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Supplementary Materials

Research Article

The chemical compositions of *Abies* foliar essential oils from the western United States

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Table S1. Instrument details for the gas chromatographic analyses of *Abies* species.

Gas Chromatography - Mass Spectrometry (GC-MS)	
Instrument	Shimadzu GC-MS-QP2010 Ultra (Shimadzu Scientific Instruments, Columbia, MD, USA)
GC Column	Zebron ZB-5ms fused silica capillary column (60 m × 0.25 mm × 0.25 μm film thickness) (Phenomenex, Torrance, CA, USA)
MS Detector Conditions	Electron impact (EI) mode, electron energy = 70 eV, a scan = 40–400 atomic mass units, scan rate = 3.0 scans/second
Carrier Gas, Conditions	Helium, column head pressure = 208.5 kPa, flow rate = 2.00 mL/min
Injector, Detector Temperatures	Injector temperature = 260 °C, interface temperature = 260 °C, ion source temperature = 260 °C
GC Oven Temperature Program	Initial temperature = 50 °C, ramp 2 °C/min to 260 °C, hold 260 °C for 5 min
Sample Concentration, Volume Injected	5% (in dichloromethane), 0.1 μL volume
Split Mode	24.5 : 1.0
Chiral Gas Chromatography - Mass Spectrometry	
Instrument	Shimadzu GCMS-QP2010S (Shimadzu Scientific Instruments, Columbia, MD, USA)
GC Column	Restek B-Dex 325 chiral GC column (30 m × 0.25 mm × 0.25 μm film thickness) (Restek Corp., Bellefonte, PA, USA)
MS Detector Conditions	Electron impact (EI) mode, electron energy = 70 eV, a scan = 40–400 atomic mass units, scan rate = 3.0 scans/second
Carrier Gas, Conditions	Helium, column head pressure = 53.6 kPa, flow rate = 1.00 mL/min
Injector, Detector Temperatures	Injector temperature = 240 °C, interface temperature = 240 °C, ion source temperature = 240 °C
GC Oven Temperature Program	Initial temperature = 50 °C, hold for 5 min, ramp 1 °C/min to 100 °C, ramp 2 °C/min to 220 °C
Sample Concentration, Volume Injected	5% (in dichloromethane), 0.3 μL volume
Split Mode	24.0 : 1.0

Table S2. Foliar essential oil composition of *Abies amabilis* from Mt. Hood, Oregon.

RI_{calc}	RI_{db}	Compounds	*A. amabilis* #1	*A. amabilis* #1
849	849	(2*E*)-Hexenal	0.2	0.4
881	880	Santene	tr	tr
923	923	Tricyclene	tr	tr
925	925	α-Thujene	0.1	0.1
933	933	α-Pinene	11.1	8.2
947	948	α-Fenchene	tr	tr
949	950	Camphene	0.2	0.1
971	970	3,7,7-Trimethylcyclohepta-1,3,5-triene	tr	tr
972	971	Sabinene	0.3	0.2
977	978	β-Pinene	20.9	12.1
989	989	Myrcene	3.0	3.3
1005	1004	*p*-Mentha-1(7),8-diene	tr	tr
1008	1006	α-Phellandrene	1.1	0.9
1010	1008	δ-3-Carene	22.4	22.1
1015	1015	1,4-Cineole	tr	tr
1017	1017	α-Terpinene	0.2	0.2
1025	1025	*p*-Cymene	0.2	0.2
1030	1030	Limonene	4.2	14.3
1032	1031	β-Phellandrene	16.1	10.6
1035	1034	(*Z*)-β-Ocimene	0.6	0.7
1046	1045	(*E*)-β-Ocimene	0.4	0.4
1058	1057	γ-Terpinene	0.4	0.4
1081	1082	*p*-Mentha-2,4(8)-diene	0.1	0.1
1085	1086	Terpinolene	2.1	2.0
1088	1090	Fenchone	tr	tr
1089	1091	*p*-Cymenene	tr	tr
1100	1101	Linalool	0.1	tr
1100	1100	Undecane	0.1	tr
1108	1108	Maltol	tr	0.1
1124	1124	*cis-p*-Menth-2-en-1-ol	0.1	0.1
1126	1126	α-Campholenal	tr	tr
1128	1128	*allo*- Ocim-(4*E*,6*Z*)-ene	tr	tr
1142	1142	*trans-p*-Menth-2-en-1-ol	0.1	0.1
1176	1178	Benzoic acid	2.3	2.0
1179	1179	2-Isopropenyl-5-methyl-4-hexenal	0.1	-
1179	1180	Octanoic acid	-	0.1
1181	1180	Terpinen-4-ol	0.3	0.3
1187	1187	Cryptone	0.1	0.1
1196	1195	α-Terpineol	1.3	1.4
1229	1229	Thymyl methyl ether	0.3	0.2
1254	1254	Piperitone	tr	tr
1277	1277	Phellandral	tr	tr
1293	1293	2-Undecanone	0.2	0.5
1376	1375	α-Copaene	tr	tr
1389	1390	*trans*-β-Elemene	0.1	0.1
1394	1396	(2*E*)-Dodecenal	tr	tr
1402	1403	Methyl eugenol	tr	0.1
1409	1409	Dodecanal	0.3	0.4
1419	1417	(*E*)-β-Caryophyllene	0.6	0.2
1429	1427	γ-Elemene	0.2	0.2
1452	1452	(*E*)-β-Farnesene	tr	tr
1455	1454	α-Humulene	0.2	0.1
1475	1475	γ-Muurolene	0.1	0.2
1481	1480	Germacrene D	0.4	0.9

Table S2. *(Continued).*

RI_{calc}	RI_{db}	Compounds	*A. amabilis* #1	*A. amabilis* #1
1489	1489	β-Selinene	0.2	0.2
1490	1489	(*Z*,*E*)-α-Farnesene	0.1	0.2
1492	1492	*trans*-Muurola-4(14),5-diene	tr	tr
1494	1494	β-Alaskene	tr	-
1495	1495	2-Tridecanone	0.1	0.1
1496	1497	α-Selinene	0.1	0.2
1498	1497	α-Muurolene	tr	0.1
1504	1504	(*E*,*E*)-α-Farnesene	0.1	0.2
1507	1508	β-Bisabolene	0.2	0.1
1510	1511	(*Z*)-γ-Bisabolene	tr	tr
1513	1512	γ-Cadinene	0.1	0.2
1518	1518	δ-Cadinene	0.2	0.5
1537	1538	α-Cadinene	tr	0.1
1558	1557	Germacrene B	0.4	0.4
1561	1560	(*E*)-Nerolidol	0.2	0.3
1613	1613	Tetradecanal	0.4	0.2
1633	1632	γ-Eudesmol	0.1	0.2
1656	1655	α-Eudesmol	0.4	0.6
1687	1688	α-Bisabolol	0.7	0.3
1765	1769	Benzyl benzoate	tr	tr
1803	1802	(9*Z*)-Hexadecenal	0.3	0.1
1816	1817	Hexadecanal	0.1	0.1
1897	1896	Rimuene	tr	tr
1921	1923	Cembrene	0.1	-
1933	1933	Beyerene	tr	tr
1936	1934	(3*Z*)-Cembrene A	tr	-
1937	1938	Hexadecanolact-16-one	-	0.1
1960	1958	Palmitic acid	1.0	2.5
1991	1989	Manoyl oxide	0.2	0.2
2009	2012	Verticilla 4(20),7,11-triene	0.1	0.1
2012	2015	13-*epi*-Manoyl oxide	0.1	0.1
2051	2049	Abietatriene	tr	tr
2053	2053	Manool	0.1	0.1
2085	2089	Abietadiene	0.1	0.1
2130	2128	(*Z*,*Z*)-Linoleic acid	0.3	1.5
2139	2140	(*Z*)-Oleic acid	2.8	6.2
2144	2141	(*E*)-Oleic acid	0.6	-
2147	2147	Abienol	0.4	1.6
2230	2245	Palustral	0.1	0.2
		Compound classes		
		Monoterpene hydrocarbons	83.4	75.9
		Oxygenated monoterpenoids	2.4	2.3
		Sesquiterpene hydrocarbons	2.9	3.8
		Oxygenated sesquiterpenoids	1.5	1.4
		Diterpenoids	1.2	2.4
		Benzenoid aromatics	2.3	2.1
		Others	6.3	12.1
		Total identified	***100.0***	***100.0***

RI_{calc} = Retention index determined with respect to a homologous series of *n*-alkanes on a ZB-5ms column. RI_{db} = Reference retention index from the databases. tr = trace (< 0.05%).

Table S3. Foliar essential oil composition of *Abies concolor* subsp. *lowiana* from Butte Meadows, California.

RI_{calc}	RI_{db}	Compounds	*A. concolor lowiana* #1	*A. concolor lowiana* #2	*A. concolor lowiana* #3	*A. concolor lowiana* #4
800	801	Hexanal	0.1	tr	0.1	tr
849	849	(2*E*)-Hexenal	0.5	0.3	0.2	tr
851	853	(3Z)-Hexenol	0.3	0.1	0.1	0.1
881	880	Santene	0.3	0.4	0.3	0.3
923	923	Tricyclene	0.5	0.4	0.2	0.3
925	925	α-Thujene	tr	tr	0.1	0.1
933	933	α-Pinene	7.3	7.4	6.4	12.2
947	948	α-Fenchene	0.1	0.1	0.1	0.1
949	950	Camphene	3.9	3.4	2.0	2.2
972	972	Sabinene	tr	0.1	0.1	0.1
978	978	β-Pinene	46.7	50.7	43.6	40.5
989	989	Myrcene	1.6	1.6	2.2	1.6
1005	1004	*p*-Mentha-1(7),8-diene	tr	tr	tr	tr
1007	1007	α-Phellandrene	0.1	0.1	0.4	0.3
1009	1009	δ-3-Carene	tr	tr	tr	0.8
1017	1017	α-Terpinene	0.1	0.1	0.2	0.2
1025	1025	*p*-Cymene	0.1	0.1	0.1	0.1
1029	1030	Limonene	2.6	3.3	2.1	2.2
1031	1031	β-Phellandrene	7.0	8.7	21.3	19.6
1058	1058	γ-Terpinene	0.1	0.1	0.2	0.2
1085	1086	Terpinolene	0.8	0.9	1.3	1.1
1090	1090	2-Nonanone	-	0.2	0.4	0.1
1096	1099	6-Camphenone	0.2	0.1	0.1	0.1
1100	1101	Linalool	0.1	0.2	-	-
1100	1100	Undecane	-	-	0.1	0.1
1120	1120	*endo*-Fenchol	0.1	0.1	0.1	tr
1125	1124	*cis-p*-Menth-2-en-1-ol	0.1	0.1	0.3	0.2
1128	1127	α-Campholenal	0.2	0.1	0.1	0.1
1131	1131	Terpin-3-en-1-ol	tr	tr	tr	tr
1139	1137	Nopinone	tr	tr	tr	-
1144	1142	*trans-p*-Menth-2-en-1-ol	0.1	tr	0.2	0.1
1144	1144	*neo-iso*-Pulegol	tr	tr	-	-
1148	1145	Camphor	0.1	tr	tr	tr
1153	1152	Citronellal	tr	tr	0.1	tr
1156	1156	Camphene hydrate	0.2	0.2	0.2	0.1
1163	1164	Pinocarvone	tr	tr	-	-
1177	1176	*cis*-Pinocamphone	0.1	tr	tr	0.1
1181	1180	Terpinen-4-ol	0.2	0.3	0.4	0.3
1188	1187	Cryptone	0.2	0.2	0.1	0.1
1196	1195	α-Terpineol	9.9	8.8	9.4	7.1
1207	1206	Decanal	tr	tr	0.4	0.2
1239	1238	Neral	0.2	0.2	tr	tr
1254	1254	Piperitone	-	0.1	0.1	0.1
1268	1268	Geranial	0.3	0.3	tr	tr
1276	1274	Cyclooctyl acetate	-	0.1	0.1	0.1
1285	1285	Bornyl acetate	4.2	2.2	0.8	1.8
1293	1293	2-Undecanone	-	0.2	0.2	0.2
1300	1300	Tridecane	-	-	-	tr
1349	1349	Citronellyl acetate	0.4	0.4	0.5	0.4
1358	1361	Neryl acetate	tr	0.1	tr	tr
1369	1370	α-Ylangene	0.1	tr	tr	tr
1378	1378	Geranyl acetate	0.6	0.8	0.1	0.1
1389	1390	*trans*-β-Elemene	0.3	-	-	-

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Table S3. *(continued).*

RI_{calc}	RI_{db}	Compounds	*A. concolor lowiana* #1	*A. concolor lowiana* #2	*A. concolor lowiana* #3	*A. concolor lowiana* #4
1394	1396	(2*Z*)-Dodecenal	tr	tr	0.1	tr
1409	1409	Dodecanal	tr	0.1	0.2	0.1
1418	1415	β-Maaliene	0.3	0.1	tr	0.1
1419	1417	(*E*)-β Caryophyllene	1.5	1.0	0.4	0.8
1429	1427	γ-Elemene	0.3	0.1	0.1	0.1
1435	1436	α-Guaiene	0.1	tr	tr	tr
1441	1442	Guaia-6,9-diene	0.2	0.1	0.1	0.1
1449	1450	*trans*-Muurola-3,5-diene	0.1	0.1	0.1	0.1
1455	1454	α-Humulene	0.5	0.3	0.1	0.3
1479	1479	α-Amorphene	0.4	0.3	0.2	0.2
1481	1480	Germacrene D	tr	tr	0.1	tr
1487	1488	δ-Selinene	0.5	0.2	0.2	0.3
1489	1489	β-Selinene	0.4	0.2	0.1	0.2
1496	1497	α-Selinene	0.4	0.2	0.1	0.2
1498	1497	α-Muurolene	0.1	tr	tr	tr
1502	1504	*epi*-Zonarene	0.1	0.1	0.2	0.3
1518	1518	δ-Cadinene	0.1	0.1	tr	tr
1519	1523	β-Guaiene	0.1	-	-	-
1537	1540	Selina-4(15),7(11)-diene	0.1	tr	tr	tr
1542	1542	Selina-3,7(11)-diene	0.1	0.1	tr	0.1
1550	1549	α-Elemol	0.1	tr	tr	tr
1559	1557	Germacrene B	0.7	0.3	0.3	0.3
1562	1562	(*E*)-Nerolidol	-	0.3	0.2	-
1562	1560	β-Calacorene	0.1	-	-	-
1583	1587	Caryophyllene oxide	0.2	0.1	tr	0.1
1594	1600	Khusimone	0.1	tr	tr	tr
1598	1603	Guaiol	0.1	0.1	tr	tr
1608	1610	5-*epi*-7-*epi*-α-Eudesmol	-	0.4	0.2	0.2
1614	1614	Tetradecanal	-	0.1	0.1	tr
1624	1624	Selina-6-en-4β-ol	0.6	0.5	0.4	0.5
1633	1632	γ-Eudesmol	0.5	0.3	0.2	0.2
1656	1655	α-Eudesmol	1.4	0.8	0.6	0.6
1666	1664	*cis*-Calamenen-10-ol	0.1	-	-	-
1666	1664	Bulnesol	tr	0.2	0.1	0.1
1698	1696	Juniper camphor	0.2	0.1	0.1	0.2
1799	1796	(9*Z*)-Hexadecenal	0.1	tr	0.1	0.1
1804	1804	(11*Z*)-Hexadecenal	0.3	0.3	0.5	0.5
1817	1817	Hexadecanal	0.1	0.1	0.2	0.3
1832	1832	(2*E*,6*E*)-Farnesyl acetate	0.4	0.6	0.3	0.1
1992	1989	Manoyl oxide	0.1	tr	tr	tr
2010	2012	Verticilla 4(20),7,11-triene	tr	tr	tr	tr
2052	2049	Abietatriene	0.1	tr	-	tr
2053	2053	Manool	-	-	0.1	-
2084	2086	Abietadiene	0.1	0.1	0.1	0.3
2229	---	Pallustral	0.1	0.1	0.1	0.1
2306	2312	Abietal	tr	tr	tr	0.2
		Compound classes				
		Monoterpene hydrocarbons	70.8	77.0	80.2	81.5
		Oxygenated monoterpenoids	16.9	13.8	12.3	10.4
		Sesquiterpene hydrocarbons	6.4	3.3	1.8	2.9

Table S3. *(continued).*

	Compound classes				
	Oxygenated sesquiterpenoids	3.5	3.4	2.0	2.0
	Diterpenoids	0.3	0.2	0.2	0.6
	Others	1.9	1.9	3.1	2.0
	Total identified	***99.7***	***99.5***	***99.7***	***99.4***

RI_{calc} = Retention index determined with respect to a homologous series of *n*-alkanes on a ZB-5ms column. RI_{db} = Reference retention index from the databases. tr = trace (< 0.05%).

Table S4. Foliar essential oil composition of *Abies grandis* subsp. *idahoensis* from Priest Lake, Idaho.

RI_{calc}	**RI_{db}**	**Compounds**	***A. grandis idahoensis* #1**	***A. grandis idahoensis* #2**	***A. grandis idahoensis* #3**
849	849	(2*E*)-Hexenal	0.4	0.4	0.3
881	880	Santene	tr	tr	tr
923	923	Tricyclene	1.1	1.2	1.0
925	925	α-Thujene	tr	tr	tr
933	933	α-Pinene	6.8	8.4	5.4
947	948	α-Fenchene	tr	tr	tr
949	950	Camphene	11.2	12.1	10.3
972	971	Sabinene	0.1	0.2	0.1
977	978	β-Pinene	14.6	10.2	20.7
989	989	Myrcene	1.3	1.3	1.3
1005	1004	*p*-Mentha-1(7),8-diene	tr	tr	tr
1008	1006	α-Phellandrene	0.4	0.3	0.2
1010	1008	δ-3-Carene	2.8	2.2	0.2
1017	1017	α-Terpinene	0.2	0.2	0.1
1025	1025	*p*-Cymene	0.2	0.1	0.1
1030	1030	Limonene	1.9	1.2	2.2
1032	1031	β-Phellandrene	20.3	24.4	14.8
1058	1057	γ-Terpinene	0.1	0.1	0.1
1081	1082	*p*-Mentha-2,4(8)-diene	tr	tr	-
1085	1086	Terpinolene	1.0	0.8	0.6
1088	1090	Fenchone	tr	tr	tr
1089	1091	*p*-Cymenene	tr	tr	tr
1090	1090	2-Nonanone	tr	tr	-
1100	1101	Linalool	0.1	tr	tr
1100	1100	Undecane	-	tr	-
1124	1124	*cis*-*p*-Menth-2-en-1-ol	0.2	0.2	0.1
1126	1126	α-Campholenal	0.2	0.1	0.2
1142	1142	*trans*-*p*-Menth-2-en-1-ol	0.2	0.1	0.1
1147	1145	Camphor	0.2	1.2	0.4
1152	1152	Citronellal	0.1	tr	tr
1155	1155	Camphene hydrate	0.4	0.4	0.3
1176	1176	*cis*-Pinocamphone	tr	tr	tr
1181	1180	Terpinen-4-ol	0.2	0.2	0.2
1187	1187	Cryptone	0.3	0.2	0.2
1196	1195	α-Terpineol	3.7	1.2	2.4
1198	1198	Methyl chavicol (= Estragole)	-	-	0.2
1229	1229	Thymyl methyl ether	-	-	tr
1254	1254	Piperitone	0.1	tr	tr
1277	1277	Phellandral	0.1	tr	tr
1283	1282	Bornyl acetate	23.0	18.0	22.9
1288	1287	α-Terpinen-7-al	tr	tr	tr
1293	1293	2-Undecanone	0.1	0.1	tr

Table S4. *(continued).*

RI_{calc}	RI_{db}	Compounds	*A. grandis idahoensis* #1	*A. grandis idahoensis* #2	*A. grandis idahoensis* #3
1300	1300	Tridecane	-	tr	tr
1307	1307	Methyl (4Z)-decenoate	0.1	0.1	0.1
1314	1314	Carvenolide	-	tr	tr
1332	1330	Bicycloelemene	-	tr	tr
1335	1335	δ-Elemene	-	0.2	tr
1348	1348	α-Cubebene	0.3	0.6	0.6
1350	1350	Citronellyl acetate	1.3	0.2	0.2
1376	1375	α-Copaene	0.2	0.6	0.6
1378	1378	Geranyl acetate	1.3	0.5	0.1
1382	1383	*cis*-β-Elemene	-	tr	tr
1388	1387	β-Cubebene	0.1	0.2	0.1
1389	1390	*trans*-β-Elemene	0.1	0.8	0.6
1419	1417	(*E*)-β-Caryophyllene	0.4	0.4	0.4
1429	1427	γ-Elemene	tr	0.1	0.2
1435	1436	α-Guaiene	tr	tr	0.1
1441	1442	Guaia-6,9-diene	tr	0.1	0.2
1445	1445	Selina-5,11-diene	-	tr	-
1449	1452	Cadina-3,5-diene	0.1	0.3	0.3
1452	1452	(*E*)-β-Farnesene	tr	0.1	tr
1455	1454	α-Humulene	0.1	0.1	0.1
1472	1472	*trans*-Cadina-1(6),4-diene	0.2	0.6	0.6
1473	1475	Selina-4,11-diene	-	0.1	-
1475	1475	γ-Muurolene	tr	0.1	0.1
1479	1479	α-Amorphene	tr	tr	0.2
1481	1480	Germacrene D	0.1	tr	tr
1487	1488	δ-Selinene	tr	0.1	0.3
1489	1489	β-Selinene	0.1	0.3	0.2
1492	1492	*trans*-Muurola-4(14),5-diene	0.2	0.6	0.5
1496	1497	α-Selinene	0.1	0.5	0.3
1498	1497	α-Muurolene	0.3	0.8	0.7
1502	1504	*epi*-Zonarene	tr	-	0.1
1513	1512	γ-Cadinene	0.1	0.1	0.2
1518	1518	δ-Cadinene	1.1	3.6	3.2
1522	1519	*trans*-Calamenene	0.2	0.3	0.3
1523	1521	Zonarene	0.2	0.6	0.7
1532	1533	*trans*-Cadina-1,4-diene	0.1	0.3	0.4
1537	1538	α-Cadinene	tr	tr	-
1541	1541	α-Calacorene	tr	tr	-
1558	1557	Germacrene B	0.1	0.3	0.6
1561	1560	(*E*)-Nerolidol	0.3	0.1	0.4
1623	1624	Selina-6-en-4β-ol	tr	tr	0.3
1628	1628	1-*epi*-Cubenol	0.5	1.3	1.2
1643	1643	Cubenol	0.3	0.7	0.7
1644	1644	τ-Muurolol	0.1	0.1	0.2
1647	1651	α-Muurolol (= δ-Cadinol)	0.1	0.1	0.2
1656	1657	α-Cadinol	0.3	0.2	0.6
1658	1660	*neo*-Intermedeol	-	0.1	-
1698	1698	Juniper camphor	-	-	0.1
1735	1735	(2*E*,6*E*)-Farnesal	tr	-	-
1803	1802	(9*Z*)-Hexadecenal	tr	0.1	0.1
1816	1817	Hexadecanal	tr	tr	tr
1831	1832	(2*E*,6*E*)-Farnesyl acetate	0.4	0.2	0.1
1921	1923	Cembrene	-	tr	-

Table S4. *(continued).*

RI_{calc}	RI_{db}	Compounds	*A. grandis idahoensis* #1	*A. grandis idahoensis* #2	*A. grandis idahoensis* #3
1960	1958	Palmitic acid	-	tr	tr
1991	1989	Manoyl oxide	-	tr	tr
2009	2012	Verticilla 4(20),7,11-triene	-	tr	tr
2051	2049	Abietatriene	-	tr	tr
2085	2089	Abietadiene	-	tr	tr
2139	2140	(*Z*)-Oleic acid	0.1	0.1	0.1
2230	2245	Palustral	-	tr	tr
		Compound classes			
		Monoterpene hydrocarbons	62.0	62.6	57.0
		Ocygenated monoterpenoids	31.3	22.2	27.0
		Sesquiterpene hydrocarbons	4.0	11.6	11.6
		Oxygenated sesquiterpenoids	2.1	2.9	3.8
		Diterpenoids	0.0	traces	traces
		Benzenoid aromatics	0.0	0.0	0.2
		Others	0.7	0.7	0.4
		Total identified	***100.0***	***100.0***	***100.0***

RI_{calc} = Retention index determined with respect to a homologous series of *n*-alkanes on a ZB-5ms column. RI_{db} = Reference retention index from the databases. tr = trace (< 0.05%).

Table S5. Foliar essential oil composition of *Abies lasiocarpa* from Mt. Hood, Oregon, and Mt. St. Helens, Washington.

RI_{calc}	RI_{db}	Compounds	*A. lasiocarpa* #1	*A. lasiocarpa* #2	*A. lasiocarpa* #3	*A. lasiocarpa* #4	*A. lasiocarpa* #5
849	849	(2*E*)-Hexenal	0.1	tr	0.4	0.2	0.2
881	880	Santene	0.1	tr	tr	tr	tr
923	923	Tricyclene	tr	tr	0.1	tr	tr
925	925	α-Thujene	0.1	0.1	0.2	0.1	0.1
933	933	α-Pinene	4.8	4.2	10.5	7.7	6.9
947	948	α-Fenchene	tr	tr	tr	tr	tr
949	950	Camphene	0.2	0.1	0.4	0.3	0.4
972	971	Sabinene	0.1	0.1	0.4	0.2	0.1
977	978	β-Pinene	24.8	18.2	11.3	5.6	6.9
989	989	Myrcene	2.3	1.7	2.6	3.4	3.0
1005	1004	*p*-Mentha-1(7),8-diene	tr	tr	tr	tr	tr
1008	1006	α-Phellandrene	0.6	0.6	1.2	0.7	0.7
1010	1008	δ-3-Carene	1.1	0.1	1.0	0.4	0.2
1015	1015	1,4-Cineole	-	-	0.2	0.1	0.1
1017	1017	α-Terpinene	0.2	0.2	0.7	0.3	0.2
1025	1025	*p*-Cymene	0.1	0.1	0.2	0.2	0.1
1030	1030	Limonene	2.1	1.8	32.5	60.0	55.9
1032	1031	β-Phellandrene	42.6	54.3	20.6	6.8	9.6
1035	1034	(*Z*)-β-Ocimene	0.1	0.1	tr	tr	-
1038	1039	2-Heptyl acetate	0.1	-	-	-	-
1046	1045	(*E*)-β-Ocimene	1.9	0.4	tr	-	-
1058	1057	γ-Terpinene	0.3	0.2	0.8	0.3	0.3
1081	1082	*p*-Mentha-2,4(8)-diene	tr	-	-	-	-
1085	1086	Terpinolene	1.2	1.1	3.4	1.3	1.0
1088	1090	Fenchone	0.1	tr	-	-	-
1089	1091	*p*-Cymenene	tr	tr	-	-	-
1090	1090	2-Nonanone	tr	-	0.1	0.1	0.1
1100	1101	Linalool	0.1	tr	-	tr	tr
1124	1124	*cis*-*p*-Menth-2-en-1-ol	0.5	0.4	0.3	0.1	0.2
1126	1126	α-Campholenal	-	-	0.1	tr	tr
1136	1136	Terpin-3-en-1-ol	-	-	0.1	tr	tr
1142	1142	*trans*-*p*-Menth-2-en-1-ol	0.3	0.2	0.2	0.1	0.1
1147	1145	Camphor	0.1	tr	-	-	-
1176	1178	Benzoic acid	0.2	-	-	-	-

Table S5. *(continued).*

RI_{calc}	RI_{db}	Compounds	*A. lasiocarpa* #1	*A. lasiocarpa* #2	*A. lasiocarpa* #3	*A. lasiocarpa* #4	*A. lasiocarpa* #5
1179	1179	2-Isopropenyl-5-methyl-4-hexenal	0.1	tr	-	-	-
1181	1180	Terpinen-4-ol	0.3	0.2	1.4	0.5	0.4
1187	1186	*p*- Cymen-8-ol	-	-	0.1	-	-
1187	1187	Cryptone	0.2	tr	0.1	0.1	0.1
1196	1195	α-Terpineol	0.6	0.4	2.3	1.2	1.3
1206	1206	Decanal	-	-	-	0.1	-
1229	1229	Thymyl methyl ether	1.0	tr	tr	tr	tr
1254	1254	Piperitone	5.3	2.7	tr	tr	tr
1257	1257	Methyl citronellate	0.5	0.6	-	-	-
1277	1277	Phellandral	tr	tr	tr	-	-
1283	1282	Bornyl acetate	0.1	0.2	0.4	0.2	0.3
1291	1293	Thymol	0.1	1.6	-	-	-
1293	1293	2-Undecanone	-	0.1	0.2	0.8	0.3
1314	1314	Carvenolide	0.1	0.1	-	-	-
1332	1330	Bicycloelemene	-	-	0.1	0.1	0.1
1335	1335	δ-Elemene	-	-	1.1	0.5	1.1
1350	1350	Citronellyl acetate	0.1	tr	tr	0.7	tr
1358	1361	Neryl acetate	tr	0.1	tr	tr	tr
1376	1375	α-Copaene	-	-	tr	tr	tr
1378	1378	Geranyl acetate	0.9	1.0	0.2	0.3	0.2
1382	1383	*cis*-β-Elemene	-	tr	tr	tr	tr
1389	1390	*trans*-β-Elemene	0.2	0.4	0.5	0.3	0.5
1402	1400	α-Champinene	-	-	-	-	0.1
1405	1406	β-Champinene	-	-	-	-	tr
1409	1409	Dodecanal	-	0.1	-	0.1	-
1418	1417	β-Maaliene	tr	-	0.1	0.1	0.2
1419	1417	(*E*)-β-Caryophyllene	tr	0.1	0.3	0.8	0.4
1429	1427	γ-Elemene	-	-	0.1	tr	0.1
1435	1436	α-Guaiene	-	-	0.1	0.1	0.1
1441	1442	Guaia-6,9-diene	-	-	0.4	0.2	0.5
1445	1445	Selina-5,11-diene	tr	tr	-	-	-
1450	1452	α-Himachalene	tr	0.1	-	-	-
1452	1452	(*E*)-β-Farnesene	tr	tr	tr	0.1	tr
1455	1453	*trans*-Muurola-3,5-diene	-	-	0.2	0.1	0.2
1455	1454	α-Humulene	tr	tr	0.1	0.2	0.2
1466	1472	Cadina-1(6),4-diene	-	-	-	-	0.1
1473	1475	Selina-4,11-diene	0.1	0.2	0.1	0.1	0.1
1477	1478	γ-Gurjunene	-	-	0.3	0.3	0.5
1479	1479	α-Amorphene	-	-	0.2	0.1	0.3
1481	1480	Germacrene D	-	-	0.2	0.1	0.2
1487	1488	δ-Selinene	tr	0.1	0.3	0.2	0.4
1489	1489	β-Selinene	0.5	1.5	0.3	0.4	0.5
1490	1489	(*Z*,*E*)-α-Farnesene	-	-	-	0.1	tr
1494	1494	β-Alaskene	0.1	-	-	-	-
1496	1497	α-Selinene	0.4	1.3	0.3	0.4	0.5
1498	1497	α-Muurolene	-	-	tr	tr	tr
1502	1504	*epi*-Zonarene	-	-	0.2	0.1	0.3
1504	1504	(*E*,*E*)-α-Farnesene	-	-	-	0.1	-
1505	1501	β-Dihydroagarofuran	0.3	0.4	-	-	-
1507	1508	β-Bisabolene	0.6	0.6	0.2	0.1	0.3
1510	1511	(*Z*)-γ-Bisabolene	0.1	0.1	-	-	-
1513	1512	γ-Cadinene	-	-	tr	tr	0.1
1518	1518	δ-Cadinene	-	-	0.2	0.1	0.2
1540	1540	(*E*)-α-Bisabolene	0.1	0.1	-	-	-
1558	1557	Germacrene B	-	tr	0.1	0.1	0.2
1561	1560	(*E*)-Nerolidol	0.1	0.1	0.2	0.3	0.2
1596	1586	Geranyl 2-methylbutyrate	0.1	0.1	-	-	-
1608	1607	5-*epi*-7-*epi*-α-Eudesmol	0.1	0.1	-	-	-
1613	1613	Tetradecanal	-	tr	-	-	-

Table S5. *(continued).*

RI_{calc}	RI_{db}	Compounds	*A. lasiocarpa* #1	*A. lasiocarpa* #2	*A. lasiocarpa* #3	*A. lasiocarpa* #4	*A. lasiocarpa* #5
1622	1624	10-*epi*-γ-Eudesmol	1.0	1.1	-	-	-
1623	1624	Selina-6-en-4β-ol	-	-	0.2	0.1	0.3
1629	1629	*iso*-Spathulenol	-	-	0.4	0.3	0.6
1633	1632	γ-Eudesmol	0.1	0.1	0.5	0.4	0.5
1637	1641	Agarospirol I (= Hinesol)	tr	0.1	-	-	-
1654	1657	Valerianol	0.5	0.6	-	-	-
1656	1655	α-Eudesmol	0.4	0.4	0.6	0.6	1.0
1658	1660	*neo*-Intermedeol	0.1	0.3	-	-	-
1687	1688	α-Bisabolol	1.9	1.1	0.5	0.2	0.9
1735	1735	(2*E*,6*E*)-Farnesal	-	-	tr	tr	-
1803	1802	(9*Z*)-Hexadecenal	tr	0.1	-	-	-
1806	1806	(2*Z*,6*Z*)-Farnesyl acetate	-	-	-	0.1	-
1831	1832	(2*E*,6*E*)-Farnesyl acetate	-	-	0.1	1.2	0.1
1921	1923	Cembrene	0.1	-	-	0.1	-
1936	1934	(3*Z*)-Cembrene A	tr	-	-	tr	-
1991	1989	Manoyl oxide	tr	tr	tr	tr	-
2009	2012	Verticilla 4(20),7,11-triene	0.1	tr	0.1	0.1	0.1
2051	2049	Abietatriene	0.1	0.1	tr	tr	tr
2053	2053	Manool	-	-	tr	0.2	0.1
2085	2089	Abietadiene	tr	tr	0.1	0.1	0.1
2139	2140	(*Z*)-Oleic acid	0.1	-	-	-	-
2147	2147	Abienol	0.1	0.1	tr	-	-
2230	2245	Palustral	tr	0.1	0.2	0.2	0.3
		Compound classes					
		Monoterpene hydrocarbons	82.4	83.4	85.9	87.3	85.5
		Oxygenated monoterpenoids	10.5	7.4	5.2	3.3	2.6
		Sesquiterpene hydrocarbons	1.9	4.3	5.2	4.4	6.9
		Oxygenated sesquiterpenoids	4.6	4.1	2.5	3.1	3.5
		Diterpenoids	0.3	0.2	0.3	0.7	0.6
		Others	0.3	0.3	0.7	1.3	0.6
		Total identified	***100.0***	***99.8***	***99.8***	***100.0***	***99.7***

RI_{calc} = Retention index determined with respect to a homologous series of *n*-alkanes on a ZB-5ms column. RI_{db} = Reference retention index from the databases. tr = trace (< 0.05%).

Table S6. Foliar essential oil composition of *Abies magnifica* from Mt. Lassen, northern California.

RI_{calc}	RI_{db}	Compounds	*A. magnifica* #1	*A. magnifica* #2	*A. magnifica* #3
800	801	Hexanal	0.1	tr	0.1
849	849	(2*E*)-Hexenal	0.4	0.2	0.7
851	853	(3*Z*)-Hexenol	0.7	0.3	1.5
865	867	1-Hexanol	0.1	tr	tr
923	923	Tricyclene	tr	tr	tr
925	925	α-Thujene	0.1	0.1	0.1
933	933	α-Pinene	6.0	7.1	6.5
947	948	α-Fenchene	tr	tr	tr
949	950	Camphene	0.2	0.2	0.1
972	972	Sabinene	0.2	0.2	0.2
977	978	β-Pinene	16.9	20.8	17.3
989	989	Myrcene	1.7	2.1	2.7
1005	1004	*p*-Mentha-1(7),8-diene	tr	tr	tr
1005	1008	(3Z)-Hexenyl acetate	tr	tr	0.1
1007	1007	α-Phellandrene	0.6	0.7	0.7
1009	1009	δ-3-Carene	tr	tr	tr
1015	1015	1,4-Cineole	0.1	tr	tr
1017	1017	α-Terpinene	0.4	0.3	0.4
1025	1025	*p*-Cymene	0.1	0.1	0.2
1029	1030	Limonene	0.5	0.5	1.1

Table S6. *(continued).*

RI_{calc}	RI_{db}	Compounds	*A. magnifica* #1	*A. magnifica* #2	*A. magnifica* #3
1031	1031	β-Phellandrene	41.2	44.6	42.1
1058	1058	γ-Terpinene	0.3	0.2	0.2
1085	1086	Terpinolene	1.6	1.0	0.9
1090	1090	2-Nonanone	0.2	0.1	0.2
1100	1101	Linalool	0.2	tr	0.1
1124	1124	*cis-p*-Menth-2-en-1-ol	0.3	0.5	0.5
1126	1126	α-Campholenal	tr	-	0.1
1142	1142	*trans-p*-Menth-2-en-1-ol	0.2	0.2	0.4
1180	1180	Terpinen-4-ol	0.6	0.3	0.4
1186	1185	Cryptone	0.2	0.2	0.4
1195	1195	α-Terpineol	2.7	2.6	4.2
1277	1277	Phellandral	0.1	0.1	0.1
1283	1282	Bornyl acetate	0.1	0.3	0.1
1286	1285	(*E*)-Anethole	0.1	tr	tr
1287	1283	Whiskey lactone	0.1	0.1	0.1
1292	1293	2-Undecanone	0.3	0.1	0.3
1331	1330	Bicycloelemene	0.1	0.1	0.1
1334	1335	δ-Elemene	1.2	1.1	0.8
1348	1349	Citronellyl acetate	0.3	0.4	0.1
1357	1361	Neryl acetate	tr	tr	0.1
1375	1375	α-Copaene	0.2	0.1	0.1
1377	1378	Geranyl acetate	1.2	0.5	0.1
1381	1383	*cis*-β-Elemene	0.1	tr	tr
1389	1390	*trans*-β-Elemene	1.2	0.8	0.8
1408	1409	Dodecanal	0.4	0.3	0.2
1418	1417	(*E*)-β-Caryophyllene	4.8	4.5	4.8
1428	1427	γ-Elemene	0.2	tr	0.1
1432	1432	*trans*-α-Bergamotene	-	0.1	0.1
1434	1436	α-Guaiene	0.2	0.2	0.2
1440	1440	Guaia-6,9-diene	0.8	0.1	0.1
1448	1447	*iso*-Germacrene D	0.1	-	-
1451	1452	(*E*)-β-Farnesene	tr	0.1	0.1
1454	1454	α-Humulene	0.9	0.8	0.8
1473	1475	Selina-4,11-diene	0.2	0.1	0.1
1477	1476	γ-Gurjunene	0.3	0.3	0.3
1479	1479	α-Amorphene	0.2	0.1	0.1
1481	1480	Germacrene D	0.2	0.1	0.1
1484	1478	γ-Muurolene	0.1	0.1	tr
1487	1488	δ-Selinene	0.4	0.2	0.2
1489	1489	β-Selinene	1.1	0.6	0.7
1492	1492	*trans*-Muurola-4(14),5-diene	tr	tr	tr
1496	1497	α-Selinene	1.1	0.6	0.7
1498	1497	α-Muurolene	0.1	tr	0.1
1501	1505	α-Bulnesene	tr	tr	tr
1502	1503	β-Himachalene	0.2	tr	tr
1503	1504	(*E*,*E*)-α-Farnesene	tr	0.1	0.1
1507	1504	Germacrene A	tr	tr	tr
1513	1512	γ-Cadinene	0.1	tr	tr
1518	1518	δ-Cadinene	0.2	0.1	0.1
1549	1549	α-Elemol	0.1	0.1	0.1
1558	1557	Germacrene B	0.4	0.1	0.1
1561	1561	(*E*)-Nerolidol	0.2	0.2	0.1
1582	1587	Caryophyllene oxide	0.1	0.1	0.2
1608	1607	Dodecyl acetate	0.1	0.1	0.1

Table S6. *(continued).*

RI_{calc}	RI_{db}	Compounds	*A. magnifica* #1	*A. magnifica* #2	*A. magnifica* #3
1624	1624	Selina-6-en-4β-ol	0.8	0.1	0.1
1630	1629	*iso*-Spathulenol	0.4	0.5	0.5
1633	1633	γ-Eudesmol	0.6	0.7	0.9
1657	1655	α-Eudesmol	0.5	0.5	0.7
1660	1660	Selin-11-en-4β-ol	0.3	0.3	0.2
1699	1696	Juniper camphor	0.1	tr	-
1832	1832	(2*E*,6*E*)-Farnesyl acetate	2.0	1.5	0.4
1992	1989	Manoyl oxide	0.6	0.4	1.3
2010	2012	Verticilla 4(20),7,11-triene	0.2	0.2	0.3
2013	2007	18-Norabieta-8,11,13-triene	0.1	0.1	0.1
2053	2053	Manool	1.2	0.8	1.5
2084	2086	Abietadiene	0.1	0.1	0.1
2146	2147	Abienol	0.1	0.1	0.1
2229	2243	Palustral	0.3	0.3	0.5
2261	2266	Dehydroabietal	tr	tr	0.1
		Compound classes			
		Monoterpene hydrocarbons	69.8	77.8	72.4
		Oxygenated monoterpenoids	5.6	4.9	6.1
		Sesquiterpene hydrocarbons	14.2	10.1	10.5
		Oxygenated sesquiterpenoids	5.0	3.8	3.3
		Diterpenoids	2.6	2.0	4.0
		Others	2.5	1.3	3.5
		Total identified	***99.7***	***99.8***	***99.9***

RI_{calc} = Retention index determined with respect to a homologous series of *n*-alkanes on a ZB-5ms column. RI_{db} = Reference retention index from the databases. tr = trace (< 0.05%).

Table S7. Enantiomeric distributions (%) of chiral monoterpenoid components in *Abies* foliar essential oils.

Enantiomers	RI_{calc}	RI_{db}	*A. a.* #1	*A. a.* #2	*A. c. l.* #1	*A. c. l.* #2	*A. c. l.* #3	*A. c. l.* #4	*A. g. i.* #1	*A. g. i.* #2	*A. g. i.* #3	*A. l.* #1	*A. l.* #2	*A. l.* #3	*A. l.* #4	*A. l.* #5	*A. m.* #1	*A. m.* #2	*A. m.* #3
(–)-α-Pinene	975	976	40.3	50.6	91.9	91.6	90.9	51.9	70.1	59.7	75.1	84.2	87.1	56.3	62.3	68.5	86.4	89.8	94.2
(+)-α-Pinene	982	982	59.7	49.4	8.1	8.4	9.1	48.1	29.9	40.3	24.9	15.8	12.9	43.7	37.7	31.5	13.6	10.2	5.8
(–)-Camphene	1001	998	61.9	68.0	93.9	94.4	93.8	91.5	96.1	97.3	96.8	80.0	86.6	82.4	83.5	89.7	92.1	87.5	91.2
(+)-Camphene	1006	1005	38.1	32.0	6.1	5.6	6.2	8.5	3.9	2.7	3.2	20.0	13.4	17.6	16.5	10.3	7.9	12.5	8.8
(+)-β-Pinene	1026	1027	1.9	2.1	1.1	1.0	1.2	1.3	1.4	1.8	1.2	1.5	1.5	2.5	3.0	2.2	1.8	1.6	1.9
(–)-β-Pinene	1028	1031	98.1	97.9	98.9	99.0	98.8	98.7	98.6	98.2	98.8	98.5	98.5	97.5	97.0	97.8	98.2	98.4	98.1
(+)-δ-3-Carene	1050	1052	100	100	-	-	-	-	100	100	-	100	-	100	100	-	-	-	-
(–)-δ-3-Carene	nd	na	0.0	0.0	-	-	-	-	0.0	0.0	-	0.0	-	0.0	0.0	-	-	-	-
(–)-α-Phellandrene	1053	1050	0.0	0.0	-	-	100	100	-	-	-	100	92.6	38.5	33.8	38.2	100	82.4	100
(+)-α-Phellandrene	1055	1053	100	100	-	-	0.0	0.0	-	-	-	0.0	7.4	61.5	66.2	61.8	0.0	17.6	0.0
(–)-Limonene	1074	1073	88.3	95.4	89.6	93.1	92.4	90.3	84.4	83.9	83.0	86.4	95.2	97.6	98.4	98.4	94.3	92.9	94.2
(+)-Limonene	1080	1081	11.7	4.6	10.4	6.9	7.6	9.7	15.6	16.1	17.0	13.6	4.8	2.4	1.6	1.6	5.7	7.1	5.8
(–)-β-Phellandrene	1081	1083	95.3	98.6	100	100	100	100	100	99.9	99.7	99.9	99.9	99.6	98.8	99.1	99.9	99.9	99.9
(+)-β-Phellandrene	1090	1089	4.7	1.4	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.1	0.1	0.5	1.2	0.9	0.1	0.1	0.1
(–)-Camphor	1254	1253	-	-	-	-	-	-	-	100	100	-	-	-	-	-	-	-	-
(+)-Camphor	nd	1259	-	-	-	-	-	-	-	0.0	0.0	-	-	-	-	-	-	-	-
(+)-Terpinen-4-ol	1297	1297	34.8	34.6	40.4	40.7	40.5	32.6	34.1	30.5	33.1	34.1	23.8	39.4	46.7	44.2	34.7	35.5	32.3
(–)-Terpinen-4-ol	1300	1300	65.2	65.4	59.6	59.3	59.5	67.4	65.9	69.5	66.9	65.9	76.2	60.6	53.3	55.8	65.3	64.5	67.7
(–)-Borneol	1335	1335	-	-	100	100	100	100	-	97.4	100	-	-	-	-	-	-	-	-
(+)-Borneol	1342	1340	-	-	0.0	0.0	0.0	0.0	-	2.6	0.0	-	-	-	-	-	-	-	-
(–)-α-Terpineol	1344	1347	91.8	91.0	97.7	98.1	98.1	95.2	94.6	90.9	97.7	91.9	96.9	90.4	88.9	91.6	94.9	97.2	96.7
(+)-α-Terpineol	1355	1356	8.2	9.0	2.2	1.9	1.9	4.8	5.4	9.1	2.3	8.1	3.1	9.6	11.1	8.4	5.1	2.8	3.3
(–)-Piperitone	1381	1380	-	-	-	-	-	-	-	-	-	91.4	91.2	-	-	-	-	-	-
(+)-Piperitone	1386	1385	-	-	-	-	-	-	-	-	-	8.6	8.8	-	-	-	-	-	-

RI_{calc} = Retention index determined with respect to a homologous series of *n*-alkanes on a Restek B-Dex 325 capillary column. RI_{db} = Retention index from our in-house database prepared using commercially available standards. nd = compound not detected. na = reference compound not available.

Figure S1. Gas chromatograms of *Abies amabilis* foliar essential oils.

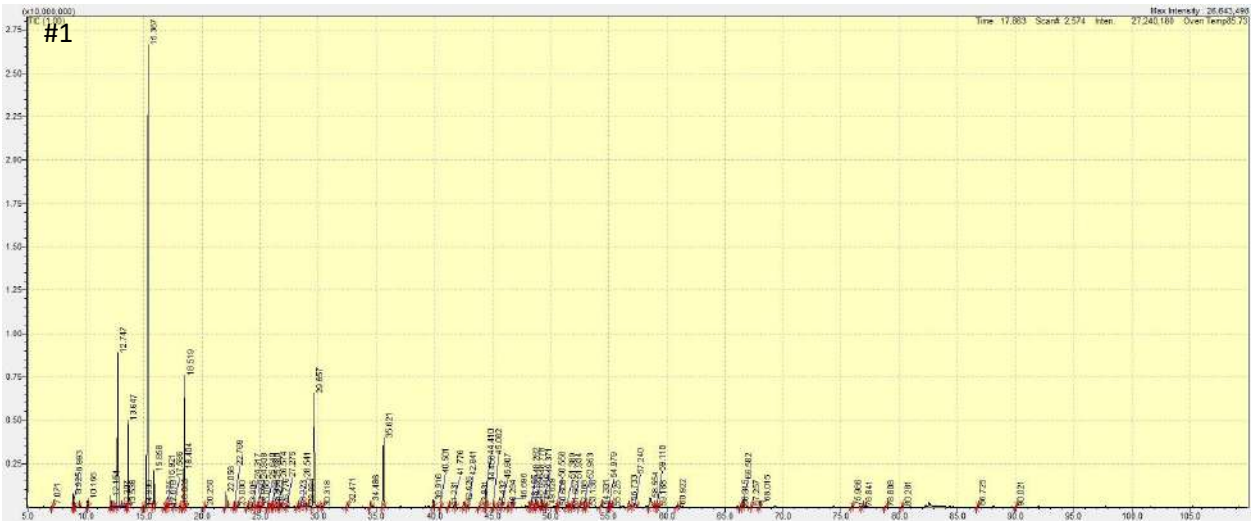

Figure S2. Gas chromatograms of *Abies concolor* subsp. *lowiana* foliar essential oils.

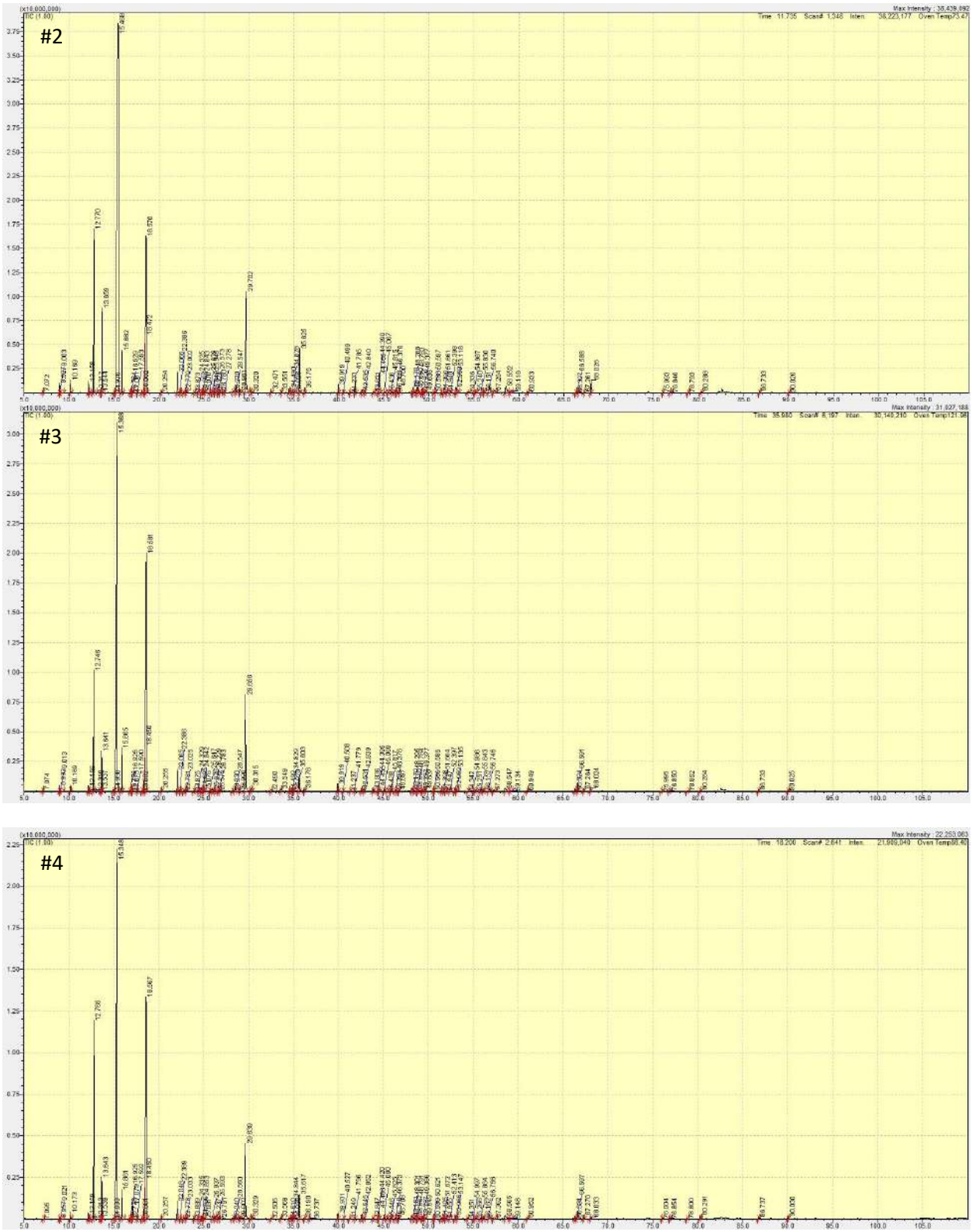

Figure S2. *(Continued).* Gas chromatograms of *Abies concolor* subsp. *lowiana* foliar essential oils.

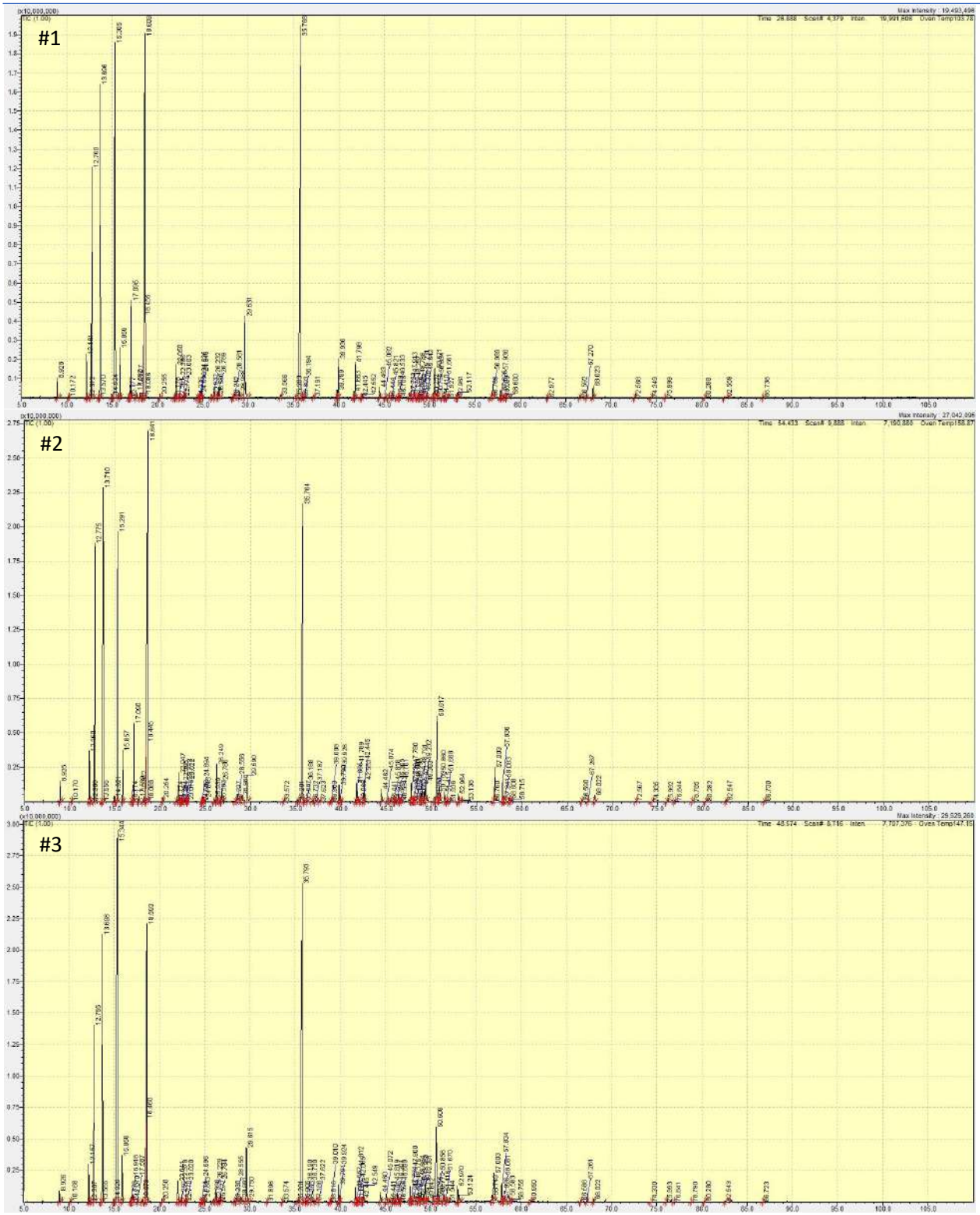

Figure S3. Gas chromatograms of *Abies grandis* subsp. *idahoensis* foliar essential oils.

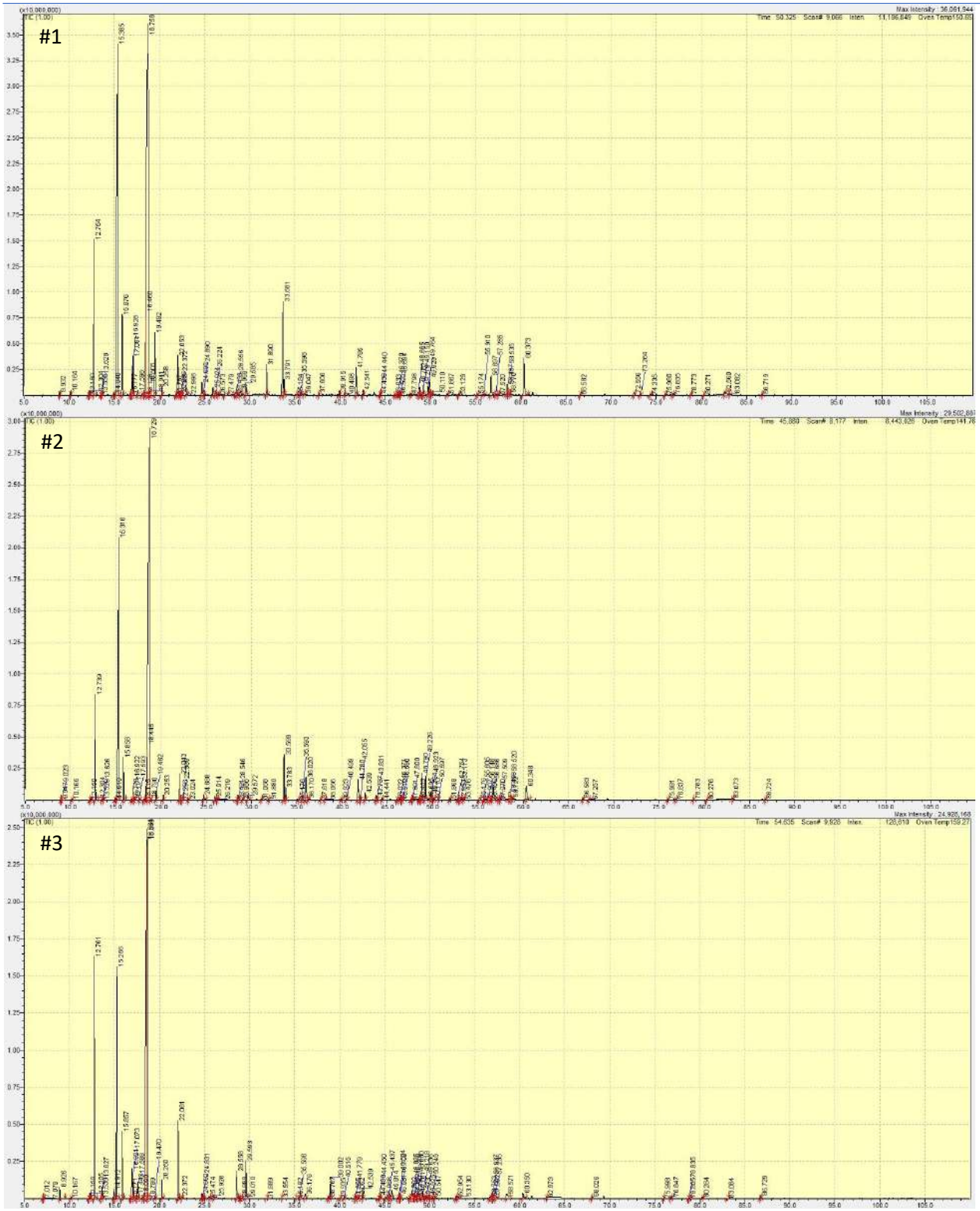

Figure S4. Gas chromatograms of *Abies lasiocarpa* foliar essential oils.

https://doi.org/10.58985/jeopc.2025.v03i02.70

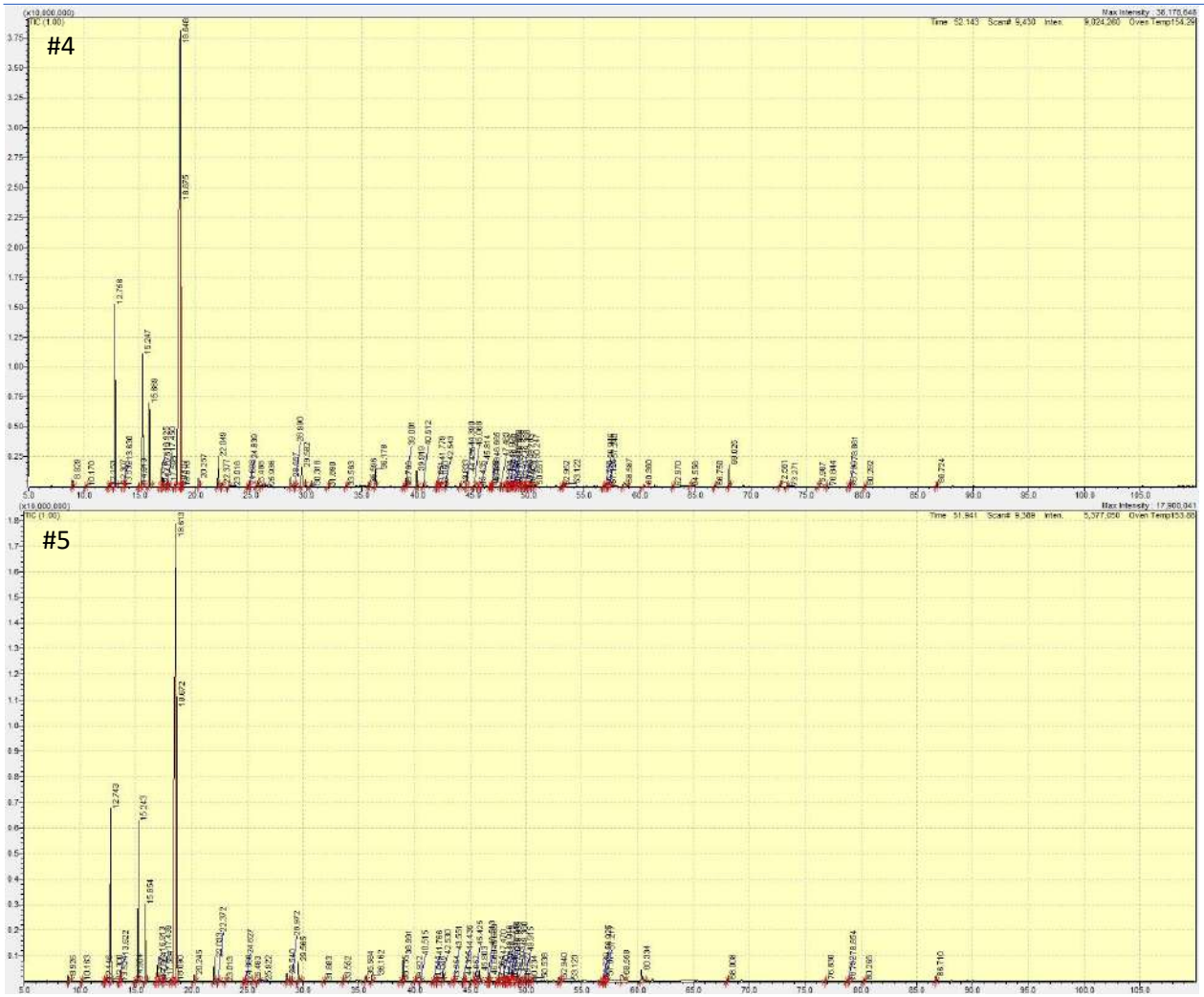

Figure S4. *(Continued).* Gas chromatograms of *Abies lasiocarpa* foliar essential oils.

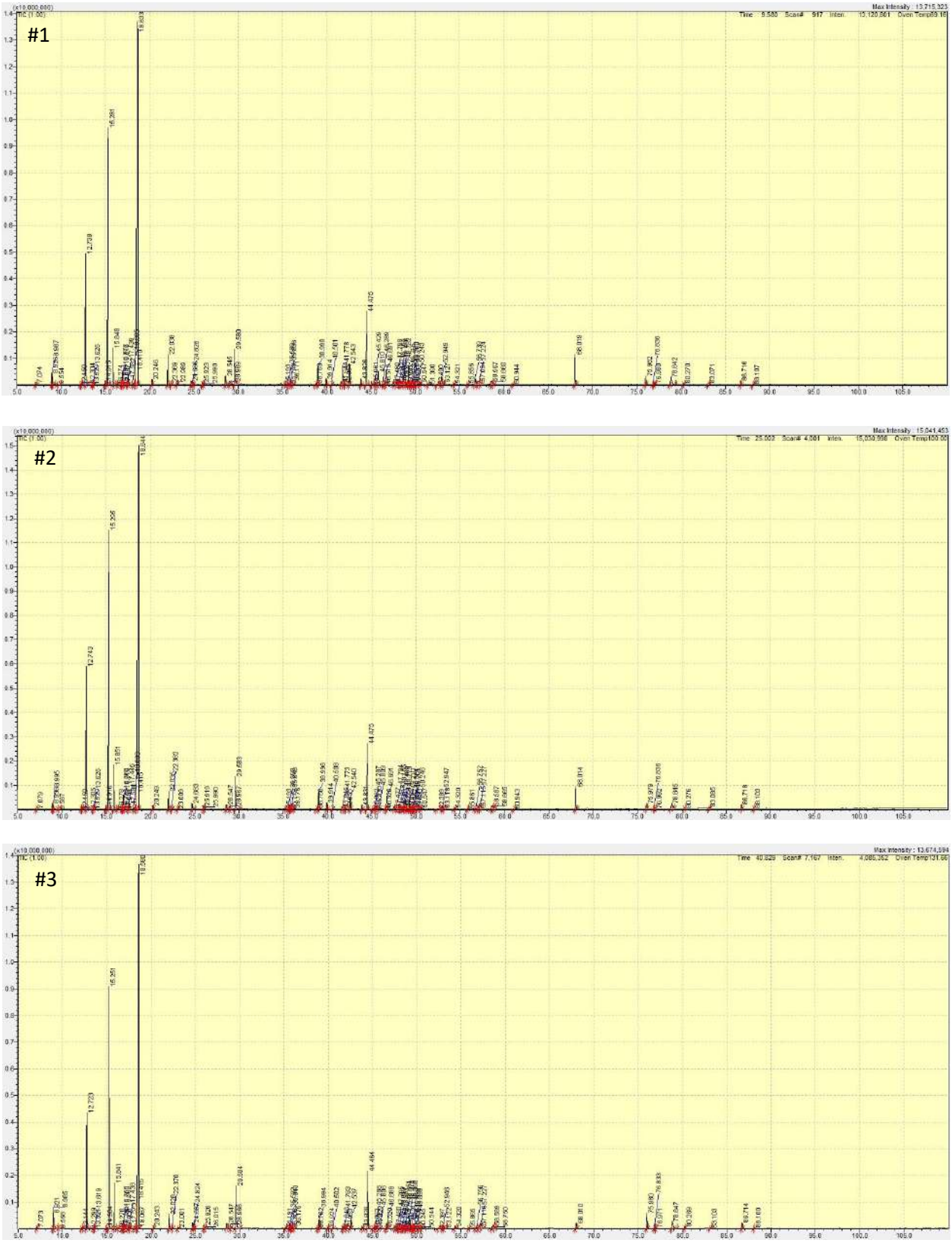

Figure S5. Gas chromatograms of *Abies magnifica* foliar essential oils.