

**Date :** March 29, 2018

**CERTIFICATE OF ANALYSIS - GC PROFILING**

*SAMPLE IDENTIFICATION*

**Internal code :** 18C20-ALZ1-1-CC

**Customer identification :** Tee Tree

**Type :** Essential oil

**Source :** *Melaleuca alternifolia* ct. Terpinen-4-ol

**Customer :** Aliz Liu

*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 :** Sylvain Mercier, M. Sc., Chimiste

**Analysis date :** March 27, 2018

Checked and approved by :

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

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*PHYSICOCHEMICAL DATA*

**Physical aspect:** Clear liquid

**Refractive index:**  $1.4780 \pm 0.0003$  (20 °C)

*CONCLUSION*

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

ANALYSIS SUMMARY

Identification	DB-5 (%)	DB-WAX (%)	Classe
Ethanol	0.15	0.17	Aliphatic alcohol
Isobutyral	0.02	0.03	Aliphatic aldehyde
Ethyl acetate	0.01	tr	Aliphatic ester
Isobutanol	tr	0.71*	Aliphatic alcohol
Isovaleral	tr	tr	Aliphatic aldehyde
2-Methylbutyral	0.02	0.02	Aliphatic aldehyde
Isoamyl alcohol	tr	0.01*	Aliphatic alcohol
2-Methylbutanol	tr	[0.01]*	Aliphatic alcohol
Isobutyric acid	0.01		Aliphatic acid
(3Z)-Hexenol	0.05	0.06	Aliphatic alcohol
$\alpha$ -Thujene	0.89	0.89	Monoterpene
$\alpha$ -Pinene	2.43	2.43	Monoterpene
$\alpha$ -Fenchene	tr	tr	Monoterpene
Camphene	0.01	0.01	Monoterpene
Thuja-2,4(10)-diene	tr	0.28*	Monoterpene
Sabinene	0.99*	[0.28]*	Monoterpene
$\beta$ -Pinene	[0.99]*	[0.71]*	Monoterpene
3-Methyl-3-cyclohexenone?	0.01	0.01*	Aliphatic ketone
Myrcene	0.84	0.83	Monoterpene
Pseudolimonene	0.46*	0.01	Monoterpene
Menthatriene isomer I	[0.46]*	[0.01]*	Monoterpene
$\alpha$ -Phellandrene	[0.46]*	0.44	Monoterpene
(3Z)-Hexenyl acetate	0.02	0.03	Aliphatic ester
$\alpha$ -Terpinene	9.32	9.34	Monoterpene
para-Cymene	2.40	2.42	Monoterpene
Limonene	3.91*	0.85	Monoterpene
1,8-Cineole	[3.91]*	3.04	Monoterpenic ether
(Z)- $\beta$ -Ocimene	tr	19.95*	Monoterpene
(E)- $\beta$ -Ocimene	0.01	0.02	Monoterpene
$\gamma$ -Terpinene	19.95	[19.95]*	Monoterpene
cis-Sabinene hydrate	0.05	0.06	Monoterpenic alcohol
para-Cymenene	3.36*	0.06	Monoterpene
Terpinolene	[3.36]*	3.30	Monoterpene
trans-Sabinene hydrate	0.04	0.04	Monoterpenic alcohol
Linalool	0.07	0.07	Monoterpenic alcohol
para-Mentha-1,3,8-triene	0.01	[0.01]*	Monoterpene
endo-Fenchol	0.01	0.01	Monoterpenic alcohol
cis-para-Menth-2-en-1-ol	0.31	0.31	Monoterpenic alcohol
Cosmene isomer I	0.01	0.01	Monoterpene
trans-Pinocarveol	0.01	0.01	Monoterpenic alcohol
Unknown	0.21	0.02	Unknown
trans-para-Menth-2-en-1-ol	[0.21]	0.33*	Monoterpenic alcohol
Borneol	tr	3.02*	Monoterpenic alcohol
$\delta$ -Terpineol	0.01	0.01*	Monoterpenic alcohol
Terpinen-4-ol	41.76*	42.19*	Monoterpenic alcohol
Dill ether	[41.76]*	0.01	Monoterpenic ether
para-Cymen-8-ol	[41.76]*	tr	Monoterpenic alcohol
$\alpha$ -Terpineol	3.00	[3.02]*	Monoterpenic alcohol

<i>cis</i> -Piperitol	0.16	0.15*	Monoterpenic alcohol
<i>trans</i> -Piperitol	0.13	0.25*	Monoterpenic alcohol
exo-2-Hydroxycineole	0.01	0.02	Monoterpenic alcohol
<i>cis</i> -para-Mentha-1(7),8-dien-2-ol	tr	0.01	Monoterpenic alcohol
Unknown	0.02	0.11*	Oxygenated monoterpene
Piperitone	0.06	0.10	Monoterpenic ketone
<i>cis</i> -Carvenone oxide?	0.01		Monoterpenic ketone
<i>trans</i> -Ascaridole glycol	0.06	0.05	Monoterpenic alcohol
<i>cis</i> -Ascaridole glycol?	0.03	0.04	Monoterpenic alcohol
Thymol	0.02	0.03	Monoterpenic alcohol
Carvacrol	0.01	0.01	Monoterpenic alcohol
Unknown	0.04	0.06	Monoterpenic alcohol
Bicycloelemene	0.02	0.02	Sesquiterpene
$\alpha$ -Cubebene	0.06	0.06	Sesquiterpene
Isoledene	0.06		Sesquiterpene
$\alpha$ -Copaene	0.10	0.10	Sesquiterpene
7-Cubebene	0.05	0.05	Sesquiterpene
7-Cubebene epimer?	0.02	0.03	Aliphatic alcohol
$\beta$ -Cubebene	0.01	0.04	Sesquiterpene
$\beta$ -Elemene	0.03	[42.19]*	Sesquiterpene
$\alpha$ -Gurjunene	0.31	0.30	Sesquiterpene
Methyleugenol	0.03	0.04	Phenylpropanoid
$\beta$ -Caryophyllene	0.35	[42.19]*	Sesquiterpene
$\gamma$ -Maaliene	0.06	[42.19]*	Sesquiterpene
$\beta$ -Gurjunene	0.02	0.02	Sesquiterpene
$\alpha$ -Maaliene	0.06	[42.19]*	Sesquiterpene
Aromadendrene	0.99	0.87	Sesquiterpene
Selina-5,11-diene	0.14	[42.19]*	Sesquiterpene
<i>trans</i> -Muuroala-3,5-diene	0.12	[0.33]*	Sesquiterpene
$\alpha$ -Humulene	0.11	0.08	Sesquiterpene
allo-Aromadendrene	0.48	0.48	Sesquiterpene
Valerena-4,7(11)-diene	0.03	0.05	Sesquiterpene
$\gamma$ -Gurjunene	0.04	0.05	Sesquiterpene
<i>trans</i> -Cadina-1(6),4-diene	0.26*	0.25	Sesquiterpene
Selina-4,11-diene	[0.26]*	[0.01]*	Sesquiterpene
$\gamma$ -Muurolole	0.03	0.03	Sesquiterpene
$\beta$ -Selinene	0.09	0.14*	Sesquiterpene
allo-Aromadendr-9-ene	0.11	[0.15]*	Sesquiterpene
<i>trans</i> -Muuroala-4(15),5-diene	0.08	[0.14]*	Sesquiterpene
$\delta$ -Selinene	0.10	0.83*	Sesquiterpene
Bicyclogermacrene	1.74*	0.90	Sesquiterpene
Epizonarene	[1.74]*	0.02	Sesquiterpene
$\alpha$ -Selinene	[1.74]*	0.08	Sesquiterpene
Viridiflorene	[1.74]*	[0.83]*	Sesquiterpene
$\alpha$ -Muurolole	0.13	0.12	Sesquiterpene
$\gamma$ -Cadinene	0.03	[0.25]*	Sesquiterpene
<i>trans</i> -Calamenene	1.38*	[0.11]*	Sesquiterpene
$\delta$ -Cadinene	[1.38]*	1.06*	Sesquiterpene
Zonarene	[1.38]*	[1.06]*	Sesquiterpene
<i>trans</i> -Cadina-1,4-diene	0.17	0.20	Sesquiterpene
$\alpha$ -Calacorene	0.01	0.02	Sesquiterpene
Eudesma-5,7(11)-diene	0.05	0.05	Sesquiterpene

Maaliol	0.03	0.04	Sesquiterpenic alcohol
Unknown	0.04*	0.01	Oxygenated sesquiterpene
Palustrol	[0.04]*	0.04	Sesquiterpenic alcohol
Unknown	[0.04]*	tr	Oxygenated sesquiterpene
Spathulenol	0.08	0.08	Sesquiterpenic alcohol
Globulol	0.22	0.23	Sesquiterpenic alcohol
Gleenol	0.03	0.03	Sesquiterpenic alcohol
Viridiflorol	0.11	0.12	Sesquiterpenic alcohol
Cubeban-11-ol	0.09	0.16*	Sesquiterpenic alcohol
Ledol	0.08	0.08	Sesquiterpenic alcohol
10-epi-Cubenol	0.01		Sesquiterpenic alcohol
Rosifoliol	0.09	0.10	Sesquiterpenic alcohol
1-epi-Cubenol	0.15	0.14	Sesquiterpenic alcohol
Isospathulenol	0.05	0.05	Sesquiterpenic alcohol
Cubenol	0.09	[0.16]*	Sesquiterpenic alcohol
$\alpha$ -Muurolol	0.04	0.04	Sesquiterpenic alcohol
<b>Total identified</b>	<b>99.18%</b>	<b>98.71%</b>	

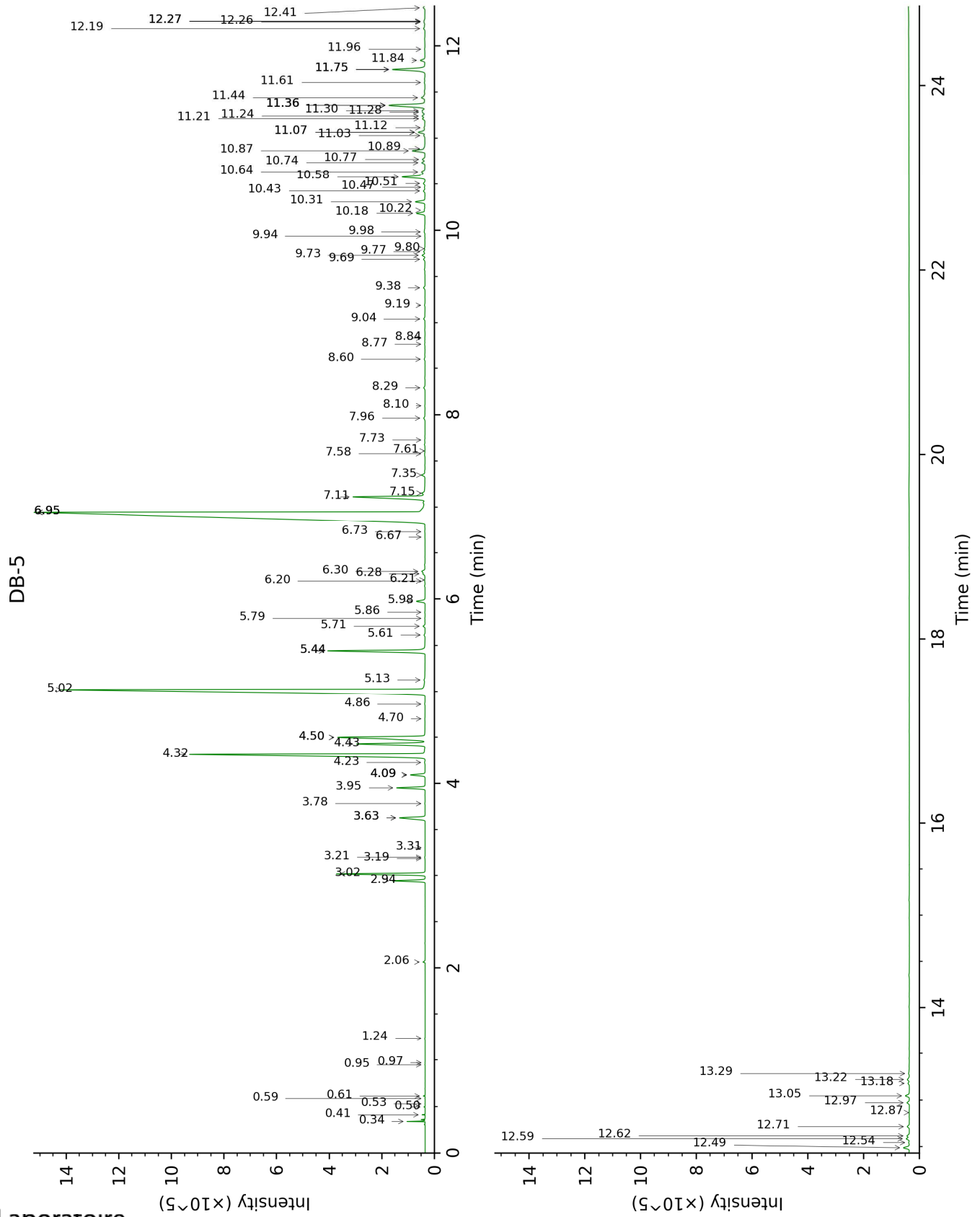
\*: Two or more compounds are coeluting on this column

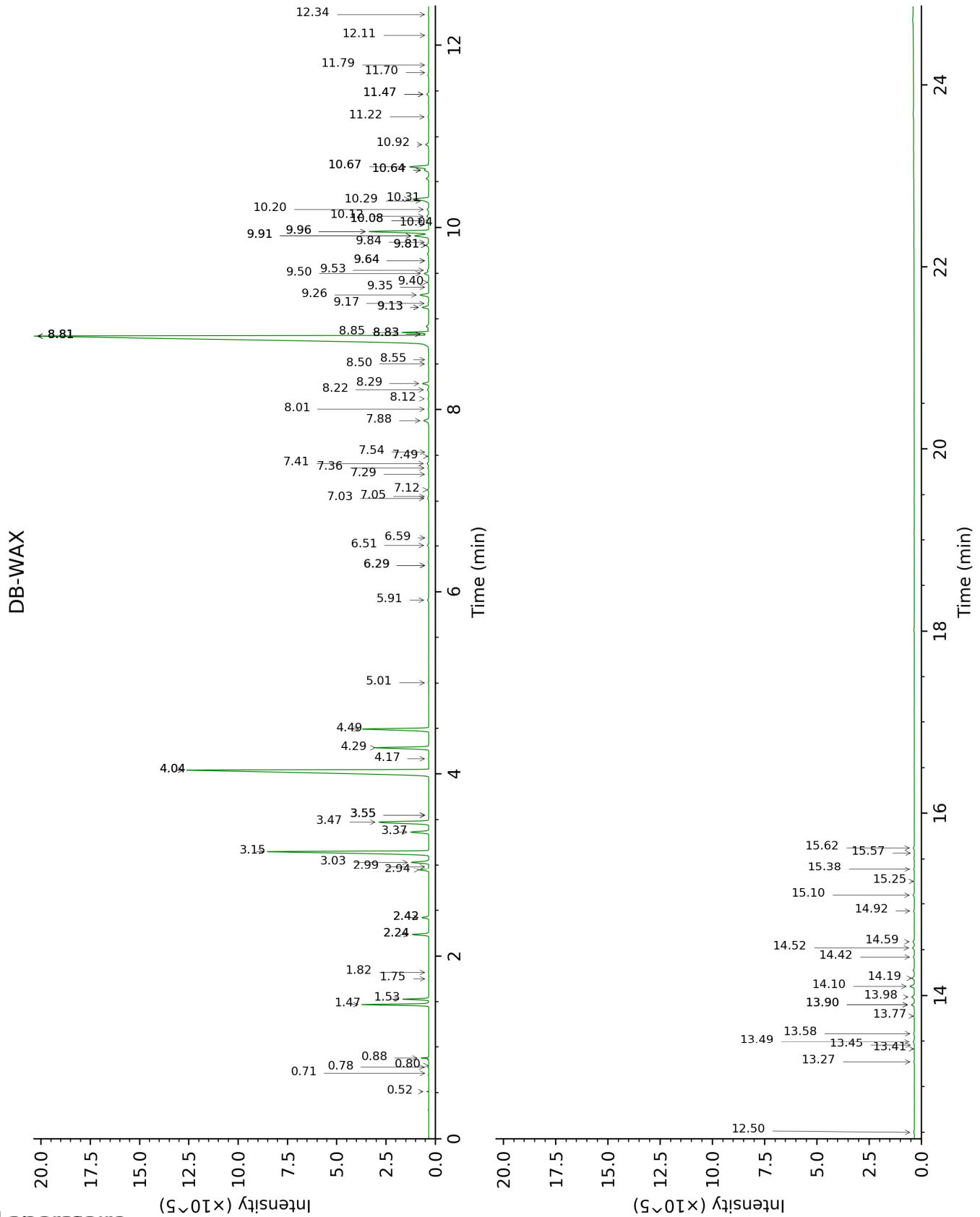
[xx]: Duplicate percentage due to coelutions, not taken account in the identified total

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	496	0.15	0.88	905	0.17
Isobutyral	0.41	538	0.02	0.52	776	0.03
Ethyl acetate	0.50	607	0.01	0.71	857	tr
Isobutanol	0.53	619	tr	2.24*	1070	0.71
Isovaleral	0.59	639	tr	0.80	886	tr
2-Methylbutyral	0.61	648	0.02	0.78	879	0.02
Isoamyl alcohol	0.95	728	tr	3.55*	1176	0.01
2-Methylbutanol	0.97	732	tr	3.55*	1176	[0.01]
Isobutyric acid	1.24	771	0.01			
(3Z)-Hexenol	2.06	854	0.05	5.91	1346	0.06
α-Thujene	2.94	922	0.89	1.53	1002	0.89
α-Pinene	3.02	927	2.43	1.47	996	2.43
α-Fenchene	3.19	939	tr	1.75	1024	tr
Camphene	3.20	940	0.01	1.82	1030	0.01
Thuja-2,4(10)-diene	3.31	947	tr	2.42*	1088	0.28
Sabinene	3.63*	968	0.99	2.42*	1088	[0.28]
β-Pinene	3.63*	968	[0.99]	2.24*	1070	[0.71]
3-Methyl-3-cyclohexenone?	3.78	979	0.01	6.29*	1373	0.01
Myrcene	3.95	990	0.84	3.03	1136	0.83
Pseudolimonene	4.09*	999	0.46	2.99	1133	0.01
Menthatriene isomer I	4.09*	999	[0.46]	3.55*	1176	[0.01]
α-Phellandrene	4.09*	999	[0.46]	2.94	1130	0.44
(3Z)-Hexenyl acetate	4.23	1008	0.02	5.01	1281	0.03
α-Terpinene	4.32	1013	9.32	3.15	1145	9.34
para-Cymene	4.43	1020	2.40	4.29	1230	2.42
Limonene	4.50*	1025	3.91	3.36	1162	0.85
1,8-Cineole	4.50*	1025	[3.91]	3.47	1170	3.04
(Z)-β-Ocimene	4.70	1038	tr	4.04*	1212	19.95
(E)-β-Ocimene	4.86	1048	0.01	4.17	1221	0.02
γ-Terpinene	5.02	1058	19.95	4.04*	1212	[19.95]
cis-Sabinene hydrate	5.13	1064	0.05	7.12	1434	0.06
para-Cymenene	5.44*	1084	3.36	6.51	1388	0.06
Terpinolene	5.44*	1084	[3.36]	4.49	1244	3.30
trans-Sabinene hydrate	5.61	1095	0.04	8.12	1508	0.04
Linalool	5.71	1101	0.07	8.22	1515	0.07
para-Mentha-1,3,8-triene	5.79	1106	0.01	6.29*	1373	[0.01]
endo-Fenchol	5.86	1111	0.01	8.55	1541	0.01
cis-para-Menth-2-en-1-ol	5.98	1118	0.31	8.29	1521	0.31
Cosmene isomer I	6.20	1132	0.01	6.59	1394	0.01
trans-Pinocarveol	6.21	1133	0.01	9.35	1603	0.01

Unknown [m/z 109, 124 (45), 119 (41), 43 (35), 91 (28), 95 (25)...]	6.28†	1137	0.21	7.05	1428	0.02
<i>trans</i> -para-Menth-2-en-1-ol	6.30†	1139	[0.21]	9.13*	1586	0.33
Borneol	6.67	1163	tr	9.96*	1652	3.02
δ-Terpineol	6.73	1166	0.01	9.64*	1626	0.01
Terpinen-4-ol	6.95*	1180	41.76	8.81*†	1561	42.19
Dill ether	6.95*	1180	[41.76]	7.54	1464	0.01
para-Cymen-8-ol	6.95*	1180	[41.76]	11.70	1798	tr
α-Terpineol	7.11	1191	3.00	9.96*	1652	[3.02]
<i>cis</i> -Piperitol	7.15	1194	0.16	9.81*	1640	0.15
<i>trans</i> -Piperitol	7.35	1206	0.13	10.64*	1708	0.25
exo-2-Hydroxycineole	7.58	1222	0.01	11.79	1805	0.02
<i>cis</i> -para-Mentha-1(7),8-dien-2-ol	7.61	1224	tr	12.11	1834	0.01
Unknown [m/z 137, 152 (28), 43 (25), 91 (24), 109 (23), 119 (19)]	7.73	1232	0.02	11.47*	1778	0.11
Piperitone	7.96	1247	0.06	10.12	1666	0.10
<i>cis</i> -Carvenone oxide?	8.10	1256	0.01			
<i>trans</i> -Ascaridole glycol	8.29	1269	0.06	14.42	2046	0.05
<i>cis</i> -Ascaridole glycol?	8.60	1290	0.03	14.92	2095	0.04
Thymol	8.77	1301	0.02	15.25	2127	0.03
Carvacrol	8.84	1306	0.01	15.57	2159	0.01
Unknown [m/z 97, 112 (92), 83 (62), 43 (44), 41 (25)... 170? (4)]	9.04	1321	0.04	15.10	2112	0.06
Bicycloelemene	9.19	1331	0.02	7.29	1446	0.02
α-Cubebene	9.38	1344	0.06	7.03	1427	0.06
Isoledene	9.69	1366	0.06			
α-Copaene	9.73	1369	0.10	7.41	1455	0.10
7-Cubebene	9.77	1372	0.05	7.36	1451	0.05
7-Cubebene epimer?	9.80	1374	0.02	7.49	1461	0.03
β-Cubebene	9.94	1384	0.01	8.01	1499	0.04
β-Elemene	9.98	1387	0.03	8.81*†	1561	[42.19]
α-Gurjunene	10.18	1401	0.31	7.88	1490	0.30
Methyleugenol	10.22	1404	0.03	13.58	1967	0.04
β-Caryophyllene	10.31	1410	0.35	8.81*†	1561	[42.19]
γ-Maaliene	10.43	1419	0.06	8.81*†	1561	[42.19]
β-Gurjunene	10.47	1422	0.02	8.50	1537	0.02
α-Maaliene	10.51	1425	0.06	8.83*†	1563	[42.19]
Aromadendrene	10.58	1430	0.99	8.85	1564	0.87
Selina-5,11-diene	10.64	1435	0.14	8.83*†	1563	[42.19]

<i>trans</i> -Muurola-3,5-diene	10.74	1442	0.12	9.13*	1586	[0.33]
$\alpha$ -Humulene	10.77	1445	0.11	9.53	1618	0.08
allo-Aromadendrene	10.87	1452	0.48	9.26	1596	0.48
Valerena-4,7(11)-diene	10.89	1454	0.03	9.17	1589	0.05
$\gamma$ -Gurjunene	11.03	1464	0.04	9.40	1607	0.05
<i>trans</i> -Cadina-1(6),4-diene	11.07*	1467	0.26	9.50	1615	0.25
Selina-4,11-diene	11.07*	1467	[0.26]	9.64*	1626	[0.01]
$\gamma$ -Muurolene	11.12	1470	0.03	9.84	1643	0.03
$\beta$ -Selinene	11.21	1478	0.09	10.08*	1662	0.14
allo-Aromadendr-9-ene	11.24	1480	0.11	9.81*	1640	[0.15]
<i>trans</i> -Muurola-4(15),5-diene	11.28	1483	0.08	10.08*	1662	[0.14]
$\delta$ -Selinene	11.30	1484	0.10	9.91*	1648	0.83
Bicyclogermacrene	11.36*	1488	1.74	10.31	1681	0.90
Epizonarene	11.36*	1488	[1.74]	10.04	1659	0.02
$\alpha$ -Selinene	11.36*	1488	[1.74]	10.20	1672	0.08
Viridiflorene	11.36*	1488	[1.74]	9.91*	1648	[0.83]
$\alpha$ -Muurolene	11.44	1495	0.13	10.29	1679	0.12
$\gamma$ -Cadinene	11.60	1507	0.03	10.64*	1708	[0.25]
<i>trans</i> -Calamenene	11.75*	1518	1.38	11.47*	1778	[0.11]
$\delta$ -Cadinene	11.75*	1518	[1.38]	10.67*	1711	1.06
Zonarene	11.75*	1518	[1.38]	10.67*	1711	[1.06]
<i>trans</i> -Cadina-1,4-diene	11.84	1526	0.17	10.92	1731	0.20
$\alpha$ -Calacorene	11.96	1535	0.01	12.34	1854	0.02
Eudesma-5,7(11)-diene	12.19	1553	0.05	11.22	1757	0.05
Maaliol	12.26	1558	0.03	13.27	1938	0.04
Unknown [m/z 107, 163 (88), 59 (60), 93 (49), 43 (47), 81 (46... 204 (5)...]	12.27*	1559	0.04	13.41	1951	0.01
Palustrol	12.27*	1559	[0.04]	12.50	1868	0.04
Unknown [m/z 161, 109 (98), 82 (93), 43 (72), 105 (68), 93 (59), 69 (56), 119 (55)... 222 (7)]	12.27*	1559	[0.04]	13.45	1955	tr
Spathulenol	12.41	1571	0.08	14.59	2062	0.08
Globulol	12.49	1576	0.22	14.10	2016	0.23
Gleenol	12.54	1581	0.03	13.77	1984	0.03
Viridiflorol	12.58	1584	0.11	14.19	2024	0.12
Cubeban-11-ol	12.62	1586	0.09	13.90*	1996	0.16
Ledol	12.72	1594	0.08	13.49	1958	0.08
10-epi-Cubenol	12.87	1606	0.01			

Rosifoliol	12.97	1615	0.09	14.52	2056	0.10
1-epi-Cubenol	13.05	1621	0.15	13.98	2004	0.14
Isospathulenol	13.18	1632	0.05	15.62	2164	0.05
Cubenol	13.22	1636	0.09	13.90*	1996	[0.16]
$\alpha$ -Muurolol	13.28	1641	0.04	15.38	2141	0.04
<b>Total identified</b>		<b>99.18%</b>			<b>98.71%</b>	
<b>Total reported</b>		<b>99.31%</b>			<b>98.80%</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