

Date : July 14, 2021

CERTIFICATE OF ANALYSIS – GC PROFILING

SAMPLE IDENTIFICATION

Internal code : 21G02-PTH08

Customer identification : Black Pepper - India - B40108207R

Type : Essential oil

Source : *Piper nigrum*

Customer : Plant Therapy

ANALYSIS

Method: PC-MAT-014  - Analysis of the composition of an essential oil or other volatile liquid by FAST GC-FID (in French); identifications validated by GC-MS.

Analyst : Sarah-Eve Tremblay, M. Sc. A., Chimiste

Analysis date : July 13, 2021

Checked and approved by :

Sylvain Mercier, M. Sc., Chimiste 2014-005

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PHYSICOCHEMICAL DATA

Physical aspect: Clear liquid

Refractive index: 1.4820 ± 0.0003 (20 °C; method PC-MAT-016)

CONCLUSION

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

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
Tricyclene	0.01	Monoterpene
α -Thujene	1.07	Monoterpene
α -Pinene	10.07	Monoterpene
Camphene	0.26	Monoterpene
α -Fenchene	0.02	Monoterpene
Thuja-2,4(10)-diene	tr	Monoterpene
meta-Cymene	0.02	Monoterpene
β -Pinene	8.41	Monoterpene
Sabinene	11.07	Monoterpene
6-Methyl-5-hepten-2-one	tr	Aliphatic ketone
Myrcene	1.43	Monoterpene
2-Carene	0.02	Monoterpene
Pseudolimonene	0.03	Monoterpene
α -Phellandrene	1.01	Monoterpene
Δ^3 -Carene	8.81	Monoterpene
α -Terpinene	0.16	Monoterpene
ortho-Cymene	0.02	Monoterpene
para-Cymene	0.41	Monoterpene
Limonene	14.05	Monoterpene
β -Phellandrene	1.43	Monoterpene
(Z)- β -Ocimene	0.02	Monoterpene
(E)- β -Ocimene	0.14	Monoterpene
Unknown	0.02	Monoterpene
γ -Terpinene	0.20	Monoterpene
cis-Sabinene hydrate	0.22	Monoterpenic alcohol
meta-Cymenene	0.01	Monoterpene
Isoterpinolene	0.09	Monoterpene
Terpinolene	0.32	Monoterpene
para-Cymenene	0.01	Monoterpene
α -Pinene oxide	0.01	Monoterpenic ether
trans-Sabinene hydrate	0.16	Monoterpenic alcohol
Linalool	0.27	Monoterpenic alcohol
Unknown	0.01	Oxygenated monoterpene
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	tr	Monoterpenic ether
trans-para-Menth-2-en-1-ol	0.02	Monoterpenic alcohol
trans-Verbenol	0.02	Monoterpenic alcohol
β -Pinene oxide	tr	Monoterpenic ether
meta-Mentha-4,6-dien-8-ol	tr	Monoterpenic alcohol
Sabinaketone	tr	Normonoterpenic ketone

Pinocarvone	tr	Monoterpenic ketone
<i>cis</i> -Sabinol	0.01	Monoterpenic alcohol
Terpinen-4-ol	0.34	Monoterpenic alcohol
meta-Cymen-8-ol	0.02	Monoterpenic alcohol
para-Cymen-8-ol	0.02	Monoterpenic alcohol
α -Terpineol	0.08	Monoterpenic alcohol
Methyl salicylate	0.01	Phenolic ester
Myrtenol	0.02	Monoterpenic alcohol
<i>cis</i> - α -Phellandrene epoxide (IPP vs Me)	0.03	Monoterpenic ether
Unknown	0.04	Oxygenated monoterpene
Car-2-en-4-one?	0.01	Monoterpenic ketone
<i>trans</i> -Carveol	0.02	Monoterpenic alcohol
<i>cis</i> -Carveol	0.02	Monoterpenic alcohol
Carvone	0.01	Monoterpenic ketone
Car-3-en-2-one	0.01	Monoterpenic ketone
Unknown	0.02	Unknown
Methyl citronellate	tr	Monoterpenic ester
<i>trans</i> -Ascaridole glycol	0.01	Monoterpenic alcohol
Bornyl acetate	0.01	Monoterpenic ester
Cuminol	tr	Monoterpenic alcohol
Unknown	tr	Oxygenated monoterpene
para-Menth-5-en-1,2-diol isomer II	0.02	Monoterpenic alcohol
Limonene hydroperoxide I	tr	Monoterpenic peroxide
para-Menth-5-en-1,2-diol isomer III	0.03	Monoterpenic alcohol
Unknown	0.01	Oxygenated monoterpene
Methyl geranate	0.01	Monoterpenic ester
Bicycloelemene	tr	Sesquiterpene
δ -Elemene isomer	0.02	Sesquiterpene
δ -Elemene	1.13	Sesquiterpene
α -Cubebene	0.18	Sesquiterpene
Unknown	0.04	Sesquiterpene
Cyclosativene I	0.12	Sesquiterpene
Cyclosativene II	0.04	Sesquiterpene
α -Ylangene	0.02	Sesquiterpene
α -Copaene	3.17	Sesquiterpene
<i>cis</i> - β -Elemene	0.01	Sesquiterpene
β -Cubebene	0.31	Sesquiterpene
β -Elemene	0.23	Sesquiterpene
Unknown	0.02	Unknown
Isocaryophyllene	0.06	Sesquiterpene
α -Gurjunene	0.13	Sesquiterpene
β -Caryophyllene	25.05	Sesquiterpene
β -Copaene	0.16	Sesquiterpene
γ -Elemene	0.01	Sesquiterpene
<i>trans</i> - α -Bergamotene	0.04*	Sesquiterpene
α -Guaiene	[0.04]*	Sesquiterpene
Unknown	0.01	Unknown
Unknown	tr	Sesquiterpene
α -Humulene	0.75	Sesquiterpene
(<i>E</i>)- β -Farnesene	0.17	Sesquiterpene
γ -Gurjunene	0.01	Sesquiterpene
<i>trans</i> -Cadina-1(6),4-diene	0.03	Sesquiterpene

γ -Muurolene	0.08	Sesquiterpene
Germacrene D	0.26	Sesquiterpene
ar-Curcumene	0.06	Sesquiterpene
β -Selinene	0.19	Sesquiterpene
<i>trans</i> -Muurolo-4(15),5-diene	0.04	Sesquiterpene
epi-Cubebol	0.10	Sesquiterpenic alcohol
Bicyclogermacrene	0.10	Sesquiterpene
Viridiflorene	0.07	Sesquiterpene
α -Selinene	0.17	Sesquiterpene
Epizonarene	0.01	Sesquiterpene
Germacrene A	0.01	Sesquiterpene
α -Muurolene	0.48	Sesquiterpene
β -Bisabolene	2.48	Sesquiterpene
γ -Cadinene	tr	Sesquiterpene
Cubebol	0.19	Sesquiterpenic alcohol
7-epi- α -Selinene	0.05	Sesquiterpene
<i>trans</i> -Calamenene	0.06	Sesquiterpene
δ -Cadinene	0.99	Sesquiterpene
<i>trans</i> -Cadina-1,4-diene	0.05	Sesquiterpene
(<i>E</i>)- γ -Bisabolene	0.01	Sesquiterpene
α -Calacorene	0.01	Sesquiterpene
(<i>E</i>)- α -Bisabolene	0.05	Sesquiterpene
Isocaryophyllene epoxide B	0.03	Sesquiterpenic ether
α -Elemol	0.01	Sesquiterpenic alcohol
Germacrene B	0.03	Sesquiterpene
(<i>E</i>)-Nerolidol	0.03	Sesquiterpenic alcohol
Spathulenol	0.05	Sesquiterpenic alcohol
Caryophyllene oxide	0.45	Sesquiterpenic ether
Caryophyllene oxide isomer	0.11	Sesquiterpenic ether
Unknown	0.01	Oxygenated sesquiterpene
Humulene epoxide I	0.01	Sesquiterpenic ether
Humulene epoxide II	0.02	Sesquiterpenic ether
α -Corocalene	0.02	Sesquiterpene
Alismol	0.12	Sesquiterpenic alcohol
Caryophylladienol II	0.03	Sesquiterpenic alcohol
τ -Muurolol	0.04	Sesquiterpenic alcohol
α -Muurolol	0.15	Sesquiterpenic alcohol
<i>cis</i> -Calamenen-10-ol	0.01	Sesquiterpenic alcohol
<i>trans</i> -Calamenen-10-ol	tr	Sesquiterpenic alcohol
(3 <i>Z</i>)-Caryophylla-3,8(13)-dien-5 β -ol	0.01	Sesquiterpenic alcohol
Unknown	tr	Oxygenated sesquiterpene
Phytone	tr	Terpenic ketone
meta-Camphorene	0.02	Diterpene
para-Camphorene	0.02	Diterpene
Consolidated total	99.03%	

*: 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.

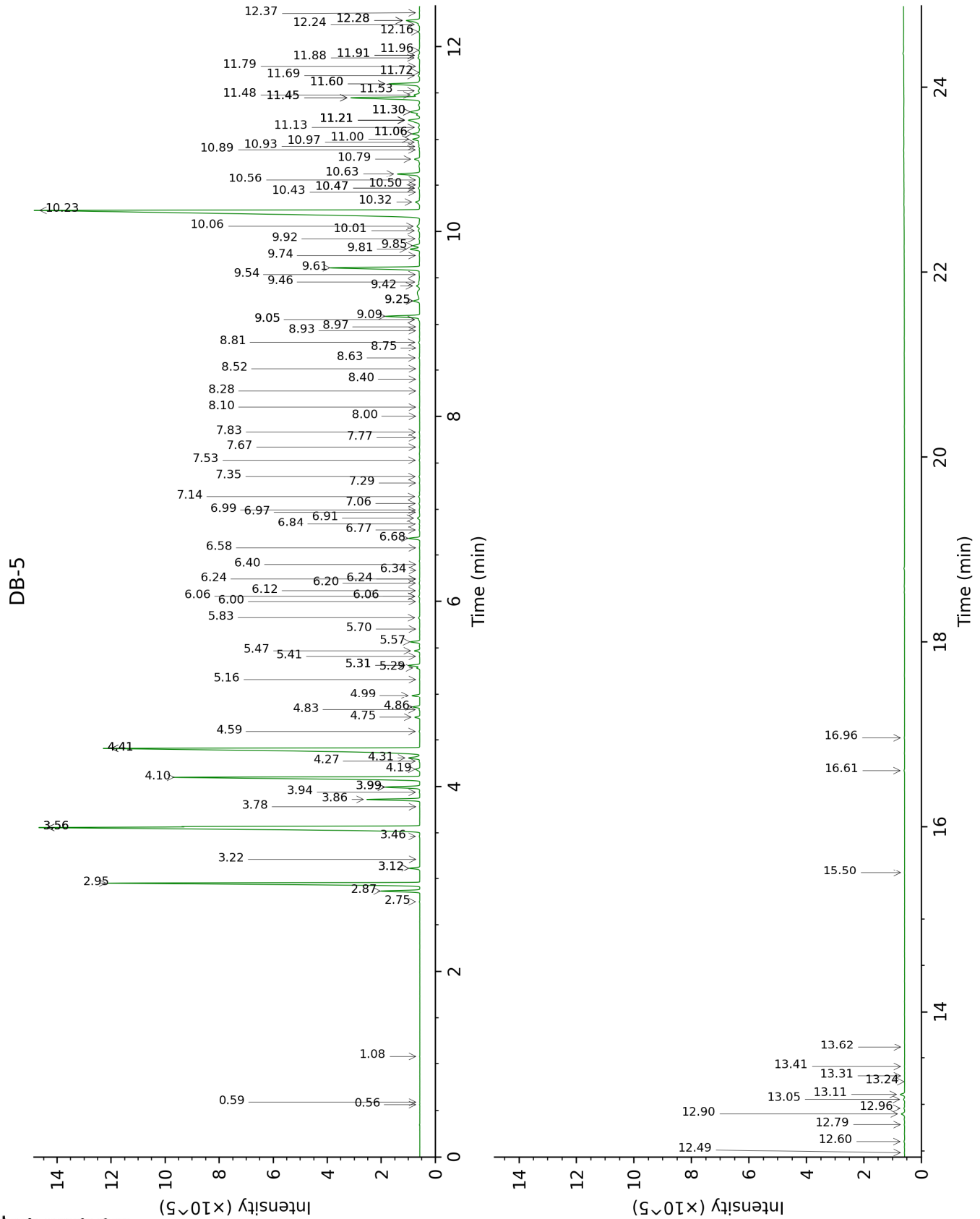
Note: no correction factor was applied

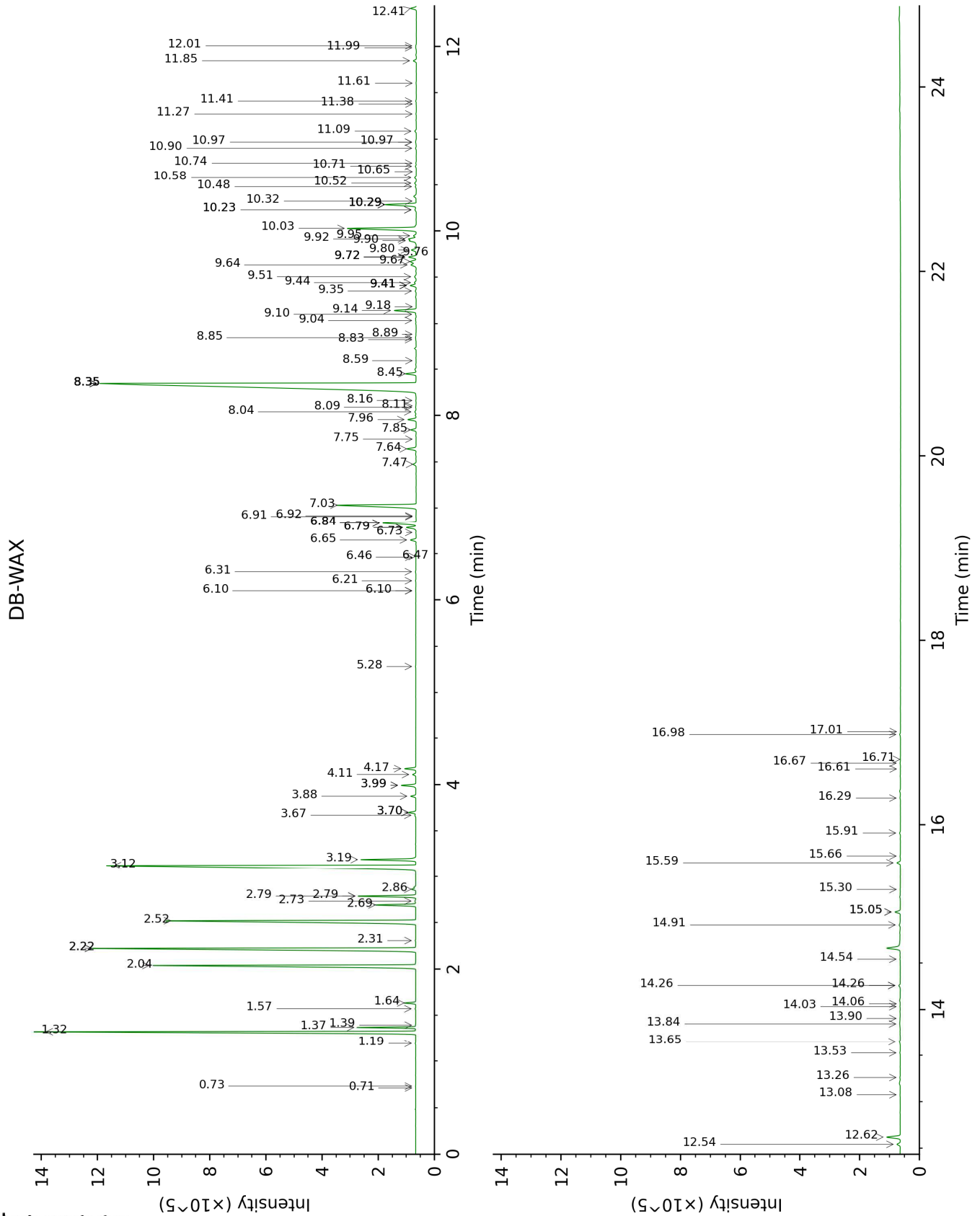
About "consolidated" data: The table above presents the breakdown of the sample volatile constituents after applying an algorithm to collapse data acquired from the multi-columns system of PhytoChemia into a single set of consolidated contents. In case of discrepancies

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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FULL ANALYSIS DATA

Identification	Column DB-5			Column DB-WAX		
	R.T	R.I	%	R.T	R.I	%
Isovaleral	0.56	643	tr	0.73	888	tr
2-Methylbutyral	0.59	653	tr	0.71	880	tr
Toluene	1.08	758	tr	1.39	1002	0.01
Tricyclene	2.75	918	0.01	1.19	971	0.01
α -Thujene	2.87	926	1.07	1.37	999	1.07
α -Pinene	2.95	932	10.07	1.32	994	10.05
Camphene	3.12*	943	0.28	1.64	1026	0.26
α -Fenchene	3.12*	943	[0.28]	1.57	1020	0.02
Thuja-2,4(10)-diene	3.22	950	tr	2.22*	1087	11.07
meta-Cymene	3.46	966	0.02	2.79*	1134	1.45
β -Pinene	3.56*	973	19.52	2.04	1068	8.41
Sabinene	3.56*	973	[19.52]	2.22*	1087	[11.07]
6-Methyl-5-hepten-2-one	3.78	988	tr			
Myrcene	3.86	994	1.43	2.79*	1134	[1.45]
2-Carene	3.94	999	0.02	2.31	1095	0.01
Pseudolimonene	3.99*	1002	1.03	2.74	1130	0.03
α -Phellandrene	3.99*	1002	[1.03]	2.69	1126	1.01
Δ^3 -Carene	4.10	1009	8.81	2.52	1113	8.79
α -Terpinene	4.19	1015	0.16	2.86	1140	0.11
ortho-Cymene	4.27	1020	0.02	3.99*	1229	0.42
para-Cymene	4.31	1023	0.41	3.99*	1229	[0.42]
Limonene	4.41*	1029	15.48	3.12	1161	14.05
β -Phellandrene	4.41*	1029	[15.48]	3.19	1166	1.43
(Z)- β -Ocimene	4.59	1041	0.02	3.67	1205	0.03
(E)- β -Ocimene	4.75	1051	0.14	3.88	1220	0.14
Unknown [m/z 93, 91 (54), 92 (31), 77 (29), 79 (17), 43 (13), 41 (10), 136 (9)]	4.83	1056	0.02	3.70*	1207	0.20
γ -Terpinene	4.86	1058	0.20	3.70*	1207	[0.20]
cis-Sabinene hydrate	4.99	1066	0.22	6.79*†	1430	1.45
meta-Cymenene	5.16	1077	0.01	6.10	1380	tr
Isoterpinolene	5.29	1085	0.09	4.11	1238	0.09
Terpinolene	5.31*	1087	0.33	4.17	1242	0.32
para-Cymenene	5.31*	1087	[0.33]	6.21	1388	0.01
α -Pinene oxide	5.41	1093	0.01	5.28	1321	0.01
trans-Sabinene hydrate	5.47	1097	0.16	7.85	1510	0.16
Linalool	5.57	1103	0.27	7.96	1518	0.26
Unknown [m/z 41, 67 (75), 69 (59), 79 (55), 81 (44), 71 (41)... 150 (5)]	5.70	1112	0.01	6.10	1380	tr

<i>trans</i> -para-Mentha-2,8-dien-1-ol	5.83	1120	0.04	8.85	1587	0.03
<i>cis</i> -Limonene oxide	6.00	1131	0.02	6.31	1395	0.02
<i>cis</i> -para-Mentha-2,8-dien-1-ol	6.06*	1135	0.04	9.35	1628	0.03
<i>trans</i> -Limonene oxide	6.06*	1135	[0.04]	6.46	1406	tr
<i>trans</i> -para-Menth-2-en-1-ol	6.12	1139	0.02	8.83	1586	0.01
<i>trans</i> -Verbenol	6.20	1144	0.02	9.41*	1633	0.20
β-Pinene oxide	6.24*	1147	0.01	6.47	1407	tr
meta-Mentha-4,6-dien-8-ol	6.24*	1147	[0.01]	9.18	1614	tr
Sabinaketon	6.34	1153	tr	8.59	1568	tr
Pinocarvone	6.40	1157	tr	7.75	1502	tr
<i>cis</i> -Sabinol	6.58	1169	0.01	10.71	1739	0.03
Terpinen-4-ol	6.68	1175	0.34	8.45	1557	0.32
meta-Cymen-8-ol	6.77	1181	0.02	11.38	1796	0.01
para-Cymen-8-ol	6.84	1185	0.02	11.41	1799	0.02
α-Terpineol	6.91	1190	0.08	9.64	1651	0.22
Methyl salicylate	6.97	1194	0.01	10.32	1707	0.01
Myrtenol	6.99	1196	0.02	10.74	1742	0.02
<i>cis</i> -α-Phellandrene epoxide (IPP vs Me)	7.06	1200	0.03	10.90	1756	0.03
Unknown [m/z 109, 91 (100), 81 (88), 94 (75), 119 (74), 96 (73), 41 (63)... 150 (2)]	7.14	1205	0.04	10.65	1734	tr
Car-2-en-4-one?	7.28	1215	0.01	9.41*	1633	[0.20]
<i>trans</i> -Carveol	7.35	1220	0.02	11.27	1787	0.01
<i>cis</i> -Carveol	7.53	1232	0.02	11.60	1816	0.02
Carvone	7.67	1241	0.01	9.90†	1672	0.49
Car-3-en-2-one	7.77	1248	0.01	10.29*	1704	1.06
Unknown [m/z 43, 97 (69), 107 (46), 41 (28), 55 (21), 109 (20)...]	7.83	1252	0.02	10.97*	1761	0.05
Methyl citronellate	8.00	1264	tr	8.11	1530	0.01
<i>trans</i> -Ascaridole glycol	8.10	1271	0.01	14.03	2038	0.01
Bornyl acetate	8.28	1283	0.01	8.09	1528	0.02
Cuminol	8.40	1291	tr	14.06	2041	tr
Unknown [m/z 43, 93 (66), 91 (44), 41 (38), 69 (35)... 152? (1)]	8.52	1299	tr			
para-Menth-5-en-1,2-diol isomer II	8.63	1307	0.02	14.26*	2060	0.06

Limonene hydroperoxide I	8.75	1312	tr			
para-Menth-5-en-1,2-diol isomer III	8.81	1316	0.03	15.05*	2138	0.17
Unknown [m/z 91, 79 (94), 77 (72), 41 (37), 93 (31)... 152 (1)]	8.93	1325	0.01			
Methyl geranate	8.98	1328	0.01	9.67	1654	0.24
Bicycloelemene	9.05*	1333	0.04	6.92	1440	tr
δ-Elemene isomer	9.05*	1333	[0.04]	6.73	1426	0.02
δ-Elemene	9.09	1336	1.13	6.84*†	1434	[1.45]
α-Cubebene	9.25*	1348	0.23	6.65	1420	0.18
Unknown [m/z 95, 147 (61), 96 (39), 93 (37), 94 (37)... 204 (4)]	9.25*	1348	[0.23]	6.84*†	1434	[1.45]
Cyclosativene I	9.42	1359	0.12	6.79*†	1430	[1.45]
Cyclosativene II	9.46	1362	0.04	6.84*†	1434	[1.45]
α-Ylangene	9.54	1368	0.02	6.91	1439	0.01
α-Copaene	9.61	1373	3.17	7.03	1448	3.12
cis-β-Elemene	9.74	1382	0.01	8.16	1534	0.01
β-Cubebene	9.81	1387	0.31	7.64	1494	0.32
β-Elemene	9.85	1390	0.23	8.35*	1548	25.37
Unknown [m/z 71, 100 (92), 111 (79), 69 (46), 109 (45)...]	9.92	1395	0.02	17.01	2340	tr
Isocaryophyllene	10.01	1401	0.06	8.04	1525	0.05
α-Gurjunene	10.06	1405	0.13	7.48	1481	0.10
β-Caryophyllene	10.23	1418	25.05	8.35*	1548	[25.37]
β-Copaene	10.32	1424	0.16	8.35*	1548	[25.37]
γ-Elemene	10.42	1432	0.01	8.89	1590	0.01
trans-α-Bergamotene	10.47*	1436	0.04	8.35*	1548	[25.37]
α-Guaiene	10.47*	1436	[0.04]	8.35*	1548	[25.37]
Unknown [m/z 41, 97 (78), 69 (77), 43 (71), 125 (67), 55 (56)... 168 (39)]	10.50	1438	0.01	16.98	2336	0.03
Unknown [m/z 139, 69 (60), 41 (51), 43 (47), 119 (41)... 204 (1)]	10.56	1442	tr			
α-Humulene	10.63	1448	0.75	9.14	1611	0.77
(E)-β-Farnesene	10.79	1460	0.17	9.41*	1633	[0.20]
γ-Gurjunene	10.89	1467	0.01	9.04	1602	0.02
trans-Cadina-1(6),4-diene	10.93	1470	0.03	9.10	1607	0.02
γ-Murolene	10.97	1473	0.08	9.44	1635	0.06
Germacrene D	11.00	1476	0.26	9.72*	1658	0.26
ar-Curcumene	11.06*	1480	0.25	10.52	1723	0.06
β-Selinene	11.06*	1480	[0.25]	9.72*	1658	[0.26]

<i>trans</i> -Muurolo-4(15),5-diene	11.13	1485	0.04	9.72*	1658	[0.26]
epi-Cubebol	11.21*	1491	0.56	11.85	1838	0.10
Bicyclogermacrene	11.21*	1491	[0.56]	9.95	1676	0.10
Viridiflorene	11.21*	1491	[0.56]	9.51	1640	0.07
α -Selinene	11.21*	1491	[0.56]	9.80	1664	0.17
Epizonarene	11.21*	1491	[0.56]	9.76	1661	0.01
Germacrene A	11.30*†	1498	0.49	10.23*	1699	0.06
α -Muurolene	11.30*†	1498	[0.49]	9.92†	1673	[0.49]
β -Bisabolene	11.45*	1509	2.48	10.03	1683	2.48
γ -Cadinene	11.45*	1509	[2.48]	10.23*	1699	[0.06]
Cubebol	11.48	1512	0.19	12.41	1888	0.20
7-epi- α -Selinene	11.52	1515	0.05	10.29*	1704	[1.06]
<i>trans</i> -Calamenene	11.60*	1521	1.11	11.09	1771	0.06
δ -Cadinene	11.60*	1521	[1.11]	10.29*	1704	[1.06]
<i>trans</i> -Cadina-1,4-diene	11.69	1528	0.05	10.48	1720	0.04
(<i>E</i>)- γ -Bisabolene	11.72	1531	0.01	10.29*	1704	[1.06]
α -Calacorene	11.79	1536	0.01	12.01	1852	0.02
(<i>E</i>)- α -Bisabolene	11.88	1543	0.05	10.58	1728	0.05
Isocaryophyllene epoxide B	11.91*	1545	0.05	11.99	1850	0.03
α -Elemol	11.91*	1545	[0.05]	13.90	2026	0.01
Germacrene B	11.96	1550	0.03	10.97*	1761	[0.05]
(<i>E</i>)-Nerolidol	12.16	1565	0.03	13.65	2002	0.03
Spathulenol	12.24	1572	0.05	14.26*	2060	[0.06]
Caryophyllene oxide	12.28*	1575	0.56	12.62	1907	0.45
Caryophyllene oxide isomer	12.28*	1575	[0.56]	12.54	1900	0.11
Unknown [m/z 161, 105 (84), 43 (80), 119 (72), 93 (62), 121 (54)... 204 (38), 222 (2)]	12.37	1582	0.01	13.84	2020	0.06
Humulene epoxide I	12.49	1591	0.01	13.08	1948	0.01
Humulene epoxide II	12.60	1600	0.02	13.26	1965	0.01
α -Corocalene	12.79	1615	0.02	13.53	1990	0.02
Alismol	12.90	1625	0.12	15.59	2191	0.11
Caryophylladienol II	12.96	1630	0.03	15.91	2225	0.03
τ -Muurolol	13.06	1638	0.04	14.91	2124	0.05
α -Muurolol	13.11	1642	0.15	15.05*	2138	[0.17]
<i>cis</i> -Calamenen-10-ol	13.24	1654	0.01	16.29	2264	0.02
<i>trans</i> -Calamenen-10-ol	13.31	1659	tr	16.67	2303	0.02
(3 <i>Z</i>)-Caryophylla-3,8(13)-dien-5 β -ol	13.41	1667	0.01	16.71	2308	0.01

Unknown [m/z 43, 108 (62), 93 (51), 41 (42), 109 (37), 69 (36)...]	13.62	1684	tr	16.61	2296	0.01
Phytone	15.50	1850	tr	14.54	2087	0.01
meta-Camphorene	16.61	1953	0.02	15.30	2162	0.01
para-Camphorene	16.96	1986	0.02	15.66	2199	0.01
Total identified	99.13%			98.71%		
Total reported	99.27%			98.81%		

*: 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