

**Date :** January 31, 2019

**CERTIFICATE OF ANALYSIS – GC PROFILING**

**SAMPLE IDENTIFICATION**

**Internal code :** 19A18-PTH01-1-CC

**Customer identification :** Lime Steam Distilled - Peru - LL010376R

**Type :** Essential oil

**Source :** *Citrus aurantifolia* ct. Distilled

**Customer :** Plant Therapy

**ANALYSIS**

**Method:** PC-PA-014-17J19 - Analysis of the composition of an essential oil, or other volatile liquid, by FAST GC-FID (in French); identifications validated by GC-MS.

**Analyst :** Alexis St-Gelais, M. Sc., chimiste

**Analysis date :** January 24, 2019

Checked and approved by :

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

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PHYSICOCHEMICAL DATA

**Physical aspect:** Faintly yellow liquid

**Refractive index:** 1.4753 ± 0.0003 (20 °C)

ISO 3519:2006 - OIL OF LIME, DISTILLED, MEXICAN TYPE

Compound	Min. %	Max. %	Observed %	Complies?
β-Bisabolene	1.0	1.5	1.5	Yes
(3E,6E)-α-Farnesene	0.6	0.9	0.5	No
trans-α-Bergamotene	0.5	0.9	0.8	Yes
β-Caryophyllene	0.4	0.8	0.5	Yes
γ-Terpineol	0.7	1.4	1.1	Yes
α-Terpineol	6.0	8.0	7.2	Yes
Borneol	0.5	0.8	0.5	Yes
endo-Fenchol	0.4	0.8	0.7	Yes
γ-Terpinene	10.0	13.0	11.1	Yes
Limonene	36.0	46.0	43.1	Yes
para-Cymene	1.5	2.8	2.6	Yes
Myrcene	1.1	1.5	1.1	Yes
β-Pinene	1.0	3.0	2.3	Yes
Sabinene	0.1	0.3	tr	No
α-Pinene	0.8	1.3	1.1	Yes
<b>Refractive index</b>	1.4740	1.4770	1.4753	Yes

CONCLUSION

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

## ANALYSIS SUMMARY

Identification	DB-5 (%)	DB-WAX (%)	Classe
Ethanol	tr	tr	Aliphatic alcohol
2-Methyl-3-buten-2-ol	tr	0.01	Aliphatic alcohol
Toluene	0.03	0.02*	Simple phenolic
1-Methylcyclohexa-1,3-diene	0.17	0.17	Alkene
3-Methylenecyclohexadiene	0.02	0.02	Alkene
Hexanal	tr	tr	Aliphatic aldehyde
Octane	tr	tr	Alkane
(3Z)-Hexenol	tr	0.07*	Aliphatic alcohol
Cyclofenchene	0.01	tr	Monoterpene
Bornylene	0.04*	0.02	Monoterpene
Nonane	[0.04]*	0.03	Alkane
Tricyclene	0.02	0.02	Monoterpene
$\alpha$ -Thujene	0.02	[0.02]*	Monoterpene
$\alpha$ -Pinene	1.14	1.15	Monoterpene
Camphene	0.66*	0.46	Monoterpene
$\alpha$ -Fenchene	[0.66]*	0.18	Monoterpene
1,4-Dimethyl-4-vinylcyclohexene?	0.01	0.01	Monoterpene
Unknown	0.02	0.01	Monoterpene
$\beta$ -Pinene	2.45*	2.25	Monoterpene
Sabinene	[2.45]*	0.01	Monoterpene
Geranic oxide	[2.45]*	0.21	Monoterpenic ether
3-Methyl-3-cyclohexenone	0.02	tr	Aliphatic ketone
Dehydro-1,8-cineole	0.03*	0.02	Monoterpenic ether
6-Methyl-5-hepten-2-one	[0.03]*	tr	Aliphatic ketone
<i>trans</i> -Dehydroxylinalool oxide	0.04	0.03	Monoterpenic ether
Myrcene	1.13	1.12	Monoterpene
$\alpha$ -Phellandrene	0.47*	0.36	Monoterpene
Octanal	[0.47]*	0.11	Aliphatic aldehyde
$\Delta^3$ -Carene	0.02	0.02	Monoterpene
$\alpha$ -Terpinene	4.22*	4.26*	Monoterpene
1,4-Cineole	[4.22]*	[4.26]*	Monoterpenic ether
para-Cymene	47.80	2.68*	Monoterpene
Limonene	[47.80]*	43.11	Monoterpene
$\beta$ -Phellandrene	[47.80]*	1.76	Monoterpene
(Z)- $\beta$ -Ocimene	0.20*	0.01	Monoterpene
(Z?)-Citroside	[0.20]*	0.09	Monoterpenic ether
(E?)-Citroside	0.22	11.47*	Monoterpenic ether
(E)- $\beta$ -Ocimene	0.43	0.42	Monoterpene
$\gamma$ -Terpinene	11.05	[11.47]*	Monoterpene
<i>cis</i> -Sabinene hydrate	0.03	0.02	Monoterpenic alcohol
Octanol	0.01	0.01	Aliphatic alcohol
Isoterpinolene	0.11	[2.68]*	Monoterpene
Terpinolene	8.05*	7.73	Monoterpene
para-Cymenene	[8.05]*	0.26	Monoterpene
Linalool	0.20	0.20	Monoterpenic alcohol
Nonanal	0.04	0.04	Aliphatic aldehyde
1,3,8-para-Menthatriene	0.05	[0.07]*	Monoterpene
endo-Fenchol	0.70	0.69	Monoterpenic alcohol

Myrcenol	0.07	0.06	Monoterpenic alcohol
Limona ketone	0.02*	0.01	Normonoterpenic ketone
4-Hydroxy-4-methylcyclohex-2-enone	[0.02]*	0.01	Aliphatic alcohol
<i>cis</i> -Limonene oxide	0.08*	0.04	Monoterpenic ether
allo-Ocimene	[0.08]*	0.01	Monoterpene
<i>trans</i> -Limonene oxide	0.94*	tr	Monoterpenic ether
1-Terpineol	[0.94]*	0.96	Monoterpenic alcohol
Cosmene isomer II	0.04	0.06	Monoterpene
Epoxyterpinolene	0.74*	0.02	Monoterpenic ether
<i>cis</i> - $\beta$ -Terpineol	[0.74]*	0.71	Monoterpenic alcohol
Citronellal	0.07	0.07	Monoterpenic aldehyde
( <i>Z</i> )-Ocimenol	0.09	0.09	Monoterpenic alcohol
Borneol	0.68*	7.76*	Monoterpenic alcohol
<i>trans</i> - $\beta$ -Terpineol	[0.68]*	0.34*	Monoterpenic alcohol
$\alpha$ -Phellandren-8-ol	0.19*	0.12	Monoterpenic alcohol
$\delta$ -Terpineol	[0.19]*	0.23*	Monoterpenic alcohol
Isopinocampone	0.03	0.03	Monoterpenic ketone
( <i>E</i> )-Ocimenol	0.02		Monoterpenic alcohol
Terpinen-4-ol	0.89	0.88	Monoterpenic alcohol
4-Methylacetophenone	0.02	0.05*	Simple phenolic
$\alpha$ -Terpineol	7.32*	[7.76]*	Monoterpenic alcohol
para-Cymen-8-ol	[7.32]*	0.17	Monoterpenic alcohol
$\gamma$ -Terpineol	1.05	1.09	Monoterpenic alcohol
<i>trans</i> -Piperitol	0.03	0.02	Monoterpenic alcohol
Decanal	0.18	0.18	Aliphatic aldehyde
<i>trans</i> -Carveol	0.01	0.01	Monoterpenic alcohol
Nerol	0.01	0.01	Monoterpenic alcohol
Unknown	0.04	0.04	Oxygenated monoterpene
Neral	0.04	0.07	Monoterpenic aldehyde
Geraniol	0.03	0.03	Monoterpenic alcohol
Geranial	0.03	0.02	Monoterpenic aldehyde
Unknown	0.06		Unknown
Unknown	0.03*	0.02	Oxygenated monoterpene
Unknown	[0.03]*	0.01	Unknown
<i>cis</i> -Ascaridole glycol?	0.02	0.03	Monoterpenic alcohol
Unknown	0.01		Unknown
Unknown	0.02	0.03	Monoterpenic alcohol
$\delta$ -Elemene	0.01	tr	Sesquiterpene
Unknown	0.08		Unknown
Neryl acetate	0.05	0.06	Monoterpenic ester
7-Cubebene	0.01	0.01	Sesquiterpene
7-Cubebene epimer?	0.02	0.02	Aliphatic alcohol
Geranyl acetate	0.09	1.35*	Monoterpenic ester
$\beta$ -Elemene	0.08	0.55*	Sesquiterpene
Isocaryophyllene	0.01	0.02	Sesquiterpene
Dodecanal	0.09	0.23*	Aliphatic aldehyde
$\beta$ -Caryophyllene	0.57*	[0.55]*	Sesquiterpene
<i>cis</i> - $\alpha$ -Bergamotene	[0.57]*	0.08	Sesquiterpene
$\alpha$ -Santalene	0.04	0.03	Sesquiterpene
$\gamma$ -Elemene	0.02	0.02	Sesquiterpene
<i>trans</i> - $\alpha$ -Bergamotene	0.79	0.80	Sesquiterpene
$\alpha$ -Humulene	0.12	0.11	Sesquiterpene

β-Santalene	0.01	0.01	Sesquiterpene
(E)-β-Farnesene	0.11	[0.34]*	Sesquiterpene
Selina-4,11-diene	0.16*	[0.23]*	Sesquiterpene
α-Amorphene	[0.16]*	0.06	Sesquiterpene
β-Selinene	0.07	0.08	Sesquiterpene
Unknown	0.06	0.04	Sesquiterpene
Valencene	0.30*	0.02	Sesquiterpene
δ-Selinene	[0.30]*	0.25	Sesquiterpene
α-Selinene	0.12	[0.23]*	Sesquiterpene
(Z)-α-Bisabolene	0.14		Sesquiterpene
β-Bisabolene	1.58*	1.45	Sesquiterpene
β-Curcumene	[1.58]*	0.01	Sesquiterpene
(3E,6E)-α-Farnesene	0.55*	[1.35]*	Sesquiterpene
γ-Cadinene	[0.55]*	[0.05]*	Sesquiterpene
δ-Cadinene	0.05	0.07	Sesquiterpene
Selina-4(15),7(11)-diene	0.09	[1.35]	Sesquiterpene
Selina-3,7(11)-diene	0.24	[1.35]*	Sesquiterpene
Unknown	0.05	[1.35]*	Sesquiterpene
(E)-α-Bisabolene	0.08	0.06	Sesquiterpene
Germacrene B	0.09	0.10	Sesquiterpene
Caryophyllenyl alcohol	0.07	0.09	Sesquiterpenic alcohol
Caryophyllene oxide	0.01	0.01	Sesquiterpenic ether
10-epi-γ-Eudesmol	0.05	0.07	Sesquiterpenic alcohol
γ-Eudesmol	0.20	0.07	Sesquiterpenic alcohol
Unknown	0.05		Oxygenated sesquiterpene
epi-α-Bisabolol	0.03	0.03	Sesquiterpenic alcohol
α-Bisabolol	0.03	0.03	Sesquiterpenic alcohol
<b>Total identified</b>	<b>97.92%</b>	<b>97.79%</b>	

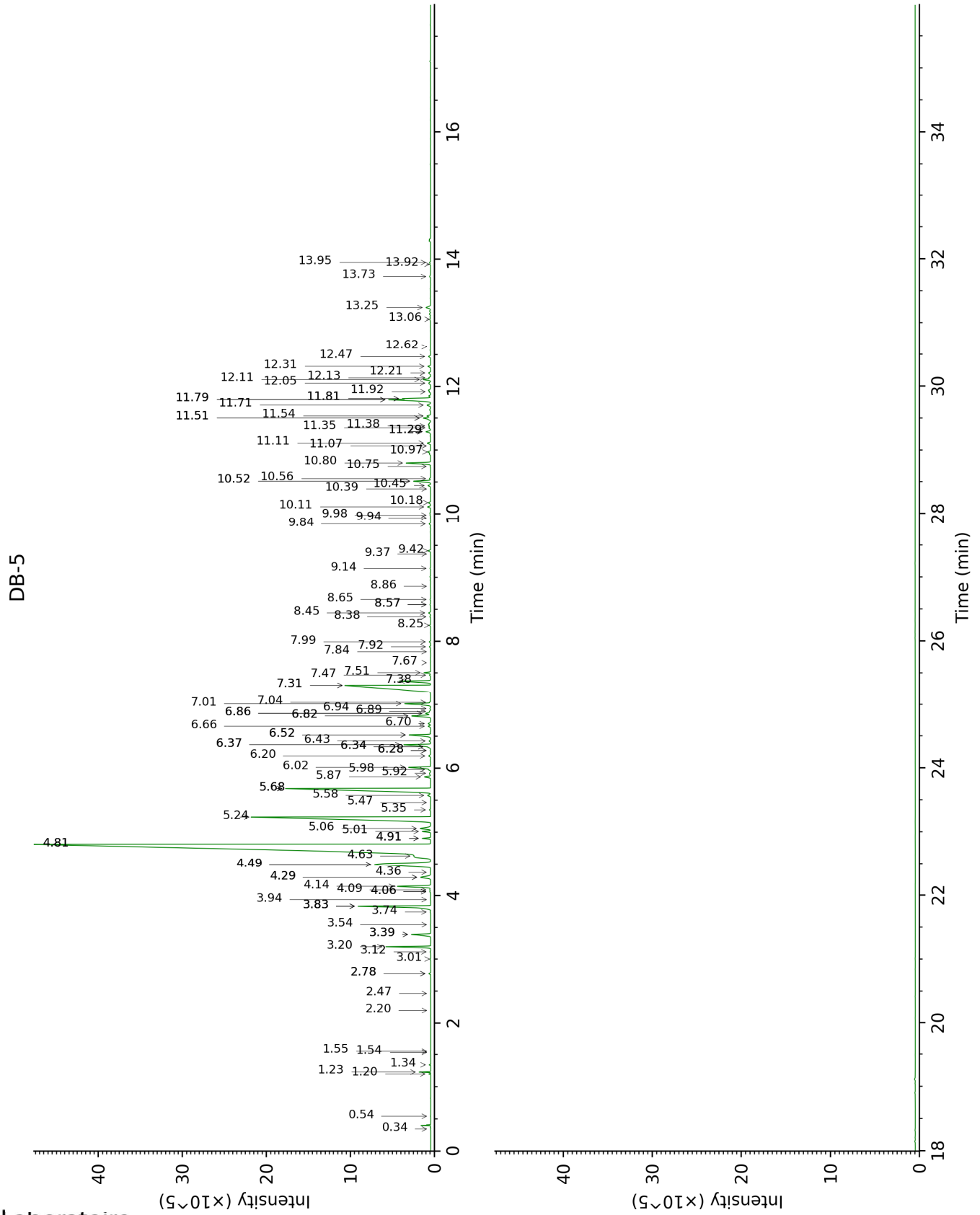
\*: Two or more compounds are coeluting on this column

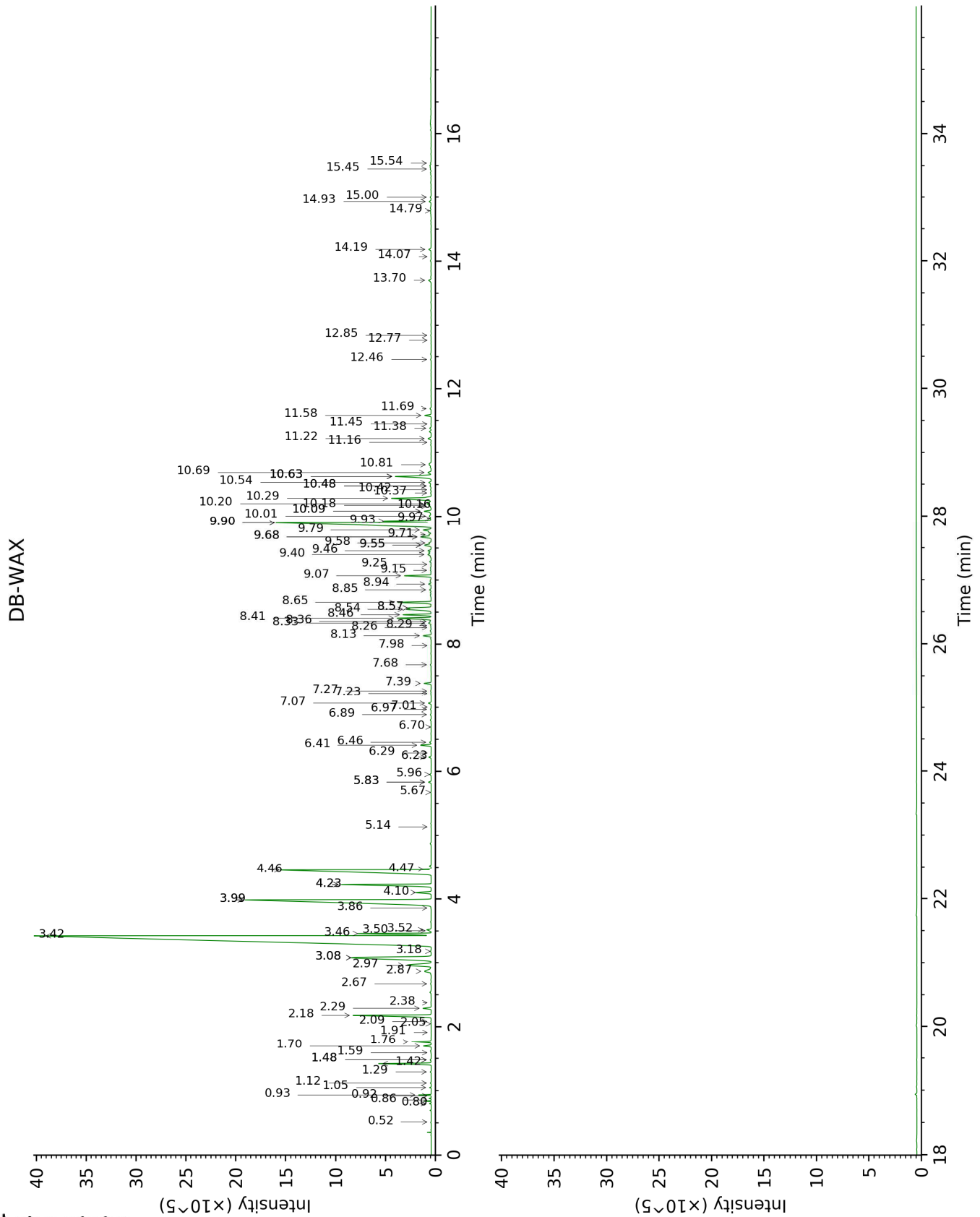
[xx]: Duplicate percentage due to coelutions, not taken account in the identified total

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

Note: no correction factor was applied

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FULL ANALYSIS DATA

Identification	Column DB-5			Column DB-WAX		
	R.T	R.I	%	R.T	R.I	%
Ethanol	0.34	513	tr	0.86	912	tr
2-Methyl-3-buten-2-ol	0.54	604	tr	1.59	1014	0.01
Toluene	1.20	752	0.03	1.48*	1003	0.02
1-Methylcyclohexa-1,3-diene	1.23	756	0.17	0.93	924	0.17
3-Methylenecyclohexadiene	1.34	771	0.02	1.05	940	0.02
Hexanal	1.54	797	tr	1.91	1044	tr
Octane	1.55	799	tr	0.52	792	tr
(3Z)-Hexenol	2.20	854	tr	5.84*	1345	0.07
Cyclofenchene	2.47	876	0.01	0.92	922	tr
Bornylene	2.78*	902	0.04	1.12	950	0.02
Nonane	2.78*	902	[0.04]	0.80	897	0.03
Tricyclene	3.01	917	0.02	1.29	975	0.02
$\alpha$ -Thujene	3.12	924	0.02	1.48*	1003	[0.02]
$\alpha$ -Pinene	3.20	930	1.14	1.42	994	1.15
Camphene	3.39*	942	0.66	1.76	1030	0.46
$\alpha$ -Fenchene	3.39*	942	[0.66]	1.70	1023	0.18
1,4-Dimethyl-4-vinylcyclohexene?	3.54	952	0.01	2.05	1056	0.01
Unknown [m/z 93, 91 (60), 121 (55), 136 (42), 79 (40)]	3.74	965	0.02	2.09	1060	0.01
$\beta$ -Pinene	3.83*	971	2.45	2.18	1069	2.25
Sabinene	3.83*	971	[2.45]	2.38	1088	0.01
Geranic oxide	3.83*	971	[2.45]	2.29	1080	0.21
3-Methyl-3-cyclohexenone	3.94	978	0.02	6.29	1378	tr
Dehydro-1,8-cineole	4.06*	986	0.03	3.18	1153	0.02
6-Methyl-5-hepten-2-one	4.06*	986	[0.03]	5.14	1305	tr
<i>trans</i> -Dehydroxylinalool oxide	4.09	988	0.04	3.50	1179	0.03
Myrcene	4.14	992	1.13	2.97	1136	1.12
$\alpha$ -Phellandrene	4.29*	1001	0.47	2.87	1128	0.36
Octanal	4.29*	1001	[0.47]	4.47	1254	0.11
$\Delta$ 3-Carene	4.36	1006	0.02	2.68	1113	0.02
$\alpha$ -Terpinene	4.49*	1014	4.22	3.08*	1145	4.26
1,4-Cineole	4.49*	1014	[4.22]	3.08*	1145	[4.26]
para-Cymene	4.63†	1023	47.80	4.23*	1235	2.68
Limonene	4.81*†	1034	[47.80]	3.42	1172	43.11
$\beta$ -Phellandrene	4.81*†	1034	[47.80]	3.46	1175	1.76
(Z)- $\beta$ -Ocimene	4.90*	1040	0.20	3.86	1207	0.01
(Z?)-Citroxide	4.90*	1040	[0.20]	3.52	1180	0.09
(E?)-Citroxide	5.01	1047	0.22	3.99*	1216	11.47
(E)- $\beta$ -Ocimene	5.06	1050	0.43	4.10	1225	0.42
$\gamma$ -Terpinene	5.24	1061	11.05	3.99*	1216	[11.47]
<i>cis</i> -Sabinene hydrate	5.35	1068	0.03	6.97	1429	0.02
Octanol	5.47	1076	0.01	8.26	1527	0.01
Isoterpinolene	5.58	1083	0.11	4.23*	1235	[2.68]

Terpinolene	5.68*	1089	8.05	4.46	1252	7.73
para-Cymenene	5.68*	1089	[8.05]	6.41	1387	0.26
Linalool	5.87	1101	0.20	8.13	1517	0.20
Nonanal	5.92	1104	0.04	5.96	1354	0.04
1,3,8-para-Menthatriene	5.98	1108	0.05	5.84*	1345	[0.07]
endo-Fenchol	6.02	1110	0.70	8.46	1542	0.69
Myrcenol	6.20	1122	0.07	8.94	1580	0.06
Limona ketone	6.28*	1128	0.02	7.98	1505	0.01
4-Hydroxy-4-methylcyclohex-2-enone	6.28*	1128	[0.02]	14.07	2027	0.01
cis-Limonene oxide	6.34*	1131	0.08	6.46	1391	0.04
allo-Ocimene	6.34*	1131	[0.08]	5.68	1334	0.01
trans-Limonene oxide	6.37*	1133	0.94	6.70	1408	tr
1-Terpineol	6.37*	1133	[0.94]	8.41	1538	0.96
Cosmene isomer II	6.43	1137	0.04	6.23	1374	0.06
Epoxyterpinolene	6.52*	1143	0.74	6.89	1423	0.02
cis-β-Terpineol	6.52*	1143	[0.74]	9.07	1590	0.71
Citronellal	6.66	1152	0.07	7.07	1436	0.07
(Z)-Ocimenol	6.70	1155	0.09	9.46	1621	0.09
Borneol	6.82*	1162	0.68	9.90*	1657	7.76
trans-β-Terpineol	6.82*	1162	[0.68]	9.68*	1639	0.34
α-Phellandren-8-ol	6.86*	1165	0.19	10.20	1682	0.12
δ-Terpineol	6.86*	1165	[0.19]	9.55*	1629	0.23
Isopinocampone	6.89	1167	0.03	7.68	1482	0.03
(E)-Ocimenol	6.94	1170	0.02			
Terpinen-4-ol	7.02	1175	0.89	8.65	1558	0.88
4-Methylacetophenone	7.04	1176	0.02	10.48*	1705	0.05
α-Terpineol	7.31*	1194	7.32	9.90*	1657	[7.76]
para-Cymen-8-ol	7.31*	1194	[7.32]	11.58	1799	0.17
γ-Terpineol	7.38	1199	1.05	9.93	1660	1.09
trans-Piperitol	7.47	1205	0.03	10.42	1700	0.02
Decanal	7.51	1207	0.18	7.39	1460	0.18
trans-Carveol	7.66	1218	0.01	11.45	1788	0.01
Nerol	7.84	1230	0.01	11.16	1763	0.01
Unknown [m/z 137, 152 (28), 43 (25), 91 (24), 109 (23), 119 (19)]	7.92	1235	0.04	11.38	1782	0.04
Neral	7.99	1240	0.04	9.58	1631	0.07
Geraniol	8.25	1258	0.03	11.69	1808	0.03
Geranial	8.38	1267	0.03	10.16	1679	0.02
Unknown [m/z 109, 127 (55), 43 (40), 81 (36), 79 (39), 82 (29)...]	8.44	1271	0.06			
Unknown [m/z 95, 67 (45), 41 (42), 110 (42), 43 (41), 59 (36)]	8.57*	1280	0.03	12.46	1877	0.02
Unknown [m/z 43, 79 (78), 128 (46), 58 (42), 127 (42)...]	8.57*	1280	[0.03]	12.77	1905	0.01
cis-Ascaridole glycol?	8.66	1286	0.02	14.79	2097	0.03
Unknown [m/z 112, 97 (93), 83 (60), 43 (46), 41	8.86	1300	0.01			

(20), 69 (19)...						
Unknown [m/z 97, 112 (92), 83 (62), 43 (44), 41 (25)... 170? (4)]	9.14	1316	0.02	15.00	2118	0.03
δ-Elemene	9.37	1332	0.01	7.01	1432	tr
Unknown [m/z 133, 105 (45), 91 (38), 119 (36)... 150 (3)]	9.42	1336	0.08			
Neryl acetate	9.84	1366	0.05	10.18	1680	0.06
7-Cubebene	9.94	1372	0.01	7.23	1448	0.01
7-Cubebene epimer?	9.98	1376	0.02	7.27	1451	0.02
Geranyl acetate	10.11	1385	0.09	10.63*†	1718	1.35
β-Elemene	10.18	1390	0.08	8.57*	1551	0.55
Isocaryophyllene	10.40	1405	0.01	8.29	1529	0.02
Dodecanal	10.45	1409	0.09	10.09*	1673	0.23
β-Caryophyllene	10.52*	1414	0.57	8.57*	1551	[0.55]
cis-α-Bergamotene	10.52*	1414	[0.57]	8.33	1532	0.08
α-Santalene	10.56	1417	0.04	8.36	1534	0.03
γ-Elemene	10.75	1431	0.02	9.15	1596	0.02
trans-α-Bergamotene	10.80	1436	0.79	8.54	1549	0.80
α-Humulene	10.97	1448	0.12	9.40	1617	0.11
β-Santalene	11.07	1456	0.01	9.25	1604	0.01
(E)-β-Farnesene	11.11	1459	0.11	9.68*	1639	[0.34]
Selina-4,11-diene	11.29*	1472	0.16	9.55*	1629	[0.23]
α-Amorphene	11.29*	1472	[0.16]	9.71	1642	0.06
β-Selinene	11.35	1477	0.07	10.01	1666	0.08
Unknown [m/z 41, 69 (90), 79 (78), 93 (72), 91 (70)...204]	11.38	1479	0.06	8.85	1573	0.04
Valencene	11.50*	1488	0.30	9.97	1663	0.02
δ-Selinene	11.50*	1488	[0.30]	9.78	1648	0.25
α-Selinene	11.54	1491	0.12	10.09*	1673	[0.23]
(Z)-α-Bisabolene	11.71	1503	0.14			
β-Bisabolene	11.79*	1510	1.58	10.29	1689	1.45
β-Curcumene	11.79*	1510	[1.58]	10.37	1696	0.01
(3E,6E)-α-Farnesene	11.81*	1511	0.55	10.63*†	1718	[1.35]
γ-Cadinene	11.81*	1511	[0.55]	10.48*	1705	[0.05]
δ-Cadinene	11.92	1520	0.05	10.54	1710	0.07
Selina-4(15),7(11)-diene	12.05	1530	0.09	10.69†	1723	[1.35]
Selina-3,7(11)-diene	12.11	1535	0.24	10.63*†	1718	[1.35]
Unknown [m/z 189, 204 (92), 161 (65), 133 (51), 105 (51), 91 (51), 119 (45)]	12.14	1537	0.05	10.63*†	1718	[1.35]
(E)-α-Bisabolene	12.21	1543	0.08	10.81	1733	0.06
Germacrene B	12.32	1551	0.09	11.22	1768	0.10
Caryophyllenyl alcohol	12.47	1563	0.07	13.70	1992	0.09
Caryophyllene oxide	12.62	1576	0.01	12.84	1912	0.01
10-epi-γ-Eudesmol	13.06	1610	0.05	14.19	2038	0.07
γ-Eudesmol	13.25	1626	0.20	14.93	2111	0.07
Unknown [m/z 69, 95 (100), 41 (89), 109 (68), 67 (61)...222]	13.73	1666	0.05			

epi- $\alpha$ -Bisabolol	13.92	1682	0.03	15.54	2172	0.03
$\alpha$ -Bisabolol	13.95	1684	0.03	15.45	2163	0.03
<b>Total identified</b>		<b>97.92%</b>			<b>97.79%</b>	
<b>Total reported</b>		<b>98.31%</b>			<b>97.93%</b>	

\*: Two or more compounds are coeluting on this column

[xx]: Duplicate percentage due to coelutions, not taken account in the identified 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