

**The Volatile Leaf Oils of
Juniperus przewalskii Kom. and
forma *pendula* (Cheng & L. K. Fu)
R. P. Adams & Chu Ge-Lin from China**

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ABSTRACT: The composition of the volatile leaf oils of *Juniperus przewalskii* and *J. przewalskii* f. *pendula* are reported. The oil of *J. przewalskii* contains moderate amounts of α -pinene (6.9-11.7%), limonene (7.1-11.8%), sabinene (3.3-10.0%), piperitone (3.1-9.0%) and several diterpenes (>15%). The oil of forma *pendula* was dominated by α -pinene (28.6%), sabinene (28.6%) and cedrol (17.2%). The continued recognition of the forma *pendula* is supported by the terpenoid data. A new name combination is made: *Juniperus przewalskii* Kom. f. *pendula* (Cheng & L. K. Fu) R. P. Adams & Chu Ge-lin.

KEY WORD INDEX: *Juniperus przewalskii*, forma *pendula*, Cupressaceae, taxonomy, monoterpenes, α -pinene, sabinene, cedrol, abietatriene, 8- β -hydroxyisopimarene, diterpene.

INTRODUCTION: *Juniperus przewalskii* Kom. is a large tree (to 20 m or more) in China. A forma has been described with drooping foliage (*Sabina przewalskii* f. *pendula* Cheng & L. K. Fu). Although previous workers in China divided the genus *Juniperus* into three genera (*Arceuthos*, *Juniperus* and *Sabina*), we accept the genus as classically defined with three sub-genera (*Caryocedrus*, *Juniperus* and *Sabina*) (1). Thus, it is necessary to create a new name combination:

Juniperus przewalskii Kom. f. *pendula* (Cheng & L. K. Fu) R. P. Adams & Chu Ge-lin, *comb. nov.*
= *Sabina przewalskii* Kom. f. *pendula* Cheng & L. K. Fu., *Acta Phytotax. Sin.*, **13**(4), 86 (1975).
= *J. zaidamensis* Kom.

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Table I. Comparisons (percentage) of volatile leaf oils of *Juniperus przewalskii* and *J. przewalskii* f. *pendula* from Gansu, China

| RT | Compound | <i>J. przewalskii</i> | | | <i>f. pendula</i> |
|------|------------------------|-----------------------|------|------|-------------------|
| | | 6777 | 6776 | 6775 | 6779 |
| 301 | tricyclene | t | t | t | t |
| 307 | α -thujene | 0.2 | 0.1 | 0.4 | 1.3 |
| 319 | α -pinene | 11.7 | 6.9 | 11.3 | 28.6 |
| 337 | α -fenchene | t | t | t | t |
| 340 | camphene | 0.1 | t | 0.1 | t |
| 379 | sabinene | 8.7 | 3.3 | 10.0 | 28.6 |
| 386 | β -pinene | 0.3 | 0.1 | 0.2 | 0.1 |
| 408 | myrcene | 1.3 | 0.7 | 1.2 | 1.4 |
| 427 | δ -3-carene | 4.6 | 4.5 | 2.5 | - |
| 435 | α -phellandrene | 0.1 | 0.1 | 0.1 | 0.1 |
| 444 | δ -3-carene | - | 0.1 | 0.4 | 0.2 |
| 457 | α -terpinene | 0.3 | 0.2 | 0.6 | 1.7 |
| 471 | p-cymene | 0.7 | 0.6 | 0.4 | 0.5 |
| 481 | limonene | 11.1 | 11.8 | 7.1 | 4.3 |
| 545 | γ -terpinene | 0.4 | 0.3 | 0.9 | 2.7 |
| 560 | trans-sabinene hydrate | 0.3 | 0.1 | 0.4 | 1.6 |
| 608 | terpinolene | 0.6 | 0.4 | 0.7 | 1.0 |
| 629 | cis-sabinene hydrate | 0.2 | 0.2 | 0.4 | 1.6 |
| 632 | linalool | 0.4 | 0.2 | 0.4 | 0.4 |
| 642 | α -thujone | 0.7 | 0.9 | 0.1 | t |
| 667 | β -thujone | 3.7 | 3.6 | 0.2 | 0.1 |
| 682 | cis-p-menth-2-en-1-ol | 0.5 | 0.5 | 0.4 | 0.6 |
| 724 | trans-menth-2-en-1-ol | - | - | - | 0.3 |
| 726 | trans-sabinol | 0.9 | 0.4 | 0.4 | - |
| 735 | trans-verbenol | 0.1 | t | 0.3 | - |
| 792 | p-mentha-1,5-dien-8-ol | 0.1 | 0.1 | 0.1 | - |
| 820 | terpinen-4-ol | 1.1 | 0.7 | 2.7 | 9.1 |
| 837 | p-cymen-8-ol | 0.2 | 0.2 | 0.1 | 0.1 |
| 852 | α -terpineol | 0.1 | 0.1 | 0.2 | 0.3 |
| 865 | cis-piperitol | 0.1 | 0.1 | t | 0.1 |
| 896 | trans-piperitol | 0.1 | 0.1 | 0.1 | 0.1 |
| 950 | citronellol | 0.9 | 0.5 | t | - |
| 1011 | piperitone | 7.0 | 9.0 | 3.1 | - |
| 1068 | terpene alcohol? | 3.7 | 4.0 | 3.0 | 2.9 |
| 1099 | bornyl acetate | 0.3 | t | 0.3 | 0.1 |
| 1101 | linalool oxide acetate | 0.2 | - | t | - |
| 1117 | trans-sabinyol acetate | 1.4 | - | 0.1 | - |
| 1442 | caryophyllene | 0.2 | 0.2 | 0.2 | t |
| 1467 | thujosene | t | 0.2 | 0.2 | 0.1 |
| 1594 | germacrene D | 0.2 | 0.2 | 0.7 | - |
| 1629 | epi-cubebol | 0.2 | t | 0.1 | - |
| 1643 | α -muurolene | 0.4 | t | 0.2 | - |
| 1676 | γ -cadinene | 0.9 | 0.3 | 0.6 | t |
| 1700 | δ -cadinene | 1.9 | 0.5 | 1.0 | 0.2 |
| 1733 | α -cadinene | 0.2 | 0.1 | t | - |

Table I. (cont.)

| RT | Compound | <i>J. przewalskii</i> | | | <i>f. pendula</i> |
|------|--|-----------------------|------|------|-------------------|
| | | 6777 | 6776 | 6775 | 6779 |
| 1759 | elemol | 1.9 | 2.6 | 2.9 | 3.2 |
| 1820 | germacrene D-4-ol | 3.0 | 0.4 | 1.0 | 0.2 |
| 1864 | longiborneol (= Juniperol) | 0.4 | t | t | - |
| 1876 | cedrol | - | 0.8 | t | 17.2 |
| 1898 | β -oplophenone | t | t | t | t |
| 1942 | 1-epi-cubenol | 0.2 | t | 0.2 | - |
| 1951 | γ -eudesmol | 0.3 | 0.4 | 0.5 | 0.8 |
| 1973 | epi- α -cadinol (= τ -cadinol) | 1.1 | 0.3 | 1.0 | 0.1 |
| 1976 | epi- α -muurolol (= τ -muurolol) | 1.1 | 0.2 | 0.9 | 0.1 |
| 1984 | torreyol (= δ -cadinol) | 0.6 | t | 0.5 | t |
| 1993 | β -eudesmol | 0.5 | 0.4 | 0.9 | 1.0 |
| 2000 | α -eudesmol | - | - | - | 1.0 |
| 2003 | α -cadinol | 3.8 | 1.7 | 3.5 | 0.1 |
| 2034 | (elemol acetate) | 0.4 | 0.6 | 0.7 | 0.7 |
| 2070 | sesquiterpene alcohol | t | t | 0.7 | - |
| 2183 | oplopanone | 0.2 | - | t | - |
| 2306 | 8- α -acetoxyelemol | 3.9 | 7.6 | 4.8 | 4.5 |
| 2526 | rimuene | - | 0.5 | t | - |
| 2535 | 8- α -isopimar-9(11),15-diene | - | 1.3 | t | - |
| 2558 | diterpene | - | 1.0 | 0.2 | - |
| 2660 | epi-13-manool | - | 1.8 | 0.4 | t |
| 2717 | diterpene | 0.6 | 2.3 | 0.6 | 0.3 |
| 2761 | phyllocladene | 0.2 | 1.0 | 0.5 | t |
| 2841 | abietatriene | 5.9 | 3.2 | 15.1 | 0.8 |
| 2891 | abietadiene | 6.0 | 1.1 | 5.7 | 3.2 |
| 2972 | 8- β -hydroxyisopimarene | t | 13.1 | 3.2 | - |
| 3107 | phyllocladanol | t | 0.4 | - | - |
| 3253 | (cis)-totarol | 0.2 | t | 0.4 | t |
| 3297 | trans-totarol | 1.0 | 1.4 | 1.2 | 1.5 |
| 3333 | trans-ferruginol | 0.3 | 0.1 | 0.2 | t |

Compounds are listed in order of their elution from a DB5 column.
Compounds in parenthesis are tentatively identified. Compositional values <0.1% are denoted as traces (t). Unidentified components <0.5% are not reported.

Juniperus przewalskii, locally called Qilian Yuan-bai, is found in the Gansu, Qinghai and Sichuan Provinces of China. *Juniperus przewalskii* f. *pendula* occurs in a limited area, in the Xiqing Mountains of eastern Qinghai and adjacent Gansu and Sichuan Provinces. In one population we found only the typical form (erect foliage) but in the second population we found both erect and pendulant foliaged trees. No information on the leaf oil compositions of these taxa has been reported.

EXPERIMENTAL: Fresh foliage (10-12 terminal branches, 15-20 cm long) was collected and voucher specimens [*J. przewalskii*, west of Jone, Gansu (R. P. Adams, 6775-6777); *J. przewalskii* f. *pendula*, Langmusi, Gansu (R. P. Adams, 6779)] are deposited at BAYLU and NWTU.

The volatile leaf oils were isolated by steam distillation (200 g foliage, FW) using a circulatory Clevenger apparatus (2) for 2 h. Oil yields (2 h basis) were 1.2% (*J. przewalskii*) and 1.5% (*J. przewalskii* f. *pendula*). Mass spectra were recorded with a Finnigan Ion Trap (ITD) mass spectrometer, model 700, directly coupled to a Varian 6500 gas chromatograph, using a J&W DB5, 0.26 mm id x 30 m, 0.25 micron coating thickness, fused silica capillary column (3). Identifications were made by library searches of our volatile oil library, LIBR(TP) (3) using combined mass spectra and retention times for searching.

RESULTS AND DISCUSSION: The volatile leaf oil of *J. przewalskii* contains moderate amounts of α -pinene (6.9-11.7%), limonene (7.1-11.1%), sabinene (3.3-10.0%), piperitone (3.1-9.0%) and generally considerable amounts of diterpenes (Table I). The forma *pendula* was dominated by α -pinene (28.6%), sabinene (28.6%) and cedrol (17.2%). Although cedrol has only been found in trace amounts in a few junipers of the western hemisphere, cedrol is fairly common in the junipers of the eastern hemisphere (*J. excelsa* (4), *J. foetidissima* (5), *J. semiglobosa* (6)), cis-p-Menth-2-en-1-ol and α -eudesmol were found only in forma *pendula*. Several compounds found in *J. przewalskii* were not found in the forma *pendula*, but additional samples of f. *pendula* would likely contain them as the terpenes appear quite variable within *J. przewalskii*.

Analysis of the volatile leaf oils supports the continued recognition of the weeping foliated plants as a form of *J. przewalskii* (i.e., *J. przewalskii* f. *pendula*).

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