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Research Article

Determination of The Fatty Acid Composition of Some Taxon of the Apiaceae Family

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Abstract: The aim of the study was to determine the fatty oil ratio and fatty acid components of 19 taxa, of which 6 are endemic and belong to the Apiaceae family, naturally distributed in the Isparta and Burdur provinces. In the study, the fruits of *the Ammi visnaga, Angelica sylvestris, Bifora radians, Echinophora tournefortii, Echinophora tenuifolia* subsp *sibthorpiana, Echinophora trichophylla* (endemic), *Foeniculum vulgare, Ferulago cassia, Ferulago pauciradiata* (endemic), *Glaucosciadium cordifolium, Heracleum platytaenium* (endemic), *Hippomarathrum cristatum, Hippomarathrum microcarpum, Laser trilobum, Opopanax hispidus, Pastinaca sativa* subsp *urens, Peucedanum chryseum* (endemic), *Prangos platychlaena* (endemic), and *Prangos uechtritzii* (endemic) were used as materials. The fatty oil ratios of the species were determined by NMR, and the fatty acid components were determined by the GC/FID instrument. In the study, the fatty oil ratios of the species varied from 4.0% to 27.6%. A total of 43 different fatty acids were identified, mainly palmitic acid, stearic acid, petroselinic acid, oleic acid, and *cisvaccinic* acid fatty acids. Most of the fatty oils of the taxa consisted of oleic acid, linoleic acid, and petroselinic fatty acids. Therefore the taxa investigated in the study are believed to be rich in fatty oil content and unsaturated fatty acids and can be used as an oil source in the future.

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Footnote: This study is derived from Ph.D. thesis named "Determination of Economic Value And Cultivation Potantials of Some Plant Species Belongıng to Apiaceae Family Growing In Lakes Region".

1. Introduction

Depending on the increase in the world population, there may be difficulties in the future in the supply of vegetable oils, which are essential for human nutrition. This will require a, higher oil yield per area, or alternative sources of vegetable oil will be sought. Apiaceae is one of the genus groups with the greatest economic importance in the world. Various plant species belonging to this family have been used as medicine and spice for many years. Worldwide, the family is represented by 455 genera and 3600-3751 species (Pimenov and Leonov, 1993; Pimenov and Leonov, 2004), while in Türkiye, it consists of 101 genera and 485 species, with an endemism percentage of 37.3% (Guner et al., 2000). Cumin, anise, fennel, and coriander species belonging to this family have been cultivated in our country

for many years. The species grown in this country are generally used as spices or essential oils in foods. In addition, the fatty oils contained in the species of the family are used. The previous study showed that especially the fruits contain fatty oil and high amounts of unsaturated fatty acids. The majority of the fatty acids are petroselinic fatty acids (18:1, *cis*-6), which are rare in other oil plants. This offers the possibility of using fatty oils as both edible and industrial oil (Bayrak and Korkut 1995; Reiter et al. 1998a; Bayrak, 2006; Tosun, 2021). In addition, the herbicidal activity of fatty acids, and some of them are currently used commercially as herbicides (Dayan et al., 2009). The objective of this study was to determine the fatty oil content and fatty acid components of the fruits of 19 taxa of the Apiaceae family, which are thought to be a source of vegetable oil.

2. Material and Methods

The research was carried out in laboratories of Isparta University of Applied Sciences, Faculty of Agriculture, Field Crops during 2017–2019. Fruit samples were collected at the full maturity period in the study using the location information of the species whose distribution areas were determined in the TUBITAK 113O284 project. Taxa used as material are listed in Table 1 with GUL Herbarium codes and location information.

Table 1. Herbarium codes and locality data of the taxa

Species	GULHerbarium Codes	Loctite/Altitude
Ammi visnaga (L.) Lam	GUL 63.58.1.1.	Burdur: Bucak/ 790 m
Angelica sylvestris L.	GUL 63.62.1.1	Isparta: Yenişarbademli/ 1600 m
Bifora radians Bieb.	GUL 63.16.2.5	Isparta:Merkez/ 1000 m
Echinophora tournefortii Jaub. & Spach.	GUL 63.7.2.5	Burdur: Yeşilova/ 1236 m
Echinophora tenuifolia L. subsp *sibthorpiana* (Guss) Tutin	GUL 63.7.2.1.2	Isparta: Merkez/ 1010 m
Echinophora trichophylla J.E.Smith (Endemic)	GUL 63.7.4.1	Isparta: Sav kasabası/ 981 m
Ferulago cassia Boiss.	GUL 63.69.11.1	Burdur: Ağlasun/1047 m
Ferulago pauciradiata Boiss. & Heldr. (Endemic)	GUL 63.69.8.1	Isparta: Eğirdir/ 1574 m
Foeniculum vulgare Miller	GUL 63.34.1.6	Isparta: Eğirdir/ 924 m
Glaucosciadium cordifolium (Boiss.) Burtt & Davis	GUL 63.83.1.5	Isparta- Antalya karayolu/ 360m
Heracleum platytaenium Boiss. (Endemic)	GUL 63.75.3.2	Isparta: Eğirdir/ 1235 m
Hippomarathrum cristatum (DC.) Boiss.	GUL 64.44.2.1	Burdur: Yeşilova/1159 m
Hippomarathrum microcarpum (Bieb.) Fedtsch.	GUL 64.44.1.1	Isparta: Eğirdir/ 946 m
Laser trilobum (L.) Borkh.	GUL 63.83.1.1	Isparta: Eğirdir/ 1575 m
Opopanax hispidus (Friv.) Gris.	GUL 63.70.2.2	Isparta: Eğirdir/ 940 m
Pastinaca sativa L. subsp *urens* (Req. Ex Gordon) Celak	GUL 63.73.1.1.2	Isparta: Eğirdir/ 932 m
Peucedanum chryseum (Boiss. & Heldr.) Chamb. (Endemic)	GUL 63.72.4.1	Isparta: Şarkikaraağaç/ 1385 m
Prangos platychlaena Boiss. ex Tchihat (Endemic)	GUL 63.42.8.1	Burdur: Bucak/ 800
Prangos uechtritzii Boiss & Hausskn (Endemic)	GUL 63.42.10.1	Isparta: Eğirdir/ 1576 m

2.1. Determination of fatty oil rate

Samples were placed in a measuring cup of the nuclear magnetic resonance ce (NMR, Bruker mqone) device measuring cup and read at five replicates, and the average oil content was calculated (Baydar and Erbas, 2014).

2.2. Fatty acid components

The ground fruit samples (5 g) were mixed with 10 ml of n-hexane to extract the crude oil. It was then filtered and dried at 45 °C to remove the solvent from the filtrate. A 25 µL of extracted oil was mixed in 750 µL 0.5% sodium methylate (NaoMe), followed by 1 ml n-hexane, and shaken to prepare the fatty acid methyl esters (FAME). A 1 µL of the upper phase (FAME) was withdrawn and subjected to gas chromatography (Shimadzu GC-2025). The operating conditions of the GC device were set as follows: column 100 m × 0.25 mm, 0.20 µm (Technochroma TR-CN100), injector temperature 250 °C, detector temperature 250 °C, flow rate 10 psi, carrier gas N (40 ml/min), injector capacity 1 µL. The initial temperature was maintained at 140 °C for 10 minutes, followed by an increase of 3 °C per minute until 240 °C was reached for 10 minutes. The peaks in the chromatograms were compared against the standard F.A.M.E. mix (Supelco® 37 Component FAME Mix, Sigma).

3. Results

The values of the fatty oil ratio and components of all species included in the study are given in Table 2.

Table 2. Fatty acid components and rate of the taxa (%)

Retention Times		Components	Av	As	Br	Et	Eteni	Etri	Fc	Fp	Fv
14.396			-	7.88	-	-	-	-	-	-	-
15.362	$C_{6:0}$	Coproic	0.13	0.21	-	0.05	-	-	2.91	9.20	0.07
19.153	$C_{8:0}$	Caprylic	0.01	0.02	-	0.02	0.01	-	0.11	0.25	-
22.937			-	-	-	-	-	-	-	-	5.21
24.349	$C_{10:0}$	Capric	<0.01	-	0.04	0.03	<0.01	-	0.06	0.04	-
27.599	$C_{11:0}$	Undecanoic	0.01	0.10	-	-	0.02	-	0.50	0.10	-
30.291	$C_{12:0}$	Lauric	0.02	0.09	0.02	0.08	0.08	-	0.15	0.04	11.79
33.289	C 13:0	Tridecanoic	-	0.03	<0.01	-	-	-	0.06	0.04	
36.137	$C_{14:0}$	Myristic	0.15	0.07	0.03	0.31	0.17	0.10	0.94	0.14	0.11
38.393	C14:1	Myristoleic	-	-	-	-	-	-	-	0.01	0.03
38.918	$C_{15:0}$	Pentadecanoic	0.03	0.02	0.02	0.11	0.04	-	0.49	0.05	-
40.916	$C_{15:1c10}$	*cis*-Pentadecanoic	<0.01	0.09	-	-	-	-	0.37	0.02	-
41.640	$C_{16:0}$	Palmitic	3.86	3.46	3.02	9.78	4.65	4.60	6.38	4.19	3.62
43.297	$C_{16:1}$	Palmitoleic	0.18	0.09	0.10	0.26	0.13	-	9.93	0.17	0.05
44.170	$C_{17:0}$	Heptadecanoic	0.03	0.06	0.03	0.10	0.04	-	0.49	0.03	0.03
45.689	$C_{17:1c10}$	cis-Heptadecanoic	0.03	0.03	0.03	0.70	0.06	-	0.47	0.27	0.01
46.816	$C_{18:0}$	Stearic	0.86	0.94	0.05	2.85	1.55	1.45	2.28	1.41	1.02
48.235	$C_{18:1n6c}$	Petroselinic	72.61	31.21	81.00	45.24	58.45	56.82	31.05	55.58	64.70
48.287	$C_{18:1n9c}$	Oleic	3.91	7.42	2.82	10.08	8.33	14.58	11.80	6.19	2.57
48.378	$C_{18:1n7c}$	*cis*-Vassenic	0.61	0.48	0.52	1.08	0.47	0.65	0.55	0.69	0.11
49.718	$C_{18:2n6t}$	Linolelaidic	0.11	0.11	0.05	0.55	-	-	0.11	0.04	-
50.252	$C_{18:2n6c}$	Linoleic	13.09	16.97	11.06	24.48	24.40	21.37	28.50	18.39	9.88
51.260	$C_{20:0}$	Arasidic	0.09	0.06	0.06	0.27	0.15	-	-	-	0.24
51.728	$C_{18:3n6}$	Ɣ-linoleic	-	0.06	-	-	0.15	-	0.55	-	0.04
52.636	$C_{20:1c1}$	Leicosenoic	0.33	0.39	0.27	1.83	0.82	0.40	0.38	0.40	0.23
54.108	$C_{18:3n3}$	Linoleic	1.23	-	0.02	-	0.03	-	0.23	0.02	0.02
55.271	$C_{21:0}$	Heneicosanoic	0.20	-	0.22	-	0.06	-	0.63	2.26	0.05
55.828	$C_{20:2\ c11.14}$	Eicosadienoic	0.06	0.10	0.02	-	0.11	-	-	0.11	0.07
57.463	$C_{20:3n3c11.14.17}$	Eicosatrienoic	2.26	-	-	0.99	-	-	-	0.02	-
57.920	$C_{20:4n6}$	Aracidonic	-	0.10	-	0.24	0.11	-	-	0.03	0.03
58.188	$C_{23:0}$	Tricosanoic	0.02	1.68	-	0.14	0.05	-	1.07	0.06	0.04
60.037	$C_{22:2c13.16}$	Docosadienoic	0.05	-	0.02	-	-	-	-	0.11	-
60.642	$C_{24:0}$	Lingoseric	0.06	0.08	-	0.48	0.12	-	-	0.12	0.07
61.263	$C_{24:1}$	Nervonic	0.04	-	-	0.36	-	-	-	-	-
65.420	$C_{22:6n3}$	Docosahexaenoic	-	28.24	-	-	-	-	-	-	-
	ΣSFA		5.48	6.82	3.49	14.20	6.94	6.14	16.07	17.94	17.06
	ΣMUFA		77.71	39.72	84.74	59.19	68.25	72.45	54.54	63.34	67.68
	ΣPUFA		16.80	45.58	11.17	26.61	24.81	21.37	29.38	18.72	10.05
	Other		-	7.88	-	-	-	-	-	-	5.21
	Oil Content (%)		23.7 ± 0.49	17.5 ± 0.53	16.6 ± 0.38	2.1 ± 0.44	9.3 ± 0.28	4.1 ± 0.18	18.8 ± 0.26	14.0 ± 1.06	20.0 ± 0.10

SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids, Av: *Ammi visnaga*, As: *Angelica sylvestris*, Br: *Bifora radians*, Et: *Echinophora tournefortii*, Eteni: *Echinophora tenuifolia* L. subsp *sibthorpiana*, Etri: *Echinophora trichophylla*, Fc: *Ferulago cassia*, Fv: *Foeniculum vulgare*.

Table 2. Fatty acid components and rate of taxa (%) (continued)

Retention Times		Components	Gc	Hc	Hm	Hp	Lt	Op	Ps	Pc	Pp	Pu
14.396			-	-	-	-	3.54	-	-	-	17.45	-
14.491			-	-	-	-	11.80	-	-	-	-	-
15.362	$C_{6:0}$	Coproic	-	0.13	0.48	1.43	0.07	-	0.10	-	0.45	-
19.153	$C_{8:0}$	Caprylic	-	-	0.04	0.34	-	0.04	-	-	0.02	0.37
22.652			-	-	-	-	-	-	-	-	-	0.83
22.937			-	-	-	11.39	-	-	3.58	-	-	1.74
24.349	$C_{10:0}$	Capric	-	-	0.06	0.02	0.02	0.02	0.37	0.08	-	6.92
26.709			-	-	-	-	-	-	-	-	-	0.97
27.599	$C_{11:0}$	Undecanoic	-	-	0.26	-	0.05	-	-	0.38	0.30	1.56
28.850			-	-	-	-	-	-	-	-	-	2.80
30.291	$C_{12:0}$	Lauric	-	0.04	0.03	0.24	0.16	0.08	0.01	0.07	0.02	0.89
33.289	C 13:0	Tridecanoic	-	-	-	-	-	-	-	22.66	-	-
36.137	$C_{14:0}$	Myristic	-	0.18	0.07	0.08	4.10	0.29	0.03	0.10	0.09	0.11
38.393	C14:1	Myristoleic	-	-	0.02		0.20	-	-	-	-	-
38.918	$C_{15:0}$	Pentadecanoic	-	0.06	0.05	0.05	0.09	0.10	0.04	0.09	0.11	0.05
40.916	$C_{15:1c10}$	*cis*-Pentadecanoic	-	-	0.01	-	0.06	-	-	-	-	0.28
41.640	$C_{16:0}$	Palmitic	8.39	4.84	4.44	4.49	7.09	7.75	5.21	5.41	3.59	4.50
43.297	$C_{16:1}$	Palmitoleic	0.16	0.22	0.30	0.14	0.15	0.20	0.16	0.33	0.24	0.27
44.170	$C_{17:0}$	Heptadecanoic	-	0.04	0.51	0.05	0.08	0.07	0.02	-	0.04	0.60
45.689	$C_{17:1c10}$	cis-Heptadecanoic	1.95	0.03	0.06	0.04	0.15	0.07	0.01	-	0.02	0.07
46.816	$C_{18:0}$	Stearic	1.39	1.36	0.70	0.97	2.49	2.22	1.08	1.10	1.16	1.07
48.235	$C_{18:1n6c}$	Petroselinic	61.19	69.43	71.47	53.73	34.96	58.94	63.93	17.29	61.35	50.80
48.287	$C_{18:1n9c}$	Oleic	4.36	6.51	4.82	7.13	10.40	0.92	4.90	21.35	2.81	5.94
48.378	$C_{18:1n7c}$	*cis*-Vassenic	0.30	0.52	0.84	0.58	0.38	-	0.38	0.81	0.59	0.60
49.718	$C_{18:2n6t}$	Linolelaidic	1.58	0.15	0.03	0.04	-	-	-	-	-	0.16
50.252	$C_{18:2n6c}$	Linoleic	17.24	15.46	15.14	18.42	21.08	26.16	19.51	27.31	10.93	18.42
51.260	$C_{20:0}$	Arasidic	-	0.11	0.07	0.12		0.27	0.12	0.14	-	0.11
51.728	$C_{18:3n6}$	Ɣ-linoleic	-	-	-	-	0.22	-	-	-	-	0.11
52.636	$C_{20:1c1}$	Leicosenoic	1.38	0.24	0.25	-	1.78	0.64	0.27	0.35	0.43	0.29
54.108	$C_{18:3n3}$	Linoleic	-	0.02	0.02	-	0.18	0.24	0.03	-	-	-
55.271	$C_{21:0}$	Heneicosanoic	-	0.31	0.10	-	0.19	1.34	0.07	0.45	0.13	-
55.828	$C_{20:2\ c11.14}$	eicosadienoic	-	0.04	0.05	0.05	-	0.16	0.05	0.50	0.06	-
56.114	C22:0	Behenic	1.02	-	-	-	-	-	-	-	-	-
57.463	$C_{20:3n3c11.14.17}$	Eicosatrienoic	-	-	-	-	-	-	-	0.23	-	-
57.920	$C_{20:4n6}$	Arachidonic	0.07	0.07	0.02	0.04	0.04	0.16	0.02	0.35	0.09	-
58.188	$C_{23:0}$	Tricosanoic	0.28	0.06	0.05	0.06	0.09	0.19	0.04	-	0.09	0.36
60.037	$C_{22:2c13.16}$	Docosadienoic	0.52	0.04	-	0.04	-	0.05	0.01	0.23	-	-
60.642	$C_{24:0}$	Lingoseric	-	0.12	0.11	0.08	0.64	0.10	0.05	0.51	0.04	0.16
65.420	$C_{22:6n3}$	Docosahexaenoic	0.15	-	-	0.07	-	-	0.03	0.25	-	-
	ΣSFA		11.61	7.27	6.96	8.13	14.40	12.47	7.13	30.99	6.03	16.72
	ΣMUFA		69.34	76.95	77.78	61.82	48.08	60.77	69.94	40.14	65.44	58.26
	ΣPUFA		19.05	15.79	15.26	18.65	22.17	26.76	19.64	28.87	11.07	18.68
	Other					11.39	15.34		3.58		17.45	6.34
	Oil content (%)		15.3 ± 0.38	7.4 ± 0.36	20.6 ± 0.41	23.1 ± 0.57	12.6 ± 0.37	11.4 ± 0.75	27.6 ± 0.33	17.2 ± 0.26	11.5 ± 0.43	16.2 ± 0.24

SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids, Gc: *Glaucosciadium cordifolium;* Hp: *Heracleum platytaenium;* Hc: *Hippomaranthum cristatum* Hm: *Hippomarathum microcarpum* Lt: *Laser trilobum* Oh: *Opopanax hispitus*; Ps: *Pastinica sativa subsp urens*; Pc: *Peucedonum chyrseum*, Pp: *Prangos platychlaena*; Pu*: Prangos uechtrizii*.

The fruits of *A. visnaga* species contained 23.7±0.49% fatty oil and consisted of 28 different fatty acids. The fatty oils consisted of 5.52% saturated fatty acids, 77.68% monounsaturated fatty acids, and 16.80% polyunsaturated fatty acids. The fatty oil of *A. visnaga* fruits had high levels of petroselinic acid (72.61%), linoleic acid (13.09%), oleic acid (3.91%), and palmitic acid (3.86%).

The fruits of *A. sylvestris* had 17.5±0.53% fatty oil, containing 27 different fatty acids. While 6.82% of the fruit oil was saturated, 39.72% was monounsaturated, 45.58% polyunsaturated fatty acids, and 7.88% was unidentified. The main fatty oil components of the fruits of the species were determined as palmitic acid (3.46%), petroselinic acid (31.21%), oleic acid (7.42%), linoleic acid (16.97%), and docosahexaenoic acid (16.97%).

The fruits of the species *B. radians* contained 16.6±0.38% fatty oil, which consisted of 21 different fatty acid components. The crude oil of the species was composed of 84.74 % monounsaturated, 11.17% polyunsaturated, and 3.49% saturated fatty acids. The main components of

the fatty oil of the species were petroselinic acid (81.0%), linoleic acid (11.06%), and palmitic acid (3.02%).

The fruits of the species *E. tournefortii* had an oil content of 2.1±0.44%, and the composition of the fatty oil consisted of 23 components. The fatty oil of the species consisted of 14.20% saturated, 59.19% monounsaturated, and 26.61% polyunsaturated fatty acids. The main components of the fatty acid composition of *E. tournefortii* fruits were petroselinic acid (45.24%), linoleic acid (24.48%), oleic acid (10.09%), and palmitic acid (9.78%).

The fruits of *E. tenuifolia* subsp *sibthorpiana* subspecies consisted of 9.3±0.28% oil and 24 different fatty acid components. The oil composition of the species comprised 6.94% saturated, 68.25% monounsaturated, and 24.81% polyunsaturated fatty acids. The major components of the fatty oil of the species consisted of 58.45% petroselinic acid, 24.40% linoleic acid, 8.33% oleic acid, and 4.65% palmitic acid.

The fruits of the species *E. trichophylla* contained 4.10±0.18% oil and 8 different fatty acids. The fatty oil of the fruits of the species consisted of 6.14% saturated, 72.45% monounsaturated, and 21.37% polyunsaturated fatty acids. The major fatty acids in the fruits of the species were petroselinic acid (56.28%), linoleic acid (21.37%), oleic acid (14.58%), and palmitic acid (4.60%).

Fruits of the genus *F. cassia* contained 18.8±0.26% oil and consisted of various fatty acids. The total fat content of the species was 16.07% saturated, 54.54% monounsaturated, and 29.38% polyunsaturated fatty acids. The major fatty acid components of the species were petroselinic acid (31.05%), linoleic acid (28.50%), oleic acid (11.80%), palmitoleic acid (9.93%), and palmitic acid (6.38%).

The fruits of the species *F. pauciradiata* contained 14.0±1.06% fatty oil and consisted of 29 different components. The fatty oil of the species consisted of 17.94% saturated, 63.34% monounsaturated, and 18.72% polyunsaturated fatty acids. The main components of *F. pauciradiata* were petroselinic acid (55.58%), linoleic acid (18.39%), caproic acid (9.20%), oleic acid (6.19%), and palmitic acid (4.19%).

The fruits of *F. vulgare* contained 20±0.10% oil and 23 different components. The fatty oil of the species consisted of 17.06% saturated, 67.68% monounsaturated, and 10.05% polyunsaturated fatty acids. The main fatty acids of the fruits of *F. vulgare* are 64.70% petroselinic acid, 11.79% lauric acid, 9.88% linoleic acid, and 3.62% palmitic acid, while the fatty acid with a retention time of 22.917 with a retention time of 5.21% was not identified.

The fruits of *G. cordifolium* contained 15.3±0.38% oil and consisted of 15 different fatty acids. The fixed oil of the species had 11.61% saturated, 69.34% monounsaturated, and 19.05% polyunsaturated fatty acids. The main fatty acid components of the species' fatty oil were petroselinic acid (61.19%), linoleic acid (17.24%), palmitic acid (8.39%), and oleic acid(4.36%).

The fruits of the species *H. cristatum* had an oil content of 7.4±0.36% and contained 23 different fatty acids. The fatty oil of the species consisted of 7.27% saturated, 76.95% monounsaturated, and 15.79% polyunsaturated fatty acids. Petroselinic acid (69.43%), linoleic acid (15.46%), oleic acid (6.51%), and palmitic acid (4.84%) were determined as the main components of the fixed oil of *H. cristatum* species.

The fruits of *H. microcarpum* species contained 20.6±0.41% oil and had 27 different fatty acids. The oil contained 6.96% saturated, 77.78% monounsaturated, and 15.26% polyunsaturated fatty acids. The fruits of *H. microcarpum* species contained a high percentage of petroselinic acid (71.47%) in oil, the other important fatty acids were linoleic acid (15.14%), oleic acid (4.82%) and palmitic acid (4.44%), which made up approximately 95% of the fatty oil of the species.

The fruits of *H. platytaenium* were 23.1±0.57% oil and consisted of 24 different fatty acids. The fatty oil of the species constituted 8.13% saturated, 61.82% monounsaturated, and 18.65% polyunsaturated fatty acids. The fatty oil of the species was found to be 53.73% petroselinic acid, 18.42% linoleic acid, 7.13% oleic acid, and 4.49% palmitic acid. However, the part that had a retention time of 20.095 and a rate of 11.39% could not be detected.

The fruits of the species *L. trilobum* contained 12.6±0.37% oil and 26 different oil components. The fatty oil of the species consisted of 14.40% saturated, 48.08% monounsaturated, and 22.17% polyunsaturated fatty acids. The oil of the fruits of the species contained 34.96% petroselinic acid, 21.09% linoleic acid, 10.40% oleic acid, 7.09% palmitic acid, and 4.10% myristic acid. The fatty acid, that appeared at 14.491 retention time and constitutes 11.80% of oil, could not be identified.

In the fruits of *O. hispidus* species, 11.4±0.75% oil and 22 different fatty acids were determined. In the fatty oil of the species, there were 12.47% saturated, 60.77% monounsaturated, and 26.76 polyunsaturated fatty acids were present. The fatty oil of the species was mainly petroselinic acid (58.94%), linoleic acid (26.16%), and palmitic acid (7.75%).

The fruits of *P. sativa* subsp *urens* contained 27.6±0.33% oil and were composed of 25 different components. The oil of the species was saturated 7.13%, monounsaturated 69.64%, and polyunsaturated 19.64% fatty acids. The major components of the fatty acid composition of *P. sativa* subsp. *urens* fruits were petroselinic acid (63.93%), linoleic acid (19.51%), palmitic acid (5.22%), and oleic acid (4.90%).

The fruits of *P. chryseum* species contained 17.2±0.26% oil and 22 different fatty acids. The fatty oil was determined to be 30.99% saturated, 40.14% monounsaturated, and 28.87% polyunsaturated fatty acids. The main components of the fatty oil of the species are linoleic acid (27.31%), tridecanoic acid (22.66%), oleic acid (21.35%), petroselinic acid (17.29%), and palmitic acid (5.41%).

The fruits of species *P. platychlaena* contained 11.5±0.43% fatty oil and 22 different fatty acids. The oil of the species had 65.44% monounsaturated, 11.07% polyunsaturated, and 6.03% saturated fatty acids. Petroselinic acid (61.35%) and linoleic acid (10.93%) were the major fatty acid components in the oil of the fruits of the species. However, the fatty acid which accounts for 17.45% of the oil and has a retention time of 14.295, wasn't identified.

The fruits of the species *P. uechtritzii* had a fatty oil content of 16.2±0.24% and consisted of 26 different components. The oil of the fruits contained monounsaturated 58.26% monounsaturated, 16.72% saturated, and 18.68% polyunsaturated fatty acids. The main components of the fatty oil of the species were petroselinic acid (50.80%), linoleic acid (18.42%), capric acid(6.92%), oleic acid (5.95%), and palmitic acid (4.50%).

4. Discussion

According to the Red Data Book of Turkish Plants, the genera *Angelica, Ferulago,* and *Prangos* are used for medicinal purposes. This is the first study describing the crude fat content and fatty acid composition of the fruits of the taxa *E. tournefortii, E. tenuifolia* subsp *sibthorpiana, E. trichophylla*, *F. cassia, F. pauciradiata*, and *G. cordifolium*. Endemic taxa also include *E. trichophylla, F. cassia, F. pauciradiata, H. platytaenium, P. chryseum, P. platychlaena,* and *P. uechtritzii.*

In an earlier study the percentage of fatty oil in the fruits of *A. visnaga* species was determined to be 12.6% containing 74.95% petroselinic acid, 16.68% linoleic acid, and 4.92% palmitic acid (Nguyen et al. 2015). Another study reported that the fruits of *A. visnaga* contain 7.2% fatty oil, composed mainly of petroselinic acid (76.10%), linoleic acid (15.60%), and palmitic acid (4.58%) (Houachri et al., 2017). Grindley (1950) stated that the fatty oil of *A. visnaga* fruits contains 5% palmitic acid, 50% petroselinic acid, 32% oleic acid, and 13% linoleic acid. The fatty oil ratio of *A. visnaga* fruits, in our study, is higher than the values compared to the previous studies, while the fatty acid composition is similar to the values available in the literature.

While the oil ratio of *A. sylvestris* was similar to Placek (1963) (17.3%), Kleiman and Spencer (1982) reported that the fruits of the species contained 32.2% fatty oil. As previously reported by other researchers, the major oil components of the species were determined as petroselinic acid (19.6-42.1%), oleic acid (32.8-18.6), and linoleic acid (33.2%) (Placek, 1963; Kleiman and Spencer, 1982). In contrast to the researchers, palmitic acid (3.46%) and docosahexaenoic acid (16.97%) were among the major components of fatty oil in our study.

Kleiman and Spencer (1982) determined the fatty oil rate of the species to be 41.5% in their study of *B. radians*. Comparison of our study with that of Kleiman and Spencer (1982) revealed a high rate of petroselinic and oleic fatty acids and a low rate of oleic and palmitic fatty acids.

Bagci (2007) reported that the fruits of the species *F. pauciradiata* contain 19.7% oil, and the major components of the oil are petroselinic acid (44.0%), linoleic acid (26.1%) and palmitic acid (7.13%). On the one hand, in contrast to the research, caproic (9.20%) and oleic (6.19%) fatty acids were determined in our study; and on the other hand, the results were similar to Bagci's study.

The oil content of *F. vulgare* fruits has been reported to vary from 9.2 to 23% (Placek, 1963; Kleiman and Spencer, 1982; Bahmani et. al., 2021). In terms of the oil ratio, our study was within the range found in previous studies. Similar to previous studies on the components of the oil of the species, the main components were petroselinic acid (62.08-89.8%) (Placek, 1963; Kleiman and Spencer, 1982;

Charvet et al., 1991; Agarwal et al., 2018), palmitic acid (0.3-4.1%) (Kleiman and Spencer, 1982; Bahmani et al., 2021), and linoleic acid (3.6-39%) (Placek, 1963; Kleiman and Spencer, 1982; Agarwal et al., 2018; Bahmani et al., 2021). In contrast to our findings, Bahmani et al. (2021) found that the main components of oleic acid (52-64%), stearic acid (1.3-2.4%), myristic acid (0.35-1.07%), and according to Agarwal et al., (2018) 10-Nonadecanone (4.70-22.80%). Contrary to the researchers, the in present study, the fruits of the species were found to be 11.79% lauric acid.

Previous studies reported oil content of *H. platytaenium* ranged from 11.2 to 19.0% (Placek, 1963; Kleiman and Spencer, 1982; Bagci, 2007; Kucukkboyaci et al., 2016). The results of our study were partially higher than those of the researchers. The difference may be due to the filling rate of the seeds of the species as well as ecological conditions. Our results on the main components of the oil were similar to previous studies reported by different researchers, which consisted of petroselinic, linoleic, and palmitic acids (Placek, 1963; Kleiman and Spencer, 1982; Bagci, 2007; Kucukboyaci et al., 2016).

While Keiman and Spencer (1982) determined the oil ratio of the species as 8.6% in studies as interest in *H. cristatum*, Kucukboyaci et al. (2016) reported that the fruits of the species contain 15.8% fatty oil. Similar to our results with the researchers, the studies on the oil content of the species found palmitic acid (4.3-7.1%), linoleic acid (13.2-19.8%), oleic acid (4.2-74.84%), and petroselinic acid (54.4-72.2) as important components of the oil (Kleiman & Spencer, 1982; Ozturk et al., 2014; Kucukboyaci et al., 2016).

Kleiman and Spencer (1982) determined the oil rate of *H. microcarpum* as 14.1% and reported that the main components were 15.0% palmitic acid, 6.5% petroselinic acid, 20.5% oleic acid, 37.8% linoleic acid. Another research reported that the *H. microcarpum* species' fruits had an oil content of 9.0%, with the main fatty acid constituents being palmitic acid 13.5%, stearic acid 8.4%, petroselenic acid 7.5%, oleic acid 26.5%, and linoleic acid 36.9% (Kucukboyaci et al. 2016). Although the fatty acid content of the species in our research was partially similar to other studies, the oil ratio was higher than the values reported by other researchers.

According to Parlatan et al. (2009), fatty acids of *L. trilobum* fruits consist of caproic acid (59.01-69.27%), myristic acid (1.77-3.16%), lignoceric acid (1.75-8.83%), and myristoleic acid (3-01-31.09%). The results of our study are very different from those of Parlatan et al. (2009). While Kleiman and Spencer (1982) determined the oil ratio of fruits of the *O. hispidus* taxon as 15.6%, the main components of the oil were 6.1% palmitic acid, 40% petroselinic acid, 16% oleic acid, and 35.2% linoleic acid. The results of our study are in agreement with those of Kleiman and Spencer (1982).

In the fruits of *P. sativa* subsp. *urens* oil content was determined to be 18.1% according to Kleiman and Spencer (1982) and 17.3% by Placek (1963). In our study, the fat ratio was higher than in the study of the researchers. The studies conducted on oil components mainly contained high levels of petroselinic fatty acid (46.0-60.1%), similar to our results. In addition, palmitic, oleic, and linoleic fatty acids are among the important components of fatty acids (Placek, 1963; Kleiman and Spencer, 1982).

As reported by Akpinar et al. (2012), *P. chryseum* species occurred at 16.0% palmitic acid, 50.89% oleic acid, and 27.79% linoleic acid. The oil contained 14.82% saturated, 52.58% unsaturated, and 31.66% polyunsaturated fatty acids. In addition, the fruits of the species in our study contained tetradecanoic acid and petroselinic fatty acids.

Bagci (2007) reported that the fruits of *P. platychlaena* species contain 18.7% oil as well as the main components of petroselinic and linoleic acids. Our results were similar to the results of the researcher.

This species reported that the oil content of *P. uechtritzii* varies from 10.11 to 22.8% (Bagci, 2007; Ghafoor et al., 2019). Similar to our results in studies on fatty acids of the species, the main components were palmitic acid, petroselinic acid, oleic acid, and linoleic acid (Bagcıcı, 2007; Ghafoor et al., 2019). Our study was similar to the results of these researchers.

When the study was evaluated, 19 different taxa belonging to the Apiaceae family were significantly rich in unsaturated fatty acids. It was determined that the fatty acid contents of the taxa were different; however, petroselinic fatty acid, oleic, and linoleic fatty acids were the main fatty acid components. Researchers have reported that the major fatty acid of Umbelliferae seeds is *cis* 6-octadecenoic or petroselinic fatty acid (Kleiman and Spencer, 1982; Reiter et al. 1998b; Bagci 2007). Petrocelinic fatty acid (18:1 *cis*6) differs from oleic acid (18:1 *cis* 9) in the way that the double bond is attached in terms of position (Cahoon and Ohlrogge 1994). The degradation of petroselinic fatty acid (C18:1 (6c)), has yielded lauric and adipic acids as important oleochemical raw materials (Reiter et al.

1998b). Moreover, petroselinic fatty acid, oleic (C18:1 (9c)), and *cis*-vaccenic fatty acids (C18:1 (11c)) were found as isomers in the fruits of Umbelliferae. Reiter et al. (1998b) reported that petroselenic fatty acids in fennel, coriander, and cumin fruits contained stearic, petroselinic, oleic, and *cis*-vaccenic fatty acids, respectively. As a matter of fact, similar to Reiter et al. (1998b), the fatty acid order of all species in our study was determined by stearic, petroselinic, oleic, and *cis*-vaccenic fatty acids. Oil plants' fatty acid composition is not steady and can change under the influence of various physiological, ecological, and cultural factors. The fatty acid composition changes depending on the species and is open to various internal and external effects (Baydar and Turgut 1988). The fatty acids in many oil plants are sensitive to various climatic conditions, especially temperature. Besides, the position of fruit formations on the plant causes a large variation in terms of fatty acids within the plant. Furthermore, after fertilization, there may be a continuous variation in fatty acids during the different developmental periods of the seed. In particular, the composition of C18 fatty acids is highly sensitive to environmental effects, especially with the temperature (Pleines and Friedt 1989); also been stated that there were cytoplasmic and maternal effects other than the effects of the nuclear genes of the embryo on genetic control (Pleines and Friedt 1989). The differences between the research results and the species compared with other studies are probably due to the light, temperature, soil type, and plant nutrients (Rahmatalla et al., 1998) as well as the differences in the climatic and geographical conditions in which the plants are grown.

5. Conclusion

In the analysis of the taxa included in the study, it was grıp found that the fatty acid ratio and composition were. However, in general, the taxa were found to have a high proportion of unsaturated fatty acids. The fatty acid consisted of fatty acids of the C18 group. Consequently, considering the species considered in the study can be used as oil sources in various fields in the coming years.

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