

**Date :** March 29, 2018

*CERTIFICATE OF ANALYSIS - GC PROFILING*

*SAMPLE IDENTIFICATION*

**Internal code :** 18C26-CHS1-1-CC

**Customer identification :** Bergamot - Italy - BCPBIO008\_PRP\_18065B

**Type :** Essential oil

**Source :** *Citrus aurantium* var. *bergamia*

**Customer :** American College of Healthcare Sciences

*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 :** Benoit Roger, Ph. D.

**Analysis date :** March 29, 2018

Checked and approved by :

---

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

*Note: This report may not be published, including online, without the written consent from Laboratoire PhytoChemia.*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.*

#### PHYSICOCHEMICAL DATA

**Physical aspect:** Bright yellow liquid

**Refractive index:** 1.4693 ± 0.0003 (20 °C)

#### COMPLIANCE WITH NF T 75-215:2009 (CITRUS AURANTIUM L. SSP. BERGAMIA, ITALY)

Compound	Min. Content	Max. Content	Observed Content	Complies?
β-Pinene	5.5	9.5	5.5	Yes
Limonene	30	45	43.5	Yes
γ-Terpinene	6	10	7.7	Yes
Linalool	3	15	6.8	Yes
Linalyl acetate	22	36	25.9	Yes
Geranial	0.25	0.50	0.38	Yes
β-Bisabolene	0.30	0.55	0.5	Yes
Refractive index	1.465	1.470	1.4693	Yes

#### CONCLUSION

No adulterant, contaminant or diluent has been detected using this method. The oil complies with the AFNOR standard for Italian bergamot oil.

## ANALYSIS SUMMARY

Identification	DB-5 (%)	DB-WAX (%)	Classe
Tricyclene	tr	tr	Monoterpene
$\alpha$ -Thujene	0.28	0.29	Monoterpene
$\alpha$ -Pinene	1.06	1.07	Monoterpene
$\alpha$ -Fenchene	0.03*	tr	Monoterpene
Camphene	[0.03]*	0.03	Monoterpene
$\beta$ -Pinene	6.39*	5.47	Monoterpene
Sabinene	[6.39]*	0.97	Monoterpene
Myrcene	1.05	1.06	Monoterpene
$\alpha$ -Phellandrene	0.03	0.03	Monoterpene
Octanal	0.05	0.04	Aliphatic aldehyde
$\Delta$ 3-Carene	tr		Monoterpene
$\alpha$ -Terpinene	0.16	0.16	Monoterpene
ortho-Cymene	0.01	0.17*	Simple phenolic
para-Cymene	0.05	[0.17]*	Monoterpene
Limonene	43.66*	43.53	Monoterpene
$\beta$ -Phellandrene	[43.66]*	0.21*	Monoterpene
1,8-Cineole	[43.66]*	[0.21]*	Monoterpenic ether
(Z)- $\beta$ -Ocimene	0.02	7.72*	Monoterpene
(E)- $\beta$ -Ocimene	0.26	0.25	Monoterpene
$\gamma$ -Terpinene	7.69	[7.72]*	Monoterpene
cis-Sabinene hydrate	0.03	0.03	Monoterpenic alcohol
Terpinolene	0.33*	0.34	Monoterpene
trans-Linalool oxide (fur.)	[0.33]*	tr	Monoterpenic alcohol
Linalool	6.81*	6.83	Monoterpenic alcohol
Nonanal	[6.81]*	0.03	Aliphatic aldehyde
cis-Limonene oxide	tr	tr	Monoterpenic ether
trans-Limonene oxide	tr	tr	Monoterpenic ether
Camphor	tr	tr	Monoterpenic ketone
Citronellal	0.02	0.02	Monoterpenic aldehyde
Terpinen-4-ol	0.04	0.04	Monoterpenic alcohol
$\alpha$ -Terpineol	0.22	0.27	Monoterpenic alcohol
Decanal	0.06	0.06	Aliphatic aldehyde
Octyl acetate	0.12	0.11	Aliphatic ester
Citronellol	0.06*	0.01	Monoterpenic alcohol
Nerol	[0.06]*	0.05	Monoterpenic alcohol
Neral	0.24	0.25	Monoterpenic aldehyde
Linalyl acetate	25.89*	25.93*	Monoterpenic ester
Geraniol	[25.89]*	0.05	Monoterpenic alcohol
Unknown	[25.89]*		Unknown
Geranial	0.38	0.36	Monoterpenic aldehyde
Bornyl acetate	0.02	[25.93]*	Monoterpenic ester
cis-para-Mentha-2,8-diene-1-hydroperoxide	0.01		Monoterpenic peroxide
trans-para-Mentha-2,8-diene-1-hydroperoxide	0.02		Monoterpenic peroxide
para-Mentha-1,8-diene-4-hydroperoxide	tr		Monoterpenic peroxide
Linalyl propionate	0.02	0.01	Monoterpenic ester

$\alpha$ -Terpinyl acetate	0.19	0.19	Monoterpenic ester
Unknown	0.01		Monoterpenic ester
Neryl acetate	0.48	0.48*	Monoterpenic ester
Geranyl acetate	0.53	0.54	Monoterpenic ester
Dodecanal	0.01	0.02	Aliphatic aldehyde
$\beta$ -Caryophyllene	0.43*	0.71*	Sesquiterpene
<i>cis</i> - $\alpha$ -Bergamotene	[0.43]*	[25.93]*	Sesquiterpene
<i>trans</i> - $\alpha$ -Bergamotene	0.35	[0.71]*	Sesquiterpene
$\alpha$ -Humulene	0.03	0.03	Sesquiterpene
( <i>E</i> )- $\beta$ -Farnesene	0.07	0.06	Sesquiterpene
Germacrene D	0.06	0.06	Sesquiterpene
( <i>Z</i> )- $\alpha$ -Bisabolene	tr	tr	Sesquiterpene
Hodiendiol derivative II	0.05		Oxygenated monoterpene
$\beta$ -Bisabolene	0.51	[0.48]*	Sesquiterpene
( <i>E</i> )-Nerolidol	0.02	0.02	Sesquiterpenic alcohol
$\alpha$ -Bisabolol	0.03	0.03	Sesquiterpenic alcohol
Nootkatone	0.08	0.08	Sesquiterpenic ketone
Citropten	0.14		Furanocoumarin
Unknown	0.16		Unknown
Bergapten	0.16		Furanocoumarin
Linoleic acid	0.10		Aliphatic acid
<b>Total identified</b>	<b>98.25%</b>	<b>97.62%</b>	

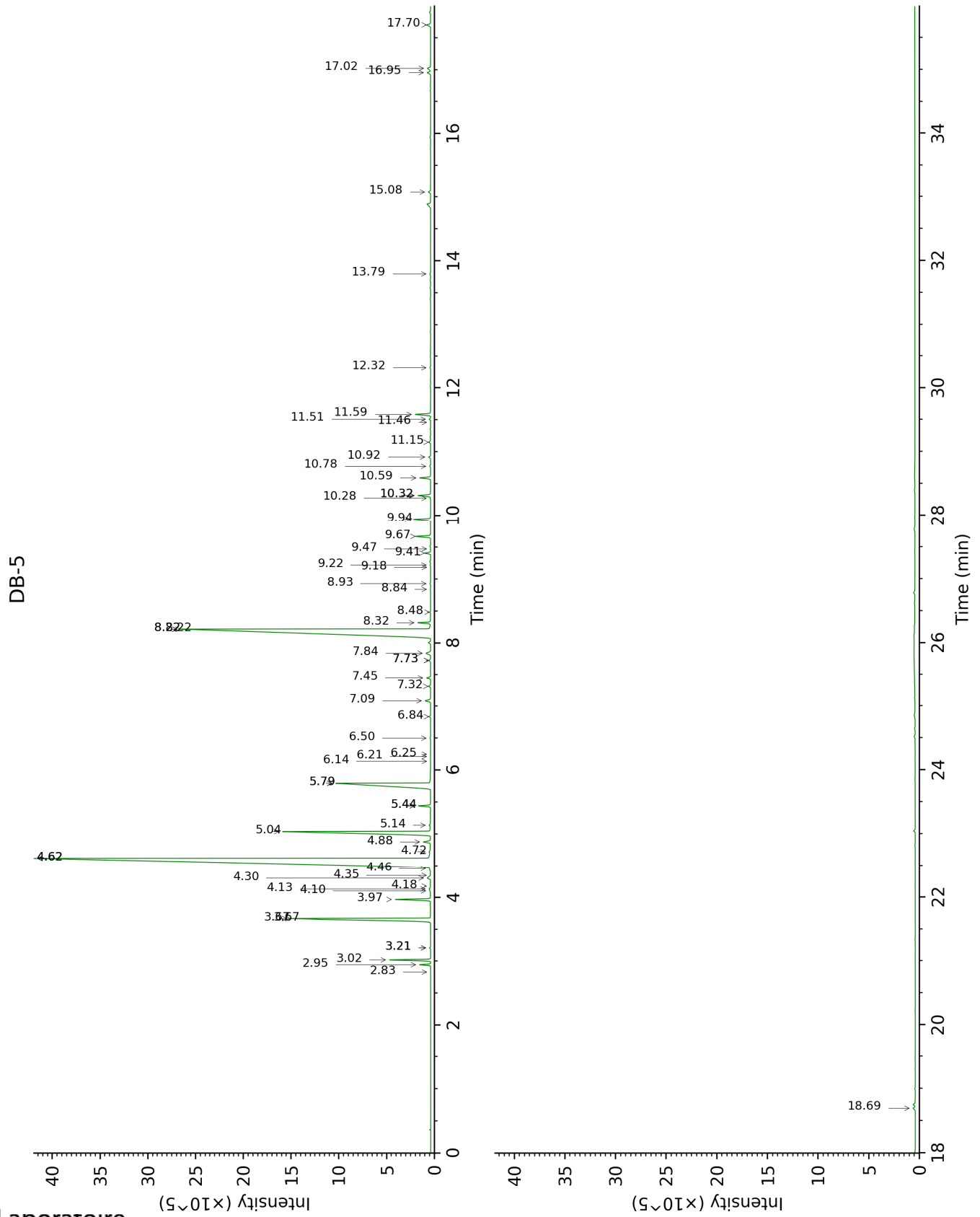
\*: Two or more compounds are coeluting on this column

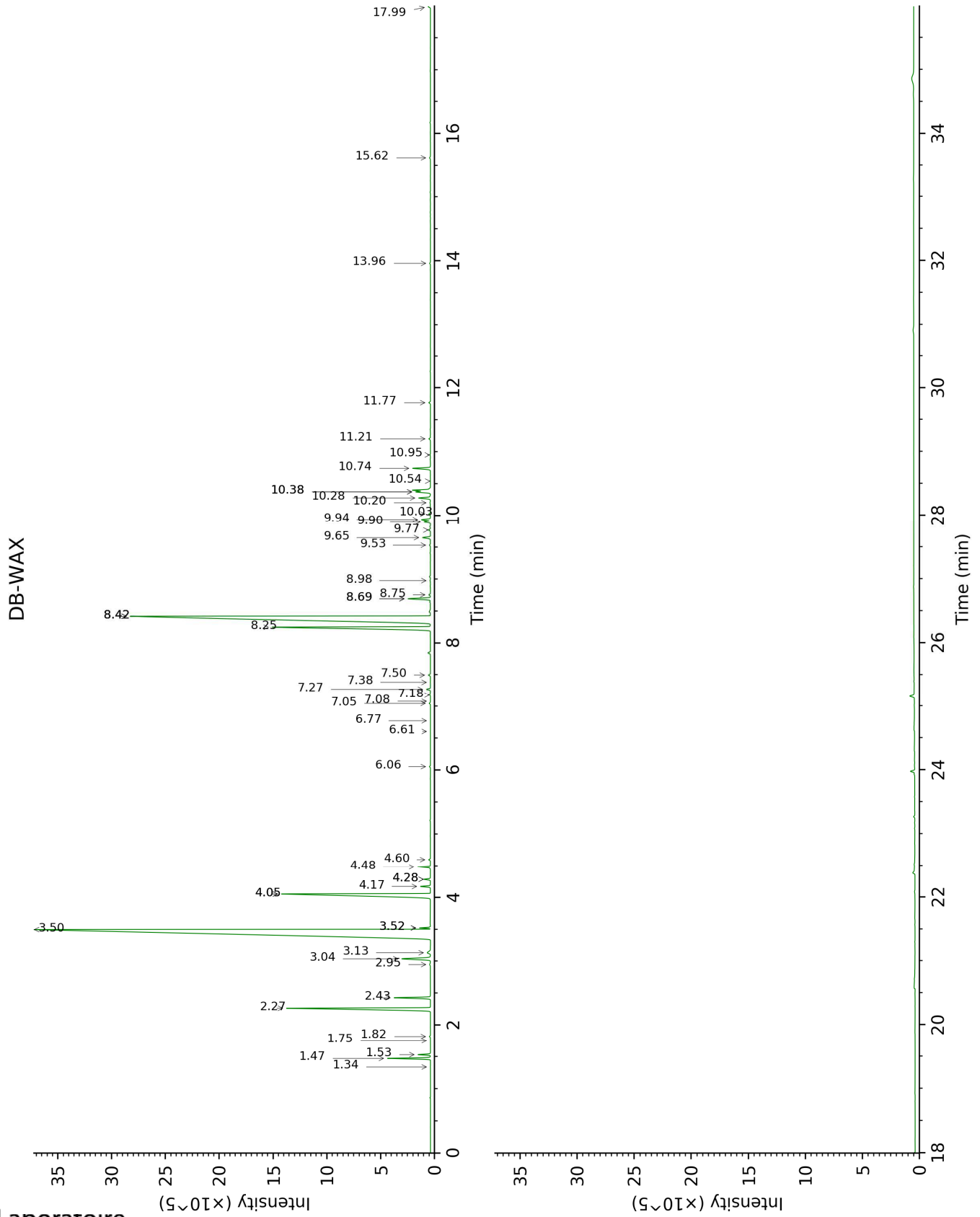
[xx]: Duplicate percentage due to coelutions, not taken account in the identified total

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

Note: no correction factor was applied

This page was intentionally left blank. The following pages present the complete data of the analysis.





FULL ANALYSIS DATA

Identification	Column DB-5			Column DB-WAX		
	R.T	R.I	%	R.T	R.I	%
Tricyclene	2.83	915	tr	1.34	976	tr
$\alpha$ -Thujene	2.95	923	0.28	1.53	1003	0.29
$\alpha$ -Pinene	3.02	928	1.06	1.47	996	1.07
$\alpha$ -Fenchene	3.21*	940	0.03	1.75	1024	tr
Camphene	3.21*	940	[0.03]	1.82	1030	0.03
$\beta$ -Pinene	3.67*	971	6.39	2.26	1073	5.47
Sabinene	3.67*	971	[6.39]	2.43	1088	0.97
Myrcene	3.97	991	1.05	3.04	1137	1.06
$\alpha$ -Phellandrene	4.10	1000	0.03	2.95	1130	0.03
Octanal	4.13	1002	0.05	4.60	1252	0.04
$\Delta$ 3-Carene	4.18	1005	tr			
$\alpha$ -Terpinene	4.30	1013	0.16	3.13	1144	0.16
ortho-Cymene	4.35	1015	0.01	4.28*	1230	0.17
para-Cymene	4.46	1022	0.05	4.28*	1230	[0.17]
Limonene	4.62*	1032	43.66	3.50	1172	43.53
$\beta$ -Phellandrene	4.62*	1032	[43.66]	3.52*	1174	0.21
1,8-Cineole	4.62*	1032	[43.66]	3.52*	1174	[0.21]
(Z)- $\beta$ -Ocimene	4.72	1039	0.02	4.05*	1213	7.72
(E)- $\beta$ -Ocimene	4.88	1049	0.26	4.17	1222	0.25
$\gamma$ -Terpinene	5.04	1059	7.69	4.05*	1213	[7.72]
<i>cis</i> -Sabinene hydrate	5.14	1065	0.03	7.05	1428	0.03
Terpinolene	5.44*	1084	0.33	4.48	1244	0.34
<i>trans</i> -Linalool oxide (fur.)	5.44*	1084	[0.33]	7.08	1430	tr
Linalool	5.80*	1107	6.81	8.25	1518	6.83
Nonanal	5.80*	1107	[6.81]	6.06	1356	0.03
<i>cis</i> -Limonene oxide	6.14	1129	tr	6.61	1395	tr
<i>trans</i> -Limonene oxide	6.21	1133	tr	6.77	1408	tr
Camphor	6.25	1136	tr	7.38	1453	tr
Citronellal	6.50	1152	0.02	7.18	1438	0.02
Terpinen-4-ol	6.84	1173	0.04	8.75	1557	0.04
$\alpha$ -Terpineol	7.09	1189	0.22	9.94	1651	0.27
Decanal	7.32	1204	0.06	7.50	1461	0.06
Octyl acetate	7.45	1213	0.12	7.27	1445	0.11
Citronellol	7.73*	1232	0.06	10.95	1734	0.01
Nerol	7.73*	1232	[0.06]	11.20	1756	0.05
Neral	7.84	1239	0.24	9.65	1627	0.25
Linalyl acetate	8.22*	1264	25.89	8.42*	1531	25.93
Geraniol	8.22*	1264	[25.89]	11.77	1804	0.05
Unknown [m/z 43, 111 (47), 93 (41), 55 (28), 67 (23), 41 (22)...]	8.22*	1264	[25.89]			
Geranial	8.32	1271	0.38	10.28	1678	0.36
Bornyl acetate	8.48	1282	0.02	8.42*	1531	[25.93]



<i>cis</i> -para-Mentha-2,8-diene-1-hydroperoxide	8.84	1306	0.01			
<i>trans</i> -para-Mentha-2,8-diene-1-hydroperoxide	8.93	1313	0.02			
para-Mentha-1,8-diene-4-hydroperoxide	9.18	1331	tr			
Linalyl propionate	9.22	1333	0.02	8.98	1574	0.01
$\alpha$ -Terpinyl acetate	9.41	1346	0.19	9.90	1647	0.19
Unknown [m/z 43, 121 (52), 93 (48), 79 (33), 41 (30), 136 (26), 81 (25)...]	9.47	1351	0.01			
Neryl acetate	9.67	1365	0.48	10.38*	1686	0.48
Geranyl acetate	9.94	1384	0.53	10.74	1717	0.54
Dodecanal	10.28	1408	0.01	10.20	1672	0.02
$\beta$ -Caryophyllene	10.32*	1411	0.43	8.69*	1552	0.71
<i>cis</i> - $\alpha$ -Bergamotene	10.32*	1411	[0.43]	8.42*	1531	[25.93]
<i>trans</i> - $\alpha$ -Bergamotene	10.59	1432	0.35	8.69*	1552	[0.71]
$\alpha$ -Humulene	10.78	1445	0.03	9.53	1618	0.03
( <i>E</i> )- $\beta$ -Farnesene	10.92	1456	0.07	9.77	1637	0.06
Germacrene D	11.15	1473	0.06	10.03	1658	0.06
( <i>Z</i> )- $\alpha$ -Bisabolene	11.46	1496	tr	10.54	1700	tr
Hodiendiol derivative II	11.51	1500	0.05			
$\beta$ -Bisabolene	11.59	1506	0.51	10.38*	1686	[0.48]
( <i>E</i> )-Nerolidol	12.32	1563	0.02	13.96	2002	0.02
$\alpha$ -Bisabolol	13.80	1683	0.03	15.62	2164	0.03
Nootkatone	15.08	1793	0.08	17.99	2415	0.08
Citropten	16.96	1966	0.14			
Unknown [m/z 266, 43 (89), 44 (67), 176 (49), 207 (44), 55 (38)...]	17.02	1972	0.16			
Bergapten	17.70	2038	0.16			
Linoleic acid	18.69	2138	0.10			
<b>Total identified</b>		<b>98.25%</b>			<b>97.62%</b>	
<b>Total reported</b>		<b>98.41%</b>			<b>97.62%</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

R.T.: Retention time (minutes)

R.I.: Retention index