The Volatile Oils of *Juniperus flaccida* Var. *Flaccida* and Var. *Poblana*

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THE VOLATILE LEAF OILS OF *JUNIPERUS FLACCIDA* VAR. *FLACCIDA* AND VAR. *POBLANA*

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Juniperus flaccida Schlecht. (Cupressaceae) is a commonly occurring tree throughout much of the mountains (1200-2900 m) of Mexico and the Chisos Mountains of Texas. The species derives its name from the flaccid, drooping, or weeping character of the branches (1). *J. flaccida* var. *flaccida* occurs from the Big Bend region of Texas, southward into Coahuila, Chihuahua, Tamaulipas, and Oaxaca, Mexico, and westward in Sonora and Jalisco, Mexico (2). *J. flaccida* var. *poblana* is found from Jalisco eastward to Oaxaca, Mexico (2). Although we have previously reported on the terpenoid similarities via numerical taxonomic procedures (3), we give here the first detailed identification of the steam-volatile leaf oil components of these junipers.

MATERIALS AND METHODS

PLANT MATERIALS.—Fresh foliage was collected and kept frozen until steam distilled from *J. flaccida* var. *flaccida* 1 km west of Huasia on Rt. 105, Hidalgo, Mexico (Zanoni 2869), and *J. flaccida* var. *poblana* on Rt. 190 near San Dionisio Ocotepec, Oaxaca, Mexico (Zanoni, 2674). Voucher specimens are deposited at the University of Texas at Austin. The volatile leaf terpenoids were isolated by the steam distillation of approximately 200 g of foliage for 2 h (4). The oils were dried over anhydrous Na_2SO_4 and kept tightly sealed in glass vials with foil-lined caps at −20° until analyzed.

Mass spectra were recorded with a Finnigan 4000 quadrupole gc/ms system using a deactivated SP2100 glass capillary column, 0.25 mm ID×30 m [see (5) for conditions]. Quantification was made by FID using a deactivated SP2100 glass capillary column (as above) on a Varian 1860 with N_2 as a carrier gas at an average linear velocity of 12 cm/sec., temperature programmed as: initial temperature, 70°; then 1.5°/min for 18 min; 2.5°/min for 24 min; 6°/min for 6 min; 4°/min for 6 min; and isothermal at 217° for 6 min. Butyl acetate and hexadecyl acetate were added as internal standards. These compounds were chosen as standards because butyl acetate elutes before the more volatile terpenes, and hexadecyl acetate elutes after most terpenes found in these oils.

Identifications were made by comparisons of the ms of each component in the oils with the ms of the known terpenes and searches of spectra from the Finnigan library based on National Bureau of Standards data. Relative retention times (RRT, hexadecyl acetate = 1.00) were also compared to the RRT of known terpenoids run under the same conditions.

RESULTS

Oils were light to medium yellow with yields from 1-3% dry weight. The composition of these two taxa are shown in Table 1. In general, the oils from the two varieties are very similar in composition. This correlated well with the data previously reported for their morphology (1). The oils are dominated by the presence of α-pinene, with moderate amounts of β-pinene, myrcene, β-phellandrene, limonene, *trans*-verbenol, borneol, 4-terpineol, and verbenone. Of the 56 components found, these taxa share 48 in common. Almost all of the compounds unique to one taxon occur in trace amounts and may well be found after a more detailed analysis of the other taxon. In general, *J. flaccida* var. *flaccida* tends to have more of the high-boiling terpenoid (sesquiterpenoids, diterpenes) than does *J. flaccida* var. *poblana*. The nerolidol is unusual in *Juniperus* leaf oils as is the β-bisabolene (3,6-8). The low amounts of both camphor and bornyl acetate are unusual for the North American junipers (3,6-8). The aromatic components derived from the phenylpropanoid pathway (e.g., methyl-*O*-thymol and methyl eugenol) are very minor in contrast to the entire (non-serrate) leaf margin junipers (*J. blancoi* Martinez, *J. horizontalis* Moench, *J. ascopulorum* Sargent, *J. silicicola* (Small) Bailey, and *J. virginiana* L. (7,8) of North America. Although *J. flaccida* has non-serrate leaf margins (at 20×magnification) and very minor serrations at 40×magnification, the other morphological characteristics, habitat preferences, and the patterns of volatile leaf oils indicate that *J. flaccida* cannot be considered a part of the aforementioned alliance of species. The morphological and chemical analyses of *J. flaccida* var. *flaccida* and var. *poblana* also indicate that it has differentiated considerably from the other

TABLE 1. Composition of the Volatile Leaf Oils of *Juniperus flaccida* var *flaccida* and var. *poblana*[a]

Compound[b]	Total Oil (%)[c]		Compound[b]	Total Oil (%)[c]	
	var. *flaccida*	var. *poblana*		var. *flaccida*	var. *poblana*
α-pinene	44.6	57.3	borneol	2.2	1.0
camphene	(t)	0.7	4-terpineol	2.0	t
bicyclo(3,2,1)-oct-2-ene, 3 me-4-methylene	1.0	0.6	myrtenal	0.5	t
β-pinene	1.9	5.4	3,7,7-trimethyl-bicyclo (3,1,1)-2-heptanone	0.8	0.5
myrcene	2.9	6.8	α-terpineol	1.2	(t)
4-carene	(t)	2.3	verbenone	3.3	t
3-carene	1.0	1.5	myrtenol	—	t
p-cymene	0.9	t	fenchyl acetate	—	t
β-phellandrene	2.6	1.7	carveol	0.8	—
limonene	5.7	5.3	cervone	—	t
trans-ocimene	0.6	0.9	methyl-o-thymol	—	t
γ-terpinene	0.5	t	citronellol	t	t
β-terpineol isomer	0.6	(t)	piperitone	(t)	0.5
p-cymenene	(t)	t	bornyl acetate	(t)	1.4
frenchone	—	t	methyl eugenol	t	t
terpinolene	t	t	caryophyllene	0.6	t
unknown 1, C_{10}-OH, RRT=0.324	2.1	t	germacrene D	(t)	t
linalool	1.2	t	β-cubebene	t	(t)
pinene hydrate	1.3	1.4	α-muurolene	t	(t)
unknown 2, C_{10}-OH, RRT=0.339	1.7	1.4	γ-cadinene	t	(t)
cis-sabineene hydrate	(t)	t	Δ-cadinene	t	(t)
camphor	0.8	t	elemol	0.6	(t)
trans-pinocarveol	1.4	0.7	nerolidol	t	(t)
camphene hydrate	(t)	0.8	β-bisabolene	1.5	2.0
trans-sabinene hydrate	t	0.7	unknown 3, C_{15}-OH, RRT=0.715	1.0	t
trans-verbenol	6.2	1.4	γ-eudesmol	t	(t)
iso-pinocamphone	—	t	β-eudesmol	0.8	(t)
			α-eudesmol	0.7	—
			mannyloxide	3.2	(t)

[a]Compounds are listed in order of their retention on OV1.

[b]Compositional values in parenthesis indicate that a compound runs at that retention time but no spectrum was obtained.

[c]Trace (t) indicates the compound was less than 0.5% of the total oil.

Juniperus species of the Western Hemisphere. Additional research (in progress) will be needed to ascertain its affinities to the *Juniperus* species of the Eastern Hemisphere.

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