A Simple Method to Obtain Essential Oils from *Salvia triloba* L. and *Laurus nobilis* L. by Using Microwave-assisted Hydrodistillation

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A microwave-assisted hydrodistillation protocol was modified to extract essential oils from leaves of *Salvia triloba* L. and *Laurus nobilis* L. The essential oils of these plants are generally obtained by hydrodistillation or steam distillation. The volatile compounds obtained by microwave-assisted hydrodistillation and hydrodistillation methods were analyzed by GC and GC/MS. Both distillation methods and analytical results were compared. 1,8-Cineole (46.8–54.2%) was the main component in the leaf oils of both samples. Although the distillation was accomplished in a shorter time, oil yields and 1,8-cineole contents were slightly higher in the microwave-assisted hydrodistillation compared to usual hydrodistillation. Microwave-assisted hydrodistillation appears to be an effective method for the production of essential oils.

Key words: Salvia triloba, *Laurus nobilis*, Microwave-assisted Hydrodistillation

Introduction

Salvia represents one of the most diverse genera of plants in Turkey with 88 species of which 51 are endemic. *S. triloba* L. (*S. fruticosa* Mill.), an aromatic perennial herb belonging to the family Lamiaceae, is considered economically the most important *Salvia* species used as culinary herb and for medicinal purposes in Turkey. *S. triloba*, commonly known as "Adaçayi (sage)" or "Elma (apple)" due to its galls which are likened to apples by the peasants, is used for a variety of chest and abdominal troubles. The plant has also been reported to possess diuretic, stomachic, antiseptic and wound-healing properties. Sage is cultivated and largely used as a spice. This plant grows abundantly on the hills of the warm regions of Western Anatolia. The essential oil is known as "Elma yağı (apple oil)". The essential oil or the infusion of the plant is used against colds, coughs, tooth-ache, stomach-ache, abdominal pains, diabetes, hypertension, rheumatism and skin diseases (Baytop, 1999).

Laurus nobilis L., commonly known as "Defne (laurel, bay or sweet bay)", an evergreen tree or shrub belonging to the family Lauraceae, is native to the Mediterranean region and Turkey. Currently, the plant is cultivated in many Mediterranean countries. Turkey is one of the main producers and suppliers of its leaves. Dried laurel leaves are mainly used as a spice. Folk remedies in different countries include it as a stomachic, carminative and antiseptic. The essential oil of laurel leaves is used widely in the perfume and soap industries (Baytop, 1999).

Hydrodistillation or steam distillation are generally used for distillation of the essential oil from plant. There are only a few studies about distillation of laurel leaves (Bayrak and Akgül, 1987; Kilic *et al.*, 2004). The use of microwave energy in sample treatment has attracted growing interest in the past few years. In recent years, numerous applications have been reported on the use of microwaves for assisting extraction (Simoneau *et al.*, 2000; Tomaniová *et al.*, 1998) from plant materials but only a few papers exist on the distillation of volatile components (Lucchesi *et al.*, 2004; Ganzler *et al.*, 1986; Craveiro *et al.*, 1989).

The main objective of the present study was to investigate the chemical composition of microwave-assisted hydrodistilled oils and to compare them with hydrodistilled oils.

Experimental

Plant material and reagents

Commercial leaves of *Salvia triloba* L. and *Laurus nobilis* L. were obtained from Türer Ltd. Sti. (Izmir, Turkey). Distilled water was used in the distillation.

Hydrodistillation (HD)

Dried leaves of *S. triloba* L. and *L. nobilis* L. were hydrodistilled for 3 h using a Clevenger-type apparatus. The yields of oils on moisture free basis were 3.5% and 1.8%, respectively.

Microwave-assisted hydrodistillation (MWHD)

The oils were obtained from *S. triloba* L. and *L. nobilis* L. by MWHD for 45 min using a Clev-

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enger-type apparatus placed in a modified microwave oven (Milestone ETHOS E Microwave Labstation, ANAMED, Istanbul). During the distillation, time, temperature, pressure and power were monitored and controlled with the "easyCONTROL" software package of the system. Microwave power applied to the plant material was controlled by a shielded thermocouple inserted directly into the flask. The oven was operated for 5 min at 1000 W up to 100 °C and then kept at 100 °C for 40 min at 800 W followed by 5 min of ventilation.

Analysis of essential oils

All the oils were analysed by GC using a Hewlett Packard HP6890 system with an Innowax FSC column (60 m × 0.25 mm ∅, with 0.25 μm film thickness). Nitrogen (from 1.2 to 0.9 ml/min ramp flow) was used as carrier gas. The 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 programmed to 240 °C at a rate of 1 °C/min. The split flow was adjusted at 12 ml/min with a 10:1 split ratio. The injector and FID detector temperatures were adjusted at 250 °C. The relative percentage amounts of the separated compounds were calculated from FID chromatograms.

The essential oils were also analysed using a Hewlett Packard G1800A GCD system with an Innowax FSC column (60 m × 0.25 mm ∅, with 0.25 μm film thickness). Helium (0.8 ml/min) was used as carrier gas. The 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 programmed to 240 °C at a rate of 1 °C/min. The mass range was recorded from *m/z* 35 to 425. The split flow was adjusted at 50 ml/min with a 50:1 split ratio. The injector temperature was adjusted at 250 °C. Mass spectra were recorded at 70 eV. Alkanes were used as reference points in the calculation of relative retention indices (RRI).

The components of essential oils were identified by comparison of their mass spectra with those of Baser Library of Essential Oil Constituents, Wiley GC/MS Library, Adams Library, Mass Finder.3 Library and confirmed by comparison of their retention indices.

Results and Discussion

Dried leaves of *S. triloba* L. and *L. nobilis* L. were hydrodistilled and microwave-assisted hydrodistilled to yield volatile compounds. The oils were analysed by GC and GC/MS. The identified components are given in Table I.

In HD and MWHD oils of *S. triloba* L. forty compounds representing 98.5% and 95.9% of the total oil were characterized, respectively, with 1,8-cineole (52.0% and 47.5%), camphor (10.4% and 11.8%), α-pinene (6.0% and 5.2%) and β-pinene (3.9% and 3.2%) as main components. The oil yields were 3.5% and 3.7%, respectively. The percentages of both oils showed similar profiles. The amounts of 1,8-cineole, the main component of sage oil, was decreased from 52.0% to 47.5% by the microwave energy. On the other hand, camphor (from 10.4% to 11.8%), β-caryophyllene (from 1.5% to 2.2%), α-terpineol (from 2.9% to 3.9%), globulol (from trace to 1.6%) were significantly increased by MWHD (Table I).

In HD and MWHD oils of *L. nobilis* L. fifty six compounds representing 93.6% and 96.5% of the total oil were characterized, respectively. 1,8-Cineole (46.8% and 54.2%), α-terpinyl acetate (7.9% and 8.9%), sabinene (8.1% and 5.6%), α-pinene (4.7% and 2.3%), α-terpineol (4.6% and 4.3%) and β-pinene (4.0% and 2.4%) were found as major constituents. The oil yields were 1.8%. Although the distillation was accomplished in a shorter time and the number of the components identified was the same, a higher 1,8-cineole content in the oil was obtained with MWHD compared to the usual HD technique. Some monoterpenes such as α-pinene, β-pinene, sabinene were significantly lower in the laurel oil obtained by MWHD (Table I)

MWHD is a new technique for the production of essential oils. Only a few studies have previously been performed on MWHD. It uses microwave energy in hydrodistillation. The essential oils of sage and laurel are normally obtained by hydrodistillation or steam distillation. Microwave-assisted hydrodistillation appears to be an effective method for the production of essential oils in a relatively shorter time.

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Table I. Comparative results of the essential oils of *Salvia triloba* and *Laurus nobilis*.

RRI	Compound	*Salvia triloba*		*Laurus nobilis*	
		HD (%)	MWHD (%)	HD (%)	MWHD (%)
1032	α-Pinene	6.0	5.2	4.7	2.3
1076	Camphene	4.7	4.0	0.5	0.3
1118	β-Pinene	3.9	3.2	4.0	2.4
1132	Sabinene	–	–	8.1	5.6
1174	Myrcene	3.3	2.7	0.6	0.3
1188	α-Terpinene	0.2	–	0.3	0.2
1203	Limonene	1.6	0.6	1.3	0.4
1213	1.8-Cineole	52.0	47.5	46.8	54.2
1255	γ-Terpinene	0.2	0.2	0.6	0.4
1265	5-Methyl-3-heptanone	0.1	0.1	–	–
1280	*p*-Cymene	1.1	1.0	0.6	0.5
1290	Terpinolene	0.1	0.1	0.2	0.1
1386	Octenyl acetate	0.1	tr	–	–
1437	α-Thujone	2.0	2.1	–	–
1451	β-Thujone	1.8	1.8	–	–
1474	*trans*-Sabinene hydrate	0.1	0.1	0.7	0.7
1532	Camphor	10.4	11.8	–	–
1553	Linalool	0.3	0.3	2.1	2.5
1565	Linalyl acetate	0.1	0.2	–	–
1597	Bornyl acetate	1.0	1.3	0.4	0.4
1611	Terpinen-4-ol	–	–	1.8	2.2
1612	β-Caryophyllene	1.5	2.2	–	–
1628	Aromadendrene	0.1	0.3	–	–
1658	Sabinyl acetate	0.1	0.1	–	–
1682	δ-Terpineol	1.0	1.0	0.5	0.6
1687	α-Humulene	0.1	0.3	–	–
1696	α-Terpinyl acetate	–	–	7.9	8.9
1706	α-Terpineol	2.9	3.9	4.6	4.3
1719	Borneol	1.6	1.2	–	–
1751	Carvone	tr	0.1	0.2	0.1
1773	δ-Cadinene	tr	0.1	–	–
1786	*ar*-Curcumene	tr	0.1	–	–
1864	*p*-Cymene-8-ol	tr	0.1	–	–
2008	Caryophyllene oxide	0.4	0.7	0.4	0.4
2030	Methyl eugenol	–	–	1.3	1.7
2045	Humulene epoxide-I	tr	0.1	–	–
2071	Humulene epoxide-II	0.2	tr	–	–
2098	Globulol	tr	1.6	–	–
2104	Viridiflorol	0.9	0.1	0.1	tr
2144	Spathulenol	0.1	tr	0.5	0.5
2186	Eugenol	–	–	1.3	1.9
2324	Caryophylladienol-II	0.1	0.2	tr	0.2
2389	Caryophyllenol-I	0.1	1.2	tr	0.3
2392	Caryophyllenol-II	0.2	0.3	tr	0.1
	Total	98.3	95.8	89.5	91.5

tr: trace (< 0.1%).

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