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Essential oil composition of *Juniperus chinensis* from the plains of northern India†

V. K. Raina,[1] S. K. Srivastava[1]* and K. V. Syamsundar[2]

[1] Central Institute of Medicinal and Aromatic Plants, PO CIMAP, Lucknow-226015, India
[2] Central Institute of Medicinal and Aromatic Plants, Field Station, GKVK PO Bangalore-560065, India

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ABSTRACT: The volatile leaf oil of *Juniperus chinensis* L., gown as ornamental tree in the plains of northern India, was examined by GC and GC-MS. Thirty-three components representing 94.8% of the oil were characterized with sabinene (19.8%), elemol (18.6%), bornyl acetate (17.5%) and limonene (14.2%) as major constituents. The oil was found to be polymorphic neither for cedrene/thujopsene/cedrol (typical juniper wood oil components) nor for phenolics such as methyl chavicol, safrole, methyl eugenol and elemicin, derived from phenyl propanoid pathway. Copyright © 2004 John Wiley & Sons, Ltd.

KEY WORDS: *Juniperus chinensis* L. Cupressaceae; essential oil composition; bornyl acetate; sabinene; elemol

Introduction

Juniperus chinensis L. (Cupressaceae) *J. chinensis* Hort.),[1] varies from shrub to tree up to 60 ft height and is sometimes procumbent; the branches are rather slender, the leaves opposite or whorled, linear, pointed and spreading, with a white band above or scale-like appressed, rhombic, 1/5–1/3 inch across with two or three seeds. The plants are very variable in habit and are commonly found in China, the Himalayas and Japan. Juniper ornamental trees and shrubs are grown for their foliage and habitat. Many cultivars of *J. chinensis* have been introduced into horticulture. In fact, *J. chinensis* cultivars are perhaps the most widely planted landscape species in the world. The volatile leaf oils of many cultivars have already been reported.[2–8] However, many of these studies only reported monterpenes and have not presented a full analysis of the oils.

Experimental

Plant material

Fresh foliage was collected from Lucknow, India, in the month of April 1997 and identified by Dr Aljos Farjon, Gymnosperm specialist, Royal Botanic Gardens Kew, UK. A voucher specimen has been deposited in the herbarium section of the Botany Department, CIMAP, Lucknow. The essential oil was isolated by hydrodistillation of fresh foliage (with lateral and terminal branches) in a Clevenger-type apparatus for 4 h, which produced an oil at 0.65% yield v/w on fresh weight basis. The sample oil was light yellow in colour, was dried over anhydrous sodium sulphate and stored in a sealed glass vial at low temperature until analysis.

Gas chromatography (GC)

GC analysis of the oil was performed on a Perkin-Elmer 8500 GC equipped with FID using fused silica capillary column (25 m × 0.32 mm i.d.; film thickness, 0.25 μm), coated with dimethyl polysiloxane (BP-1). Samples were injected in the split ratio 1:80 using pressure-controlled nitrogen as a carrier gas at a linear velocity of 10 psi. Injection and detector temperatures were maintained at 250 and 300 °C, respectively. Oven temperature was programmed from 60 to 220 °C at 5 °C/min and the temperature was held for 15 min.

Gas chromatography–mass spectrometry (GC-MS)

GC-MS data were obtained on Shimadzu QP-2000 instrument at 70 eV and 250 °C. The GC column was an Ulbon HR-1 (equivalent to OV-1), fused silica capillary (50 m × 0.25 mm i.d., film thickness 0.25 μm), using helium as a carrier gas at a flow rate of 2 ml/min. The oven temperature was programmed at 80 °C for 7 min and then heated at 5 °C/min to 250 °C.

* Correspondence to: S. K. Srivastava, Central Institute of Medicinal and Aromatic Plants, PO CIMAP, Lucknow-226015, India.
E-mail: santoshkumar_1955@yahoo.com
† CIMAP' Communication no. 99–24J.

Identification of compounds

Compounds were identified by comparing retention indices[2,3,5–10] of peaks on BP-1 column with literature values, but finally confirmed by comparison of mass spectra of peaks with published data[11–14] and computer matching against the Wiley and Nist libraries. Relative amounts of individual components are based on peak areas obtained without FID response factor correction. The retention indices were obtained from gas chromatograms by logarithmic interpolation between bracketing *n*-alkanes. A homologous series of *n*-alkanes (C-8 to C-22; Poly Science; Niles, USA) was used as standards.

Results and Discussion

The volatile oil was obtained by conventional hydrodistillation of leaves of *J. chinensis*, which gave oil at 0.65% yield on a fresh weight basis. GC and GC-MS analysis enabled the identification of a total of 33 constituents in the *J. chinensis* oil from Lucknow, India. The relative concentration of the volatile components identified are presented in Table 1 according to their elution order on the BP-1 column. The major constituents in the oil were bornyl acetate (17.5%), elemol (18.6%), sabinene (19.8%), limonene (14.2%), myrcene (5.7%) and terpinene-4-ol (4.3%). On comparing our results with Adams *et al.*,[8] who recently analysed three samples of *J. chinensis*, it was observed that out of 33 constituents identified in our oil, 20 were common to four of the oils. Out of the 20 common compounds the major constituents sabinene and limonene and minor and trace compounds β-pinene, α-terpinene, (E)-ocimene, *trans*-sabinene hydrate, linalool, *cis*-sabinene hydrate, α-terpineniol and α-cadinene had very similar compositions. Apart from the above similarities, however, significant differences were also observed in the percentage composition of various major and minor constituents. Myrcene and terpinene-4-ol were two to four times more abundant in our oils, while α-pinene was three to six times more abundant in Adams' samples. On the other hand, the major

Table 1. Essential oil composition of *J. chinensis* from the plains northern India

Compound	Percentage	Retention indices
Tricyclene	0.8	925
α-Thujene	0.8	929
α-Pinene	3.5	938
Camphene	0.7	950
Sabinene	19.8	973
β-Pinene	0.3	976
Myrcene	5.7	987
α-Phellandrene	t	999
δ-3-Carene	1.0	1013
α-Terpinene	0.1	1017
Limonene	14.2	1028
(E)-β-Ocimene	0.2	1043
γ-Terpinene	2.0	1056
trans-Sabinene hydrate	0.3	1062
Terpinolene	1.1	1084
Linalool	0.6	1090
cis-Sabinene hydrate	0.1	1099
Camphor	0.1	1132
trans-*p*-Menth-2-en-ol	0.1	1142
Terpinen-4-ol	4.3	1171
p-Cymen-8-ol	0.3	1182
α-Terpineol	0.1	1188
Methyl carvacrol	0.2	1247
Bornyl acetate	17.5	1278
α-Terpinyl acetate	0.1	1342
β-Caryophyllene	0.1	1428
α-Cadinene	t	1451
α-Humulene	0.1	1461
β-Cadinene	t	1478
δ-Cadinene	0.3	1523
Elemol	18.6	1551
γ-Eudesmol	1.4	1638
α-Eudesmol	0.4	1645

t, less than 0.05%.

Table 2. Variation in the major components of *Juniperus chinensis*

Compound	Percentage					
	J. chinensis India	*J. chinensis*[a]			*J. chinensis pfitzeriana*[b]	*J. chinensis* var. kaizuca[8]
		I	II	III		
Ethyl acetate	—	20.6	12.5	19.6		—
α-Pinene	3.5	11.1	10.6	22.6		18.6
Sabinene	19.8	18.6	13.1	16.7		15.7
Myrcene	5.7	2.5	2.8	3.1		8.6
Limonene	14.2	13.4	14.3	12.1		3.0
Terpinen-4-ol	4.3	1.0	2.8	1.5		2.5
Bornyl acetate	17.5	0.2	t	t	14.9	15.8
Safrole	—	—	6.3	8.6		—
Methyl eugenol	—	—	4.4	5.3		—
Elemol	18.6	—	—	—	12.4	10.8
Cedrol	—	19.5	19.1	0.9		—

[a] *J. chinensis*[8]; I = 6765, II = 6766, III = 6767.
[b] *J. chinensis* pfitzeriana; access to the original paper not available.[3,4]

constituents cedrol (0.9–19.5%), ethyl acetate (12.5–20.6%), safrole (6.3–8.6%) and methyl eugenol (4.4–5.3%) were only reported in the Adams samples, while bornyl acetate [(17.5%), trace in Adams] and elemol were present only in our oil. Adams' oils were polymorphic for cedrene/thujopsene/cedrol (typical Juniper wood oil components)[9,10] and phenolics such as methyl chavicol, safrole, methyl eugenol and elemicin, derived from the phenyl propanoid pathway, while ours were not.

On the other hand, in contrast to the Adams samples[8] our results matched well with respect to bornyl acetate and elemol with Fournier *et al*.,[2,3] *J. chinensis fitzeriana*, and Adam *et al*.,[8] *J. chinensis* var. kaizuca, who reported 14.9 and 15.8% bornyl acetate and 12.4 and 10.8% elemol with no polymorphism for cedrene/cedrol.

In the plains of northern India, *J. chinensis* is grown as an ornamental tree and the presence of bornyl acetate (17.5%) as one of the major constituents makes this oil more valuable. Hence leaves of this tree can be utilized as a new source for isolation of bornyl acetate.

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