CHARACTERISTICS OF TURKISH EXTRA VIRGIN OLIVE OILS ACCORDING TO THE THEIR FATTY ACID PROFILE

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Abstract. In this study, a Mobile Olive Oil Processing Unit (TEM *Oliomio* 500-2GV, Italy) was designed and used to manufacture cold press extra virgin olive oil (EVOO) under the optimum conditions. The local olive varieties Beylik, Tavşan Yüreği, Uslu, and Saurani in the Turkish provinces Antalya, Manisa, and Hatay have been investigated. EVOO was stored before and after paper filtration. Generally, no significant change was observed in the fatty acid composition during 60 days of storing. The filtration had no detectable effect, and there was significant difference among the EVOOs obtained from different cultivars. The results of this study have shown that the fatty acid profile of EVOOs is a good method to classify Turkish olive oils. Beylik and Tavşan Yüreği had a higher oleic acid content than other cultivars. The Saurani EVOO had the highest content of palmitic and stearic acids. The highest amount of linoleic acid was detected in the EVOO Uslu (Manisa), with the range 12.06–12.09%. The maximum amount of linolenic acid (0.85%) was detected in Saurani (Hatay), and the lowest concentration (0.49%) of linolenic acid was found in Tavşan Yüreği (Antalya). Beylik (Antalya) extra virgin olive had 0.5% of it, and this amount increased after filtration (0.59%). Uslu (Manisa) had 0.7% of linolenic acid. The olive oil samples were classified as EVOO according to the International Olive Council (IOC) regulations. The linolenic acid levels in the Turkish virgin olive oil samples were below the maximum value (0.9%) provided for by the Turkish Food Codex. Predictably, oleic acid (C18:1) was the most abundant fatty acid (70.56–68.64%), followed by palmitic acid (C16:0) and linoleic acid (C18:1). The results have shown that Beylik and Tavşan Yüreği extra virgin olive oil have a unique fatty acid profile due to high oleic acid content. Turkish virgin olive oils are low in linoleic and palmitic acids, and high in oleic acid.

Keywords: olive oil, Turkish olive cultivars, fatty acid composition, classification, storage.

Introduction. Formulation of the problem

Olive oil is the oily juice separated from the other ingredients of the olive fruit. It is extracted from fresh, mature olive fruit, and has a characteristic sensory profile and nutrition value. Olive oil has a good balance of saturated, monounsaturated, and polyunsaturated fatty acids. Unlike other vegetable oils, it can be consumed in the crude form, as it retains its nutritionally significant vitamin and phenolic content. Virgin olive oils (VOOs) have the characteristic aroma, taste, colour, and nutritive properties that distinguish them from other edible vegetable oils. VOO is obtained from the olive fruit by only mechanical or other physical processing. Virgin olive oil is the backbone of the Mediterranean diet. Mediterranean countries, including Spain, Italy, Greece, Tunisia, Syria, Turkey, and Morocco, are the most important olive oil producers. Turkey-located Upper Mesopotamia is the homeland of the olive tree, because of its rich soil and genetic resources. The genetic resources of the olive tree are found in South-Eastern Anatolia, in the Mediterranean, Aegean, Marmara, and the Black Sea regions. The olive tree, with its three thousand years of life and eight thousand years of agricultural history, has long been adapted to different ecological conditions. Some people, who know its superior properties, develop its new varieties in a vegetative way and use them to establish new gardens. However, while maintaining some local varieties, the characteristics of some them have been modified genetically.

Analysis of recent research and publications

Tanılgan et al. [1] studied the physical and chemical characteristics of five Turkish olive varieties (*Olea europea* L.) and their oils. The olive fruit yielded approximately 17.7%–43.5% oil. The crude fibre contents were 5.5% (Gemlik), 7.0% (Kilis), 3.6% (Uslu), 4.2% (Tirilye), and 5.6 (Ayvalik). The fatty acid composition of the cultivars included oleic acid (65.7%–83.6%), palmitic acid (8.1–15.2%), linoleic acid (3.5–15.5%), stearic acid (2.0–5.6%), and

linolenic acid (0.1–3.0%). Gurdeniz et al. [2] classified Turkish olive oils taking into account the cultivar (Ayvalık, Gemlik, Erkence, Nizip, Ayvalık-Edremit, and Gemlik-Edremit), geographic origin, and harvest year, using the fatty acid profile and mid-IR spectroscopy. The results showed that using the statistical method (PCA) basing on the fatty acid composition was quite successful for the classification of olive oil samples.

Matthäus and Özcan [3] investigated olive oils of the Edremit, Gemlik, Domat, and Sarıulak varieties from different locations in Turkey. The major fatty acid of all cultivars was oleic acid that ranged 61.09–72.78%. Besides, the amounts of 1.2- and 1.3-diacylglycerols ranged 27.5–49.2 and 50.8–72.5, respectively.

Yorulmaz et al. [4] characterised Turkish olive oils by triacylglycerol structures and sterol profiles. Diraman and Dibeklioğlu [5] used the lipid profiles to characterise some Turkish monocultivar olive oils obtained by different systems. They showed that triacylglycerols and fatty acid profiles could be used to identify monocultivar olive oils with regard to authenticity and classification.

Diraman et al. [6] characterised the most important domestic and foreign olive cultivars from the National Olive Collection Orchard (Bornova, Turkey) by chemometric methods. In their study, twelve samples from domestic olive cultivars (Memecik, Uslu, Domat, Ayvalık, Çelebi, Memeli, Erkence, Gemlik, Çakir, İzmir Sofralik, Cekişte, and Çilli) and nine samples from foreign olive varieties (Picholine, Arbequnia, Hojiblanca, Manzanilla, Frontoio, Leccio, Saurani, Baroui, and Meski) were investigated. The quality parameters, colour values, fatty acid composition, and squalene content of the olive oils samples were analysed. The contents of free fatty acids, oleic acid, and squalene in the Uslu variety were reported to be 0.5, 75.34, and 0.35, respectively. The fatty acid profile of virgin olive oils from domestic and foreign cultivars grown in the same pedoclimatic conditions showed considerable differences among th cultivars.

Diraman et al. [7] had a survey on the geographical classification of Turkish virgin olive oils from the Aegean region Edremit Gulf (Ayvalik), Izmir province (Ayvalık, Memeli, Memecik, and Gemlik), Aydın province (Memecik, Manzanilla, and Gemlik), Muğla (Memecik), Manisa (Gemlik, Domat, Uslu, Ayvalık), İzmir Peninsula (Erkence), and different firms (polycultivar or commercial blends) for two harvest years (2001–2002 and 2002–2003) based on their fatty acid profiles. They reported that the fatty acid profile was a useful tool to classify Turkish olive oils. In this study, Uslu was in the Manisa group that clearly stood aside from the other groups, according to their fatty acid profiles.

Although there are some data related to some chemical properties of local varieties such as Uslu and Saurani, no information is available about Antalya cultivars (Tavşan Yüreği and Beylik). In this study, the olive oil qualities of some local olive varieties, including Antalya cultivars (Tavşan Yüreği and Beylik), Saurani (Hatay), and Uslu (Manisa) that were used in olive oil production under the optimum extraction conditions, have been determined.

The purpose of this study was determination of the fatty acid profile of the most important and well-known olive cultivars, and their classification according to their fatty acid composition.

The objectives of the study:

1. Classification of Turkish olive oils according to their fatty acid composition
2. Determination of the oleic acid content in extra virgin olive oil from Turkish olive cultivars
3. Investigation of how the storage time and filtration effect on the fatty acid profile.

Research materials and methods

Production of extra virgin olive oil (EVOO)

A Mobile Olive Oil Processing Unit (MOOPU) with state-of-the-art Oliomio equipments was designed in order to produce premium quality EVOO (Fig. 1). A special container was constructed and equipped with a crusher knife and a two-phase horizontal decanter Oliomio D500 (Italy). The mobile unit is an articulated lorry with a special semi-trailer measuring 2,438×12,192×2,896 mm which is divided into three separate sections. The first section is the olive accepting unit including the bunker, the leaf removers, the washer and crusher units of the system. The second section is the processing unit including the malaxer, the decanter, the filter, and the bag-in-box filling machine. The third section is the support unit with a power plant and a water supply tank. The processing unit is a hygienic area protected from temperature changes, dust, and odour. This hygienic area is equipped with an air conditioner, isolation and filter ventilation systems. The MOOPU was carried by a trailer truck to the orchards in the season of 2014–2015. Olive fruits were harvested by hand in the early harvest period and processed into cold press EVOO in the MOOPU in a few hours. Olive paste was prepared after crushing with a hammer mill and mixed in the malaxer at 27°C for 15 min (Cold press). After decantation, the EVOO was packaged before filtration (Unfiltered) and after it (Filtered). A filter press Oliomio Jolly 40 (Italy) with paper Gruppo Cardenons E2 (paper weight 350 g/m^2, thickness 0.81 mm, apparent density 0.43 g/cm^3, water absorption 8 g/dm^2) was used for filtration. The olive oil samples were put in 250 ml amber glass bottles (headspace 4 cm) and filled with nitrogen. The bottles were stored at room temperature (18–24°C) and analysed monthly.

Fatty acid composition

The fatty acid composition was determined by the IOC method [8]. The analysis was performed with the TRACE™ Ultra Gas Chromatograph equipment (Thermo Fisher Scientific, USA) with the operation conditions given below. The TRACE™ Ultra Gas Chromatograph equipped with a flame ionisation detector, a split injector (40:1), an HP-88 column (100 metres long, 0.25 mm I. D, film thickness 0.20 μm) was used for separation. The carrier gas was helium (with 1mL/min flow rate), and the initial temperature was 100°C. The temperature ramping rate was 4°C/min. The injection temperature and the detector temperature were 240°C and 250°C, respectively.

Statistical analysis

The statistical analysis was performed with the statistical software SPSS 17 (SPSS Inc.Chicago, IL) and by the one-way ANOVA method. All analyses

were performed at least twice, and differences among all groups were determined by Duncan's test.

Results of the research and their discussion

The fatty acid analysis was performed for both filtered (F) and unfiltered (UF) olive oils of the cultivars Tavşan Yüreği (Antalya), Beylik (Antalya), Uslu (Manisa), and Saurani (Hatay) during the first two months of storage (Tables 1–3). There was no change in the fatty acid composition from the beginning to the second month of storage. Therefore the storage time had no significant effect on the fatty acid profiles of EVOO. In our samples, C14:0 (myristic acid), C16:0 (palmitic acid), C16:1 (palmitoleic acid), C17:0 (heptadecanoic acid), C17:1 (cis-10-heptadecenoic acid), C18:0 (stearic acid), C18:1n9c (oleic acid), C18:1n9t (elaidic acid), C18:2n6c (linoleic acid), C18:3n3 (*alfa*-linolenic acid), C20:0 (arachidic acid), C20:1n9 (cis-11-eicosenoic acid), C22:0 (behenic acid), and C24:0 (lignoceric acid) were detected (Fig. 1). According to IOC regulations, all samples were categorised as EVOO for their fatty acid composition.

All of our EVOOs had the same content of myristic acid (0.01%), which was found in trace amount in the olive oils (Tables 1–3). According to IOC regulation, the maximum amount of myristic acid in olive oil should be 0.03. So, the EVOO samples were below this limit. No change was detected in the amount of myristic acid after filtration.

Palmitic acid, or hexadecanoic acid in the IUPAC nomenclature, is the most common fatty acid (saturated) found in animals, plants, and microorganisms. The content of palmitic acid found in olive oil ranges 7.5–20%. The EVOO from Saurani (Hatay) had the highest palmitic acid content among all the cultivars (16.50–16.53%), and a slight decrease in it was observed after filtration. It was followed by the Beylik (Antalya) EVOO, where this parameter was 15.51–15.52%. In the EVOO from Tavşan Yüreği (Antalya), it ranged 14.42–14.51%. Palmitoleic acid was found in olive oil in the range 0.3–3.5%. The highest and the lowest palmitoleic acid contents were in the EVOOs from Uslu (1.34–1.37%) and Saurani (0.92–1.01), respectively. The palmitoleic acid content of the EVOOs from Tavşan Yüreği (Antalya) was 1.29%, and it was 1.05% in the EVOOs of Beylik (Antalya). After filtration, the palmitoleic acid content of the Tavşan Yüreği and Beylik EVOOs did not change, while it slightly increased in the EVOOs from Uslu (Manisa) and Saurani (Hatay). According to the IOC standard, the maximum level of heptadecanoic acid in olive oil is 0.3%. The results have shown that the highest heptadecanoic acid content was in the Tavşan Yüreği EVOO. The Beylik EVOO was the lowest in heptadecanoic acid among all the varieties. The heptadecanoic acid content did not change in the Tavşan Yüreği and Beylik EVOOs after filtration. The heptadecanoic acid content of the EVOOs from Uslu and Saurani was 0.05% and 0.03–0.04%, respectively. These values slightly decreased after filtration. The maximum content of cis-10-heptadecenoic acid in olive oil should be 0.3% according to the IOC standard. Beylik (Antalya) had the lowest amount of cis-10-heptadecenoic acid. Higher amounts of cis-10-heptadecenoic acid were detected in the EVOOs from Saurani (0.25%) and Tavşan Yüreği (0.24%). After filtration, the cis-10-heptadecenoic contents decreased in the EVOOs from all the cultivars except for Uslu. Another important saturated fatty acid of olive oil is stearic acid. The stearic acid content of olive oil should be 0.5–5% according to the IOC standard. The maximum stearic acid content (3.52%) was in the Saurani EVOOs, and the minimum content (2.36%) was found in the filtered samples obtained from Uslu. The EVOO of Tavşan Yüreği had 2.47% of stearic acid, and this value increased after filtration, whereas it decreased in the EVOO from Beylik.

Oleic acid is the most important fatty acid of olive oil. The oleic acid content of EVOO is 55–88% according to the IOC standard. The oleic acid contents of all EVOOs considered in this study were within this range. The highest amount of oleic acid (70.51%) was in the EVOOs from Tavşan Yüreği, and the lowest was detected in Uslu (68.64%). The EVOOs from Tavşan Yüreği, Beylik, and Saurani had a lower oleic acid content after filtration than that before filtration, whereas it increased in the EVOO from Uslu. Elaidic acid is a trans-form of oleic acid, and its content should be no more than 0.05% according to the IOC regulation. All EVOOs had no elaidic acid except for that from Saurani. Linoleic acid is a polyunsaturated omega-6 fatty acid. It is one of the most important fatty acids present in olive oil. According to IOC regulations, the linoleic acid content of EVOO must be within the range 3.5–21%. The results have shown that all monocultivar oils used in this study complied with the IOC limits in their linoleic acid content The lowest amount of linoleic acid was found in Saurani (7.68–7.70%), and it increased after filtration. The highest amount of linoleic acid was detected in the EVOO from Uslu, where it ranged 12.06–12.09%. After filtration, this parameter decreased in the EVOOs from Uslu and Beylik. Linolenic acid is another polyunsaturated fatty acid in olive oil. A significant content of linolenic acid in olive oil makes is responsible for its health benefits. According to the IOC, the maximum olive oil content in EVOO is 1%. The highest in linolenic acid (0.85%) was the Saurani EVOO, and the lowest linolenic acid content (0.49%) was found in the EVOO from Tavşan Yüreği. The Beylik EVOO had 0.5% of it, but its content increased (0.59%) after filtration. The Uslu EVOO had 0.7% of it. These results have shown that the linolenic content of all monocultivar oils was within the IOC limits. The maximum content of arachidic acid in olive oil is 0.6% according to the IOC standard. The EVOOs from Beylik had the lowest amount of arachidic acid (0.36%). On the other hand, the Uslu EVOO had the highest amount of arachidic acid (0.52%). The arachidic acid contents of the Tavşan Yüreği and Saurani EVOOs were 0.4% and 0.46%, respectively. No change was observed after filtration. These results have shown that arachidic acid in all the monocultivar oils was within the limits provided for by the IOC.

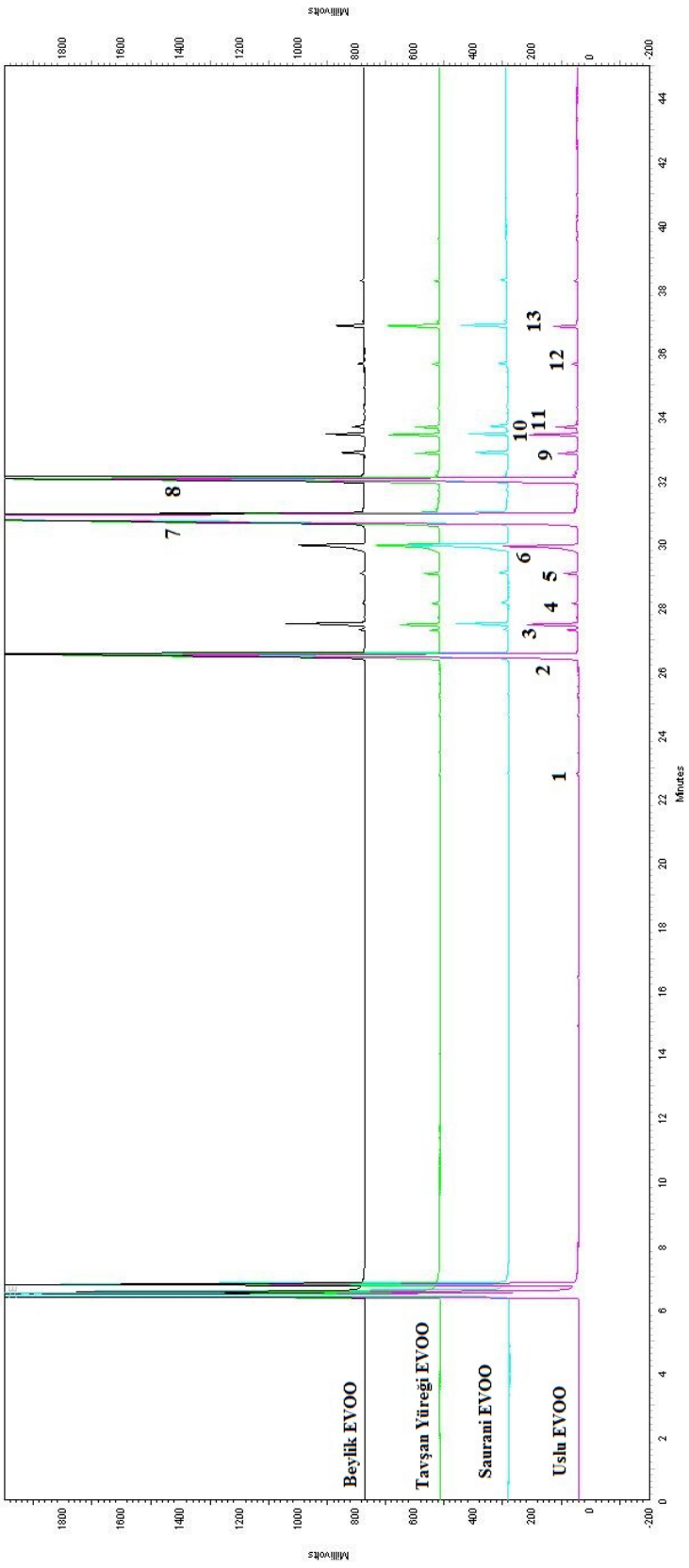

Fig. 1. Fatty acid profiles of extra virgin olive oils extracted from Turkish olive cultivars
1 – myristic acid, 2 – palmitic acid, 3 – palmitoleic acid, 4 – heptadecanoic acid, 5 – cis-10-heptadecenoic acid, 6 – stearic acid, 7 – oleic acid, 8 – linoleic acid, 9 – *alfa*-linolenic acid, 10 – arachidic acid, 11 – cis-11-eicosenoic acid, 12 – behenic acid, 13 – lignoceric acid

Table 1 – Fatty acid profile of Turkish EVOOs extracted from different cultivars in the zeroth month of storage

Zeroth month	C14:0	C16:0	C16:1	C17:0	C17:1	C18:0	C18:1n9c	C18:1n9t	C18:2n6c	C18:3n3	C20:0	C20:1n9	C22:0	C24:0
Tavşan Yüreği (F)	0.01	14.50	1.29	0.09	0.24	2.47	70.50	0.00	9.80	0.49	0.40	0.10	0.08	0.02^{c}
Tavşan Yüreği (UF)	0.01	14.42	1.29	0.09	0.22	2.55	70.48	0.00	9.81	0.48	0.40	0.12	0.09	0.02^{c}
Beylik (F)	0.01	15.51	1.05	0.02	0.03	2.60	70.56	0.00	9.12	0.50	0.36	0.10	0.11	0.02^{c}
Beylik (UF)	0.01	15.50	1.05	0.02	0.02	2.58	70.5	0.00	9.11	0.59	0.36	0.11	0.11	0.02^{c}
Uslu (F)	0.01	13.80	1.34	0.06	0.21	2.35	68.64	0.00	12.09	0.70	0.52	0.20	0.05	0.02^{c}
Uslu (UF)	0.01	13.74	1.37	0.05	0.21	2.36	68.74	0.00	12.02	0.71	0.52	0.20	0.04	0.01^{d}
Saurani (F)	0.01	16.52	0.92	0.03	0.25	3.52	69.29	0.01	7.70	0.85	0.46	0.21	0.17	0.05^{a}
Saurani (UF)	0.01	16.5	1.01	0.04	0.24	3.5	69.15	0.01	7.80	0.85	0.46	0.22	0.16	0.04^{b}

*Different superscript letters in the same column indicate significant difference between mean values (P < 0.01).

Table 2 –Fatty acid profile of Turkish EVOOs extracted from different cultivars in the first month of storage

First month	C14:0	C16:0	C16:1	C17:0	C17:1	C18:0	C18:1n9c	C18:1n9t	C18:2n6c	C18:3n3	C20:0	C20:1n9	C22:0	C24:0
Tavşan Yüreği (F)	0.01^{a}	14.50^{c}	1.29^{b}	0.09^{a}	0.24^{a}	2.47^{d}	70.50^{a}	0.00^{b}	9.80^{b}	0.49^{d}	0.40^{c}	0.10^{e}	0.08^{c}	0.02^{c}
Tavşan Yüreği (UF)	0.01^{a}	14.42^{c}	1.29^{b}	0.09^{a}	0.22^{b}	2.55^{c}	70.48^{a}	0.00^{b}	9.81^{b}	0.48^{d}	0.40^{c}	0.12^{c}	0.09^{c}	0.02^{c}
Beylik (F)	0.01^{a}	15.51^{b}	1.05^{c}	0.02^{f}	0.03^{c}	2.60^{b}	70.56^{a}	0.00^{b}	9.12^{c}	0.50^{c}	0.36^{d}	0.10^{e}	0.11^{b}	0.02^{c}
Beylik (UF)	0.01^{a}	15.50^{b}	1.05^{c}	0.02^{f}	0.02^{c}	2.58^{b}	70.50^{a}	0.00^{b}	9.11^{c}	0.59^{c}	0.36^{d}	0.11^{d}	0.11^{b}	0.02^{c}
Uslu (F)	0.01^{a}	13.80^{d}	1.34^{a}	0.06^{b}	0.21^{b}	2.35^{e}	68.64^{b}	0.00^{b}	12.09^{a}	0.70^{b}	0.52^{a}	0.20^{b}	0.05^{d}	0.02^{c}
Uslu (UF)	0.01^{a}	13.74^{d}	1.37^{a}	0.05^{c}	0.21^{b}	2.36^{e}	68.74^{b}	0.00^{b}	12.02^{a}	0.71^{b}	0.52^{a}	0.20^{b}	0.04^{d}	0.01^{d}
Saurani (F)	0.01^{a}	16.52^{a}	0.92^{d}	0.03^{e}	0.25^{a}	3.52^{a}	69.29^{c}	0.01^{a}	7.70^{d}	0.85^{a}	0.46^{b}	0.21^{a}	0.17^{a}	0.05^{a}
Saurani (UF)	0.01^{a}	16.50^{a}	1.01^{c}	0.04^{d}	0.24^{a}	3.50^{a}	69.15^{c}	0.01^{a}	7.80^{d}	0.85^{a}	0.46^{b}	0.22^{a}	0.16^{a}	0.04^{b}

*Different superscript letters in the same column indicate significant difference between mean values (P < 0.01).

Table 3 – Fatty acid profile of Turkish EVOOs extracted from different cultivars in the second month of storage

Second month	C14:0	C16:0	C16:1	C17:0	C17:1	C18:0	C18:1n9c	C18:1n9t	C18:2n6c	C18:3n3	C20:0	C20:1n9	C22:0	C24:0
Tavşan Yüreği (F)	0.01^{a}	14.51^{c}	1.29^{b}	0.09^{a}	0.24^{a}	2.47^{d}	70.51^{a}	0.00^{b}	9.80^{b}	0.48^{d}	0.40^{c}	0.09^{bc}	0.09^{d}	0.01^{c}
Tavşan Yüreği (UF)	0.01^{a}	14.44^{c}	1.29^{b}	0.09^{a}	0.22^{b}	2.55^{c}	70.48^{a}	0.00^{b}	9.81^{b}	0.48^{d}	0.40^{c}	0.11^{b}	0.09^{d}	0.02^{b}
Beylik (F)	0.01^{a}	15.52^{b}	1.05^{c}	0.02^{d}	0.03^{c}	2.60^{b}	70.57^{a}	0.00^{b}	9.11^{c}	0.50^{c}	0.36^{d}	0.10^{b}	0.10^{c}	0.02^{b}
Beylik (UF)	0.01^{a}	15.50^{b}	1.05^{c}	0.02^{d}	0.02^{c}	2.58^{b}	70.50^{a}	0.00^{b}	9.11^{c}	0.59^{c}	0.36^{d}	0.11^{b}	0.11^{b}	0.02^{b}
Uslu (F)	0.01^{a}	13.81^{d}	1.34^{a}	0.06^{b}	0.21^{b}	2.35^{e}	68.64^{c}	0.00^{b}	12.06^{a}	0.70^{b}	0.52^{a}	0.20^{a}	0.05^{e}	0.02^{b}
Uslu (UF)	0.01^{a}	13.76^{d}	1.37^{a}	0.05^{b}	0.21^{b}	2.36^{e}	68.75^{c}	0.00^{b}	12.00^{a}	0.71^{b}	0.52^{a}	0.20^{a}	0.04^{f}	0.01^{c}
Saurani (F)	0.01^{a}	16.53^{a}	0.92^{d}	0.03^{c}	0.25^{a}	3.52^{a}	69.30^{b}	0.01^{a}	7.68^{d}	0.85^{a}	0.46^{b}	0.21^{a}	0.16^{a}	0.05^{a}
Saurani (UF)	0.01^{a}	14.51^{c}	1.29^{b}	0.09^{a}	0.24^{a}	2.47^{d}	70.51^{a}	0.00^{b}	9.80^{b}	0.48^{d}	0.40^{c}	0.09^{bc}	0.09^{d}	0.01^{c}

*Different superscript letters in the same column indicate significant difference between mean values (P < 0.01).

Virgin olive oil has a maximum of 0.4% of cis-11-eicosenoic acid according to the IOC standard. Saurani had the highest amount of cis-11-eicosenoic acid among the monocultivar EVOOs. Uslu had 0.2%, Beylik and Tavşan Yüreği were the lowest in cis-11-eicosenoic acid (0.1–0.11 and 0.09–0.12, respectively). The results have shown that the cis-11-eicosenoic acid contents in all the monocultivar EVOOs were within the IOC limits. The behenic acid content of olive oil should be ≤0.2% according to the IOC standard. The EVOOs of Uslu had the lowest amount of behenic acid (0.05%), and the EVOOs of Saurani had the highest amount of it (0.17%). The Beylik EVOO had 0.11% of behenic acid, and it did not change after filtration. Tavşan Yüreği had 0.08% of behenic acid, and a slight increase was detected after filtration. The results suggested that the behenic acid contents of all the monocultivar olive oils did not exceed the IOC standard. Another trace fatty acid in olive oil is lignoceric acid. The maximum content of it in olive oil should be 0.2%. The Saurani EVOO had the highest amount of lignoceric acid among all the EVOOs (0.05%). Other cultivars contained 0.01–0.02% of lignoceric acid. After filtration, the lignoceric acid content decreased in the EVOOs from Uslu and Saurani.

Gómez-Alonso et al. [9] evaluated the changes that occurred in fatty acids of Spanish olive oils stored at room temperature for 21 months. In their study, there were no detectable changes in oleic acid after 21 months of storage. The decrease observed in linoleic and linolenic acids of the olive oil samples ranged between 2.1% and 3.8% for linoleic acid, and between 5.8% and 10.0% for linolenic acid. Morelló et al. [10] reported that oleic acid of VOO (the cultivar Arbequina) increased after 12 months' storage as a result of degradation of linoleic and linolenic acids. Rastrelli et al. [11] reported that the amounts of polyunsaturated fatty acids (C18:2n-6+C18 n-3%) showed an increasing and a decreasing trends during 12 months of storage, but in general, they decreased after 12 months. Méndez and Falqué [12] reported that the degree of unsaturation decreased as expiry date became closer, although the percentage of fatty acid was constant during the first 3 months of storage; after 6 months of storage, the degree of saturation increased and the oleic acid content decreased.

Conclusion

The fatty acid composition is an important quality parameter and authenticity indicator of virgin olive oils. No change in fatty acid composition of the samples was revealed during 60 days of storage. Filtration had no detectable effect on their fatty acid composition. Predictably, oleic acid (C18:1) was the most abundant (68.64–70.56%) fatty acid followed by palmitic acid (C16:0) and linoleic acid (C18:1). The oleic acid (C18:1) contents of early-harvested monocultivar olive oils produced in Turkey were 62.41–80.26% [13]. Linoleic and linolenic acids, which are much more susceptible to oxidation than monounsaturated fatty acids (MUFA), ranged 7.70–12.09% and 0.48–0.85%, respectively. These results agree with those for olive oils produced in Mediterranean countries [14]. Virgin olive oils are classified into two types based on their fatty acid compositions. Turkish, Spanish, Italian, and Greek virgin olive oils, which are low in linoleic and palmitic acids and high in oleic acid, are the first type, while Tunisian oils are the second type as they are high in linoleic and palmitic acids and low in oleic acid [13,14]. The linolenic acid level of the Turkish virgin olive oil samples was below the maximum value (0.9%) provided for by the Turkish Food Codex [15] and the EU regulations [16].

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References:

1. Tanılgan K, Özcan MM, Ünver A. Physical and chemical characteristics of five Turkish olive (Olea europea L .), GRASAS Y ACEITES. 2007; 58:142-147. https://doi.org/10.3989/gya.2007.v58.i2.78
2. Gurdeniz G, Ozen B, Tokatli F. Classification of Turkish olive oils with respect to cultivar, geographic origin and harvest year, using fatty acid profile and mid-IR spectroscopy, Eur. Food Res. Technol. 2008; 227(4):1275-1281. https://doi.org/10.1007/s00217-008-0845-7
3. Matthäus B, ÖZCAN MM. Determination of Fatty Acid, Tocopherol Sterol Contents and 1,2- and 1,3-Diacylglycerols in Four Different Virgin Olive Oil, J. Food Process. Technol. 2011; 2(4):2-5. http://dx.doi.org/10.4172/2157-7110.1000117
4. Yorulmaz A. Determination of phenolic compounds, Sterol and triglycerides structures of Turkish olive oils. Doctorate Thesis, Institute of Science and Technology, Ankara University, Turkey. 2009.
5. Diraman H, Dibeklioğlu H. Characterization of Turkish virgin olive oils produced from early harvest olives. JAOCS, J. Am. Oil Chem. Soc. 2009; 86:663-674. https://doi.org/10.1007/s11746-009-1392-5.
6. Dıraman, H., Characterization by chemometry of the most important domestic and foreign olive cultivars from the National Olive Collection Orchard of Turkey, GRASAS Y ACEITES. 2010; 61(4):341-351. https://doi.org/10.3989/gya.111609
7. Diraman H, Saygi H, Hişil Y. Geographical classification of Turkish virgin olive oils from the Aegean Region for two harvest years based on their fatty acid profiles, JAOCS, J. Am. Oil Chem. Soc. 2011; 88(12):1905-1915. https://doi.org/10.1007/s11746-011-1862-4
8. International Olive Council (IOC) Regulation. Preparation of Fatty acid Methyl Esters from Olive oil and Olive-Pomace oil, COI/T.20/Doc.no.24/2001.
9. Gómez-Alonso S, Mancebo-Campos V, Salvador MD, Fregapane G. Evolution of major and minor components and oxidation indices of virgin olive oil during 21 months storage at room temperature. Food Chemistry. 2007;100(1):36-42. https://doi.org/10.1016/j.foodchem.2005.09.006

10. Morelló JR, Motilva MJ, Tovar MJ, Romero MP. Changes in commercial virgin olive oil (cv Arbequina) during storage, with special emphasis on the phenolic fraction. 2004;85:357-364https://doi.org/10.1016/j.foodchem.2003.07.012
11. Rastrelli L, Passi S, Ippolito F, Vacca G, De Simone F. Rate of degradation of alpha-tocopherol, squalene, phenolics, and polyunsaturated fatty acids in olive oil during different storage conditions. Journal of agricultural and food chemistry. 2002;50(20):5566-5570. https://doi.org/10.1021/jf011063j
12. Méndez AI, Falqué E. Effect of storage time and container type on the quality of extra-virgin olive oil. Food Control. 2007; 18 (5):521-529. https://doi.org/10.1016/j.foodcont.2005.12.012
13. Ghanbari Shendi E, Sivri Ozay D, Ozkaya MT, Ustunel NF. Changes occurring in chemical composition and oxidative stability of virgin olive oil during storage. OCL, 2018; 25(6):1-8. https://doi.org/10.1051/ocl/2018052
14. Ghanbari Shendi E, Sivri Ozay D, Ozkaya M.T, Ustunel N.F. Effects of Filtration Process and Storage Time on The Chemical Changes and Sensory Properties of Olive Oil Extracted from Turkish Uslu Cultivar. Food science and technology. 2019; 13(1):49-59. DOI: http://dx.doi.org/10.15673/fst.v13i1.1341
15. AnonymousThe Official Gazette of Republic of Turkey, Ankara. 7 Aug 2010. Number 27665.
16. European Commission Regulation. Amending Regulation no. 2598/91, EU no. 1348/2013. Characteristics of olive oil and olive-residue oil and on the relevant methods of analysis. Official Journal of the European Communities.2013; -L338:31-67.