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# COMPOSITION OF THE ESSENTIAL OILS OF *Juniperus oxycedrus* SUBSP. *macrocarpa* FROM TURKEY

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*Juniperus* L. is represented in Turkey by eight taxa. *Juniperus oxycedrus* has two subspecies – subsp. *oxycedrus* and subsp. *macrocarpa* – in Turkey[1]. *J. oxycedrus* L. subsp. *macrocarpa* (Sibth. et Sm.) Ball. is called "Buyuk Kozalakli Katran Ardici" [2]. Leaf oil contents and compositions of *Juniperus oxycedrus* subsp. *macrocarpa* from countries like Italy [3], Colombia [4], Greece [5], and Spain [6] have been reported. The isolation and structure elucidation of junicedranol, a sesquiterpene with a novel carbon skeleton, from the leaf oil of *Juniperus oxycedrus* subsp. *macrocarpa* was reported in [7].

*Juniperus oxycedrus* subsp. *macrocarpa* leaves were collected in May, August, and October 1998 – in order to determine seasonal differences, from Altin Kum Beach of Ciftlik Village in Cesme - Izmir and distilled for 3 hours using a Clevenger Apparatus. Voucher specimens are kept at the Herbarium of the Faculty of Pharmacy of Gazi University. (GUEF98-444). The oils were analyzed by GC/MS using a Hewlett Packard GCD system. An HP-Innowax FSC column (60 m × 0.25 mm *dia*., with 0.25 mm film thickness) was used with helium as carrier gas (1 ml/min.). GC oven temperature was kept at 60°C for 10 min and programmed to 220°C at a rate of 4°C/min, then kept constant at 220°C for 10 min and then programmed to 240°C at a rate of 1°C/min. Split ratio was adjusted at 50:1. The injector temperature was at 250°C. MS were taken at 70 eV. Mass range was from 35 to 425 *m/z*.

The components were identified by comparison of their mass spectra with Wiley GC/MS Library, MassFinder and in-house Baser Library of Essential Oil Constituents. Relative percentage amounts of the separated compounds were calculated automatically from peak areas of the total ion chromatogram. Alkanes were used as reference points in the calculation of relative retention indices (RRI). The compounds identified in the oil can be seen in Table 1.

Oil contents varied between 0.03% and 0.13%. The highest yield was attained with the August samples. In the May, August, and October samples, 106, 83, and 94 components were characterized representing 84.6%, 95.2%, and 90.1% of the oils, respectively. The main components found in the oils are shown in Table 1. Manoyl oxide (7.7–21.9%), $\alpha$-pinene (7.2–11.1%), $\alpha$-cedrol (2.3–9.7%), widdrene (2.1–5.7%), $\alpha$-muurolene (4.1–4.8%), *trans*-verbenol (1.7–4.3%), germacrene D (1.5–4.1%), $\delta$-cadinene (3.2–3.8 %), $\alpha$-campholene aldehyde (1.7–3.2%), *trans*-pinocarveol (1.5–3.0%), cubebol (1.4–2.4%), caryophyllene oxide (1.5–1.9%), $\delta$-cadinene (1.0–1.8%), $\beta$-caryophyllene (0.7–1.8%), and epi-cubebol (1.0–1.4%) were the main constituents of the oils. Manoyl oxide (21.9%), a diterpene, was the main component in the August sample. It was followed by $\alpha$-cedrol (9.7%), $\alpha$-pinene (7.2%), and widdrene (5.7%). The main components in the October sample were $\alpha$-pinene (11.1%), manoyl oxide (9.1%), $\alpha$-muurolene (4.8%), *trans*-verbenol (4.0%), and $\alpha$-cedrol (3.4%). Manoyl oxide (7.7%), $\alpha$-pinene (7.6%), *trans*-verbenol (4.3%), and $\alpha$-muurolene (4.1%) were predominant in the May sample.

In previous studies, $\alpha$-pinene (14.5% and 22.6%) and sabinene (24.6% and 26.5%) were reported as the main constituents in the oils of Colombia [4] and Spain [6], respectively. $\alpha$-Pinene (26.9% and $\alpha$-cedrol (13.9%) were the main constituents of the oil from Greece [5]. In the Italian oil [3], only the components detected were indicated without percentage amounts.

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TABLE 1. The Composition of the Leaf Essential Oils of *Juniperus oxycedrus* subsp. *macrocarpa*

| RRI | Compound | % | | | RRI | Compound | % | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | | | A | B | C |
| 1032 | α-Pinene | 7.6 | 7.2 | 11.1 | 1726 | Germacrene D | 2.9 | 1.5 | 4.1 |
| 1076 | Camphene | 0.1 | 0.1 | 0.1 | 1729 | *cis*-Muurola-4(15),5-diene* | 0.6 | 0.7 | 0.4 |
| 1118 | β-Pinene | 0.3 | 0.2 | 0.4 | 1740 | *p*-Menth-1,5-dien-8-ol | 1.6 | 0.9 | 1.6 |
| 1132 | Sabinene | 0.1 | Tr. | 0.1 | 1740 | α-Muurolene | 4.1 | 4.3 | 4.8 |
| 1159 | δ-3-Carene | 0.4 | 1.1 | 1.5 | 1751 | Carvone | 0.2 | 0.1 | 0.3 |
| 1174 | Myrcene | 1.1 | 0.3 | 1.3 | 1758 | α-Cuprenene | 0.1 | 0.6 | 0.2 |
| 1203 | Limonene | 0.6 | 0.4 | 0.7 | 1758 | (*E*,*E*)-α-Farnesene | - | - | 0.2 |
| 1218 | β-Phellandrene | 0.7 | 0.1 | 1.3 | 1765 | Naphthalene | 0.2 | - | 0.2 |
| 1266 | (E)-β-Ocimene | 0.1 | 0.1 | 0.5 | 1766 | Decanol | 0.3 | - | - |
| 1280 | *p*-Cymene | 0.5 | 0.3 | 0.5 | 1772 | δ-Cadinene | 3.3 | 3.8 | 3.2 |
| 1290 | Terpinolene | 0.3 | 0.2 | 0.6 | 1776 | γ-Cadinene | 1.8 | 1.0 | 1.8 |
| 1400 | Nonanal | 0.2 | Tr. | 0.2 | 1786 | ar-Curcumene | - | 0.1 | - |
| 1435 | γ-Campholene aldehyde | 0.5 | 0.2 | 0.3 | 1797 | *p*-Methylacetophenone | 0.1 | - | Tr. |
| 1444 | α,*p*-Dimethylstyrene | 0.2 | 0.1 | 0.2 | 1798 | Cubenene | 0.5 | - | - |
| 1466 | α-Cubebene | 0.4 | 0.3 | 0.4 | 1803 | β-Cuprenene | - | 0.6 | - |
| 1500 | α-Campholene aldehyde | 3.2 | 1.7 | 2.2 | 1804 | Myrtenol | 1.0 | 0.5 | 0.7 |
| 1529 | α-Bourbonene | Tr. | 0.6 | - | 1811 | 3,7-Guaiadiene | 0.1 | 0.1 | 0.1 |
| 1535 | Pinocamphone | 0.9 | 0.3 | 0.4 | 1827 | (*E*,*E*)-2,4-Decadienal | 0.2 | Tr. | 0.2 |
| 1535 | β-Bourbonene | - | - | 0.3 | 1845 | *trans*-Carveol | 1.4 | - | 1.4 |
| 1542 | Benzaldehyde | 0.1 | Tr. | Tr. | 1849 | Cuparene | - | 2.2 | 0.2 |
| 1547 | β-Cubebene | 0.3 | 0.4 | 0.5 | 1849 | Calamenene | 0.6 | 0.7 | 0.2 |
| 1553 | Linalool | 0.4 | 0.1 | - | 1864 | *p*-Cymen-8-ol | 0.2 | 0.1 | 0.3 |
| 1562 | Isopinocamphone | - | 0.2 | - | 1868 | (*E*)-Geranylacetone | 1.2 | 0.1 | Tr. |
| 1562 | Octanol | 0.8 | - | 0.3 | 1900 | *epi*-Cubebol | 1.1 | 1.0 | 1.4 |
| 1568 | *trans*-α-Bergamotene | 0.1 | 0.2 | - | 1921 | β-Calacorene | Tr. | Tr. | Tr. |
| 1571 | *trans*-*p*-Menth-2-en-1-ol | 0.1 | - | Tr. | 1941 | α-Calacorene | 0.4 | 0.4 | 0.2 |
| 1577 | α-Cedrene | - | 0.5 | - | 1957 | Cubebol | 1.9 | 1.4 | 2.4 |
| 1586 | Pinocarvone | 1.2 | 0.4 | 1.0 | 1973 | Dodecanol | 0.1 | - | Tr. |
| 1594 | β-Funebrene | 0.2 | 0.6 | 0.3 | 1984 | γ-Calacorene | 0.2 | 0.1 | 0.1 |
| 1597 | Bornyl acetate | 0.4 | 0.4 | 0.4 | 2008 | Caryophyllene oxide | 1.9 | 1.5 | 1.8 |
| 1600 | β-Elemene | - | - | 0.3 | 2043 | Salvial-4(14)-en-1-on | 0.4 | 0.2 | 0.4 |
| 1604 | Methyl thymol | 0.4 | - | 0.4 | 2045 | Humulene epoxide I | 0.1 | - | - |
| 1612 | β-Caryophyllene | 1.5 | 0.7 | 1.8 | 2050 | (*E*)-Nerolidol | Tr. | 0.2 | 0.1 |
| 1614 | Methyl carvacrol | 0.1 | - | 0.3 | 2051 | Gleenol | 0.1 | 0.2 | 0.2 |
| 1645 | Widderene | 2.1 | 5.7 | 2.4 | 2070 | Cinnamaldehyde | 0.8 | - | - |
| 1648 | Myrtenal | 1.0 | 0.9 | 1.0 | 2071 | Humulene epoxide II | 0.7 | 0.9 | 1.1 |
| 1655 | (*E*)-2-Decenal | 0.1 | - | 0.1 | 2080 | Cubenol | 0.3 | 0.3 | 0.4 |
| 1668 | *cis*-Verbenol | 0.8 | 0.4 | 0.7 | 2084 | Octanoic acid | 0.2 | - | - |
| 1671 | *trans*-Pinocarveol | 3.0 | 1.5 | 2.1 | 2088 | 1-*epi*-Cubenol | 1.5 | 1.3 | 1.4 |
| 1674 | *p*-Mentha-1,5-dien-8-ol | 0.6 | 0.5 | 0.4 | 2096 | (*E*)-Methyl cinnamate | 0.1 | - | - |
| 1678 | *epi*-Zonarene | 0.6 | 0.9 | 0.6 | 2131 | Hexahydrofarnesylacetone | 0.3 | - | 0.2 |
| 1684 | *trans*-Verbenol | 4.3 | 1.7 | 4.0 | 2149 | α-Cedrol | 2.3 | 9.7 | 3.4 |
| 1698 | Myrtenyl acetate | 0.4 | - | - | 2179 | Widdrol | 0.3 | 0.8 | 0.4 |
| 1700 | γ-Muurolene | 0.4 | 0.2 | - | 2187 | T-Cadinol | 0.6 | 0.6 | 1.0 |
| 1707 | α-Terpineol | 0.7 | 0.4 | 1.2 | 2205 | Thymol | 0.4 | - | - |
| 1709 | α-Terpinyl acetate | 0.5 | 0.7 | 0.5 | 2209 | T-muurolol | 0.3 | 0.2 | 0.3 |
| 1719 | Borneol | 0.1 | 0.1 | 0.1 | 2219 | δ-Cadinol | 0.3 | 0.2 | 0.3 |
| 1725 | Verbenone | 0.7 | 0.3 | 0.7 | 2246 | Carvacrol | 0.3 | 0.2 | 0.3 |

TABLE 1. (continued)

| RRI | Compound | % | | | RRI | Compound | % | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | | | A | B | C |
| 2256 | Cadalene | 0.2 | 0.2 | 0.2 | 2419 | 4-Isopropyl-6-methyl-1-tetralone | Tr. | 0.1 | Tr. |
| 2264 | 4,7-Dimethyl-1-tetralone | 0.1 | 0.1 | Tr. | 2489 | 8,13-Abietadiene | 1.1 | 1.4 | 1.0 |
| 2287 | Sandaracopimaradiene | 0.2 | 0.1 | Tr. | 2503 | Dodecanoic acid | 2.2 | - | 0.9 |
| 2300 | Decanoic acid | 0.3 | - | 0.2 | 2524 | Abietatriene | 0.6 | 1.1 | 0.5 |
| 2349 | Cadina-4,10(15)-dien-3-one | 0.1 | - | 0.1 | 2554 | Nootkatone | Tr. | - | 0.1 |
| 2376 | Manoyl oxide | 7.7 | 21.9 | 9.1 | 2713 | Tetradecanoic acid | 0.2 | - | 0.1 |
| 2386 | Farnesyl acetone | 0.2 | - | - | 2931 | Hexadecanoic acid | 0.1 | - | 0.1 |
| 2396 | 8$\alpha$-13-oxy-14-en-epiladane | - | 0.3 | 0.3 | | Number of components | 106 | 83 | 94 |
| 2419 | 4-Isopropyl-6-methyl-1-tetralone | Tr. | 0.1 | Tr. | | Total, % | 84.6 | 95.2 | 90.1 |

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A: Collected in May; B: collected in August; C: collected in October.

RRI: Relative retention indices calculated against *n*-alkanes calculated TIC data.

*Tentative identification from Mass Finder.

Tr.: trace < 0.1%.

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