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Analyses of the Leaf and Resin Essential Oils of *Pinus sibirica* (Rupr.) Mayr from Mongolia

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ABSTRACT: The leaf and resin essential oils of *Pinus sibirica* were analyzed by GC/MS. The leaf oil was dominated by α-pinene (57.2%), β-phellandrene (19.7%), and β-pinene (7.7%) with lesser amounts of limonene (2.2%), myrcene (2.1%), terpinolene (1.3%) and camphene (1.3%). The resin oil contained α-pinene (39.1%), δ-3-carene (23.0%), and β-pinene (9.1%) with moderate amounts of cembrene (4.9%), β-phellandrene (2.1%), camphene (1.7%) and terpinolene (1.3%).

KEY WORD INDEX: *Pinus sibirica*, Pinaceae, essential oil composition, leaf oil, resin oil, α-pinene, β-phellandrene, δ-3-carene.

PLANT NAME: *Pinus sibirica* (Rupr.) Mayr, common name: Siberian pine, sibirin khush (Mongolia), kedr sibirskii (Russia).

SOURCE: Foliage consisted of mixed years leaves from several trees and the resin was collected from natural resin bleeds. All samples were collected in the Bogd-Ula Mountains near Ulan Bator (S. Shatar, 57/94). Voucher specimens have been deposited at the herbarium at the Mongolian Academy of Science, Ulan Batar.

PLANT PART: Fresh leaves were steam distilled in a circulatory Clevenger-type apparatus (1) for 2 h to produce a clear oil with yields of 0.9-1.1% (fresh weight basis). Resin was steam distilled (3 h) to produce a clear oil of 10-14% yield, based on the resin weight at the time of extraction.

PREVIOUS WORK: Shatar (2,3) examined the leaf oil from the Mongolian Khentein Mountains. He found the leaf oil to be dominated by α-pinene (see Table I). Other studies (4-7) have reported minor amounts of ylangene, longifolene, caryophyllene, α- and γ-muurolene, and bisabolene in the leaves. The main components of the resin oil, previously reported (8), are α- and β-pinene, limonene, β-phellandrene and caryophyllene. No complete analyses of the leaf and resin oils have be reported as far as known.

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Table I. Composition of the volatile leaf and resin oils of *Pinus sibirica* from Mongolia

KI	Compound	Percentage	
		Leaf oil	Resin oil
926	tricyclene	0.1	0.2
931	α-thujene	-	0.2
939	α-pinene	57.2	39.1
953	camphene	1.3	1.7
957	thuja-2,4(10)-diene	t	0.4
973	unidentified monoterpene	-	0.9
976	sabinene	0.2	-
980	β-pinene	7.7	9.1
991	myrcene	2.1	0.6
1001	δ-2-carene	-	t
1005	α-phellandrene	0.2	0.1
1011	δ-3-carene	0.8	23.0
1018	α-terpinene	0.1	0.1
1022	o-cymene	-	0.1
1026	p-cymene	-	0.5
1027	sylvestrene	-	0.2
1031	limonene	2.2	0.5
1031	β-phellandrene	19.7	2.1
1062	γ-terpinene	0.1	0.2
1082	m-cymenene	-	t
1088	terpinolene	1.3	1.3
1112	α-fenchol	-	t
1121	cis-p-menth-2-en-1-ol	t	-
1125	α-campholenal	-	0.2
1139	trans-pinocarveol	0.1	0.3
1143	camphor	t	0.4
1148	camphene hydrate	-	0.1
1153	citronellal	0.1	-
1160	p-mentha-1,5-dien-8-ol	t	-
1165	borneol	t	0.8
1173	isopinocamphone	-	t
1177	terpinen-4-ol	0.2	0.5
1180	m-cymen-8-ol	-	0.1
1183	p-cymen-8-ol	-	0.1
1186	m-α-terpineol	-	0.9
1189	α-terpineol	0.4	1.0
1193	myrtenal	-	0.1
1195	methyl chavicol	0.1	-
1204	verbenone	-	0.2
1217	trans-carveol	-	t
1228	citronellol	0.4	0.1
1235	methyl thymol	0.3	0.1
1285	bornyl acetate	0.8	0.6
1291	2-undecanone	0.1	-
1350	α-terpinyl acetate	0.2	t
1351	α-longipinene	t	0.9

Table I. (Cont.)

KI	Compound	Percentage	
		Leaf oil	Resin oil
1372	α-ylangene	-	0.1
1376	α-copaene	-	0.2
1383	geranyl acetate	t	-
1398	β-longipinene	-	0.1
1402	longifolene	-	0.6
1418	β-caryophyllene	0.1	0.9
1439	α-guaiene	-	t
1454	α-humulene	-	0.1
1458	(E)-β-farnesene	t	0.3
1467	9-epi-(E)-caryophyllene	t	t
1477	γ-muurolene	t	0.7
1480	germacrene D	0.2	-
1493	δ-decalactone	0.6	-
1494	bicyclogermacrene	-	t
1499	α-muurolene	0.1	0.9
1508	β-bisabolene	0.2	0.7
1513	γ-cadinene	t	-
1524	δ-cadinene	0.3	0.3
1564	(E)-nerolidol	-	t
1576	spathulenol	0.2	0.1
1581	caryophyllene oxide	-	0.1
1627	1-epi-cubenol	t	0.1
1640	epi-α-cadinol (=T-cadinol)	0.3	t
1641	epi-α-muurolol	t	t
1645	α-muurolol (=torreyol)	-	0.2
1653	α-cadinol	0.5	-
1683	α-bisabolol	0.2	0.1
1929	cembrene	0.2	4.9
1942	cembrene isomer	t	1.6

KI = Kovat's Index on DB-5(=SE54) column. Compositional values less than 0.1% are denoted as traces (t). Unidentified components less than 0.5% are not reported

PRESENT WORK: GC/MS analysis was made using a Finnigan Ion Trap 800 instrument fitted with a 30 m x 0.26 mm DB-5 fused silica capillary column (film thickness: 0.25 μm). The column was programmed from 60°-240°C at 30°C/min. Oil components were identified by a combination of retention times and mass spectral data (9). Table I shows the composition of the oil of *P. sibirica* leaf and resin oils. The major constituents of the leaf oil were α-pinene (57.2%), β-phellandrene (19.7%), and β-pinene (7.7%). Limonene (2.2%), myrcene (2.1%), terpinolene (1.3%) and camphene (1.3%) were found in lesser amounts. The major components of the resin oil were α-pinene (39.1%), δ-3-carene (23.0%), and β-pinene (9.1%) with moderate amounts of cembrene (4.9%), β-phellandrene (2.1%), camphene (1.7%) and terpinolene (1.3%).

Mass spectra of unidentified constituents: [ITMS, m/z (rel. int.): KI **973**, 41(21), 51(13), 65(10), 77(13), 91(53), 105(6), 119(100), 134(8), monoterpene; KI **1484**, 41(100), 55(33), 71(30), 81(9), 99(43), 105(9), 121(7), 142(8), 161(4), 185(5); KI **1944**, 41(100), 55(28), 67(41), 79(46), 91(41), 105(31), 119(22), 133(17), 161(25), 229(9), 257(4), 272(2), cembrene isomer.

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