

## Fatty acid composition of the seeds of some species of *Peucedanum* (kral otu) from Turkey

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Received: 04.10.2010

**Abstract:** The fatty acid compositions of the seeds of *Peucedanum ruthenicum*, *Peucedanum chryseum*, *Peucedanum palimbioides*, *Peucedanum obtusifolium*, and *Peucedanum zedelmeieranum* were investigated by gas chromatography (GC). The main fatty acids in the species were found to be palmitic acid (C 16:0, 5.78%-14.68%), oleic acid (C 18:1  $\omega$ -9, 31.28%-68.06%), and linoleic acid (C 18:2  $\omega$ -6, 15.99%-33.74%). Trace amounts of *cis*-vaccenic acid (C 18:1  $\omega$ -7, 0.82%-1.40%) were found in the seed oils of all of the species investigated.

**Key words:** Apiaceae, *Peucedanum*, fatty acids

### Türkiye'deki bazı *Peucedanum* (kral otu) türleri tohumlarının yağ asit bileşenleri

**Özet:** *Peucedanum ruthenicum*, *Peucedanum chryseum*, *Peucedanum palimbioides*, *Peucedanum obtusifolium* ve *Peucedanum zedelmeieranum* tohumlarının yağ asit bileşenleri gaz kromatografisi (GC) ile analizlenmiştir. Türlerde ana yağ asitlerinin palmitik asit (C 16:0, % 5,78-14,68), oleik asit (C 18:1  $\omega$ -9, % 31,28-68,06) ve linoleik asit (C 18:2  $\omega$ -6, % 15,99-33,74) olduğu bulunmuştur. *cis*-Vaksenik asit (C 18:1  $\omega$ -7, % 0,82-1,40) incelenen tüm türlerin tohumlarında eser miktarda belirlenmiştir.

**Anahtar sözcükler:** Apiaceae, *Peucedanum*, yağ asitleri

### Introduction

The genus *Peucedanum* L. (Apiaceae) comprises about 100-120 species, mainly distributed in Europe and Asia (1). Recent studies have shown that the *Peucedanum* species in Turkish flora are represented by 18 taxa (with 19 species, 2 of which are suspected), of which 7 are endemic to Turkey with an endemism rate of 28.5% (2-7).

The *Peucedanum* species, whose Turkish common name is "kral otu," appear to be under investigation due to their substantial amounts of chemically active phytochemicals, especially coumarins and their glycoside derivatives (1,8,9). It has been indicated that several species of *Peucedanum*, such as *P. dissolutum* and *P. praeruptorum*, have been used in Chinese medicine (Qianhu) to cure ailments such as coughs,

phlegm, and other respiratory illnesses (9,10). At the same time, the antimicrobial and antiproliferative activities and the essential oil compositions of different parts of species of this genus have been investigated (9,11,12).

Although there have been many studies on the chemical composition and pharmacological properties of the metabolites, such as the coumarins, of this genus, there is little information and no available data on the fatty acid composition. Thus, the present study aimed to establish the fatty acid composition of the seed oils of 5 *Peucedanum* species in Turkish flora, including 2 endemic species.

## Materials and methods

### Plant materials

The *Peucedanum* species used in this study, collected and identified by H. Aşkın Akpulat, were *Peucedanum ruthenicum* M.Bieb. (collected from A8, Artvin: Borçka, Muratlı, 600-700 m), *Peucedanum chryseum* (Boiss. & Heldr.) D.F.Chamb. (collected from C3 Antalya: Seydişehir road exit, 1104 m; 37°24'10"N, 31°52'07"E; endemic to Turkish flora), *Peucedanum palimbioides* Boiss. (collected from A6 Samsun: Havza road exit 10th km, 1511 m; 41°00'01.1"N, 35°49'47.1"E; endemic to Turkish flora), *Peucedanum obtusifolium* Sm. (collected from A2(E) İstanbul: sand dunes, north of Lake Terkos), and *Peucedanum zedelmeieranum* Manden. (collected from A8 Erzurum: road junction of Güzeyayla village, 2087 m; 40°12'21"N, 41°28'23"E).

### Extraction and esterification of fatty acids from seeds

The air-dried seed material was ground. From each of the milled samples, 1 g was taken and stored in chloroform-methanol (2:1, v/v) for 48 h at 4 °C (13). Weighed samples were homogenized in chloroform-methanol (2:1, v/v) using an Ultra-Turrax T25 homogenizer in an ice bath, and the isolation of the total lipids from seeds was carried out (14). The total lipids obtained were saponified by refluxing with methanol (50%) containing 5% sodium hydroxide for 1 h. The saponifiable lipids were converted to their methyl esters using the standard boron trifluoride-methanol (BF<sub>3</sub>) method (15).

### Gas chromatography (GC) analyses

Fatty acid methyl esters (FAMES) were analyzed on an HP (Hewlett-Packard) Agilent 6890N model gas chromatograph equipped with a flame ionization detector (FID) and fitted with an HP-88 capillary column (100 m × 0.25 mm i.d., 0.2 µm film). The injector and detector temperatures were 240 °C and 250 °C, respectively. The oven was programmed at an initial temperature of 160 °C and an initial time of 2 min. Thereafter, the temperature was increased 4 °C/min to 185 °C, then increased 1 °C/min to 200 °C, and finally held for 46.75 min at 200 °C. The total run-time was 70 min. The carrier gas was helium (1 mL/min).

The identification of fatty acids was carried out by comparing the sample FAME peak relative retention times with those obtained for Alltech and AccuStandard standards. The results were expressed as FID response area relative percentages. Each reported result is the average value of 3 GC analyses. The results are presented as mean ± SD.

### Results and discussion

The fatty acid compositions of 5 different species of *Peucedanum* from Turkish flora are presented in the Table. Thirty FAMES were identified from the seeds of the investigated species.

The principal fatty acid in all of the *Peucedanum* species investigated was palmitic acid (C 16:0), in the saturated form of fatty acids (SFAs). The richest species in C 16:0 was *P. obtusifolium* (14.68%), while *P. zedelmeieranum* had the lowest percentage (5.78%). The second major fatty acid in the SFA fraction was stearic acid (C 18:0); the levels of this acid among the species ranged from 1.50% (*P. zedelmeieranum*) to 4.16% (*P. obtusifolium*). In our previous study on the fatty acids of *Nepeta* species from Turkey, it was established that C 16:0 and C 18:0 were the main components of the SFAs (16).

Oleic acid (C 18:1 ω-9) was determined as the major fatty acid in the monounsaturated form of the fatty acids (MUFAs). The proportion of C 18:1 ω-9 in the MUFA fraction ranged from 68.06% (*P. palimbioides*) to 31.28% (*P. obtusifolium*). This finding showed that C 18:1 ω-9 had the highest rate of all of the fatty acid fractions. It was found that C 14:1 ω-5,

Table. Fatty acid composition of *Peucedanum* species from Turkey, with endemic species.\*

Fatty acids	<i>Peucedanum palimbioides</i> **	<i>Peucedanum zedelmeieranum</i>	<i>Peucedanum chryseum</i> **	<i>Peucedanum ruthenicum</i>	<i>Peucedanum obtusifolium</i>
C 10:0	0.14 ± 0.04	0.06 ± 0.02	0.07 ± 0.01	0.14 ± 0.05	0.63 ± 0.27
C 11:0	0.15 ± 0.03	0.04 ± 0.01	0.05 ± 0.01	0.57 ± 0.16	0.54 ± 0.08
C 12:0	0.33 ± 0.07	0.12 ± 0.04	0.84 ± 0.11	0.20 ± 0.01	0.76 ± 0.09
C 13:0	0.38 ± 0.04	0.05 ± 0.01	0.07 ± 0.03	0.09 ± 0.06	0.22 ± 0.08
C 14:0	0.73 ± 0.04	0.65 ± 0.02	0.70 ± 0.06	0.19 ± 0.03	1.17 ± 0.04
C 15:0	0.34 ± 0.02	0.76 ± 0.08	0.16 ± 0.05	0.11 ± 0.00	0.69 ± 0.03
C 16:0	6.23 ± 0.32	5.78 ± 0.01	10.09 ± 0.16	6.31 ± 0.07	14.68 ± 0.34
C 17:0	0.19 ± 0.01	0.08 ± 0.03	0.17 ± 0.01	0.27 ± 0.16	0.39 ± 0.04
C 18:0	2.02 ± 0.13	1.50 ± 0.01	2.17 ± 0.01	1.59 ± 0.02	4.16 ± 0.01
C 19:0	0.07 ± 0.04	0.06 ± 0.01	0.07 ± 0.03	0.03 ± 0.00	0.12 ± 0.01
C 20:0	0.09 ± 0.04	0.35 ± 0.11	0.08 ± 0.03	0.06 ± 0.02	0.14 ± 0.08
C 21:0	0.10 ± 0.01	1.25 ± 0.06	0.22 ± 0.04	0.14 ± 0.01	0.15 ± 0.03
C 22:0	0.07 ± 0.05	0.06 ± 0.04	0.13 ± 0.06	0.03 ± 0.03	0.39 ± 0.02
<b>Σ SFA</b>	<b>10.84 ± 0.13</b>	<b>10.76 ± 0.09</b>	<b>14.82 ± 0.22</b>	<b>9.73 ± 0.04</b>	<b>24.04 ± 0.18</b>
C 14:1 ω-5	0.26 ± 0.00	0.06 ± 0.00	0.05 ± 0.01	0.04 ± 0.02	0.25 ± 0.07
C 15:1 ω-5	0.08 ± 0.04	0.03 ± 0.00	0.04 ± 0.01	0.15 ± 0.01	0.26 ± 0.10
C 16:1 ω-7	0.52 ± 0.04	2.58 ± 0.01	0.11 ± 0.00	0.28 ± 0.01	0.57 ± 0.01
C 17:1 ω-8	0.15 ± 0.07	0.20 ± 0.00	0.13 ± 0.08	0.05 ± 0.03	0.20 ± 0.04
C 18:1 ω-9	68.06 ± 0.14	52.41 ± 0.16	50.89 ± 0.19	58.61 ± 0.33	31.28 ± 0.06
C 18:1 ω-7	1.13 ± 0.13	0.82 ± 0.00	1.10 ± 0.01	1.15 ± 0.03	1.40 ± 0.02
C 20:1 ω-9	0.16 ± 0.01	0.34 ± 0.09	0.19 ± 0.03	0.18 ± 0.07	0.48 ± 0.11
C 22:1 ω-9	0.14 ± 0.04	0.11 ± 0.02	0.07 ± 0.01	0.05 ± 0.01	0.24 ± 0.08
<b>Σ MUFA</b>	<b>70.50 ± 0.19</b>	<b>56.55 ± 0.27</b>	<b>52.58 ± 0.09</b>	<b>60.51 ± 0.30</b>	<b>34.68 ± 0.13</b>
C 18:2 ω-6	15.99 ± 0.09	30.71 ± 0.07	27.79 ± 0.04	27.45 ± 0.08	33.74 ± 0.19
C 18:3 ω-6	0.38 ± 0.02	0.18 ± 0.04	0.28 ± 0.02	0.20 ± 0.02	0.89 ± 0.05
C 20:2 ω-6	0.06 ± 0.01	0.07 ± 0.03	0.10 ± 0.01	0.11 ± 0.01	0.21 ± 0.04
C 20:4 ω-6	0.21 ± 0.02	0.18 ± 0.02	0.38 ± 0.06	0.17 ± 0.04	0.85 ± 0.04
C 22:2 ω-6	0.12 ± 0.03	0.02 ± 0.01	0.03 ± 0.01	0.02 ± 0.01	0.11 ± 0.03
C 22:4 ω-6	0.06 ± 0.02	0.06 ± 0.01	0.04 ± 0.00	0.02 ± 0.00	0.08 ± 0.06
<b>Σ ω-6</b>	<b>16.82 ± 0.04</b>	<b>31.22 ± 0.15</b>	<b>28.62 ± 0.10</b>	<b>27.97 ± 0.21</b>	<b>35.88 ± 0.16</b>
C 18:3 ω-3	0.67 ± 0.01	0.45 ± 0.01	2.90 ± 0.07	0.83 ± 0.01	3.97 ± 0.21
C 20:5 ω-3	0.19 ± 0.06	0.06 ± 0.03	0.10 ± 0.04	0.02 ± 0.01	0.41 ± 0.05
C 22:3 ω-3	0.05 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	0.11 ± 0.09
<b>Σ ω-3</b>	<b>0.91 ± 0.07</b>	<b>0.54 ± 0.05</b>	<b>3.04 ± 0.11</b>	<b>0.87 ± 0.22</b>	<b>4.49 ± 0.16</b>
<b>Σ PUFA</b>	<b>17.73 ± 0.13</b>	<b>31.76 ± 0.09</b>	<b>31.66 ± 0.18</b>	<b>28.84 ± 0.04</b>	<b>40.37 ± 0.33</b>

\*Each datum is the average of 3 experimental analyses.

\*\*Endemic species for Turkish flora.

C 15:1  $\omega$ -5, C 16:1  $\omega$ -7, C 17:1  $\omega$ -8, C 18:1  $\omega$ -7, C 20:1  $\omega$ -9, and C 22:1  $\omega$ -9 were the minor compounds in the MUFA fraction. Previous studies also confirmed that C 18:1  $\omega$ -9 was the main fatty acid in the MUFA fraction in the *Nepeta* species (16,17). Furthermore, it is well known that petroselinic acid (C18:1  $\omega$ -6 cis), a positional isomer of C18:1  $\omega$ -9, is a major fatty acid in the seed oils of most of the members of the Umbelliflorae plant families (18). A comprehensive study carried out on 4 different plant species, *Corylus avellana*, *Arachis hypogaea*, *Pinus pinea*, and *Juglans regia*, showed that the most abundant and primary fatty acid in the fatty acid content of *C. avellana* and *J. regia* was C 18:1  $\omega$ -9 at 77.4% and 47.2%, respectively (19). Another important finding in the present study was the presence of *cis*-vaccenic acid (C 18:1  $\omega$ -7) in the seed oils of the *Peucedanum* species. The species richest in C 18:1  $\omega$ -7 was *P. obtusifolium* (1.40%), while *P. zedelmeieranum* (0.82%) had the lowest amount of this acid. A previous study conducted on *Dracunculus vulgaris* from Turkey indicated that C 18:1  $\omega$ -7 may be an important chemotaxonomic marker and is expressed in small quantities in plant seeds (20). It appears that these data are compatible with a previous study carried out on some Umbelliferae seed oils (21).

All of the species of *Peucedanum* in our study contained linoleic acid (C 18:2  $\omega$ -6) as a major polyunsaturated fatty acid (PUFA). Amounts of C 18:2  $\omega$ -6 in the species were found to be between 15.99% (*P. palimbioides*) and 33.74% (*P. obtusifolium*). It was found that linolenic acid (C 18:3  $\omega$ -3) was a minor compound in *P. palimbioides* (0.67%), *P. zedelmeieranum* (0.45%), and *P. ruthenicum* (0.83%). However, amounts of C 18:3  $\omega$ -3 in *P. obtusifolium* and *P. chryseum* were 3.97% and 2.90%, respectively. It was found that C 18:3  $\omega$ -6, C 20:2  $\omega$ -6, C 20:4  $\omega$ -6, C 22:2  $\omega$ -6, C 20:5  $\omega$ -3, C 22:3  $\omega$ -3, and C 22:4  $\omega$ -6 were present in trace amounts in the PUFA fraction. In comparison, the amounts of C 18:2  $\omega$ -6 and C 18:3  $\omega$ -3 in *D. vulgaris* seed oil were found to be 23.21% and 2.07%, respectively (20). These findings are also compatible with our findings. However, 2

independent studies on the seed oils of the *Nepeta* species from Turkey indicated that C 18:3  $\omega$ -3 had the highest percentages in all of the fatty acid fractions (16,17). A study conducted on the fatty acid content of the *Hypericum* species (*H. scabrum*, *H. scabroides*, and *H. amblysepalum*) from Turkey showed that the most abundant fatty acid in this genus was C18:3  $\omega$ -3, ranging from 29.84% to 48.60%, in the species investigated (22). In 3 different studies covering the families Asteraceae, Fabaceae, and Malvaceae, a higher amount of either C 18:2  $\omega$ -6 or C 18:3  $\omega$ -3, rather than saturated and monounsaturated forms of the fatty acids, was found (23-25). From this point of view, it appears that many of the plant species have higher amounts of polyunsaturated fatty acids, especially C 18:2  $\omega$ -6 and C 18:3  $\omega$ -3. From these data, we can interpret that there may be some marker differences in fatty acid patterns between different plant genera, and this can be useful in chemotaxonomic studies.

This is the first report on the fatty acid compositions of the genus *Peucedanum* from Turkey, with 2 endemic species. The seed oils of the *Peucedanum* species were found to contain C 18:1  $\omega$ -7 and have unusual levels of C 18:1  $\omega$ -9. When considering that Turkey has numerous endemic and rare plants, most of which are known as locally grown species (26), and comparing the fatty acid patterns of the other plant species mentioned above, the *Peucedanum* species exhibit a novel chemical profile in terms of fatty acids. Based on our data, we would suggest that this novelty, in terms of fatty acid patterns, can be useful in the chemotaxonomy of this genus.

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