# Composition of the Volatile Oils of Two *Anthemis* L. Taxa from Turkey

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Z. Naturforsch. **66 c**, 535–540 (2011); received December 10, 2010/August 23, 2011

The essential oils of water-distilled aerial parts of *Anthemis pseudocotula* and *Anthemis cretica* subsp. *pontica* (Asteraceae) were analysed by GC-MS. As a result thirty-five and forty compounds were identified representing 93.1% and 89.0% of the oils, respectively. The main compounds of *A. pseudocotula* were 1,8-cineole (39.40%), camphor (9.36%), artemisiaketone (5.68%), filifolene (5.15%), and $\alpha$-terpineol (4.69%), whereas $\beta$-caryophyllene (20.26%), azulene (14.98%), spathulenol (6.03%), and germacrene D (5.82%) were the major constituents of *A. cretica* subsp. *pontica.*

*Key words: Anthemis*, 1,8-Cineole, Caryophyllene

## Introduction

The genus *Anthemis* L. (family Asteraceae, tribe Anthemideae) is divided into three subgenera (*Anthemis*, *Maruta*, and *Cota*) according to the Flora of Turkey (Davis, 1975). In Turkey only 50 species have been recorded of which about 54% are endemic. These plants prefer dry, open sites on wood-steppe hillsides and grow especially on calcareous soils (Davis, 1975). Furthermore, the genus *Anthemis* (tribe Anthemideae Cass.) consists of more than 210 species. The total geographical distribution of *Anthemis* encompasses most of western Eurasia, the Mediterranean, and a small part of eastern Africa. While the central European region is inhabited by only a few archaeophytic species, the main centre of diversity is located in southwestern Asia with 150–210 species, including all of the presently accepted subgenera and sections. Some species inhabit northern America and the southern hemisphere as well (Oberprieler, 2001). The position of the genus within the tribe Anthemideae is still unresolved and infrageneric taxonomy of *Anthemis*, mainly based on life form, achene morphology, and achene anatomy, is in need of revision. According to some authors, the subgenus *Cota* should be treated as an independent genus (Oberprieler, 2001).

The species of the genus *Anthemis* are widely used in the pharmaceutics, cosmetics, and food industry. The flowers of the genus have a well-documented use as antiseptic and healing herbs, the main components being flavonoids and essential oils (Vaverkova *et al*., 2001). In Europe extracts, tinctures, tisanes (teas), and salves are widely used as anti-inflammatory, antibacterial, antispasmodic, and sedative agents, respectively. The activity of the essential oils and different extracts from several *Anthemis* species has been reported previously (Holla *et al*., 2000; Grace, 2002). Sesquiterpene lactones have received considerable attention because of their chemo-ecological functions (Cis *et al*., 2006; Nawrot *et al*., 1983), biological activities, and taxonomic significance (Picman, 1986; Zhang *et al*., 2005). They represent one of the major classes of secondary metabolites in the genus *Anthemis*. Three skeletal types of sesquiterpene lactones – guaianolides, germacranolides, and eudesmanolides – have been detected in *Anthemis* species (Seaman, 1982).

*A. cretica* is a highly polymorphic species in which a number of different taxa are recognizable and have been variously treated at specific or infraspecific levels by some authors (Davis, 1975). Having all of the above-mentioned in mind, the aim of the present study was to perform a detailed chemical composition of the essential oil hydrodistilled from the above-ground parts of *A. pseudocotula* and *A. cretica* subsp. *pontica* from the eastern Anatolian region in Turkey. The

obtained results could be of use in the clarification of infrageneric taxonomy of the genus *Anthemis*.

## Material and Methods

### *Plant material*

The aerial parts of plants were collected from their natural habitats. *A. pseudocotula* Boiss. was collected from Elazig-Keban, Asagi Cakmak village, Turkey in May 2010 at an altitude of 1300 m. *A. cretica* subsp. *pontica* (Willd.) Grierson was also collected from Elazig-Keban, Guneytepe village, Turkey in June 2010 at an altitude of 1350 m. The voucher specimens have been deposited at the herbarium of Department of Biology, Firat University, Elazig, Turkey.

### *Isolation of the essential oils*

Air-dried aerial parts of the plant materials were subjected to hydrodistillation using a Clevenger-type apparatus for 3 h.

### *Gas chromatography-mass spectrometry (GC-MS) analysis*

The oils were analysed by GC-FID-MS, using a Hewlett Packard-Agilent 5973 N GC-MS system (Elazig, Turkey) with 6890 GC in the Plant Products and Biotechnology Research Laboratory (BUBAL) of Firat University, Elazig, Turkey. A HP-5 MS column (30 m × 0.25 mm i.d., film tickness 0.25 $\mu$m) was used with helium as the carrier gas. Injector temperature was 250 °C, split flow was 1 ml/min. The GC oven temperature was kept at 70 °C for 2 min, raised to 150 °C at a rate of 10 °C/min, then kept constant at 150 °C for 15 min, and finally raised to 240 °C at a rate of 5 °C/min. Alkanes were used as references in the calculation of relative retention indices (RRI). Mass spectra were taken at 70 eV and a mass range of 35–425. Component identification was carried out using spectrometric electronic libraries (WILEY, NIST). Cluster analysis (Wang *et al.*, 2009) was applied to classify the compounds of *A. pseudocotula* and *A. cretica* subsp. *pontica* in Figs. 1 and 2.

### *Statistical analysis*

The statistical software Cropstat (IRRI 2005) was used to perform the standard analyses of variance (ANOVA) and pattern analysis.

## Results and Discussion

The chemical composition of the essential oils of dried aerial parts of *A. pseudocotula* and *A. cretica* subsp. *pontica* was analysed by GC-MS. Thirty-five and forty compounds were identified in *A. pseudocotula* and *A. cretica* subsp. *pontica*, respectively, accounting for 93.1% and 89.0% of the respective total essential oils. The yields of essential oils from the two samples were 0.3 and 0.4 ml, respectively. The main compounds

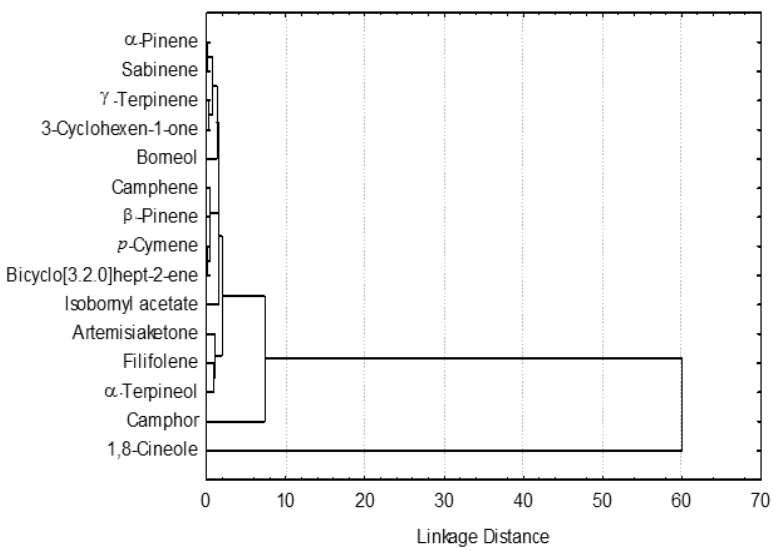


Fig. 1. Dendrogram presenting the hierarchical clustering of major compounds of essentail oils of *A. pseudocotula.*

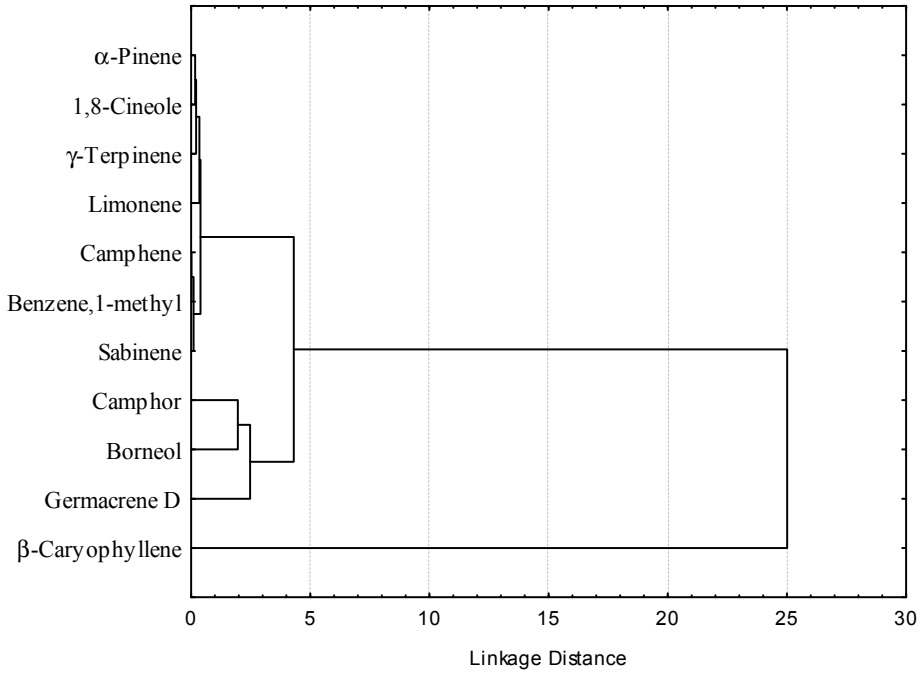


Fig. 2. Dendrogram presenting the hierarchical clustering of major compounds of essentail oils of *A. cretica* subsp. *pontica.*

of *A. pseudocotula* were 1,8-cineole (39.40%), camphor (9.36%), artemisiaketone (5.68%), filifolene (5.15%), and *α*-terpineol (4.69%), whereas *β*-caryophyllene (20.26%), azulene (14.98%), spathulenol (6.03%), and germacrene D (5.82%) were the major constituents of *A. cretica* subsp. *pontica.* The compositions of the essential oils are listed in Table I.

Classification results are shown in dendrograms of essential oils of *A. pseudocotula* (Fig. 1) and *A. cretica* subsp. *pontica* (Fig. 2). *A. pseudocotula* and *A. cretica* subsp. *pontica* were both classified into three main groups. In *A. pseudocotula* 1,8-cineole was in the first group, camphor in the second group, and other constituents were determined as third group (Fig. 1), whereas in *A. cretica* subsp. *pontica β*-caryophyllene was in the first group, germacrene D in the second group, and other constituents were determined as third group (Fig. 2).

1,8-Cineole (eucalyptol) was found as the major compound in the essential oil of *A. pseudocotula* (39.40%) (Table I and Fig. 1). Furthermore 1,8-cineole has been detected as the main compound in the essential oil of aerial parts of *A. wiedemanniana* Fisch. & Mey. from Turkey (8.49%) (Kivcak *et al*., 2007), *A. tinctoria* L. from Slovak Republic (7.9%) (Holla *et al*., 2000), *A. segetalis* Ten. from Montenegro (6.1%) (Radulovic *et al*., 2009), flowers and leaves from *A. xylopoda* O. Schwarz from Turkey (5.45%–16.74%) (Uzel *et al*., 2004), and *A. triumfetti* (L.) DC. (5.8%) from Montenegro (Pavlovic *et al*., 2006). On the other hand, 1,8-cineole has not been reported for the essential oils of *A. marschalliana* Willd. subsp. *pectinata* (Boiss.) from Turkey (Albay *et al*., 2009), *A. cretica* L. subsp. *argaea* Boiss. & Bal. from Turkey (Albay *et al*., 2009) *A. hyalina* DC. from Iran (Sajjadi and Mehregan, 2006), and also *A. altissima* L. from Iran (Rezaee *et al*., 2006) samples.

Camphor was also detected as a major compound in the essential oil of *A. pseudocotula* (9.36%) (Table I and Fig. 1), whereas camphor was not detected in the essential oils of *A. marschalliana* subsp. *pectinata* (Albay *et al*., 2009), *A. cretica* subsp. *argaea* (Albay *et al*., 2009), *A. wiedemanniana* (Kivcak *et al*., 2007), *A. segetalis* (Radulovic *et al*., 2009), *A. tinctoria* (Holla *et al*., 2000), and *A. altissima* (Rezaee *et al*., 2006) samples. Moreover camphor has been reported as one of the major compounds in the volatile constituents of flowers (11.6%) and leaves (1.7%) of

Table I. Composition of the essential oils of *A. pseudocotula* and *A. cretica* subsp. *pontica*.

| Compound | RRI[a] | *A. pseudocotula* (%) | *A. cretica* subsp. *pontica* (%) |
|---|---|---|---|
| Santolina triene | 997 | 0.98 | -[b] |
| Tricyclene | 1014 | 0.08 | - |
| Bicyclo[3.1.0]hex-2-ene | 1016 | 0.18 | - |
| *α*-Pinene | 1022 | 2.45 | 0.55 |
| Camphene | 1034 | 1.70 | 0.06 |
| Sabinene | 1052 | 2.52 | 0.12 |
| *β*-Pinene | 1056 | 1.50 | - |
| 6-Methyl-5-hepten-2-one | 1060 | - | 0.18 |
| *β*-Mrycene | 1064 | - | 0.23 |
| 1,3,6-Heptatriene | 1066 | 0.50 | - |
| Mrycene | 1069 | - | 0.64 |
| *β*-Phellandrene | 1224 | 0.28 | - |
| *α*-Terpinene | 1086 | 0.98 | - |
| *p*-Cymene | 1092 | 1.26 | - |
| Limonene | 1095 | 0.36 | 0.35 |
| 1,8-Cineole | 1098 | 39.40 | 0.65 |
| *cis*-Ocimene | 1100 | - | 0.90 |
| 1,3,6-Octatriene | 1108 | - | 0.17 |
| Artemisiaketone | 1117 | 5.68 | - |
| *γ*-Terpinene | 1120 | 3.07 | 0.77 |
| 1,3,6-Heptatriene | 1133 | 0.65 | - |
| *α*-Terpinolene | 1137 | 0.22 | - |
| Bicyclo[3.2.0]hept-2-ene | 1148 | 1.31 | - |
| Linalool | 1151 | - | 2.88 |
| 2*H*-Pyran-3(4*H*)-one | 1161 | - | 0.44 |
| Filifolene | 1164 | 5.15 | - |
| 1,4-Cyclohexadiene | 1166 | 0.35 | - |
| Camphor | 1186 | 9.36 | 4.39 |
| Borneol | 1205 | 3.72 | 3.26 |
| Naphthalene | 1215 | - | 0.12 |
| *α*-Terpineol | 1216 | 4.69 | - |
| *β*-Fenchyl alcohol | 1231 | - | 0.55 |
| Propanal | 1249 | 0.17 | - |
| *δ*-3-Carene | 1253 | 0.50 | - |
| 3-Cyclohexen-1-one | 1258 | 2.92 | - |
| *m*-Menthadien-6-ol | 1276 | - | 0.36 |
| Isobornyl acetate | 1283 | 0.48 | - |
| Eugenol | 1340 | 0.12 | - |
| 3-Carene | 1361 | 0.20 | - |
| *β*-Bourbenene | 1370 | - | 0.21 |
| 3,5-Heptadienal | 1373 | 0.71 | - |
| Benzene | 1378 | 0.80 | - |
| *β*-Elemene | 1394 | - | 1.64 |
| *β*-Caryophyllene | 1400 | 0.13 | 20.26 |
| Aromadendrene | 1406 | - | 0.28 |
| Bicyclo[3.1.1]hept-2-ene | 1415 | - | 0.80 |
| 1,6,10-Dodecatriene | 1416 | - | 1.16 |
| 3-Dodecan-1-al | 1424 | 0.44 | - |
| *α*-Humulene | 1425 | - | 1.77 |
| *β*-Selinene | 1430 | - | 0.47 |
| *β*-Lonone | 1433 | - | 0.10 |
| Germacrene D | 1435 | 0.37 | 5.82 |
| Eudesmol | 1440 | - | 1.17 |
| Bicyclogermacrene | 1445 | - | 1.20 |
| Germacrene A | 1452 | - | 0.37 |
| Spathulenol | 1495 | - | 6.03 |
| *α*-Gurjunene | 1505 | - | 0.20 |
| *α*-Selinene | 1541 | - | 5.30 |
| 6-Isopropenyl | 1576 | - | 0.46 |
| Azulene | 1579 | - | 14.98 |
| Phenol | 1586 | - | 0.40 |
| Cyclopentadecane | 1602 | 0.03 | - |
| 2-Pentadecanone | 1634 | - | 4.64 |
| *n*-Hexadecanoic acid | 1692 | - | 0.35 |
| Nonadecane | 1903 | - | 0.43 |
| Total | | 93.1 | 89.0 |

[a] RRI, relative retention index.
[b] Not detected.

*A. hyalina* (Sajjadi and Mehregan, 2006), in the essential oil of *A. triumfetti* (15.0%) (Pavlovic *et al.*, 2006), and in our study with *A. pseudocotula* (9.36%) and *A. cretica* subsp. *pontica* (4.39%) (Table I).

Azulene was detected as one of the major compounds in the essential oil of *A. cretica* subsp. *pontica* (14.98%) (Table I). However the absence of this compound from the essential oils of *A. pseudocotula* (Table I), *A. marschalliana* subsp. *pectinata*, *A. cretica* subsp. *argaea* (Albay *et al.*, 2009), *A. wiedemanniana* (Kivcak *et al.*, 2007), *A. segetalis* (Radulovic *et al.*, 2009), *A. tinctoria* (Holla *et al.*, 2000), *A. altissima* (Rezaee *et al.*, 2006), *A. hyalina* (Sajjadi and Mehregan, 2006), *A. xylopoda* (Uzel *et al.*, 2004), and *A. triumfetti* samples are noteworthy (Pavlovic *et al.*, 2006).

The studies undertaken on *A. tinctoria* (Holla *et al.*, 2000) showed that the main compounds of the oils were 1,8-cineole (7.9%), *β*-pinene (7.3%), decanoic acid (5.4%), and *α*-pinene (4.4%). Santolinatriene (27.33%), *α*-pinene (6.44%), and sabinene (6.09%) have been reported major components in *A. melampodina* Delile (Grace, 2002).

Spathulenol was reported the major compound in chemical constituents of the leaf (18.2%) and flower (18.7%) oils of *A. altissima* (Rezaee *et al.*, 2006), also in *A. marschalliana* subsp. *pectinata* (21.7%) (Albay *et al.*, 2009), and in our study

with *A. cretica* subsp. *pontica* (6.03%) (Table I), but it was not determined in the essential oils of *A. xylopoda* (Radulovic *et al*., 2009) and *A. pseudocotula* (Table I) which is noteworthy. While germacrene D was among the main components of *A. segetalis* (12.6%) (Radulovic *et al*., 2009) and in our study with *A. cretica* subsp. *pontica* (5.82%) (Table I), the cited compound was not a major component of the *A. wiedemanniana* (Kivcak *et al*., 2007), *A. tinctoria* (Holla *et al*., 2000), and *A. triumfetti* (Pavlovic *et al*., 2006) essential oils, respectively, whereas germacrene D was determined in very low amounts in *A. pseudocotula* (0.37%) (Table I).

According to Uzel *et al.* (2004), borneol (31.8%–30.15%) was among the main compounds of the flowers and leaves of *A. xylopoda*, respectively; according to Albay *et al*. (2009) borneol also was among the main components of *A. cretica* subsp. *argaea* from Turkey (10.6%). Whereas borneol was detected in low amounts (3.72% and 3.26%) in our study with *A. pseudocotula* and *A. cretica* subsp. *pontica*, respectively (Table I), this compound was not determined in the essential oils of *A. hyalina* (Sajjadi and Mehregan, 2006) and *A. triumfetti* (Pavlovic *et al*., 2006).

Linalool, the major compound in *A. wiedemanniana* (12.75%) (Kivcak *et al*., 2007), was not determined in *A. xylopoda* (Uzel *et al*., 2004) and in *A. pseudocotula* (Table I). Sabinene was determined as the main component in *A. segetalis* (19.5%) (Radulovic *et al*., 2009), but in our study this compound was not determined as a major constituent both in *A. pseudocotula* (2.52%) and *A. cretica* subsp. *pontica* (0.12%) (Table I).

$\alpha$-Pinene was analysed as the major constituent in *A. cretica* subsp. *argaea* (14.3%) (Albay *et al*., 2009) and 14.4% in *A. triumfetti* (Pavlovic *et al*., 2006), but this compound was not among the main components in leaf oil of *A. xylopoda* (1.33%) (Uzel *et al*., 2004) and *A. pseudocotula* (2.45%) (Table I). Also $\beta$-pinene was determined as one of the main components in *A. cretica* subsp. *argaea* (14.6%) (Albay *et al*., 2009), in *A. triumfetti* (16.9%) (Pavlovic *et al*., 2006), and in *A. tinctoria* (7.3%) (Holla *et al*., 2000), but this compound was not determined in the essential oil of *A. xylopoda* (Uzel *et al*., 2004) and in *A. cretica* subsp. *pontica* in this study (Table I).

## Conclusions

This study demonstrates the occurrence of the 1,8-cineole chemotype of *A. pseudocotula* and $\beta$-caryophyllene chemotype of *A. cretica* subsp. *pontica* in the eastern Anatolian region of Turkey (Table I, Figs. 1 and 2). Other *Anthemis* species have different types of essential oils, like the $\alpha/\beta$-pinene chemotype in *A. cretica* subsp. *argaea* (Albay *et al*., 2009) and the sabinene/germacrene D chemotype in *A. segetalis* (Radulovic *et al*., 2009).

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