28	1575	0.01	13.76	2014	0.01
Unknown [m/z 161, 105 (84), 43 (80), 119 (72), 93 (62), 121 (54)... 204 (38), 222 (2)]	12.33	1579	0.01	13.80	2018	0.01
Ledol	12.50	1592	0.02	13.22	1963	0.04
Humulene epoxide II	12.57	1597	0.05	13.26	1967	0.05
α-Corocalene	12.76	1612	0.02	13.53	1993	0.03
Unknown [m/z 161, 43 (74), 105 (57), 121 (45), 81 (43)... 204 (31)...]	12.81	1617	0.03	14.48	2086	0.02
Alismol	12.88	1623	0.25	15.58	2196	0.27
Caryophylladienol II	12.97	1630	0.01	15.83	2222	0.01
τ-Muurolol	13.03	1635	0.05	14.90	2127	0.05
α-Muurolol	13.08	1639	0.18	15.04	2141	0.18
cis-Calamenen-10-ol	13.28	1655	0.01	16.28	2270	0.02
trans-Calamenen-10-ol	13.34	1660	0.01	16.60	2304	0.01
(3*Z*)-Caryophylla-3,8(13)-dien-5β-ol	13.43	1668	0.16	16.66	2311	0.18
Phytone	15.46	1844	0.01	14.54	2091	0.02
Phytol	18.24	2110	0.01	19.00	2577	0.01
Total identified		**98.10%**			**98.58%**	
Total reported		**98.30%**			**98.65%**	

*: 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