Available online at www.sciencedirect.com
ScienceDirect
Food Chemistry 104 (2007) 1393–1395
Food Chemistry
www.elsevier.com/locate/foodchem

# Essential oil of *Teucrium scorodonia* L. ssp. *scorodonia* from Italy ☆

Simonetta Maccioni [a], Rosa Baldini [a], Marianna Tebano [b], Pier Luigi Cioni [b], Guido Flamini [b,*]

[a] *Dipartimento di Scienze Botaniche, Via Ghini 5, 56100 Pisa, Italy*
[b] *Dipartimento di Chimica Bioorganica e Biofarmacia, University of Pisa, Via Bonanno 33, 56126 Pisa, Italy*

Received 9 December 2005; accepted 31 January 2007

**Abstract**

The essential oil of the flowering aerial parts of *Teucrium scorodonia* L. ssp. *scorodonia* growing in Italy on Verrucano, was analyzed by GC and GC–MS. All the identified compounds were sesquiterpene hydrocarbons. The main ones were germacrene B (26.2%) and β-caryophyllene (25.2%).


*Keywords:* *Teucrium scorodonia* L. ssp. *scorodonia*; Lamiaceae; Essential oil composition; Sesquiterpenes; Germacrene B; β-Caryophyllene

## 1. Introduction

The genus *Teucrium* (Lamiaceae) is present in Europe, with many species, mainly in the Mediterranean basin. Here, *Teucrium scorodonia* L. is present with three subspecies: *T. scorodonia* L. ssp. *scorodonia*, the most common one, *T. scorodonia* L. ssp. *euganeum* (Vis.) Arcangeli, growing in Italy and Sicily, and *T. scorodonia* L. ssp. *baeticum* (Boiss. & Reuter) Tutin, growing in south-western Spain (Tutin et al., 1976).

Pignatti (1982) describes, for Italy, the species *T. scorodonia* L., without subspecies, and raises to species rank *T. euganeum* Vis., at present included within the endemic *T. siculum* Rafin.

The joint examination of these two dichotomous keys showed that the plant material could be referred to as *T. scorodonia* L. ssp. *scorodonia*, being characterized by a 4 mm calyx, white-yellowish corolla, oval bracts, and inflorescence axis and calyx covered by short hairs. This species prefers broad-leaved forests, generally on acid soil, from sea level up to 1500 m (Pignatti, 1982).

Some *Teucrium* species are valuable as alimentary plants. Hydroalcoholic extracts of wild germander (*Teucrium chamaedrys*) are currently used in the preparation of flavoured wines, bitters and liqueurs (Bosisio, Giavarini, Dell'Agli, Galli, & Galli, 2004).

*T. scorodonia* resembles hops in taste and flavour (Hedrick, 1972). An infusion of the leaves and flowers is used as a hop substitute for flavouring beer in some areas (Hedrick, 1972; Grieve, 1984; Facciola, 1990). It is said to clear the beer more quickly than do hops, but imparts too much colour to the brew (Grieve, 1984).

Many species of *Teucrium* are known for their utilization in traditional folk medicine and are claimed to exhibit interesting biological properties, e.g., hypoglycaemic, hypolipidemic, antipyretic, antiulcer and antibacterial (Nagao, Ito, Kohno, Kuroda, & Fujita, 1982; Autore et al., 1984; Gharaibeh, Elayan, & Salhab, 1988; Tariq, Ageel, Al-Yahya, Mossa, & Al-Said, 1989; Roman-Ramos, Flores-Saenz, Partida-Hernandez, Lara-Lemus, & Alarcon-Aguilar, 1991; Fernandez, Iglesias, & Villar del Fresno, 1997; Galati et al., 2000; Rasekh, Khoshnood-Mansourkhani, & Kamalinejad, 2001; Couladis, Tzakou, Verykokidou, & Harvala, 2003). Furthermore, *Teucrium* contains antioxidant compounds (Panovskai, Kulevanova, & Stefova, 2005). The potential of the antioxidant constituents of

☆ In memory of Prof. Ivano Morelli (1940–2005).
* Corresponding author. Tel.: +39 05044074; fax: +39 05043321.
*E-mail address:* flamini@farm.unipi.it (G. Flamini).

0308-8146/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodchem.2007.01.070

plant materials for the maintenance of health and protection from coronary heart disease and cancer is also raising interest among food manufacturers as consumers move towards functional foods with specific health effects (Loliger, 1991).

The genus *Teucrium* is characterized by essential oils rich in sesquiterpene hydrocarbons (Kovacevic, Lakusic, & Ristic, 2001).

Only one previous paper reports the composition of the essential oil of the flowering aerial parts of *T. scorodonia* L. ssp. *scorodonia* from different regions of Spain (Velasco Negueruela & Pérez Alonso, 1990). This oil contained low amounts of monoterpenes (10.1–20.1%), whereas sesquiterpenes were present in higher percentages (81.7–88.0%). The main constituents were an unresolved mixture of aristolene/β-caryophyllene (12.5–21.0%), germacrene D (6.4–13.4%) and α-copaene (4.8–9.3%).

*Teucrium* species are commonly used for their diuretic, antiseptic, anti-inflammatory and antispasmodic properties, useful for treatment of gastro-intestinal and pulmonary diseases (Kovacevic et al., 2001).

In Italian folk medicine, *T. scorodonia* L. is known for its astringent, anti-scurvy, antiseptic and eupeptic properties (Gastaldo, 1987).

This study is part of a research project on the chemistry of plants from Caprione Promontory (Maccioni, Flamini, Cioni, & Tomei, 1992; Flamini, Cioni, Morelli, Maccioni, & Tomei, 1994; Flamini, Cioni, Morelli, Maccioni, & Baldini, 2004), within the Montemarcello-Magra Natural Regional Park (Chiosi, 1978; Maccioni & Tomei, 1988; Maccioni, 1991; Monti & Maccioni, 1996; Cardelli, Di Tommaso, & Signorini, 2000; Maccioni, Baldini, & Amadei, 2001; Maccioni & Cardelli, 2002) (La Spezia province, Eastern Liguria). This paper deals with the composition of the essential oil obtained from the flowering aerial parts of *T. scorodonia* L. ssp. *scorodonia* growing in this area.

## 2. Materials and methods

The flowering aerial parts of *T. scorodonia* L. ssp. *scorodonia* were collected at the end of June 2004, near Montemarcello (La Spezia province, Italy), in the locality Bavognano. Here the plant grows on Verrucano soil (Montemarcello Nappe, Massa Unit) (AA.VV., 2001), facing east-north-east, at 200 m above the sea level. The plant material was collected inside a shady slope, protected from the wind, at the edges of a pinewood of *Pinus pinaster* Aiton, where also some *Quercus pubescens* Willd. individuals were present. During collection, the plant was exhaling a strong smell, at first nauseating, then pungent.

A voucher specimen is deposited at *Herbarium Horti Botanici Pisani* (Nuove Acquisizioni N. 7212 *T. scorodonia*/7).

The plant material was dried in the shade to constant weight (110 g) and hydrodistilled in a Clevenger-like apparatus for 2 h.

The GC analyses were accomplished with a HP-5890 Series II instrument equipped with HP-WAX and HP-5 capillary columns (both 30 m × 0.25 mm, 0.25 μm film thickness), working with the following temperature programme: 60 °C for 10 min, ramp of 5 °C/min up to 220 °C; injector and detector temperatures 250 °C; carrier gas nitrogen (2 ml/min); detector dual FID; split ratio 1:30; injection of (0.5 μl). The identification of the components was performed, for both columns, by comparison of their retention times with those of pure authentic samples and by means of their linear retention indices (lri) relative to the series of *n*-hydrocarbons.

GC/EIMS analyses were performed with a Varian CP-3800 gas-chromatograph equipped with a DB-5 capillary column (30 m × 0.25 mm; coating thickness 0.25 μm) and a Varian Saturn 2000 ion trap mass detector. Analytical conditions were: injector and transfer line temperatures 220 and 240 °C, respectively; oven temperature programmed from 60 °C to 240 °C at 3 °C/min; carrier gas helium at 1 ml/min; injection of 0.2 μl (10% hexane solution); split ratio 1:30. Identification of the constituents was based on comparison of the retention times with those of authentic samples, comparing their linear retention indices relative to the series of *n*-hydrocarbons, and on computer matching against commercial (NIST 98 and ADAMS) and home-made library mass spectra built up from pure substances and components of known oils and MS literature data (Stenhagen, Abrahamsson, & McLafferty, 1974; Massada, 1976; Jennings & Shibamoto, 1980; Swigar & Silverstein, 1981; Davies, 1990; Adams, 1995). Moreover, the molecular weights of all the identified substances were confirmed by GC/CIMS, using MeOH as CI ionizing gas.

## 3. Results and discussion

The essential oil yield was 0.03% (w/w) and its composition is shown in Table 1. Ten compounds were identified in the essential oil, accounting for 96.7% of the whole oil. All of them were sesquiterpene hydrocarbons, with germacrene B (26.2%) and β-caryophyllene (25.2%) as the main ones.

Table 1
Composition of the essential oil of the flowering aerial parts of *Teucrium scorodonia* L. ssp. *scorodonia* from Italy

| Constituents | l.r.i. | (%) |
|---|---|---|
| α-Cubebene | 1351 | 8.0 |
| α-Copaene | 1376 | 4.3 |
| β-Cubebene | 1390 | 6.5 |
| α-Gurjunene | 1409 | 6.0 |
| β-Caryophyllene | 1419 | 25.2 |
| α-Humulene | 1456 | 8.0 |
| Germacrene D | 1481 | 6.3 |
| α-Cuprenene | 1496 | 3.2 |
| δ-Cadinene | 1524 | 3.0 |
| Germacrene B | 1558 | 26.2 |
| Total identified | | 96.7 |
| Yield (w/w) | | 0.03 |

Other important constituents were α-cubebene and α-humulene (both 8.0%).

Germacrene B, the main compound of the essential oil of *T. scorodonia* L. ssp. *scorodonia*, was not detected at all in the Spanish study (Velasco Negueruela & Pérez Alonso, 1990). It has been detected in other *Teucrium* species, namely, *T. montanum* L., *T. polium* L., *T. lepicephalum*, *T. carolipaui*, *T. lusitanicum* and *T. algarbiensis* (Perez, Blazquez, & Boira, 2000; Kovacevic et al., 2001; Cavaleiro, Salgueiro, Miguel, & Proenca da Cunha, 2004), but always in small amounts. These differences could be related to the distinct habitat in which the plant has been collected.

## References


AA.VV. (2001) Piano del Parco Naturale Regionale di Montemarcello-Magra; Cartography, Table 10A, Geological Chart.

Adams, R. P. (1995). *Identification of essential oil components by gas chromatography/mass spectroscopy*. Carol Stream: Allured.

Autore, G., Capasso, F., De Fusco, R., Fasulo, M. P., Lembo, M., Mascolo, N., et al. (1984). Antipyretic and antibacterial actions of *Teucrium polium* (L.). *Pharmacological Research Communications, 16*, 21–29.

Bosisio, E., Giavarini, F., Dell'Agli, M., Galli, G., & Galli, C. L. (2004). Analysis by high-performance liquid chromatography of teucrin A in beverages flavoured with an extract of *Teucrium chamaedrys* L. *Food Additives and Contaminants, 21*, 407–414.

Cardelli, M., Di Tommaso, P. L., & Signorini, M. A. (2000). Le pinete di pino d'Aleppo (*Pinus halepensis* Miller) del Monte Caprione. *Parlatorea, 4*, 25–38.

Cavaleiro, C., Salgueiro, L. R., Miguel, M. G., & Proenca da Cunha, A. (2004). Analysis by gas chromatography–mass spectrometry of the volatile components of *Teucrium lusitanicum* and *Teucrium algarbiensis*. *Journal of Chromatography A, 1033*, 187–190.

Chiosi, R. (1978). *Notizie botaniche relative alla zona costiera ed alle colline dell'immediato entroterra del Golfo della Spezia. Parte 1*. San Giovanni Valdarno (Italy): Itinerari nel passato. Quaderno XXII.

Couladis, M., Tzakou, O., Verykokidou, E., & Harvala, C. (2003). Screening of some Greek aromatic plants for antioxidant activity. *Phytotherapy Research, 17*, 472–476.

Davies, N. W. (1990). Gas Chromatographic retention indexes of monoterpenes and sesquiterpenes on methyl silicone and Carbowax 20M phases. *Journal of Chromatography, 503*, 1–24.

Facciola, S. (1990). *A source book of edible plants*. Kampong: Kampong Publ.

Fernandez, P. B., Iglesias, P. I., & Villar del Fresno, A. M. (1997). Anti-inflammatory and antiulcer activity of *Teucrium buxifolium*. *Journal of Ethnopharmacology, 55*, 93–98.

Flamini, G., Cioni, P. L., Morelli, I., Maccioni, S., & Baldini, R. (2004). Phytochemical typologies in some populations of *Myrtus communis* L. on Caprione Promontory (East Liguria, Italy). *Food Chemistry, 85*, 599–604.

Flamini, G., Cioni, P. L., Morelli, I., Maccioni, S., & Tomei, P. E. (1994). Characterization of the volatile fraction of a *Sideritis romana* population from Montemarcello (Eastern Liguria). *Journal of Essential Oil Research, 6*, 239–242.

Galati, E. M. et al. (2000). Effects of *Teucrium divaricatum* Heldr. ssp. *divaricatum* decoction on experimental ulcer in rats. *Journal of Ethnopharmacology, 72*, 337–342.

Gastaldo, P. (1987). *Compendio della flora officinale italiana*. Padova: Piccin Editore.

Gharaibeh, M. N., Elayan, H. H., & Salhab, A. S. (1988). Hypoglycemic effects of *Teucrium polium*. *Journal of Ethnopharmacology, 24*, 93–99.

Grieve, M. (1984). *A modern herbal*. London: Penguin.

Hedrick, U. P. (1972). *Sturtevant's edible plants of the world*. New York: Dover Publications.

Jennings, W., & Shibamoto, T. (1980). *Qualitative analysis of flavor and fragrance volatiles by glass capillary chromatography*. New York: Academic Press.

Kovacevic, N. N., Lakusic, B. S., & Ristic, M. S. (2001). Composition of the essential oil of seven *Teucrium* species from Serbia and Montenegro. *Journal of Essential Oil Research, 13*, 163–165.

Loliger, J. (1991). The use of antioxidants in Food. In O. I. Aruoma & B. Halliwell (Eds.), *Free radicals and food additives* (pp. 129–150). London: Taylor & Francis.

Maccioni, S. (1991). *Guida al Parco di Montemarcello*. Genova: Sagep.

Maccioni, S., Baldini, R., & Amadei, L. (2001). La flora del Promontorio del Caprione. Secondo contributo. *Memorie dell'Accademia Lunigianese di Scienze, 71*, 139–163.

Maccioni, S., & Cardelli, M. (2002). L'Orto Botanico di Montemarcello nel Parco Naturale Regionale di Montemarcello-Magra (La Spezia, Liguria Orientale). *Atti della Società Toscana di Scienze Naturali, Memorie Serie B, 109*, 111–117.

Maccioni, S., Flamini, G., Cioni, P. L., & Tomei, P. E. (1992). Le tipologie fitochimiche in alcune popolazioni di *Thymus vulgaris* L. presenti sul Promontorio del Caprione (Liguria Orientale). *Rivista Italiana EPPOS, 7*, 13–18.

Maccioni, S., & Tomei, P. E. (1988). Contributo alla conoscenza della flora del promontorio del Caprione (Montemarcello–La Spezia). *Memorie dell'Accademia Lunigianese di Scienze, 51–53*, 119–154.

Massada, Y. (1976). *Analysis of essential oils by gas chromatography and mass spectrometry*. New York: J. Wiley & Sons.

Monti, G., & Maccioni, S. (1996). Ricerche sulla flora micologica della Liguria. I macromiceti delle leccete del Caprione (Liguria orientale). *Micologia Italiana, 1*, 55–73.

Nagao, Y., Ito, N., Kohno, T., Kuroda, H., & Fujita, E. (1982). Antitumor activity of *Rabdosia* and *Teucrium* diterpenoids against P 388 lymphocytic leukemia in mice. *Chemical and Pharmaceutical Bullettin, 30*, 727–729.

Panovskai, T. K., Kulevanova, S., & Stefova, M. (2005). In vitro antioxidant activity of some *Teucrium* species (Lamiaceae). *Acta Pharmaceutica, 55*, 207–214.

Perez, I., Blazquez, M. A., & Boira, H. (2000). Chemotaxonomic value of the essential oil compounds in species of *Teucrium pumilum* aggregate. *Phytochemistry, 55*, 397–401.

Pignatti, S. (1982). *Flora d'Italia*. Bologna: Edagricole.

Rasekh, H. R., Khoshnood-Mansourkhani, M. J., & Kamalinejad, M. (2001). Hypolipidemic effects of *Teucrium polium* in rats. *Fitoterapia, 72*, 937–939.

Roman-Ramos, R., Flores-Saenz, J. L., Partida-Hernandez, G., Lara-Lemus, A., & Alarcon-Aguilar, F. (1991). Experimental study of the hypoglycemic effect of some antidiabetic plants. *Archivos de investigacion medica, 22*, 87–93.

Stenhagen, E., Abrahamsson, S., & McLafferty, F. W. (1974). *Registry of mass spectral data*. New York: J. Wiley & Sons.

Swigar, A. A., & Silverstein, R. M. (1981). *Monoterpenes*. Milwaukee: Aldrich Chem. Comp.

Tariq, M., Ageel, A. M., Al-Yahya, M. A., Mossa, J. S., & Al-Said, M. S. (1989). Anti-inflammatory activity of *Teucrium polium*. *International Journal of Tissue Reactions, 11*, 185–188.

Tutin, T. G., Heywood, V. H., Burges, N. A., Moore, D. M., Valentie, D. H., & Webb, D. A. (1976). *Flora Europaea* (Vol. 3). Cambridge: Cambridge University Press.

Velasco Negueruela, A., & Pérez Alonso, M. J. (1990). The volatiles of six *Teucrium* species from the Iberian peninsula and the Balearic Islands. *Phytochemistry, 29*, 1165–1169.