Introduction

In the flora of Iran, genus *Stachys* is represented by 34 species while its number is about 300 species in the world. *Stachys fruticulosa*, with the local name of Sonbole gachdust, is grown in many parts of Iran, Iraq, and Anatolia, and is used as an anti-inflammatory agent in traditional medicine (1). *Salvia lavandulifolia* is known as mountain tea (Chaye-kuhi in Iran) and its English name is Betony. In addition, it is used as the herbal tea in gastrointestinal disorders (2).

The hydrodistillation of the aerial parts of *S. palaeastina* collected in Lebanon yielded 0.1% (w/w) of EO. Gas chromatography (GC) and GC-mass spectrometry (MS) analyses enabled the identification of 87 compounds representing 90.8% of the total oil. Hexadecanoic acid (10%), hexahydrofarnesyl acetone (6.9%), eugenol (4.3%), and (E)-caryophyllene (4.3%) were the main components (3). According to another report (4), the water distilled EO of the aerial part of *S. pubescence* was rich in fatty acids like hexadecanoic and linoleic acids in addition to benzaldehyde and spathulenol whereas the steam distilled oil of the plant contained hexadecanoic acid, spathulenol, and eugenol. Both oils were rich in fatty acids (36.6% and 27.9%, respectively).

The chemical composition of the EOs from the aerial parts of two endemic Turkish species (i.e., *Stachys amanica* and *S. petrokosmos*) was analyzed by GC and GC-MS. The major components of the EO of *S. amanica* in Dadagli were found to be α-pinene, α-bisabolol, (E)-β-caryophyllene, and germacrene D. However, the EO from *S. amanica* in Basyurt contained α-pinene, β-pinene, and (E)-β-caryophyllene. On the other hand, the major components of the EO from *S. petrokosmos* in Dadagli were reported as α-pinene, α-bisabolol, α-zingiberene, (E)-β-caryophyllene, and γ-curcumene. Moreover, the EO from *S. petrokosmos* in Belen included α-pinene, γ-curcumene, α-bisabolol, 16-kaurene, and α-zingiberene (5). In another study (6), characterization by the GC-flame ionization detector and GC/MS analyses of the *S. officinalis* EO obtained by the hydrodistillation of the aerial parts allowed the identification of 190 components that represented 97.9% of the total oil content. The main identified constituents were germacrene D (19.9%), β-caryophyllene (14.1%), and α-humulene (7.5%). A
Identification of Oil Components

Clevenger-type apparatus for 4 hours and n-hexane.

The aerial parts of the plant were air-dried and the oil was obtained by hydrodistillation-solvent extraction using a Clevenger-type apparatus. The yield of the oil was 0.25% and the S. fruticulosa oil was examined by GC and GC-MS (Figure 1). Table 1 presents the list of compounds that were identified in the oil of S. fruticulosa. Seventeen compounds were identified, representing 98.2% of the EO, in which the major components were p-cymene (18.2), β-phellandrene (18.2), α-terpinyl acetate (24.6), and 3-n-butyl phthalide (20.5). The other compounds included β-myrcene (2.6%), α-terpineol (1.5%), Z-butylidenephthalide (1.2%), E-butylidenephthalide (1.2%), palmitic acid (1.2%), carvacrol (1.1%), thymol (0.9%), γ-terpinene (0.7%),

Results

The EO of S. fruticulosa was obtained by hydrodistillation-solvent extraction using a Clevenger-type apparatus.

The analytical GC method was carried out using a ThermoQuest 2000 GC coupled with the Thermo/Finnigan mass system and an RTx-1 glass capillary column (methyl phenyl siloxane 30 m X 0.32 mm, 0.25 μm film thickness), N₂ as the carrier gas with a flow rate of 1.5 mL/minute, the split ratio of 1:10, and a flame ionization detector. Temperature programming was performed from 50-250°C at 3/minute with injector and detector temperatures to 270 °C. The quadrupole mass spectrometer operated at 70 eV ionization energy and electron ionization mass spectral spectra were obtained in the scan mode at the m/e range of 35-400 amu. Next, retention indices were determined by using the retention times of n-alkanes, which was injected after the oil under the same chromatographic conditions.

In addition, the retention indices for all components were determined using n-alkanes as the standard. Then, the constituents were identified by comparing retention indices (i.e., RRI & RTx-1) with those reported in the literature, along with comparing their mass spectra with those held in the Wiley library of mass spectra or with the published mass spectra.

Methods

Plant Material and Isolation Procedure

The plant material was collected from the Savejbolagh area in the northwest of Tehran in July 2006. A voucher specimen was deposited in the Herbarium of the School of Pharmacy, Shahid Beheshti University of Medical Sciences. The aerial parts of the plant were air-dried and the oil was obtained by hydrodistillation-solvent extraction using a Clevenger-type apparatus for 4 hours and n-hexane.

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α-phellandrene (0.7%), sabinene (0.6%), β-pinene (0.6%), α-pinene (0.5%), and linalool (0.3%). This oil mainly composed of monoterpane hydrocarbons (41.9%), monoterpane alcohols (3.9%), Monoterpene acetate (24.6%), and phthalides (23.2%).

**Discussion**

*Stachys fruticulosa* M. Bieb. was found to contain 17 compounds, in which monoterpane hydrocarbons (41.9%) and phthalides (23.2%) were the major classes. To the best of our knowledge, it is the first report on the chemical constituents of *S. fruticulosa*.

The main components of the oil from the other *Stachys* species were reported to be germacrene-D (6,7,10,11), muurolol (8), and α-pinene (5), which completely contradicts the findings of the present study, in which only 0.5% α-pinene was present in the oil. Hexadecanoic acid reported in the *S. fruticulosa* EO (1.2%) was found in *S. palaestina* (3) and *S. pubescence* as well (4).

Renda et al (15) investigated the volatile components of three species of *Stachys* and revealed that carvacrol (28.8%), p-cymene (18.2%), and α-pinene (11.2%) in *S. macrantha*, as well as, limonene (37.0%), α-cedrene (11.2%), and γ-muurolene (10.2%) in *S. sylvatica*, and (Z)-β-ocimene (24.8%), β-pinene (23.1%), and α-pinene (11.4%) in *S. annua* ssp. annua var. annua. are the major components of EO. Although the reported compounds in these species were different from those of the present study, as a whole, the major constituents in *S. annua* ssp. annua var. annua are of the present study. It is noteworthy that *S. macrantha* mainly contained oxygenated monoterpenes (42.1%).

Likewise, Sarikaya (16) reported that benzaldehyde (46.34%), β-caryophyllene (11.23%), and (E)-2- hexenal (8.50%) were the major constituents of *Stachys cretica* subsp. *anatolica*. They also evaluated the volatile oil of *S. lavandulifolia* and revealed that the main components were β-phellandrene (27.71%), myrcene (11.56%), and α-pinene (11.20%).

Eventually, Javidnia et al (17) found that the main components of *S. lavandulifolia* Vahl were germacrene-D (13.2%), β-phellandrene (12.7%), β-pinene (10.2%), myrcene (9.4%), α-pinene (8.4%), and Z-β-ocimene (5.8%). The findings of these studies contradict the results of the present study.

**Conclusion**

Literature survey and investigation of the results of different studies was induced by considering the results of the present study and the comparison of the findings of other studies. Thus, it seems that many factors are involved in a wide diversity of chemical constituents of the EOs, and the investigation of volatile oils is a subject of pharmacognostical studies at all times.

**Acknowledgement**

We are thankful to Mohammad Kamali-Nejad, Medicinal Plant Laboratory, Shahid Beheshti University of Medical Sciences, Iran for the collection and identification of plant specimens.

**References**

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