ISBR-2019

1st INTERNATIONAL SYMPOSIUM ON BIODIVERSITY RESEARCH

THE BOOK OF ABSTRACTS AND FULL TEXTS OF THE ISBR 2019

2-4 May 2019

Çanakkale Onsekiz Mart University

Çanakkale

1st International Symposium on Biodiversity Research



HONORARY PRESIDENT

Prof. Dr. Sedat Murat

Rector

Çanakkale Onsekiz Mart University

CHAIR OF THE SYMPOSIUM

Prof. Dr. Murat Tosunoğlu

Department of Biology, Faculty os Sciences and Arts, Çanakkale Onsekiz Mart University

EDITED BY

Assoc. Prof. Dr. Ersin Karabacak

Department of Biology, Faculty os Sciences and Arts, Çanakkale Onsekiz Mart University

ISBN: 978-605-82906-2-4

Çanakkale, 2019

Organization Committee

Honorary Chair

Prof. Dr. Sedat Murat - Rector of Çanakkale Onsekiz Mart University

Symposium Chair

Prof. Dr. Murat Tosunoğlu - Çanakkale Onsekiz Mart University

Symposium Secretary

Assoc. Prof. Dr. Nurşen Çördük - Çanakkale Onsekiz Mart University

Organizing Committee

Prof. Dr. Murat Tosunoğlu

Prof.Dr. Herdem Aslan

Assoc. Prof. Dr. Hüseyin Erduğan

Assoc. Prof. Dr. Çiğdem Gül

Assoc. Prof. Dr. Nurcihan Hacıoğlu-Doğru

Assoc. Prof. Dr. Ersin Karabacak

Assoc. Prof. Dr. Nurşen Çördük

Assist. Prof. Dr. İbrahim Uysal

Assist. Prof. Dr. Tülay Bican-Süerdem

Dr. Selin Ertürk-Gürkan

Scientific Committee

Dr. Ahmet Gökkuş (Çanakkale Onsekiz Mart University, Turkey)
Dr. Ahmet Gönüz (Çanakkale Onsekiz Mart University, Turkey)
Dr. Ahmet Uludağ (Çanakkale Onsekiz Mart University, Turkey)
Dr. Alexandre Roulin (Université de Lausanne, Switzerland)
Dr. Ali Erdoğan (Akdeniz University, Turkey)
Dr. Ali İşmen (Çanakkale Onsekiz Mart University, Turkey)
Dr. Ali Sungur (Çanakkale Onsekiz Mart University, Turkey)
Dr. Atilla Durmuş (Van Yüzüncü Yıl Üniversitesi, Türkiye)
Dr. Arzu Ünal (Iğdır University, Turkey)
Dr. Banur Boynukara (Namık Kemal University, Turkey)
Dr. Berrak Damla YAĞAN (Çanakkale Onsekiz Mart University, Turkey)
Dr. Binnur Meriçli-Yapıcı (Çanakkale Onsekiz Mart University, Turkey)
Dr. C. Çiğdem Yığın (Çanakkale Onsekiz Mart University, Turkey)
Dr. Cemal Varol Tok (Çanakkale Onsekiz Mart University, Turkey)
Dr. Cengiz Akbulak (Çanakkale Onsekiz Mart University, Turkey)
Dr. Çetin Ilgaz (Dokuz Eylül University, Turkey)
Dr. Cherif Abdennour (University of Annaba, Algeria)
Dr. Çiğdem Gül (Çanakkale Onsekiz Mart University, Turkey)
Dr. Coşkun Sılan (Çanakkale Onsekiz Mart University, Turkey)
Dr. Cüneyt Akı (Çanakkale Onsekiz Mart University, Turkey)
Dr. Daniela Gianetto (Muğla Sıtkı Koçman Üniversitesi, Türkiye)
Dr. David Tarkhnishvili (Ilia State University, Georgia)
Dr. Derya Doğanay (Biruni University, Turkey)
Dr. Engin Gür (Çanakkale Onsekiz Mart University, Turkey)
Dr. Erdinç Yiğitbaş (Çanakkale Onsekiz Mart University, Turkey)
Dr. Ersin Karabacak (Çanakkale Onsekiz Mart University, Turkey)
Dr. Esra Koçum (Çanakkale Onsekiz Mart University, Turkey)
Dr. F. Güler Ekmekçi (Hacettepe University, Turkey)
Dr. Farkhanda Manzoor (Lahore College for Women University, Pakistan)
Dr. Gianluca Sara (University of Palermo, Italy)
Dr. Graham Saunders (Scottish Natural Heritage, Scotland)
Dr. Gül Nilhan Tuğ (Ankara University, Turkey)
Dr. Güray Uyar (Gazi University, Turkey)
Dr. Hanane Kennouche-Bradaï (University of Tipaza, Algeria)
Dr. Hanife Akyalçın (Çanakkale Onsekiz Mart University, Turkey)
Dr. Hanife Genç (Çanakkale Onsekiz Mart University, Turkey)
Dr. Harun Baytekin (Çanakkale Onsekiz Mart University, Turkey)
Dr. Hasan Özcan (Çanakkale Onsekiz Mart University, Turkey)
Dr. Hasan Tatlı (Çanakkale Onsekiz Mart University, Turkey)
Dr. Herdem Aslan (Çanakkale Onsekiz Mart University, Turkey)
Dr. Hüseyin Aşkın Akpulat (Cumhuriyet University, Turkey)
Dr. Hüseyin Ekinci (Çanakkale Onsekiz Mart University, Turkey)
Dr. Hüseyin Erduğan (Çanakkale Onsekiz Mart University, Turkey)
Dr. İbrahim Uysal (Çanakkale Onsekiz Mart University, Turkey)
Dr. İlhami Kiziroğlu (Hacettepe University, Turkey)
Dr. İrfan Albayrak (Kırıkkale University, Turkey)
Dr. İskender Tiryaki (Çanakkale Onsekiz Mart University, Turkey)
Dr. İsmail Kasap (Çanakkale Onsekiz Mart University, Turkey)
Dr. Joao Monteiro (University of the Azores, Portugal)
Dr. Kemal Çelik (Çanakkale Onsekiz Mart University, Turkey)
Dr. Kemal Gökkaya (Çanakkale Onsekiz Mart Üniversitesi, Türkiye)
Dr. Kenan Kaynaş (Çanakkale Onsekiz Mart University, Turkey)
Dr. Konstantinos Sotiropoulos (University of Ionia, Greece)
Dr. Levent Genç (Çanakkale Onsekiz Mart University, Turkey)
Dr. Lütfi Atay (Çanakkale Onsekiz Mart University, Turkey)
Dr. Marja Tiirola (Jyvaskyla University, Finland)
Dr. Mark Benfield (Louisiana State University, USA)

Article ID: 23205
Oral Presentation

Comparison of olive oil chemical characteristics of some local olive genotype

Esra Rüveyda Örnek[1], Mehmet Ali Gündoğdu[2], Murat Şeker[2]

[1] Horticulture Program, Institute of Natural and Applied Science, Çanakkale Onsekiz Mart University, Çanakkale-Turkey
[2] Department of Horticulture, Faculty of Agriculture, Çanakkale Onsekiz Mart University, Çanakkale-Turkey
e-mail: eornek@comu.edu.tr

Olive oil is squeezed directly from the fruit of the olive tree; It is a greenish, yellowish, liquid oil which is obtained without any chemical treatment, without additives, can be consumed as liquid at room temperature, obtained with its natural state. The quality of olive oil is effected by the genotype, year of production, ecological conditions, cultural practices, the region where olive comes and olive oil technology after harvesting.

In olive oil, there are many functional groups which are unsaponified other than fatty acids. Among these, tocopherols and polyphenols are particularly important compounds. Turkey has many genotypes with different characteristics in terms of biodiversity with the fact that olives are ancestor, and the determination of the chemical properties of them is important for olive breeding, industry and genotype characterization

In this study, olive genotypes locally called Yamalak Sarısı from the Aegean region; Gökçeada from the Marmara region; Adana Topağı, Beyrut, Çortak, Çöplüce, Gök Zeytini, Kargaburun, Silifke Yağlık from Mediterranean region; Butko, Otur, Sati from the Black Sea region were investigated and compared for their fatty acids, tocopherol and total polyphenol contents. Olive samples were taken from the trees of those genotypes in two consecutive years and olive oil samples were obtained in laboratory conditions by centrifugation. Obtained olive oils were analyzed by HPLC (High Pressure Liquid Chromatography), GC (Gas Chromatography) and spectrophotometry techniques for their fatty acid components, tocopherols and total polyphenol levels. According to results of the analysis, the total polyphenol content of genotypes was found between 321 mg / kg (Adana Topağı) and 78 mg / kg (Otur). Total tocopherol contents ranged from 154, 14 (Adana Topağı) to 52,10 mg/kg (Gökçeada). In terms of components of fatty acids, oleic acid (C18: 1) constitutes the highest fatty acid ratio in all varieties as expected.

Keywords: *Olea europaea*, olive oil, fatty acids, polyphenol, tocopherol, HPLC, GC

INTRODUCTION

Olive and olive oil is an agricultural product that has an important place in human nutrition and health from prehistoric times to this day. The existence of olive in the social, cultural and economic areas of the Mediterranean and Anatolian civilizations for centuries has been a good evidence of the historical depth and importance of this precious product.

Table olives and olive oil are one of the major component of traditional Mediterranean diet. The Mediterranean diet is rich in virgin olive oil as a source of fat, and in vegetables, fruits, legumes and other plant foods, and low in saturated and trans-fatty acids and cholesterol. The Mediterranean diet uses mostly olive oil, which contains monounsaturated fatty acids and several minor components with biological activity, as opposed to seed or other oils.

The olive is found in the Oleaceae family containing approximately 30 genera and 600 species. It is

estimated that there are more than 2000 cultivated olives in the world. Olive is one of the most abundant species. There are 346 olive cultivars and ecotypes in Spain, 200 in Italy, 49 in Greece and 89 in Turkey (Anonymous, 2019). It is seen that some genotypes with superior properties have been lost while the more fruitful varieties with large fruits, more fat content, resistant to diseases, pests and abiotic environmental conditions develop. Although many types were defined in ancient times, many of them were still classified as locals' olive causing a complex situation.

The olive is a native to the coastal areas of the eastern Mediterranean Basin (the adjoining coastal areas of South-eastern Europe, Western Asia and Northern Africa) as well as North-western region of Turkey. Nowadays, world olive production is reached 19 million tonnes in 37 countries which 29 in the northern and 8 in the southern hemisphere, around 1 billion olive trees in 10.7 million hectares. 95% of world olive cultivation is a characteristic product in Mediterranean countries. Among the countries that have a prominent place in this production, Spain ranks first with a share of 34%, Greece with 12%, Italy with 11%, and our country is the 4th olive producer with 1.730.000 tons and 9% in the world (FAO, 2018).

There are many functional groups in the composition of olive oil. The chemical composition of the olive fruit is approximately given in Figure 1. As can be seen in the figure, olive oil is the most important component. Oils, that are ranges %20-%30 depending on varieties, the most important component of the olive fruits and there are many functional groups in the composition of olive oil. Olive oil contains fatty acid methyl esters and triacylglycerols that are saponifable fractions (98-99%), and small quantities of tocopherols, phytosterols, phenolic compounds, hydrocarbons, pigments and aroma compounds. Among these constituents unsaponifiable fractions (1-2%) plays a significant role on human health.

Natural olive oil, the most important feature which distinguishes it from other vegetable oils is obtained by its characteristic color, taste and aroma as well as a minimum process. It is a known fact that natural olive oil is increasingly preferred with excellent organoleptic and nutritional quality (Salvador et al., 2003).

Tocopherols are natural antioxidants synthesized only by higher plants. They exist in four isomer forms, α-, β-, γ- and δ-tocopherol, differing in both molecular structure and biological effectiveness. Tocopherols are important dietary nutrients and have beneficial effects in the prevention of cardio-vascular diseases. It was found that high doses of vitamin E given in vitamin A deficiency increase the resistance of lysosomes in the liver. It has been found in recent years that hemolysis of blood cells with hydrogen peroxide has an effect on the prevention of anemia.

The most important function of vitamin E in body work is its antioxidant properties. Due to this feature, vitamin E prevents oxidation of various oxidizable compounds. It also prevents oxidation of unsaturated fatty acids in body tissues. It prevents the oxidation of vitamin A especially in the stomach, intestine and liver cells, increases the effect of this vitamin on the organism and helps to store it in the liver.

Most of the phenolic compounds in olive fruit are water soluble. With the processing of olive oil, some of these components pass into the oil. In olives fruit, Oleuropein is the main phenolic compound, whereas hydroxytyrosol is in olive oil. Phenolic compounds, which have an effect on the sensory qualities and oxidative stability of olive oil, have the quality of eliminating the harmful effects of free radicals in the body due to their antioxidative effects.

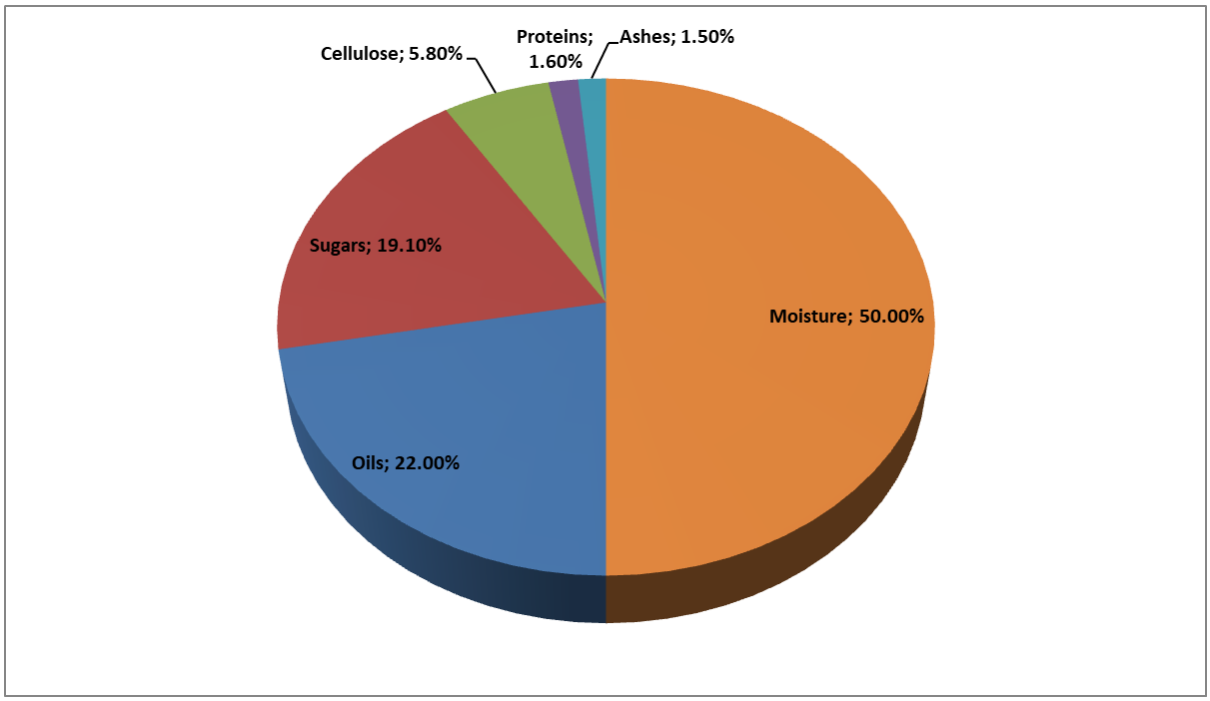


Figure 1. Chemical composition of olive fruit.

In our country, very different genotypes are grown according to regions. The sensory analyzes and aromas of the obtained oils differ in each species. Olive is cultivated in a wide field ranging from Artvin, which is the northest location, to Hatay, which is the southest location, and along the coast ranging from Tekirdağ to Mardin, in Turkey (TUIK, 2018).

In this study, twelve olive genotypes that harvested from 4 regions and 6 cities, were investigated and compared for their fatty acid methyl esters, tocopherols and total polyphenol contents.

MATERIALS AND METHODS

Sampling

Twelve grown ecotypes of olive were collected from trees cultivated in four geographical regions of Turkey. The varieties were 'Gökçeada' from Çanakkale (Marmara Region); 'Yamalak Sarısı' from Aydın (South Aegean Region); 'Adana Topağı', 'Beyrut', 'Çortak', 'Çöplüce', 'Gök Zeytini', 'Kargaburun' and 'Silifke Yağlık' from Adana, Mersin and Hatay (East Mediterranean Region); 'Butko', 'Otur' and 'Sati' from Artvin (Black Sea Region).

All the varieties are widely cultivated in the mentioned regions. Fruit samples have been manually harvested from three different orchards for each variety in one region. All the trees for sample preparation were more than 20 years old and under optimum management techniques. A total of 100 fruit samples from each trees of the varieties were collected from the beginning of December to the end of January in 2004-2005 and 2005-2006. Each variety was harvested when 75% of the fruit were coloured pink/purple. Trees of the same variety were harvested on the same day. The harvested olives were crushed with an inox hammer crusher, malaxed for 30 min at 28 °C and the oil was separated out by a vertical centrifuge at 4000 rpm in Canakkale Onsekiz Mart University.

Total Polyphenol Content Analysis:

The total phenolic compounds of the oils are determined by analysis methods based on the determination of the rate of induction in the presence of active oxygen in the presence of gallic acid. To determine the total phenolic compounds of olive oil, the method applied by Gutfinger, (l981) was used.

The total amount of phenol in olive oil is determined as follows; 10-20 g of filtered oil are weighed and dissolved by adding 50 ml of hexane. The mixture is taken to the separating funnel. A mixture of 20 ml of methanol / water (60% methanol + 40% water, v/v) was added and the separating funnel was agitated for 2 minutes. At the end of the period is left to decantation. The lower phase is taken into a 100 ml flask. The washing process is repeated 3 times. The balloon is finished with distilled water. This solution is the main solution used to determine the total amount of phenolic compounds.

Add 25 ml of distilled water to the 50 ml flask, 5 ml of the above prepared solution and then add 2.5 ml of Folin-ciocelteu reagent and wait for 3 minutes. Add 5 ml of 20% sodium carbonate. The balloon is finished with pure water and waited for 1 hour. Then read the absorbance value at 725 nm in the spectrophotometer. The readings are then matched with the curve in the phenolic compound curve to determine the gallic acid concentration.

Tocopherol Analysis:

The olive oil samples were analysed as described by Seker et al. (2007) for tocopherol analysis. Each sample containing 30 mg olive oil was prepared. Then, 0.5 ml of a 0.001% solution (w/v) of β-tocopherol in isooctane was added as internal standard (Calbiochem, USA). After adding 1.5 ml of isooctane the tubes were closed with a PE-cap and agitated on a vortex-mixer for 2-3 sec. After storage for 15 h in the dark at room temperature, the solution was agitated again and centrifuged at 5,000 x g for 7 min. An aliquot of 0.8 ml of the clear supernatant was filtered through a disposable filter holder (0.45 mm), and stored in 0.8 ml high-performance liquid chromatography vials. Then 10 ml of the solution were injected into the high-performance liquid chromatography system (Waters 510 Model) for tocopherol analysis.

All samples were analyzed at The Institute for Plant Breeding and Plant Production of the Georg-August University, Göttingen, Germany. All reagents were of analytical grade. All analyses were conducted in triplicate.

Determination of Fatty Acid Components:

Determination of fatty acid components in olive oil samples was carried out at the Institute of Plant Breeding in Georg-August University (Gottingen-Germany). The method described by Anonymous (1985) was used for the analysis. Analyses were performed with a Perkin Elmer AutoSystem XL gas chromatograph equipped with a flame ionization detector. A fused silica high polar capillary column (DB-5 Capillary GC Column; length 15 m, 0.25 mm ID, and 0.10 µm film thickness) was used. Helium was used as a carrier gas at a column head pressure of 45 ml min^{-1}. The injection was carried out with 1:20 split mode on 220°C and detector was identified in 250°C. All reagents were of analytical grade. All analyses were conducted in triplicate.

RESULT AND DISCUSSION

Total Phenol Amount of Olive Oils

The amounts of phenolic compounds determined in olive oils obtained from different olive varieties are given in Figure 1. The highest amount of phenolic compounds was found in the "Adana Topağı" (321 mg kg^{-1}) genotype and the lowest values in "Butko" (89 mg kg^{-1}), "Sati" (79 mg kg^{-1}) and "Otur" (78 mg kg^{-1})

genotypes. Olive genotypes of Eastern Black Sea region has low aromatic structure of the most important reason is the low amount of phenolic compounds.

Phenolic compounds, which have an effect on the sensory qualities and oxidative stability of olive oil, have the quality of eliminating the harmful effects of free radicals in the body due to their anti-oxidative effects. Phenolic compounds are part of the polar constituents of extra virgin olive oil and there is evidence that the resistance of olive oils to autoxidation is partly due to these compounds in fats. The phenolic compounds of oils vary according to many factors, such as the type of olives, the area of cultivation, altitude, maturity and extraction method. According to Garcia et al. (2003), the total phenol content of commercial virgin olive oils is 30-400 mg kg^{-1}. Montedoro et al. (1992) gave a very wide range for the total phenol content of Italian olive oils. In addition, according to the total phenol content of oils, low (50-200 ppm), medium (200-500 ppm), high (500-1000 ppm) divided into 3 classes. They determined the total amount of phenol as caffeic and gallic acid by chromatographic method.

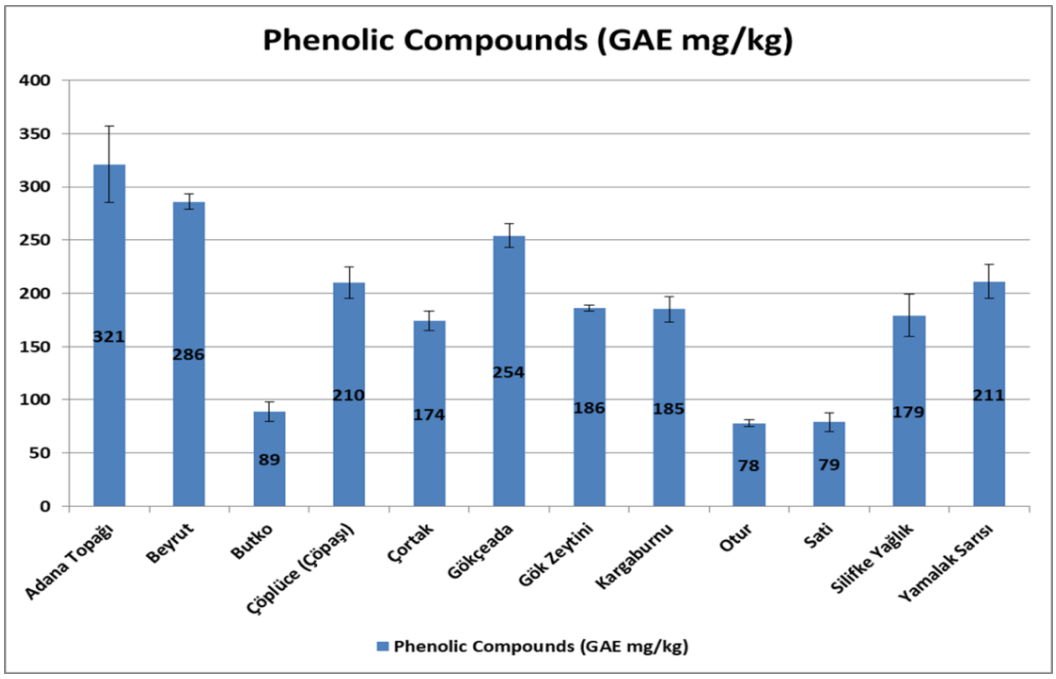


Figure 1. Total Polyphenol Contents of Tested Genotypes

Natural olive oil acts as an antioxidant and is the only vegetable oil that contains phenolic compounds in high concentrations, which protects the oil against oxidation during storage. Phenolic compounds are the compounds that have an effect on the aroma and taste of olive oil. They increase the stability and quality of olive oil (Angerson, 1999). According to different authors, the total amount of phenols (from 50 to 1000 mg kg^{-1}) varies greatly (Boskou, 1996). This change depends on many factors such as climate and environmental factors, degree of maturity, variety, processing, storage of oil (Alessandri, 1997; Garcia, et al., 1999; Gutierrez et al., 1999).

Tocopherol Compositions of Olive Oils:

Tocopherol compositions of tested varieties were given in Table 1 and Figure 2.

Table 1. Comparison of tocopherol contents of olive varieties

Genotype	α-tocopherol (mg kg^{-1})	γ- tocopherol (mg kg^{-1})	Total tocopherol (mg kg^{-1})
Adana Topağı	149.81	4.33	154.14
Beyrut	83.76	5.25	89.01
Butko	54.66	0	54.66
Çöplüce (Çöpaşı)	108.2	19.75	127.95
Çortak	159.78	0	159.78
Gökçeada	52.00	0	52.1
Gök Zeytini	137.74	0	137.74
Kargaburnu	137.96	0	137.96
Otur	88.45	0	88.45
Sati	98.54	0	98.54
Silifke Yağlık	138.75	0	138.75
Yamalak Sarısı	139.74	0	139.74

Although α-tocopherol was the most common type of tocopherol, γ-tocopherol was determined in only 3 genotypes which are "Adana Topağı", "Beyrut" and "Çortak" varieties.

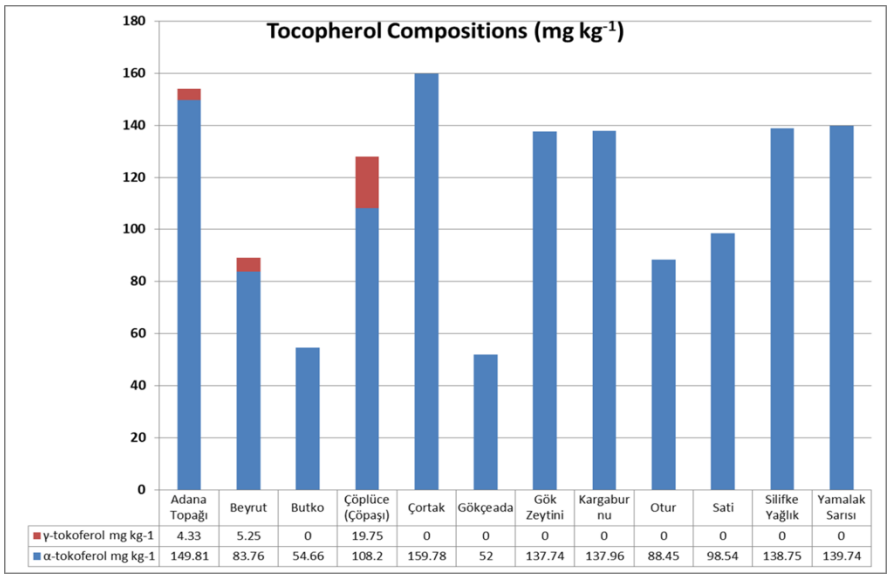


Figure 2. Total Tocopherol (mg kg-1) Compositions of tested genotypes

The α-tocopherol level ranged from 52.00 mg kg^{-1} ("Gökçeada") to 149.81 mg kg^{-1} ("Adana Topağı"). When the total amount of tocopherol was taken into consideration, the highest level of tocopherol was determined in "Çortak" genotype with a value of 159.78 mg kg^{-1} and the lowest amount was found in "Gökçeada" with a value of 52.00 mg kg^{-1}. In a study conducted in our country, it was determined that the amount of tocopherol in natural olive oils ranged from 27.5 mg kg^{-1} to 130 mg kg^{-1}. Varieties, ecological conditions, olive oil processing technologies are listed as reasons of difference (Nergiz, 1993).

Fatty Acid Methyl Esters of Olive Oils

Results of fatty acid composition of genotypes are given in Table 2. Besides monounsaturated and polyunsaturated fatty acids values were calculated by summing up the values of the respective fatty acids on Table 3. The sum of the ratios of palmitoleic acid and oleic acid were used for determining monounsaturated fatty acid, although the sum of the ratios of linoleic acid, linolenic acid were used for calculating ratio of the polyunsaturated fatty acid. In this research, some of the most important fatty acids for olive oils were shown. It is known that oleic acid, palmitic acid and linoleic acid are the major fatty acid

of the olive oil, although palmitoleic acid, stearic acid and linolenic acid have the secondary importance of FAME in olive oil.

Table 2. Comparison of fatty acid methyl esters of olive varieties

Genotypes	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	C22:0
Adana Topağı	0.033	11.61	0.76	3.53	71.92	9.08	0.19	0.50	0.08
Beyrut	0.074	14.65	0.76	3.40	74.12	9.33	0.33	0.38	0.09
Butko	0.054	7.97	0.77	2.63	74.92	9.02	0.24	0.45	0.09
Çöplüce (Çöpaşı)	0.070	12.45	0.71	3.41	71.11	9.99	0.24	0.56	0.08
Çortak	0.026	12.24	0.65	3.15	68.06	9.77	0.27	0.31	0.07
Gökçeada	0.039	10.21	0.16	1.05	75.76	11.28	0.4	0.26	0.07
Gök Zeytini	0.073	14.88	0.61	3.51	65.30	7.81	0.24	0.60	0.08
Kargaburnu	0.033	12.94	0.70	3.35	68.64	8.75	0.22	0.28	0.09
Otur	0.042	9.25	0.80	2.27	76.10	9.42	0.26	0.42	0.06
Sati	0.041	9.32	0.82	2.25	75.30	9.37	0.24	0.31	0.08
Silifke Yağlık	0.058	12.65	0.91	3.40	69.31	11.63	0.24	0.30	0.08
Yamalak Sarısı	0.071	11.09	0.53	3.21	65.75	13.11	0.25	0.34	0.08

The factors that make olive oil superior to other vegetable oils are the minor components such as phenolic compounds, tocopherols and sterols, as well as major components.

The high proportion of monounsaturated fatty acid components, especially the high oleic acid ratio (C18:1), increases the resistance of olive oil to oxidation as well as thermal stability. In this context, it could say that the genotypes with the highest content of oleic acid are Gökçeada, "Otur", "Sati" and "Butko" varieties which are over 75%. Oils of "Gök Zeytini" and "Yamalak Sarisi" varieties had the lowest oleic acid content due to the rate of 66%.

In a study reported in the Olive Research Institute in 1981, oleic acid content of genotypes of our country ranged from 65.2% to78% (Anonim, 1981). In another study conducted in Hatay, it was reported that the highest oleic acid Kargaburnu (74.51%) and Savrani (74.20%), the lowest was the Gemlik (70.61%) variety (Toplu, 2000).

Than oleic acid, the two compounds with the highest ratios are palmitic acid and linoleic acid. It is also known that one of these acids is saturated fatty acid components (palmitic acid); besides, linoleic acid is polyunsaturated fatty acids.

Palmitic acid (C16:0) is the major saturated fatty acid in olive oils (Table 2). In our study, "Gök Zeytini" and "Beyrut" varieties have the highest rate of palmitic acid, although "Butko", "Otur" and "Sati" genotypes were found to have the lowest rate.

Linoleic acid (C18:2) ratios of olive oils belonging to "Yamalak Sarisi", "Silifke Yaglik" and "Gökçeada" were found to be at the highest level (Table 2). It was determined that the oils of the genotypes of "Gök Zeytini" and "Kargaburnu" had the lowest linoleic acid ratios.

Palmitic and linoleic acid ratios of different olive varieties were determined by Oktar ve Çolakoğlu (1989) 11.36%-13.58% and 8.55%-11.57%; Fontanazza et al. (1993) 11.06%-13.43% and 4.70%-10.32%; Pandolfi et al. (1993) 8.83%-12-36% and 3.78%-8.54%; Tous and Romero (1993) 9.7%-14.9% and 3.6%-12.5%; Ağar et al. (1995) 10.39%-16.69% and 8.16%-21.96%; Gundogdu and Kaynas (2018) 19.83%-8.62% and 21.09%-5.38%, respectively.

Although the effect of saturated fatty acids on increasing the oxidative stability of the oil is known to be

higher, the effect of the height of the polyunsaturated fatty acid components on human health is also known. In this context, olive oil is important because it has the closest proportions to breast milk in terms of fatty acid component (Akbulut, 2019; Şeker, 2019)

Stearic acid (C18:0) is the second most important saturated fatty acid component after palmitic acid (Table 2). Although "Adana Topağı" (3.53 %) and "Gök Zeytini" (3.51 %) varieties had the highest stearic acid ratio, "Gökçeada" (1.05 %) had the lowest ratio.

Palmitoleic acid (C16:1) is the second monounsaturated fatty acid that determined in research (Table 2). Rates of palmitoleic acid of genotypes were ranged from 0.16% ("Gökçeada") to 0.91% ("Silifke Yağlık").

Linolenic acid (C18:3) is the second polyunsaturated fatty acid that identified in research (Table 2). It varied from 0.40% ("Gökçeada") to 0.19% ("Adana Topağı").

Linolenic acid ratios of different olive varieties were determined by Fontanazza et al. (1993) 0.52%-1.97%; Ağar et al. (1995) 0.78%-2.27%; Gundogdu and Kaynas (2018) 1.11%-0.19%, respectively.

Arachidic acid (C20:0), behenic acid (C22:0) and miristic acid (C14:0) compounds were the other identified saturated fatty acids. Arachidic acid ranged from 0.60% ("Gök Zeytini") to 0.26% ("Gökçeada") and behenic acid varied from 0.09% ("Beyrut", "Butko" and "Kargaburnu") to 0.06% (Otur). "Beyrut", "Gök Zeytini", "Yamalak Sarisi" and "Çöplüce" had the highest ratio of miristic acid, than "Çortak" had the lowest ratio (Table 2).

The chemical structure of olive oil consists of saturated and polyunsaturated fatty acids (13%-13%) and mainly monounsaturated fatty acids (74%). It is important for oxidative stability for olive oil. Consequently, olive cultivars for oil production purpose such as 'Gökçeada', 'Otur', 'Sati' and 'Butko' varieties have less PUFA and high MUFA ratio. It was determined that the genotypes of "Gök Zeytini" and "Yamalak Sarisi" had the lowest MUFA ratio (below 66%). PUFA of oils of "Yamalak Sarisi", "Silifke Yaglik" and "Gökçeada" genotypes had the highest ratio just like linoleic acid. Although it was determined that oils of "Gökzeytini" and "Kargaburnu" varieties had the lowest PUFA ratio.

It was determined that "Gök Zeytin" and "Beyrut" genotypes had the highest SFA ratio, however, it was determined that oils of "Gökceada", "Butko", "Otur" and "Sati" varieties had the lowest SFA ratio.

Both Fontanazza (1988) and Oktar and Çolakoğlu (1989) stated that the temperature increased the ratio of palmitic acid and SFA ratio.

Olive oil contains more oleic acid and less linoleic and linolenic acids than other vegetable oils, that is, more monounsaturated than polyunsaturated fatty acids. This renders olive oil more resistant to oxidation because generally, the greater the number of double bonds in the fatty acid, the more unstable and easily broken down by heat, light, and other factors the oil is (Olive Oil Source, 2018).

CONCLUSIONS

According to results of the analysis; the total polyphenol content of genotypes was ranged between 321 mg kg^{-1} (Adana Topağı) and 78 mg kg^{-1} (Otur); Total tocopherol contents ranged from 154.14 mg kg^{-1} (Adana Topağı) to 52.10 mg kg^{-1} (Gökçeada).

In terms of components of fatty acids, olive varieties harvested from Blacksea region especially Otur genotype has the highest oleic acid and MUFA ratio.

Gökzeytini olive genotype had both the lowest oleic acid, MUFA ratio and lowest linoleic acid, PUFA ratio.

Although, it was determined that this genotype had the highest ratio of palmitic acid and SFA.

Table 3. Comparison of saturated, mono unsaturated and poly unsaturated fatty acids of olive varieties

Genotypes	Saturated Fatty Acids (SFA %)	MonoUnsaturated Fatty Acids (MUFA %)	PolyUnsaturated Fatty Acids (PUFA %)
Adana Topağı	15.75	72.68	9.27
Beyrut	18.59	74.88	9.66
Butko	11.19	75.69	9.26
Çöplüce (Çöpaşı)	16.57	71.82	10.23
Çortak	15.80	68.71	10.04
Gökçeada	11.63	75.92	11.68
Gök Zeytini	19.14	65.91	8.05
Kargaburnu	16.69	69.34	8.97
Otur	12.04	76.90	9.68
Sati	12.00	76.12	9.61
Silifke Yağlık	16.49	70.22	11.87
Yamalak Sarısı	14.79	66.28	13.36

The low amount of phenolic compounds in the oil samples obtained from Artvin region has caused a difference in the aromatic structure of oil. It is clear that olive oil has no bittersweet, exquisite and aromatic structure in the olives of the Black Sea region. However, it can be said that these varieties are weak in terms of antioxidants.

In addition to genetic and ecological factors, it is known to affect the composition of fatty acids in cultural applications. The ratio of the total unsaturated fatty acids in the varieties is over 85%. Very low level of linoleic acid (PUFA <10%), which is important in nutrition and accepted as essential fatty acid, is advantageous in terms of storage but is negative in nutritional value.

The results of the study are important for olive genotype characterization and olive oil industry.

ACKNOWLEDGEMENTS

This study was supported by TUBITAK by TOVAG-3358.

REFERENCES

Ağar İ. T., Garcia J. M, Zahran A., Kafkas S., Kaşka N., 1995. Adana Ekolojik Koşullarında Yetiştirilen Bazı Zeytin (*Olea europaea* L.) Çeşitlerinin Yağ Asitleri Karakteristikleri. *Türkiye II. Ulusal Bahçe Bitkileri Kongresi*, 3-6 Ekim 1995, l: 741-745, Adana.

Akbulut G., 2019. http://www.aeo.org.tr/Reklam/OMEGA-3-6-9-YAG-ASITLERI-VE-SAGLIK-UZERINE-ETKILERI-DOC-DR-GAMZE-AKBULUT.pdf (Date of Access: 01.05.2019)

Alessandri S., 1997. Techniques Agrouomiques et Characteristiques de I'Huile d'Olive. in *Encyclopedic Mondiale de l'Olivier* (pp.195-217). Conseil Oleicole Internationale, Madrid (Espagne).

Angerson C., 1999. Olive Harvesting and Storage. *Oleagineux Corps gras Lipides* 6: 80-83.

Anonymous, 1981. *Zeytinyağlarının Bileşenleri ve Özellikleri.* Zeytincilik Araştırma Enstitüsü Yayınları No: 34, Bornova-İzmir.

Anonymous, 1985. *Hayvansal ve Bitkisel Katı ve Sıvı Yağlar-Yağ Asitleri Metil Esterlerinin Gaz-Sıvı Kromatografisiyle Analizi*. Türk Standartları Enstitüsü Yayınları, 4664, Ankara, 9 s.

Anonymous, 2019. Olea Databases. (http://www.oleadb.it) Date of Access: 01.05.2019

FAO, 2018. Agricultural statistical database. (http://www.fao.org/faostat/en/#data/QC) (Date of Access: 01.10.2018).

Fontanazza G., Patumi M., Sounas M., Serraiocco A., 1993. Influence of Cultivars on the Composition and Quality of Olive Oil. *Proceedings of the The Second International Symposium on Olive Growing*, 06-10 September 1993, Jerusalem-Israel, 358-361.

Garcia A., Brenes M., Gaicia P., Romero C., Garrido A. 2003. Phenolic Content of Commercial Olive Oils. *Eur. Food Res. Technol* 216: 520-525.

Gundogdu M.A., Kaynas K., 2018. Investigation of Fatty Acid Compositions and Some Pomological Characteristics of Different Olive Cultivars during Maturation in Cool Subtropical Condition of Turkey. *30th International Horticultural Congress*, 12-16 August 2018, Istanbul-Turkey (In Press).

Gutfinger, T., 1981. Polyphenols in Olive Oils. *J. Am. Oil Chem. Soc.* 58: 966-968.

Gutierrez F., Arnaud T., Albi A. M., 1999. Influence of Ecological Cultivation on Virgin Olive Oil Quality. *Journal of the American Oil Chemist's Society* 76(5): 617-621.

Montedoro G., Servili M., Baldioli M., Miniati E. 1992. Simple and Hydrolyzable Phenolic Compounds in Virgin Olive Oil. 1. Their Extraction, Separation, and Quantitative and Semiquantitative Evaluation by HPLC. *J. Agric. Food Chem.* 40(9):1571 – 1576.

Nergiz C., 1993. Rafinasyon İşlemlerinin Natürel Zeytinyağında Fenolik Bileşikler ile Tokoferol Miktarına Olan Etkisi, *E. Ü. Mühendislik Fakültesi Dergisi, Gıda Mühendisliği Yayınları* 11(1): 37 -46.

Oktar A, Çolakoğlu A., 1989. Agronomik Faktörlerin Zeytinyağının Kalitesi Üzerine Etkileri. *Bursa I. Uluslararası Gıda Sempozyumu* 4-6 Nisan 1989:477-485, Bursa.

Olive Oil Source. 2018. www.oliveoilsource.com/page/chemical-characteristics

Pandolfi S., Tombesi A., Pilli, M., Preziosi, P., 1993. Fruit Characteristics of Olive Cultivars of Different Origin Grown in Umbria. *Proceedings of the Second International Symposium on Olive Growing*, 06-10 September 1993, :362-366, Jerusalem-Israel.

Salvador, M.D., Arairda, F., Gomez-Alonso, S., Fregapane, G., 2003. Influence of Extraction System, Production Year and Area on Cornicabra Virgin Olive Oil: A Study of Five Crop Seasons. *Food Chemistry* 80: 359-366.

Seker M., 2019. *Biochemistry Lecture Notes*. Çanakkale Onsekiz Mart University Faculty of Agriculture, Department of Horticulture Lecture Notes, Çanakkale (Unpublished)

Seker, M., Gül, M.K., İpek, M., Toplu, C., Kaleci, N., 2007. Screening and comparing tocopherols in the rapeseed (*Brassica napus* L.) and olive (*Olea europaea* L.) varieties using high-performance liquid chromatography". *International Journal of Food Sciences and Nutrition* 59(6): 483-490.

Toplu C., 2000. Hatay İli Değişik Üretim Merkezlerindeki Zeytinliklerin Verimlilik Durumları, Fenolojik, Morfolojik ve Pomolojik Özellikleri ile Beslenme Durumları Üzerinde Araştırmalar. Çukurova Üniversitesi Fen Bilimleri Enstitüsü Doktora Tezi, Adana. 210 s.

Tous J., Romero A., 1993. Cultivar and Location Effects on Olive Oil Quality in Catalonia, Spain. *Proceedings of the Second International Symposium on Olive Growing*, 06-10 September 1993, 323-326, Jerusalem-Israel.

TUIK, 2019. Türkiye Zeytin Üretimi İstatistikleri. Türkiye İstatistik Kurumu, Ankara. (http://www.tuik.gov.tr) Date of Access: 01.05.201