

# GC/EI-MS investigation of cultivated *Petroselinum hortense* Hoffm. fruit volatile oil from Northwest Iran

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The volatile oil constituents of cultivated *Petroselinum hortense* Hoffm. fruits from Northwest Iran were identified and quantified by GC/EI-MS. Twenty-eight components were identified, comprising 98.7% of total oil. Phenylpropanoids (70.7%) were the main group of volatile oil components, followed by monoterpene hydrocarbons (26.1%). Oxygenated monoterpenes (1.5%) and sesquiterpenes (0.4%) had a minor part in the essential oil profile. Myristicine (43.1%), apiol (13.9%),  $\alpha$ -pinene (11.5%),  $\beta$ -pinene (9.6%), elemicin (7.6%) and allyltetramethoxy benzene (6.1%) were the main components of essential oil. Sabinene has been determined in appreciable amounts (2.8%). In total, the volatile oil of *P. hortense* fruits studied in the present experiment was characterized as a volatile oil rich in phenylpropanoid derivatives along with substantial amounts of  $\alpha$ -pinene and  $\beta$ -pinene, which may be used as a possible source of these highly valued volatile oil compounds in pharmaceutical, food and fragrance industries.

**Key words:** *Petroselinum hortense* Hoffm., Apiaceae, volatile oil, phenylpropanoids, myristicine, apiol

## INTRODUCTION

*Petroselinum hortense* Hoffm. (Syn: *Petroselinum crispum* (Miller) A. W. Hill., *P. sativum* Hoffm. or *P. crispum* (Mill.) Nym.), commonly known as common garden parsley or parsley, is an aromatic herb belonging to the family Apiaceae or Umbelliferae [1]. Botanically, parsley is a biennial plant up to 30–80 cm in height, with an erect stem, curled leaves, thick spindle-like tap roots and small white or greenish flowers aggregated in terminal umbels. Parsley fruits are small, egg-shaped or spherical, dark brown with two side attached mericarps [2, 3]. From the agronomical point of view, this plant produces fruits in the second year of growth beyond vernalization. Parsley is frost-tolerant but drought-sensitive. Parsley is a shade-friendly plant capable of growing in most of climatic conditions, preferably in cool regions. This plant needs plenty of nitrogenous fertilizers for a high produce [4]. Parsley is a cosmopolitan herb commonly growing in all parts of the world [3]. Leaves, roots and fruits have been used for medicinal and culinary purposes [3, 5]. Parsley has a wide array of phytochemicals such as essential oils, fixed oil (with

a high frequency of petroselinic acid), flavonoids, furanocoumarins, oleoresins, proteins, carbohydrates, tannins, glycosides (mostly apiin or apioside), vitamins A, B and C, and minerals such as iron and calcium [3, 5].

Essential oil (*Petroselinum aetheroleum*) extracted from parsley fruits (*Petroselinum fructus*) is the main secondary metabolite of this plant with great applications in food (meat products, tinned foods, soups, sauces and spicy mixtures), pharmaceutical and fragrance industries [6, 7].

For therapeutic purposes, this plant and its preparations have been used as muscle relaxant, carminative, diuretic, expectorant, rheumatoid, anti-bronchitis, laxative, vasodilative and spasmolytic [3, 5, 6, 8, 9]. In folk medicine, parsley has a long history of use as a digestive, colic, for relief of bladder inflammation and to treat kidney ailments, increase lactation, resume menstruation, lessen gum and dental pains and for treatment of skin diseases [3, 5, 9]. Brankovic et al. [10] have reported that parsley preparations can reduce arterial blood pressure, decrease blood glucose concentration, potentiate the anticoagulant effects of warfarin and exhibit estrogen activity. Furthermore, potential antibacterial, bactericidal,

antifungal, antioxidant and antipyretical properties characterize the essential oil components of this plant [9–11].

Compositional analysis of the *Petroselinum hortense* Hoffm. essential oil has been the subject of several studies [11–18]. Several components such as  $\beta$ -phellandrene, 1,3,8-p-menthatriene, myristicine, apiole,  $\alpha$ -pinene,  $\beta$ -pinene and p-cymene were identified with a high occurrence [11–18]. Despite these comprehensive studies from different localities of the world, there is scarce information on the essential oil composition of *Petroselinum hortense* Hoffm. from Northwest Iran. Therefore, the objective of the present experiment was to characterize the volatile oil composition of *Petroselinum hortense* plants cultivated in Northwest Iran.

## EXPERIMENTAL

**Plant material.** Fruits of 20 individual plants representing the local population of cultivated *Petroselinum hortense* Hoffm. from Northwest Iran (Gharamalek district near Tabriz) were harvested in July 2009. A voucher specimen was deposited in the herbarium of the University of Maragheh, Iran. The harvested fruits were air-dried in a shaded place at an ambient temperature of about 30 °C. The air-dried materials were mixed and ground to obtain a homogeneous fine-grade powder.

**Volatile oil extraction.** A sample (50 g) of air-dried powdered plant material was extracted by the hydrodistillation technique during 3 hours in an all-glass Clevenger-type apparatus. The extracted crude essential oil was dried over anhydrous sodium sulphate and stored in a hermetically sealed glass flask with a rubber lid, covered with aluminum foil to protect the contents from photo-conversion and kept under refrigeration at 4 °C until analysis. The extraction was carried out in triplicate.

**Instrumentation.** A GC/MS instrument (Agilent 6890N GC and Agilent 5973 mass selective detector operating in the EI mode, USA) was employed for the compositional analysis of volatile oil. Ultra pure helium (99.99%, Air Products, UK) passed through a molecular sieve trap and oxygen trap (Chromatography Research Supplies, USA) was used as the carrier gas at a constant velocity of 1 ml/min. The injection port was held at 300 °C and used in the split mode (split ratio 1 : 100, volume injected 4  $\mu$ l of pure volatile oil). The detector temperature was 200 °C. Separation was carried out on an apolar HP5MS (5%-phenyl methyl polysiloxane; 30 m  $\times$  0.25 mm i. d. and 0.25  $\mu$ m film thickness) capillary column (Hewlett-Packard, USA). The oven temperature was programmed as follows: 50 °C (held for 2 min) raised to 110 °C at a rate of 10 °C/min, then heated to 200 °C at the 20 °C/min rate, finally increased to 280 °C at 10 °C/min and kept isothermal at this temperature for 2 min. The mass operating parameters were as follows: ionization potential 70 eV, interface temperature 200 °C and acquisition mass range 50–800.

**Identification and quantification of volatile oil components.** Relative percentage amounts of the volatile oil constituents were evaluated from the total peak area (TIC) by apparatus software. The components of the essential oil were identified by comparing their mass spectral fragmentation patterns with those of similar compounds from the database (NIST and WILEY library) as well as by comparing their Kovats gas chromatographic retention indices with those from the literature.

## RESULTS AND DISCUSSION

Hydrodistillation of *Petroselinum hortense* Hoffm. fruits provided a yellow liquid with 2.2% (v/w) concentration based on air-dried fruit weight. The chemical profile of the volatile oil, the percentage content of individual components, their elution order on an apolar column as well as the major classes and chemical groups of the identified and quantified components of the volatile oil are reported in Table. In total, 28 constituents were identified, representing 98.7% of total oil (Table). Phenylpropanoids (70.7%) were found to be the most abundant class of volatile oil components, followed by monoterpene hydrocarbons (26.1%). Myristicine (43.1%), apiole (13.9%), elemicine (7.6%) and allyltetramethoxy benzene (6.1%) were the major phenylpropanoids in the volatile oil. Considering the phenylpropanoid derivatives profile of the volatile oil, it seems that there is some discrepancy and / or similarity between the findings of the present experiment and reports of other researchers [11–18]. Monoterpene hydrocarbons possessed the second priority among volatile oil components. The highlighted representatives of this class were  $\alpha$ -pinene (11.5%),  $\beta$ -pinene (9.6%) and sabinene (2.8%). The content of all other monoterpenoids was below 1%. Taking into account the monoterpenoid profile of the identified components, there seem to be considerable quantitative and certain qualitative differences between our results and previous reports [11–18]. Petropoulos et al. [12, 14] reported  $\beta$ -phellandrene as the most abundant constituent of parsley from Greece. Meanwhile, this compound was absent in our experiment. Furthermore, 1,3,8-p-menthatriene has been frequently reported as the major component of parsley essential oil [15, 16], although in our study the content of this important compound was low (0.3%). Sesquiterpenoids were the minor class of volatile oil components. This finding is in a good conformity with previous reports [11–18]. Appendino et al. [19] reported that crispanone and crispane were notable sesquiterpenoids of parsley from Italy. These compounds were absent in our volatile oil profile. From the chemical point of view, phenylpropane derivatives (70.7%) were the major class of oil constituents with the dominance of myristicine and apiole, followed by a minor share of ketones (1%). In particular, like nearly in most of the previous experiments, the dominance in volatile oil was with phenylpropanoids. Generally, taking into consideration the chemical profile of the essential oil of cultivated *P. hortense* fruits

from Northwest Iran and reports of other researchers, there seem to be moderate qualitative and quantitative differences among the chemical profiles of the essential oils. However, in many of the reports from different localities of the world, the dominance in the volatile oil belonged to myristicine and apiole.

It is possible that these chemical variations are due to the climatological and geographical as well as agronomical (irrigation, soil properties, fertilizers, weed control, allelopathy) differences of *P. hortense* cultivation in different countries. Besides the aforementioned reasons, the effects of different genetic, biochemical and physiological potentials

beyond the compartmentalization of different biochemical pathways is worthy of consideration. Moreover, it appears that different volatile isolation procedures and also analytical and instrumental conditions have an inevitable impact on the chemical profile of volatile oil. In brief, the chemical composition of the volatile oil of cultivated *P. hortense* Hoffm. from Northwest Iran was characterized by a high content of the phenylpropane derivatives myristicine and apiole. Accordingly, parsley fruits studied in the present experiment can be a promising inexpensive and easy-to-access source of myristicine and apiole to substitute other sources of these high-valued volatile compounds, for example, to replace the restricted *Myristica fragrans* plant from tropical regions and to satisfy the high demands of pharmaceutical, food and fragrance industries for these phenylpropanoids-owing to the easy cultivation and broad climatological adaptability of this herb.

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Table. Volatile oil components in *Petroselinum hortense* Hoffm. from Iran

Compound	RI	%
$\alpha$ -Thujene	0930	0.2
<b><math>\alpha</math>-Pinene</b>	<b>0939</b>	<b>11.5</b>
Camphene	0954	0.2
<b>Sabinene</b>	<b>0975</b>	<b>2.8</b>
<b><math>\beta</math>-Pinene</b>	<b>0979</b>	<b>9.6</b>
Myrcene	0991	0.5
$\alpha$ -Phellandrene	1003	0.2
$\gamma$ -Terpinene	1017	0.2
p-Cymene	1025	0.1
(Z)- $\beta$ -Ocimene	1037	0.1
(E)- $\beta$ -Ocimene	1050	0.1
p-Cymenene	1091	0.3
1,3,8-p-Menthatriene	1110	0.3
(E)-Verbenol	1145	0.1
Myrtenal	1196	0.4
(Z)-Piperitone epoxide	1254	0.1
Piperitenone	1343	tr
Piperitenone oxide	1369	0.9
(E)-Caryophyllene	1419	0.1
<b>(E)-<math>\beta</math>-Farnesene</b>	<b>1457</b>	<b>0.2</b>
Germacrene D	1485	tr
$\beta$ -Bisabolene	1506	tr
$\gamma$ -Cadinene	1514	tr
<b>Myristicine</b>	<b>1519</b>	<b>43.1</b>
<b>Elemicine</b>	<b>1557</b>	<b>7.6</b>
<b>Allyltetramethoxy benzene</b>	<b>1621</b>	<b>6.1</b>
Patchouli alcohol	1658	0.1
<b>Apiole</b>	<b>1678</b>	<b>13.9</b>
<b>Total identified</b>		<b>98.7</b>
<b>Monoterpene hydrocarbons</b>		<b>26.1</b>
Oxygenated monoterpenes		1.5
Sesquiterpene hydrocarbons		0.3
Oxygenated sesquiterpenes		0.1
<b>Phenylpropanoids</b>		<b>70.7</b>
Ketones		1
Aldehydes		0.4
Alcohols		0.2

Compounds are reported according to their elution order on a non-polar column.  
tr = trace (content <0.1%).

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**ŠIAURĖS VAKARŲ IRANE KULTIVUOJAMŲ *PETROSELINUM HORTENSE* HOFFM. VAISIŲ ETERINIŲ ALIEJŲ TYRIMAS DUJŲ CHROMATOGRAFIJOS–MASIŲ SPEKTROMETRIJOS METODU**

*S a n t r a u k a*

Nustatyti šiaurės vakarų Irane kultivuojamų *Petroselinum hortense* Hoffm. vaisių eterinių aliejų lakieji komponentai. Identifikuoti 28 komponentai, sudarantys 98,7 % eterinių aliejų. Pagrindinės lakiųjų komponentų grupės yra fenilpropanoidai (70,7 %) ir monoterpeniniai angliavandeniliai (26,1 %).