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The oil content and fatty acid composition of *Fagus orientalis* Lipsky seeds from different populations in Turkiye

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Abstract: Knowledge of the nutrient content of edible seeds of oriental beech (*Fagus orientalis* Lipsky) as a food resource for rural people, is incomplete and there is a need for studies that will provide this information. The seeds of oriental beech collected from 12 different locations in a primary distribution area of Turkey were investigated for their oil content and fatty acid composition. The fatty acid contents of these 12 different populations were determined by gas chromatography-mass spectrometry (GC/MS) of the fatty acids methyl esters (FAME). The seeds of the various tree populations were found to contain total oil amount ranging from 44.66% to 49.07%, which was primarily composed of oleic, linoleic, palmitic, and gadoleic acids. As the predominant unsaturated fatty acid, there was no difference among the populations in the percentage of oleic acid with the highest percentage of unsaturated fatty acids. As the primary saturated fatty acid, the highest palmitic acid content was determined in the Ordu-Akkuş population (13.85%), where the species made the optimal development, while the lowest value was determined in the Kahramanmaraş-Andırın population (7.14%), which is an isolated population of the species. In the study of oriental beech populations, palmitic acid was found in the major saturated fatty acids, on the other hand oleic, linoleic, and gadoleic acids were found in major unsaturated fatty acids. This study highlights the potential of oriental beech seeds as a nutrient-rich food source due to their high total fat content.

Keywords: linoleic acid, major unsaturated fatty acid, oriental beech, palmitic acid, saturated fatty acid

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Introduction

Fagus is one of the most abundant and economically important hardwood genera in the northern hemisphere temperate forests (Sagheb-Talebi et al., 2011). The oriental beech (*Fagus orientalis* Lipsky) species is native to Eurasia. The species has distributed from the Strandja Mountain in southeastern Bulgaria through northwestern Turkey and eastward to the Caucasus Mountains in Georgia and

Russia and the Alborz Mountains in Iran. The prediction of warmer conditions in the future showed that the populations on the southern slopes of the North Anatolian Mountains were expected to shrink. There would be a reduction in the populations found in the main distribution area in the Istranca Mountains and the Northern Anatolia, especially in populations in the transition zone of Central Anatolia (Ayan et al., 2022). Also, oriental beech would lose its isolated-marginal populations in the southeast of Turkey. Oriental beech is the third largest species in the forests of Turkey, spreading over an area of 1.96 million ha and composing nearly 8.5% of the total forest area of this country (Ercanlı et al., 2014; Turfan et al., 2016; Turfan et al., 2017; Turfan et al., 2019; Ayan et al., 2022). The diversity of this species is rather rich thanks to the variety of growing conditions in Turkish forests. Due to its shade-tolerance, north-facing slopes provide optimal growth conditions for the species (Ertekin et al., 2015). Although much research has been carried out on the properties of oriental beech wood, there are limited studies on its seeds, which provide a food source for local populations (Güney et al., 2013). Prasad and Gülz (1989) emphasized that even though the nuts are reported to be containing low molecular weight toxic components (i.e trimethylamine). Beechnut contain several toxins, including one called fagin (Trimethylamine). The raw fruits contain oxalic acid, it causes stomach upset and symptoms of poisoning. Especially, this can happen by excessive consumption the uncooked beechnuts. It is therefore important to always heat the nuts before consumption. Moreover, oxalic acid inhibits the uptake of iron from foods. The raw nuts also contain alkaloids and saponins, which can produce the above-described symptoms especially in sensitive persons. Alkaloids and saponins can also destroyed by heating. Beechnuts are especially harmful in persons with gout, arthritis and kidney diseases (URL 1, 2023a; URL2, 2023b). However, the oil was reported to be a good source for edible purposes because of its good taste and stability. Of the few, Ayaz et al. (2011) presented information on the fatty acid and nutrient contents of oriental beech seeds, while Güney et al. (2013) reported variations in the soluble sugar content of the seeds in six different natural oriental beech populations.

Hunger is increasing worldwide due to rising food prices and food scarcity, which have led populations in many parts of the world to search for alternative food sources that would contribute to satisfying their nutritional needs. Consequently, many people collect nuts to supplement their diets. However, since our knowledge of the nutrient content of edible nuts is incomplete, there is a need for studies that will provide this information (Ayaz et al. 2011). Oriental

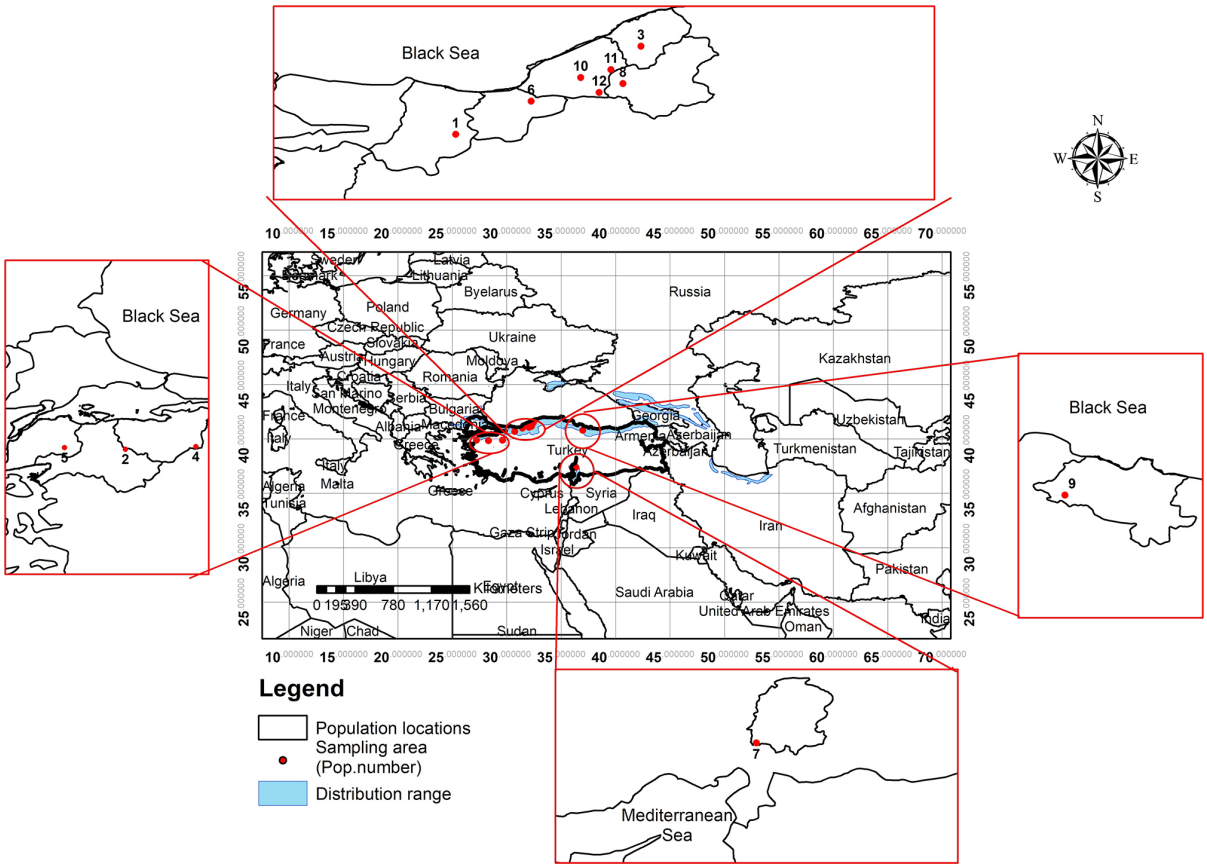

Fig. 1. Locations of seed collected populations in the research

beech is a broadleaf species with large potential for afforestation and as a food resource for local people. Prompted by these advantages, this study investigated the variations in fatty acid compositions and oil percentages of the seeds of different oriental beech populations in Turkey.

Material and methods

Collection of the seeds and sample preparation

Seeds were collected from 12 locations in the natural distribution area of oriental beech in Turkiye (Fig. 1). The trees were selected using a randomized sampling design, and the mean distance between the sampled trees was 150 m to 200 m. Detailed information about these locations is given in Table 1. From each location, healthy and mature seeds were gathered from the upper part of different trees at the end of the vegetation season (September–October–November) in 2021. Collection dates have been decided by taking into account the observations of practitioners in different locations for many years and the climatic characteristics of the harvest year. When evaluated in terms of the 6-month vegetation period, which is the maturation process of the seeds, it has been determined that the average temperature varies between 14.5–16.7 °C and the average rainfall varies between 40.8–68.9 mm in the 5-6-month vegetation period among the 12 locations where seeds are collected (MGM, 2021). The average age of the trees from which the seeds were collected varies between 80 and 100 years (4^{th} age class). Seed-collected beech trees are in the middle and thick growth stages, and the stands are pure, single-layered, and same-aged stand characteristics.

The average length, width and thickness of the seeds collected from different beech populations used in the study were 15.9±1.2 mm, 9.6±0.8 mm and 7.4±0.77 mm, respectively. At the stage when they were brought to the laboratory, seeds with different moisture content were adjusted to air-dry humidity (10±3%) before analysis. Seed samples were mixed well, then weighed into 5 g samples (About 20 seeds). The samples were dried at a temperature of 70 °C for 48 h in 5 replicates. The dried samples were then ground using a stainless-steel mill to a particle size of 1 mm (Cole-Parmer Analytical Mill, Vernon Hills, IL) and made ready for chemical analysis.

Fatty acid analysis

The grinded seeds (5 g) were placed into Soxhlet cartridges, to which dissolvent was added drop-wise.

Table 1. Information about the locations where the Oriental beech seeds were collected

No.	Population	Coordinates		Altitude (m)	Aspect	Stand type
1	Adapazarı-Karasu	41°01'13"	30°44'45"	300 to 500	Northwest	Knd_2
		41°00'38"	30°45'01"			
2	Balıkesir-Dursunbey	39°27'35"	28°33'54"	800 to 1000	North	Knd_1
		39°27'30"	28°32'44"			
3	Bartın-Kumluca	41°29'43"	32°26'32"	450 to 700	North	Knd_3
		41°29'55"	32°27'54"			
4	Bursa-İnegöl	39°58'44"	29°29'04"	700 to 1200	Northwest	Knd_3
		39°58'02"	29°28'46"			
5	Çanakkale-Kalkım	39°46'56"	27°09'46"	400 to 600	North	Knd_2
		39°46'11"	27°09'10"			
6	Düzce-Yığılca	31°25'35"	31°25'35"	700 to 1100	Northwest	Knd_3
		31°25'35"	31°25'35"			
7	Kahramanmaraş-Andırın	37°46'12"	36°22'10"	1400 to 1800	North	Knd_3
		37°44'52"	36°23'34"			
8	Karabük-Yenice	41°09'08"	32°16'37"	600 to 900	North	Knd_1
		41°08'52"	32°15'53"			
9	Ordu-Akkuş	40°47'25"	36°58'50"	1100 to 1400	North	Knd_2
		40°46'56"	36°59'05"			
10	Zonguldak-Devrek	41°12'27"	31°53'15"	500 to 700	Northwest	Knd_1
		41°12'05"	31°54'23"			
11	Zonguldak-Gökçebey	41°16'49"	32°11'31"	500 to 850	Northwest	Knd_2
		41°16'13"	32°12'52"			
12	Zonguldak-Yazıcık	41°03'46"	31°54'57"	500 to 900	Northwest	Knd_2
		41°04'06"	31°54'32"			

Knd_1: Pure oriental beech stands (POBS), 36 cm ≤ $d_{1.3}$ ≤ 51.9 cm and crown closure (CC) 11% ≤ CC ≤ 40%; Knd_2: POBS, 36 cm ≤ $d_{1.3}$ ≤ 51.9 cm and 41% ≤ CC ≤ 70%; Knd_3: POBS, 36 cm ≤ $d_{1.3}$ ≤ 51.9 cm, CC ≥71%.

The cartridges were clogged with cellulose filter paper to prevent the samples from spilling out. Shimadzu GC/MS QP 2010 ULTRA device with RTX-2330 capillary column (Dimensions: 60 m; 0.25 mm; 0.20 μm) was used to determine the fatty acid compositions. The column furnace temperature is given as 100 ˚C, injection temperature is 250 ˚C, interface temperature is 250 ˚C, ion source temperature is 200 ˚C, pressure is 90 kPa, injection volume is 2 μL. Helium gas was used as the carrier gas. The following procedure was carried out by placing the cartridges in a Soxhlet extraction device to obtain the fixed oil volume, according to TSE-TS standard 1632 EN ISO 665 (2001): 80 mL to 100 mL of petroleum ether ($(C_2H_5)_2O$) dissolvent was added into glass flask containers, which were connected to an extractor and cooler. The glass flasks were kept in a drying-oven to remove the remaining solvent after 3 h of extraction, and they were cooled in a desiccator for 1 h, and then weighed on a scale with a 1 mg sensitivity.

After recording the last weight of the flask, the percentages of the fixed oil in the seeds were calculated according to Formula 1:

$$\%\ \text{Total Amount of Oil}\left(\frac{g}{100}\right) = \frac{\text{Total Amount of Oil in the Seeds}}{\text{Seed Weights}} \times 100 \quad (1)$$

The obtained oil was analyzed at the Central Research Laboratory of Istanbul Technical University using a GC-MS device (Shimadzu GC-MS QP 2010 Ultra) to determine the fatty acid composition and the percentages of the populations, according to CSN EN ISO standard 17059 (2010).

Statistical analysis

An analysis of variance (ANOVA) was performed to determine whether each parameter of the fatty acid compounds detected on the seeds differed significantly by population. These findings were presented using the SPSS program (version 11, IBM Corporation, Armonk, NY). The difference that existed between each of the processes, according to the ANOVA results, as well as the significant differences among the primary values of the processes were determined by Tukey's test.

Results and discussion

In this study, the total oil percentage and fatty acid composition in the seeds of 12 different oriental beech populations were determined, and the results are presented in Table 2. Significant differences were found among populations in terms of both the total saturated (∑SFA), and unsaturated fatty acid (∑UFA) contents. However, no significant differences were found in terms of the margaric acid, oleic acid, linolenic acid, and arachidic acid contents in the seeds representing the populations. The genetic is mainly dominant factor on the chemical composition of the seed. However, environmental factors and cultivation studies also have a limited impact (Bewley & Black, 1994; Copeland & McDonald, 1999). Transportation to water, temperature, soil fertility and cultivation activities are the main environmental factors that affect the chemical composition of the seed.

The total oil of the oriental beech seeds varied between 49.07% and 44.66% with the greatest values extracted from trees in Ordu-kkuş (49.07%), Bartın-Kumluca (48.86%), and Düzce-Yığılca (48.54%) and the least values extracted from trees in Kahramanmaraş-Andırın (44.66%), Zonguldak-Devrek (44.86%), and Çanakkale-Kalkım (45.31%). These values agree with those of Ayaz et al. (2011), who reported a mean total fatty acid content of 45.0% in oriental beech seeds. In the research conducted by Yilmaz (2008a) in four different origins, the chemical composition of the beech seeds was determined as follows: It contains 48.69% lipids, 29.04% protein, 3.16% starch, and 4.10% ash (dry weight) in average. 88.44% of the lipids of oriental beech seeds was unsaturated fatty acids. In a related study on European beech (*Fagus sylvatica* L.), Prasad and Gülz (1989) similarly determined a 40.7% total fat in seeds on a dry weight basis. Collectively, these high values emphasize that these seeds offer a good food source and have potential for industrial applications. Siger et al. (2017) also stated that European beech may be considered as unconventional oilseeds crops because of relatively high content of fat (27.25%).

Gas chromatographic spectral mass (GC/MS) analysis of the oil of oriental beech seeds revealed that the fatty acid content was composed of 12 different fatty acids with carbon numbers ranging from 14 to 22. Oleic, linoleic, gadoleic, and palmitic acids were the predominant fatty acids, while margaric acid was found in lower levels. Myristic, palmitoleic, margoleic, arachidic, and eicosadienoic acids were also quantified below 1%. Ayaz et al. (2011) also revealed that oriental beech seeds contained high percentages of glutamic acid (50.1% to 54.4%), oleic acid (37.8%), and linoleic acid (34.1%) as well as slightly lower contents of aspartic acid (22% to 28.3%) and arginine (21.0% to 27.3%). Dandik et al. (1992) were investigated of the oil characteristics of oriental beech originating from Kırklareli, Turkey for the first time. Results of this study show that the physical and chemical characteristics of oriental beech oil closely resemble those of European beech

Table 2. Total oil content and fatty acid compositions of oriental beech collected from different population

Fatty acid ($X \pm S_X$)	Population name												*F*-value	*p*-value
	Adapazarı-Karasu	Balıkesir-Dursunbey	Bartın-Kumluca	Bursa-İnegöl	Çanakkale-Kalkım	Düzce-Yığılca	Kahramanmaraş-Andırın	Karabük-Yenice	Ordu-Akkuş	Zonguldak-Devrek	Zonguldak-Gökçebey	Zonguldak-Yazıcık		
Total oil content	47.47 ±0.55^{ab}	47.16 ±0.36^{ab}	48.86 ±2.92^{a}	47.78 ±0.87^{ab}	45.31 ±0.27^{b}	48.54 ±0.35^{a}	44.66 ±0.23b	46.91 ±0.53^{ab}	49.07 ±0.40^{a}	44.86 ±0.19^{b}	46.42 ±0.45^{ab}	46.51 ±0.51^{ab}	2.435	0.033*
C14:0	0.23 ±0.014^{abc}	0.23 ±0.012^{abc}	0.20 ±0.027^{bcd}	0.260 ±0.011^{a}	0.19 ±0.018^{cd}	0.25 ±0.008^{a}	0.17 ±0.008^{d}	0.20 ±0.006^{bcd}	0.24 ±0.012^{ab}	0.20 ±0.012^{bcd}	0.22 ±0.008^{abc}	0.22 ±0.006^{abc}	3.483	0.005**
C16:0	10.24 ±1.14^{bcd}	9.47 ±0.72^{cde}	8.55 ±0.53^{de}	11.24 ±1.41^{bc}	8.05 ±0.26^{de}	12.12 ±0.55^{ab}	7.14 ±0.16^{e}	9.37 ±0.87^{cde}	13.85 ±0.43^{a}	7.53 ±0.24^{e}	8.84 ±0.63^{de}	8.78 ±0.57^{de}	7.439	0.000***
C17:0	0.06 ±0.008	0.06 ±0.005	0.05 ±0.008	0.05 ±0.01	0.05 ±0.005	0.06 ±0.005	0.03 ±0.003	0.05 ±0.003	0.06 ±0.006	0.05 ±0.003	0.05 ±0.005	0.04 ±0.006	1.700	0.134^{ns}
C20:0	0.91 ±0.18	0.81 ±0.08	0.66 ±0.05	0.92 ±0.20	0.63 ±0.09	0.85 ±0.18	0.62 ±0.03	0.82 ±0.12	1.07 ±0.10	0..63 ±0.03	0.71 ±0.10	0.83 ±0.16	1.251	0.309^{ns}
∑SFA	11.46 ±1.32^{bcd}	10.58 ±0.79^{cde}	9.47 ±0.55^{de}	12.47 ±1.61^{bc}	8.93 ±0.32^{de}	13.29 ±0.56^{ab}	7.97 ±0.19^{e}	10.45 ±0.96^{cde}	15.24 ±0.36^{a}	8.42 ±0.25^{e}	9.83 ±0.69^{cde}	9.88 ±0.71^{cde}	6.854	0.000***
C16:1	0.42 ±0.02^{abc}	0.41 ±0.01^{abc}	0.35 ±0.005^{cd}	0.42 ±0.02^{ab}	0.37 ±0.02^{abcd}	0.43 ±0.03^{a}	0.31 ±0.02^{d}	0.37 ±0.01^{abcd}	0.44 ±0.02^{a}	0.31 ±0.005^{d}	0.35 ±0.03^{cd}	0.35 ±0.02^{bcd}	4.445	0.001**
C17:1	0.15 ±0.01^{cd}	0.15 ±0.003^{cd}	0.19 ±0.01^{bc}	0.13 ±0.02d	0.21 ±0.03^{ab}	0.12 ±0.00^{d}	0.25 ±0.01^{a}	0.17 ±0.03^{bcd}	0.15 ±0.01^{cd}	0.22 ±0.01^{ab}	0.17 ±0.008^{bcd}	0.19 ±0.03^{bc}	5.003	0.000***
C18:1	41.99 ±0.87	42.35 ±0.99	43.57 ±0.52	42.29 ±1.24	43.82 ±0.79	43.25 ±0.36	44.55 ±1.40	42.84 ±1.10	41.54 ±0.73	43.63 ±1.27	42.59 ±1.27	42.56 ±1.45	0.663	0.758^{ns}
C20:1	5.74 ±0.37^{de}	6.33 ±0.34^{cde}	7.15 ±0.14^{bc}	5.39 ±0.46^{e}	7.57 ±0.23^{b}	6.07 ±0.31^{cde}	8.68 ±0.57^{a}	6.59 ±0.26^{bcd}	5.35 ±0.24^{e}	7.73 ±0.50^{ab}	6.70 ±0.10^{bcd}	6.63 ±0.29^{bcd}	8.074	0.000***
C22:1	1.51 ±0.09^{ef}	1.72 ±0.07^{de}	2.38 ±0.12^{bc}	1.38 ±0.16^{ef}	2.51 ±0.18^{ab}	1.43 ±0.17^{ef}	2.82 ±0.20^{a}	1.99 ±0.09^{cd}	1.19 ±0.03^{f}	2.57 ±0.08^{ab}	2.30 ±0.12^{bc}	2.31 ±0.11^{bc}	17.182	0.000***
∑MUFA	49.81 ±0.99^{de}	50.98 ±0.88^{cde}	53.58 ±0.28^{bc}	49.62 ±1.66^{de}	54.50 ±0.51ab	51.31 ±0.16^{cde}	56.63 ±0.77^{a}	51.97 ±0.81^{bcd}	48.69 ±0.55^{e}	54.47 ±0.82ab	52.13 ±1.12^{bcd}	52.05 ±1.08^{bcd}	6.730	0.000***
C18:2	34.80 ±0.04^{a}	34.54 ±1.06^{ab}	32.71 ±0.67^{abcd}	34.03 ±0.49^{abc}	32.09 ±0.60^{cd}	31.05 ±0.36^{d}	30.96 ±0.27^{d}	33.62 ±0.52^{abc}	32.41 ±0.60^{bcd}	33.35 ±0.65^{abc}	33.81 ±0.76^{abc}	33.92 ±1.00^{abc}	3.828	0.003**
C18:3	3.71 ±0.79	3.67 ±0.54	3.99 ±0.35	3.67 ±0.47	4.22 ±0.68	4.10 ±0.16	4.14 ±0.40	3.75 ±0.46	3.46 ±0.34	3.49 ±0.35	4.01 ±0.44	3.91 ±0.40	0.322	0.973^{ns}
C20:2	0.20 ±0.008^{bc}	0.22 ±0.02^{bc}	0.23 ±0.02^{abc}	0.20 ±0.01^{bc}	0.25 ±0.01^{abc}	0.23 ±0.01^{abc}	0.29 ±0.01^{a}	0.20 ±0.01^{bc}	0.19 ±0.01^{c}	0.25 ±0.01^{ab}	0.22 ±0.01^{bc}	0.23 ±0.02^{abc}	2.305	0.042*
∑PUFA	38.72 ±0.53	38.44 ±1.40	36.94 ±0.35	37.91 ±0.55	36.56 ±0.42	35.40 ±0.52	35.41 ±0.61	37.59 ±0.99	36.09 ±0.94	37.11 ±0.68	38.04 ±1.06	38.06 ±1.10	1.899	0.092 ^{ns}
∑UFA	88.53 ±1.32^{bcd}	89.41 ±0.79^{abc}	90.52 ±0.55^{ab}	87.52 ±1.61^{cd}	91.06 ±0.32^{ab}	86.70 ±0.56^{ed}	92.02 ±0.19^{a}	89.55 ±0.96^{abc}	84.76 ±0.36^{e}	91.57 ±0.25^{a}	90.17 ±0.69^{abc}	90.11 ±0.71^{abc}	6.854	0.000***

Note: C14:0 Myristic acid; C16:0 Palmitic acid; C16:1 Palmitoleic acid; C17:0 Margaric acid; C17:1 Margoleic acid ; C18:1 Oleic acid; C18:2 Linoleic acid; C18:3 Linolenic acid; C20:0 Arachidic acid; C20:1 Gadoleic acid; C20:2 Eicosadienoic acid; C22:1 Erusic acid; ∑SFA: Total saturated fatty acid; and ∑UFA: Total unsaturated fatty acids; Note: ns: non-significant, * *p*-value less than 0.05: ** *p*-value less than 0.01; *** *p*-value less than 0.001; ∑PUFA: Total poly unsaturated fatty acids; ∑MUFA: Mono unsaturated fatty acids.

oil. Oriental beech oil has higher linoleic acid content (48.9%) than the others, and it has approximately 2.0% other saturated and unsaturated fatty acids. From the data presented, it could be seen that both margaric acid and margoleic acid were detected in only 0.03% to 0.06% and 0.12% to 25% of the seeds obtained from the populations. Oleic acid, linoleic acid, and palmitic acid are major fatty acids in all populations. No significant differences were found among the populations in terms of the percentage of oleic acid. However, linoleic acid was detected as the highest in the Sakarya-Karasu population, while the lowest values were found in the Kahramanmaras-Andırın and Duzce-Yıgılca populations. As the primary saturated fatty acid, the highest palmitic and palmitoleic acids contents were found in the Ordu-Akkuş population (13.85%), where is located in the Eastern Black Sea Region, where the species has its main and optimal distribution in Turkey, and high increment and productivity in terms of stand development, while the lowest value was found in the Kahramanmaraş-Andırın population (7.14%), which is an isolated population of the species, as well as the Zonguldak-Devrek population (7.53%). The highest values in terms of the gadoleic and eicosadienoic acid contents were found in the Kahramanmaraş-Andırın population, and the lowest value was found in the Ordu-Akkus population.

It is evident from the results of this study that in the seed oil of oriental beech populations, palmitic acid is the major saturated fatty acid, with the highest level found in the Ordu-Akkuş (13.85%) population and lowest level being found in the Kahramanmaraş-Andırın (7.14%) population.

Comparatively, it has been reported that European beech seed oil contains a total of 76% oleic and linoleic acid, which are approximately the same as in oriental beech seed oil (Siger et al. 2017). In both species, oleic acid is confirmed as the highest fatty acid. Importantly, Omega-3 (alpha-linolenic acid), Omega-6 (linoleic acid), and Omega-9 (oleic acid) fatty acids have many benefits in terms of human well-being, *e.g.*, healthy brain function, increased immunity, and prevention of coronary heart diseases. In addition, it is known that a deficiency of these fatty acids causes skin disorders, asthma, arthritis, regression in growth, some types of cancer, and learning difficulties (Lewis et al. 2000).

In Table 2, it can be seen that the highest percentage of oleic acid (44.55%) and erusic acids (2.82%) were found in the Kahramanmaras-Andırın population, while the highest linoleic acid (34.8%) content was detected in seeds from the Sakarya-Karasu location. However, the lowest linoleic acid contents were found in the Kahramanmaras-Andırın (30.96%) and Duzce-Yıgılca (31.05%) populations. Yilmaz (2008b) found that oil from oriental beech seeds is composed of 48.69% total fat, specifically oleic acid (40.42%), linoleic acid (34.98%), eicosanoic acid (7.30%), palmitic acid (7.11%), linolenic acid (3.69%), stearic acid (2.97%), and erusic acid (1.38%). Kahramanmaraş-Andırın and Adapazarı-Karasu populations exhibit a richer composition as food compared to other populations. Because these populations are the richest populations in terms of oleic acid (Omega-9) and linoleic acid (Omega-6), they are considered to have the potential of a good food substance.

The total unsaturated fatty acid (∑UFA) of the studied oriental beech populations ranged between 84.76% to 92.02% (as shown in Table 2), with the highest ∑UFA found in the Kahramanmars-Andırın population and the lowest in the Ordu-Akkus population. The ∑SFA of the studied oriental beech populations ranged between 7.97% and 15.24%, with the highest content in the Ordu-Akkus population and the lowest in the Kahramanmaras-Andırın population. Siger et al. (2017) suggested that oriental beech seeds can be accepted as a non-traditional oilseed class based on their mineral and chemical components, including a high fat content and a percentage of healthy fatty acids, *i.e.*, Omega-3, 6, and 9. Thus, it is important to further evaluate these seeds for food, pharmaceutical, and other industrial uses.

Fatty acids consist of two categories, saturated and unsaturated fatty acids. The saturated fatty acids found in oriental beech seeds were palmitic acid, arachidic acid and myristic acid, and the unsaturated fatty acids found in birch seeds included palmitoleic acid, oleic acid, lineloic acid, and linolenic acid. Polyunsaturated and monounsaturated fatty acids are highly beneficial for blood maintenance and help to prevent thrombosis and vascular occlusion as well as protect heart health (Açkurt et al., 1999). Oleic acid, or Omega-9, is deemed one of the most important polyunsaturated fatty acids, which much be consumed since it cannot be synthesized by the body (Reaven & Witztum, 1996). Oleic acid is known to lower HDL (high-density lipoprotein) cholesterol, triglyceride levels, and blood pressure as well as to protect lipoproteins and cell membranes against oxidative stress, contributing to the durability of the cells (Solfrizzi et al., 2006; Barberger-Gateau et al., 2007; Paniagua et al., 2007). This study reports the presence of 42.92% Omega-9 and 33.11% Omega-6 fatty acids in oriental beech seeds, signifying the importance of these seeds as a rich nutrient source for humans.

Conclusion

The following conclusions and recommendations can be expressed by the observations and determinations made during the investigation and the evaluation of the data obtained:

It was determined that oriental beech seeds contain approximately 47% total fat on a dry weight basis and 12 different fatty acids. The carbon numbers of these fatty acids ranged from 14 to 22 with the major fatty acids being oleic, linoleic, palmitic, and gadoleic.

As the predominant unsaturated fatty acid, there was no difference among the populations in the percentage of oleic acid with the highest percentage of unsaturated fatty acids. As the primary saturated fatty acid, the highest palmitic acid content was found in the Ordu-Akkuş population (13.85%), where the species had optimal development, while the lowest value was found in the Kahramanmaraş-Andırın population (7.14%), which is an isolated population of the species.

Comparing these values to other beech seeds, the literature reveals that oriental beech seeds are richer in total fat than European beech seeds. This study highlights the potential of oriental beech seeds as a nutrient-rich food source due to their high total fat content.

The aims of future studies should focus on the determination and conservation of high total fatty acid-containing populations and genotypes as well as the establishment of *ex situ* plantations using these materials. The obtained data suggests that genetic variations in the same species of seeds collected from the same climate and location may result from their different compositions of fatty acids.

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Conflict of interest

The authors declare that they have no conflict of interest.

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