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**Research Paper / Araştırma Makalesi**

# Some Quality Characteristics of Olive Oil from Gemlik Variety Grown in Bucak District of Burdur Province, Türkiye

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## ABSTRACT

In this study, some quality characteristics of olive oil produced from cv. Gemlik olives grown in the Bucak district of Burdur province (Türkiye) were determined, and they were compared with the limits required by the Turkish Food Codex Communiqué on Olive Oil and Olive-Pomace Oil (Communiqué No. 2017/26) and with the literature reported for olive oils from the same cultivar grown nationwide. For olive oil samples from ripe harvest fruits using a two-phase decanter system, the fatty acid profile, free fatty acidity, peroxide value, specific extinction coefficients under UV light ($K_{232}$, $K_{270}$), stigmastadiene content, sterol composition, total phenolic content, and DPPH radical scavenging activity were determined. Except for the Δ-7-stigmastenol content, all values complied with the criteria required for virgin olive oil as defined by the Communiqué. The free fatty acidity value, oleic acid content, palmitic acid content, and peroxide value of olive oil were 1.14%, 70.86%, 13.81%, and 9.02 meq$O_2$/kg, respectively. The $K_{232}$ and $K_{270}$ values oils were 1.63, and 0.10, respectively. The total sterol content of oil was 1442.5 mg/kg, with total β-sitosterol accounting for 94.8% of sterols. The total phenolic content of oil was 226.64 mg GAE/kg (gallic acid equivalents), and the DPPH radical scavenging activity was 83.53% (1.094 mM TE/kg, Trolox® equivalents). The Δ-7-stigmastenol content of olive oil was determined as 0.6%. The Δ-7-stigmastenol content in olive oil is an adulteration marker, but it could exceed the maximum limit of 0.5% imposed by the Turkish Food Codex under seasonal conditions characterized by low relative humidity and elevated temperatures as reported in previous studies, and considering the ongoing trend of global warming, the likelihood of observing similar seasonal conditions has been increasing. Therefore, further research could be recommended to elucidate how global warming and drought might impact the amounts and compositions of minor constituents other than sterols in olive oil for reassessing the regulatory limits.

**Keywords:** Gemlik, Olive Oil, Quality, Burdur, Bucak

## Burdur İli Bucak İlçesinde Yetiştirilen Gemlik Çeşidi Zeytinlerden Üretilen Zeytinyağının Bazı Kalite Özellikleri

## ÖZ

Bu çalışmada, Burdur ili Bucak ilçesinde yetiştirilen Gemlik çeşidi zeytinlerinden üretilen zeytinyağının bazı kalite özellikleri belirlenmiş ve Türk Gıda Kodeksi Zeytinyağı ve Prina Yağı Tebliği'nde (Tebliğ No. 2017/26) istenen limitler ve aynı çeşitten ülke genelinde yetiştirilen zeytinyağları için bildirilen literatür bilgileri ile karşılaştırılmıştır. Olgun hasat meyvelerden iki fazlı dekanter sistemi kullanılarak elde edilen zeytinyağı örneklerinde, yağ asidi profili, serbest yağ asidi miktarı, peroksit değeri, UV ışığında özgül soğurma değerleri ($K_{232}$, $K_{270}$), stigmastadien içeriği, sterol kompozisyonu, toplam fenolik madde içeriği ve DPPH serbest radikalleri yakalama aktivitesi değeri belirlenmiştir. Δ-7-stigmastenol içeriği hariç tüm değerler tebliğde tanımlanan natürel birinci sızma zeytinyağı için istenen kriterleri karşılamaktadır. Zeytinyağının serbest yağ asidi değeri %1.14, oleik asit miktarı %70.86, palmitik asit miktarı %13.81, peroksit değeri 9.02 meq$O_2$/kg, $K_{232}$ değeri 1.63, $K_{270}$ değeri 0.10 olarak saptanmıştır. Zeytinyağının toplam sterol içeriği 1442.5 mg/kg olup β-sitosterol miktarı sterollerin %94.8'ini oluşturmaktadır. Zeytinyağının toplam fenolik madde miktarı 226.64 mg GAE/kg (gallik asit eşdeğeri), serbest radikalleri yakalama aktivitesi (DPPH) değeri ise %83.53 (1.094 mM TE/kg, Trolox® eşdeğeri) olarak tespit edilmiştir. Zeytinyağının Δ-7-stigmastenol değeri ise %0.6 olarak belirlenmiştir. Zeytinyağındaki Δ-7-stigmastenol içeriği tağşiş belirtecidir, daha önceki çalışmalarda bildirildiği gibi düşük bağıl nem ve yüksek sıcaklıkların görüldüğü mevsimsel koşullarda Türk Gıda Kodeksi tarafından belirlenen %0.5'lik maksimum sınırı aşabilmektedir ve dünya genelinde küresel ısınmanın devam ettiği göz önüne alındığında, benzer mevsimsel koşulların gözlemlenme olasılığı artmaktadır. Küresel ısınma ve kuraklığın zeytinyağındaki steroller dışındaki diğer minör bileşenlerin miktar ve bileşimlerini nasıl etkileyebileceğinin açıklığa kavuşturulması ve yasal sınırların yeniden değerlendirilmesi amacıyla daha fazla araştırma yapılması önerilebilir.

**Anahtar Kelimeler:** Gemlik, Zeytinyağı, Kalite, Burdur, Bucak

## INTRODUCTION

Olive (*Olea europaea* L.) is a fruit species cultivated in Mediterranean climates, and its fruits cannot be consumed directly; therefore, fruits are mostly processed into table olives or oil [1]. Türkiye ranks among the world's leading countries in olive cultivation, owing to its location within the Mediterranean Basin and favorable climatic conditions. Olive cultivation has spread primarily across the Aegean, Mediterranean, and Marmara regions, and, to a lesser extent, along the Southeastern Anatolia and Black Sea coasts [2-4]; however, in conjunction with climate change, factors such as rising temperatures, shifts in precipitation regimes, drought, and extreme weather events are leading to significant changes in the distribution of olive-growing areas, production levels, and olive oil quality [26, 3]. The olive tree is typically grown in regions characterized by a Mediterranean climate, with mild and rainy winters and hot, dry summers. Nevertheless, the concurrence of temperature increases and irregularities in precipitation regimes observed in recent years have resulted in a contraction of ecologically suitable areas for olive cultivation [2-4].

Studies employing MaxEnt and BioClim climate change scenario models project that highly suitable areas for olive cultivation will contract, with suitability shifting northward and to higher elevations, and establishing new olive groves in these zones is suggested as a means to offset losses in production [2-4]. Developing strategies that enable adaptation to climate change is of critical importance for the sustainability of the olive oil industry. Leveraging Turkey's advantages in terms of biodiversity may be a key enabler of adaptation to climate change. According to information obtained from the Burdur Provincial Directorate of Agriculture and Forestry, the region has a transitional climate between the Central Anatolian, Mediterranean, and Aegean regions. The majority of the annual precipitation falls as rain and snow in the winter months. The average annual precipitation is 428.1 mm. The first frosts occur in November, while the last frosts continue until the second half of April. In a study modeling the regional suitability for the potential future distribution of olives in the medium to long term due to climate change, the Burdur region is categorized as more suitable for cultivation compared to previous years [34]. According to the T.C. Burdur Governorship Provincial Directorate of Food, Agriculture and Livestock, owing to the high elevation (850 meters) and continental climate of Bucak district, the Gemlik cultivar of olives can be the most suitable variety for the region's olive groves. To enhance quality and yield, in 2015, 14000 wild olive trees were grafted by the Ministry of Forestry and Water Affairs across 270 decares in Ağlasun and 16000 across 40 decares in Bucak (Burdur, Türkiye). Wild olive genotypes that have not been domesticated exhibit greater tolerance to temperature, salinity, and drought and constitute an important resource for future sustainable olive cultivation and new cultivar development projects [5]. Within the scope of the Project for the Effective Use of Agricultural Lands (TAKE), financed by the General Directorate of Crop Production of the Ministry of Agriculture and Forestry in Türkiye, the Olive Production Development Project prepared by the Burdur Provincial Directorate of Agriculture and Forestry carried out the distribution of 47500 certified olive saplings to farmers in 2024 for cultivation in Bucak, Çeltikçi, Ağlasun, and the central district and villages with the aim that the region would possess significant potential for olive oil production in the future. Due to the climatic conditions in the Bucak district of Burdur province becoming more favorable for olive cultivation, olive tree plantation in the region is increasing. In this study, an attempt was made to reveal the competitiveness of the produced oil within the olive oil sector, in terms of specified quality criteria, by determining some quality parameters of the olive oil produced from Gemlik variety olives grown in the region, according to the Turkish Food Codex Communiqué on Olive Oil and Pomace Oil (Communiqué No: 2017/26).

## MATERIALS and METHODS

Extra virgin olive oil samples were obtained in the 2018-2019 harvest season from a farmer with an olive grove in the Bucak district of Burdur province, and the samples were from Gemlik olives from the same orchard. Olive fuits harvested in the third week of October were processed into oil using a two-phase system at an olive mill in Antalya (Türkiye) with which the farmer had previously contracted for oil extraction. No adulteration or mixing of other olive varieties was allowed at any stage from harvest to oil extraction in the oil mill. Temperature did not exceed 45°C during oil processing. Filtered olive oils were delivered on the same day to the Department of Food Engineering at Burdur Mehmet Akif Ersoy University (Burdur, Türkiye) and stored at -18°C under a nitrogen atmosphere prior to analyses. Chemicals used in the study were purchased from

Merck KGaA (Darmstadt, Germany), and Supelco® 37 Component FAME Mix (Sigma-Aldrich Co. LLC, St. Louis, Missouri, USA) was used as the fatty acid methyl ester standard.

## Methods Used for Determining Olive Oil Quality Characteristics

The stigmastadiene content, sterol composition, total sterols, and erythrodiol + uvaol contents of olive oil were analyzed by accredited tests reported by the İzmir Food Control Laboratory Directorate in accordance with the Turkish Food Codex Communiqué on Analysis Methods for Olive Oil and Olive-Pomace Oil 2014/53. The free fatty acidity values of oil samples were determined using AOCS Ca 5a-40, and results were expressed as percent oleic acid [6]. Peroxide values were determined according to AOCS Cd 8b-90 [6]. The specific UV absorption values of olive oil samples were determined spectrophotometrically using AOCS Ch 5-91 [6]. These analyses were performed in duplicate, and the results were found to be very close. The data presented in this study represent the average of these measurements.

## Determination of Fatty Acid Composition

The fatty acid profiles of olive oil samples were analyzed using a gas chromatography instrument (GC-2025, Shimadzu Corporation, Kyoto, Japan), and the preparation of fatty acid methyl esters was carried out according to IUPAC 2.301 [7]. The instrument includes an auto injector (Shimadzu AOC-20i), a TR-CN100 column (100×0.25 mm, 0.20 µm; Teknokroma Analítica, S.A., Barcelona, Spain), and a flame ionization detector (Shimadzu FID). The detector temperature was set to 250°C. The injection volume was 1 µL while the column flow rate was set to 0.87 mL/min with the split ratio of 1:70. The initial column and injector temperatures were 140°C and 250°C, respectively. After holding at 140°C for 5 min, it was increased to 240°C at a rate of 4°C/min and held at this temperature for 35 min. The analysis was completed in 60 min. Helium was used as the carrier gas. This analysis was performed in duplicate, and the results were found to be very close. The data presented in this study represent the average of these measurements.

## Determination of Total Phenolic Content

The total phenolic content of olive oil was determined on the aqueous extracts of olive oils according to the Folin-Ciocalteu reagent-phenol reaction. Measurements were performed with a spectrophotometer (Optizen POP UV/VIS Spectrofotometer, MecasysCo. Ltd., Yuseong-gu, Daejeon, Korea) following Singleton and Rossi [8]. In a capped test tube, the mixture of olive oil (2.5 g) and chromatographic-grade methanol (2.5 mL) was vortexed briefly and then centrifuged at 4100 rpm for 5 min (NF 800R, Nüve Sanayi Malzemeleri İmalat ve Tic. A.Ş., Ankara, Türkiye), and the upper phase was transferred into a 10 mL volumetric flask and its final volume was adjusted with methanol. A series of gallic acid solutions in pure water (0.0, 25.0, 50.0, 62.5, and 100.0 mg/L) were used for the calibration curve. A portion of gallic acid solution or samples (1 mL) was mixed with Folin-Ciocalteu reagent (5 mL) in a clean glass test tube. After 5 min, saturated sodium carbonate ($Na_2CO_3$, 75 g/L) (4 mL) was added, and the mixture was vortexed. Reaction was taken place in the dark at room temperature for 2 h, and the absorbance of colored solutions was obtained at 760 nm. The total phenolic content of olive oils samples was calculated by multiplying by the dilution factor and expressed as mg GAE (gallic acid equivalents) per kg. The analysis was conducted in four replicates.

## DPPH Free Radical Scavenging Activity

Phenolic extracts were obtained from olive oil using a methanol-water mixture (80:20, v/v). An aliquot of 50 µL of each extract was transferred into a test tube and mixed with 450 µL of Tris-HCl buffer (50 mM, pH 7.4). Subsequently, 1.0 mL of DPPH solution (0.10 mM in methanol) was added, and the mixture was incubated in the dark at room temperature for 30 min. After incubation, the absorbance of the solution at 517 nm was measured using a spectrophotometer (T70+ UV/VIS, PG Instruments, Leicestershire, UK). For the control, pure water was used instead of the phenolic extract. The analysis was carried out in four parallel runs. Trolox® was used to obtain a calibration curve, and results were expressed as mM TE (trolox equivalents) per kg olive oil. The DPPH free radical scavenging activity was calculated using the following equation, and results were expressed as percent inhibition [9].

$$\% \text{ Inhibition (DPPH)} = [(Abs_{Control} - Abs_{Sample})/Abs_{Control}] \times 100 \text{ [9]}$$

## RESULTS and DISCUSSION

The amount and composition of minor and major components in olive oil samples may vary according to olive cultivar, the geographic and climatic conditions of olive orchard, cultural practices such as irrigation and fertilization, the ripening stage of fruits, the extraction conditions applied during oil production, and the storage and preservation conditions of olive oils [10]. In our study, oleic acid was the predominant fatty acid in olive oil, accounting for 70.86% of the total fatty acids (Table 1). The oleic acid/linoleic acid ratio was 7.47, and a high oleic acid content could be indicative of good oxidative stability in olive oil [11,12]. The free fatty acidity of the olive oil was 1.14%, the peroxide value was 9.02 $meqO_2/kg$, the $K_{232}$ value was 1.63, the $K_{270}$ value was 0.10, and the $\Delta K$ value was -0.0015. Low peroxide and specific UV absorbance values might indicate that the olive oil was fresh and well preserved. Based on the criteria in Table 1 and Table 2, olive oil samples displayed the profile of a high-quality virgin olive oil, consistent with the limit values of the Turkish Food Codex Communiqué on Olive Oil and Olive-Pomace Oil and with published data for Gemlik cultivar olive oils.

Table 1. Comparison of the fatty acid profile of olive oil from Gemlik variety grown in Bucak (Burdur, Türkiye) with regulatory limits and literature

| Fatty Acid | Content* (%) | Fatty acid values in Turkish Food Codex** | Literature min-max values (%) | References |
|---|---|---|---|---|
| Myristic acid, C14:0 | 0.01 | ≤0.03 | - | |
| Palmitic acid, C16:0 | 13.81 | 7.5-20 | 12.24-19.47 | 12, 18-25 |
| Palmitoleic acid, C16:1 (9) | 0.96 | 0.3-3.5 | 0.87-2.08 | 12, 18, 20, 21, 23, 24 |
| Heptadecanoic acid, Margaric acid, C17:0 | 0.16 | ≤0.4 | 0.03-0.16 | 12, 21, 23, 24 |
| *cis*-10-Heptadecenoic acid, C17:1 (10) | 0.50 | ≤0.6 | 0.08-0.30 | 12, 19-21, 23, 24 |
| Stearic acid, C18:0 | 3.06 | 0.5-5 | 2.09-4.41 | 12, 18-25 |
| Elaidic acid, C18:1 (9t) | 0.01 | ≤0.05 | 0.020-0.035 | 12 |
| Oleic acid, C18:1 (9) | 70.86 | 55-83 | 64.34-75.79 | 12, 18-25 |
| Linoleic acid, C18:2 (9,12) ω-6 | 9.49 | 2.5-21 | 4.47-13.46 | 12, 18-25 |
| Arachidic acid, C20:0 | 0.41 | ≤0.6 | 0.10-0.83 | 12, 18, 20, 21, 23-25 |
| Gadoleic (9-eicosenoic acid), C20:1 (9) | ND*** | ≤0.5 | 0.21-0.36 | 12, 20, 24 |
| Linolenic acid, C18:3 (9,12,15) ω-3 | 0.39 | ≤1.0 | 0.43-0.91 | 12, 18-21, 23-25 |
| Linoleic acid (*trans*) + Linolenic acid (*trans*) | 0.04 | ≤0.05 | 0.019-0.031 | 12 |
| Behenic acid, C22:0 | 0.15 | ≤0.2 | 0.08-0.16 | 12, 23-25 |
| Lignoceric acid, C24:0 | 0.15 | ≤0.2 | 0.06 | 23 |

*The results of this study, **Values required for virgin olive oil in the Annex of the Turkish Food Codex Olive Oil and Olive-Pomace Oil Communiqué (Communiqué No: 2017/26), ***ND: Not detected

Table 2. Comparison of some quality characteristics of olive oil from Gemlik variety grown in Bucak (Burdur, Türkiye) with regulatory limits and literature

| Parameter | Content* | Legal Limit** | Literature min-max values | References |
|---|---|---|---|---|
| Cholesterol (within total sterols, %) | ND*** | ≤0.5 | ND-1.77 | 12,17-19 |
| Brassicasterol (within total sterols, %) | ND | ≤0.1 | 0.01-0.16 | 17,18 |
| Campesterol (within total sterols, %) | 1.8 | ≤4.0 | 0.75-4.11 | 12, 17-19 |
| Stigmasterol (within total sterols, %) | 0.85 | <Campesterol | 0.41-2.34 | 12, 17-19 |
| Δ-7-Stigmastenol (within total sterols, %) | 0.6 | ≤0.5 | 0.09-1.47 | 12, 17-19 |
| Δ-7-Avenasterol (within total sterols, %) | 1.95 | - | 0.25-1.38 | 12, 17,18 |
| Total β-sitosterol (within total sterols, %) | 94.8 | ≥93 | 76.12-96.68 | 12, 17-20 |
| Total sterols (mg/kg) | 1442.5 | ≥1000 | 880.18-2410.53 | 12, 17,18 |
| Erythrodiol and uvaol (within total sterols, %) | 1.35 | ≤4.5 | ND-4.27 | 12, 17,18 |
| Total phenolic content (mg/kg, gallic acid equivalent) | 226.64±30.49 | - | 1.065-383.67 | 20, 24, 27 |
| Antioxidant activity (mM/kg, trolox equivalent) | 1,094±0,256 | - | 0.521-1.23 | 20, 24, 27, 28, 30 |
| % Inhibition, DPPH | 83.53±1.18 | - | 39.64-80.21 | 23, 29 |
| Stigmastadiene (mg/kg) | 0.04 | ≤0.05 | | |

*The results of this study, **Values required in the Annex of the Turkish Food Codex Olive Oil and Olive-Pomace Oil Communiqué (Communiqué No: 2017/26), ***ND: Not detected

The total phenolic content of olive oils is one of the most important parameters determining their shelf life, quality, and health values. Phenolic compounds may impart the characteristic sensory attributes of olive oils such as bitterness and pungency and contribute to the overall flavor and aroma profile, and they can enhance the oil's oxidative stability, inhibit lipid oxidation, and thereby extend shelf life. From a health perspective, they may exhibit cardioprotective, anticancer, and antimicrobial effects [13]. In our study, the total phenolic content of olive oils was 226.64 mg GAE/kg. This value was within the general range reported in the literature for Gemlik olive oils; however, it was below the European Union's restricted limit of 250 mg/kg total phenolics for health-related claims on olive oil [14]. A total phenolic content of 226.64 mg/kg might suggest a somewhat lower predicted shelf life and reduced antioxidant and anti-inflammatory potential [15]. The relatively low phenolic content could be attributed to the use of mature-harvest olives and processing temperatures of approximately 45°C. In contrast, early harvesting and processing olives at temperatures below 27°C, so-called cold pressing, might result in higher phenolic contents in olive oils [10,16]. Determination of the DPPH free radical scavenging capacity of olive oil extract is an important tool for assessing oil quality, serving both as an indicator of the richness of its phenolic content and as a predictor of its potential health benefits. The phenolic compounds present in olive oil (particularly hydroxytyrosol and oleuropein aglycone) not only passively scavenge free radicals, but also function as signaling molecules that, by triggering far more sophisticated mechanisms within the body, activate the cells' endogenous antioxidant defense systems. In other words, they effectively instruct the organism to "raise its defensive shields" [32]. In previous studies, the DPPH free radical-scavenging capacity values of Gemlik variety olive oils were reported, in terms of % inhibition, to range between 39.64% and 80.21%, and in terms of antioxidant activity, to vary between 0.521 and 1.23 mM TE/kg [20, 23, 24, 27-30]. In our study, the DPPH free radical–scavenging capacity of the analyzed olive oil was determined as 83.53±1.18% inhibition, with an antioxidant activity value of 1.094±0.256 mM TE/kg. Irrigation and water stress conditions exert a pronounced influence on the antioxidant constituents of olive oil, particularly on its polyphenol content [31]. Despite belonging to the same cultivar, the wide variation observed between the findings of our study and those reported in the literature can be attributed to several factors, including the oil extraction methods employed, the ripening stage of the fruit, the climatic characteristics of the region in which the olive trees are grown, and agronomic practices such as fertilization and irrigation [12]. The beneficial effects of extra virgin olive oil on health do not stem from the potency of individual compounds alone, but rather from the phenolic synergy arising from their coexistence. For instance, while oleocanthal exerts anti-inflammatory effects, hydroxytyrosol, as one of the most powerful antioxidants, prevents the oxidation of LDL cholesterol, and oleuropein contributes to the enhancement of vascular elasticity [10]. Tyrosol, in turn, activates signaling pathways that protect cells [32]. None of these compounds alone can exert an effect as powerful as that achieved when they act together. Therefore, instead of taking a supplement containing a purified phenolic compound, it is far more effective to consume extra virgin olive oil, which provides these constituents within their natural matrix, and to include it in the diet throughout life [32, 33].

The sterol composition of olive oil is one of the most important indicators for assessing adulteration. In our study, the sterol profile of olive oils complied with the legal requirements in Turkish Food Codex, except for Δ-7-stigmastenol (Table 2). The Δ-7-stigmastenol value of olive oils was determined as 0.6%, which was 0.1% above the regulatory limit. Yorulmaz [17] reported that some olive oils, particularly from the southern regions of Türkiye, had Δ-7-stigmastenol contents exceeding the maximum limit of 0.5% set by the Turkish Food Codex. Similarly, Konuşkan [18] found Δ-7-stigmastenol content above the regulatory limit in certain olive oils produced from different cultivars grown in the Hatay region of Türkiye. Sevim et al. [19], in a study covering the harvest seasons between 2017 and 2020, observed higher Δ-7-stigmastenol contents under seasonal conditions characterized by low relative humidity and high temperatures. In addition, factors such as olive cultivar, ripening degree, extraction method, and storage conditions might influence the sterol content and profile of olive oil [12].

## CONCLUSION

In this study, some quality characteristics of olive oil produced from Gemlik olives grown in the Bucak district of Burdur province were determined, and these characteristics were compared with the regulatory limits and literature. The analytical values of olive oil obtained from ripe olives using a two-phase decanter system were found to meet the criteria required for virgin olive oil under the Turkish Food Codex Olive Oil and Olive-Pomace Oil Communiqué (Communiqué No: 2017/26), with the exception of Δ-7-stigmastenol. Previous studies reported that under seasonal conditions characterized by low relative humidity and high temperatures, the Δ-7-stigmastenol content of olive oils might exceed the maximum limit of 0.5% restricted in the Turkish Food Codex. In the context of ongoing global warming, during harvest years with comparable climatic conditions, olive oils that did not conform to the current codex limits might need to be evaluated in light of these environmental factors, and the establishment of specific or revised limit values for such conditions could be justified.

In our study, the virgin olive oil analyzed exhibited a DPPH free radical scavenging capacity of 83.53% inhibition, with an antioxidant activity of 1.094 mM TE/kg. The total phenolic content of the olive oil was determined to be 226.64 mg GAE/kg, which is below the 250 mg/kg total phenolic content threshold required by the European Union for health claim eligibility in olive oil. Informing regional farmers that early harvesting and processing olives at temperatures below 27°C, which is known as cold extraction, could be effective for achieving higher phenolic contents in oils, and this might enhance producers' competitiveness in the olive oil industry. Determining certain quality characteristics of olive oils produced from Gemlik variety of olives grown in the Bucak district of Burdur province could contribute to the literature and the local community. As the number of olive trees in the area has increased recently, olive cultivation and olive oil production would gain even greater importance in the coming years.

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## REFERENCES

[1] Tunalıoğlu, R., Bektaş, T. (2010). The problem of olive mill wastewater in the Turkish olive industry. *Zeytin Bilimi*, 1(2), 65-71.

[2] Özdel, M.M., Ustaoğlu, B., Cürebal, İ. (2024). Modeling of the potential distribution areas suitable for olive (*Olea europaea* L.) in Türkiye from a climate change perspective. *Agriculture*, 14, 1629.

[3] Yıldız, H., Sırlı, B., Doğan, D., Aydoğdu, M. (2024). Impact of climate change on olive suitability areas. *Soil Studies*, 13(2), 89-96.

[4] Türkeş, M., Şahin, S. (2025). Will olive groves have a future under climate change conditions in the north Aegean sub-region, a Mediterranean agricultural ecosystem of Türkiye? *Turkish Journal of Agriculture - Food Science and Technology*, 13(1), 43-58.

[5] Çıvğa, A. (2025). Unlocking the habitat suitability and industrial potential of wild olive in the face of climate change. *Bioresources* 20(1), 1214-1229.

[6] AOCS (2004). Official methods and recommended practices of the American Oil Chemists' Society, 5th Edition, 2nd Printing. AOCS Press, Champaign, IL (USA).

[7] IUPAC (1987). Standard methods for analysis of oils, fats and derivatives. 7th Edn. Blackwell Scientific, Oxford (UK).
[8] Singleton, V.L., Rossi, J.A. (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. *American Journal of Enology and Viticulture*, 16(3), 144-158.
[9] Dorman, H.J.D., Peltoketo, A., Hiltunen, R., Tikkanen, M.J. (2003). Characterisation of the antioxidant properties of de-odourised aqueous extracts from selected Lamiaceae herbs. *Food Chemistry*, 83(2), 255-262.
[10] Boskou, D. (Ed.). (2015). Olive and olive oil bioactive constituents. AOCS Press, Urbana, IL (USA).
[11] Yang, Y., Ferro, M.D., Cavaco, I., Liang, Y. (2013). Detection and identification of extra virgin olive oil adulteration by GC-MS combined with chemometrics. *Journal of Agricultural and Food Chemistry*, 61(15), 3693-3702.
[12] Demirağ, O., Bozdoğan Konuşkan, D. (2021). Quality properties, fatty acid and sterol compositions of East Mediterranean region olive oils. *Journal of Oleo Science*, 70(1), 51–58.
[13] Tuck, K.L., Hayball, P.J. (2002). Major phenolic compounds in olive oil: metabolism and health effects. *The Journal of Nutritional Biochemistry*, 13(11), 636-644.
[14] Diamantakos, P., Ioannidis, K., Papanikolaou, C., Tsolakou, A., Rigakou, A., Melliou, E., Magiatis, P. (2021). A new definition of the term “high-phenolic olive oil” based on large scale statistical data of Greek olive oils analyzed by qNMR. *Molecules*, 26(4), 1115.
[15] Mancebo-Campos, V., Salvador, M.D., Fregapane, G. (2023). EFSA health claims-based virgin olive oil shelf-life. *Antioxidants*, 12(8), 1563.
[16] European Commission (2012). Commission implementing regulation (EU) no. 29/2012 of 13 January 2012 on marketing standards for olive oil. *Official Journal of the European Union*, L12, 55.
[17] Yorulmaz, A. (2009). Determination of phenolic, sterol and triglyceride structures of Turkish olive oils. Ankara University Graduate School of Natural and Applied Sciences Department of Food Engineering Ph. D. Thesis. Date accessed: 24.09.2025. https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=tmIG9auWeXxeYVJXi_VzfQ&no=i_bxpbREI7LGdOjo3C5FwQ
[18] Konuşkan, D.B. (2017). Fatty acid and sterol compositions of Hatay olive oils. *Turkish Journal of Agriculture-Food Science and Technology*, 5(2), 170-175.
[19] Sevim, D., Köseoğlu, O., Özdemir, D., Hakan, M., Büyükgök, E.B., Uslu, H., Dursun, Ö., Savran, M.K., Eralp, Ö., Kaptan, S., Köktürk, H., Asker, Ö., Pazarlı, S., Ayaztek, M., Akbaş¸ N., Yalçın, S., Topdemir, P. Ç. (2023). Determination of the quality and purity characteristics of olive oils obtained from different regions of Turkey, depending on climatic changes. *Journal of the American Oil Chemists' Society*, 100(3), 197-213.
[20] Uluata, S., Altuntaş, U., Özçelik, B. (2021). Characterization of Turkish extra virgin olive oils and classification based on their growth regions coupled with multivariate analysis. *Food Analytical Methods*, 14, 1682-1694.
[21] Koyuncu, G., Cabaroğlu, T. (2020). Determination of quality parameters and volatile compounds of Gemlik olive variety grown in Adana. *Gıda*, 45(6), 1163-1174.
[22] Özcan, M.M., Al Juhaimi, F., Uslu, N., Ghafoor, K., Ahmed, I.A.M., Babiker, E.E. (2019). The effect of olive varieties on fatty acid composition and tocopherol contents of cold pressed virgin olive oils. *Journal of Oleo Science*, 68(4), 307-310.
[23] Bozdogan, A., Eker, T., Konuskan, D., Oz, A.T., Kafkas, E. (2019). Effects of the storage of Turkish Gemlik olives under $CO_2$ and $N_2$ on the phenolic compounds and fatty acid compositions of olive oils. *Journal of Food Measurement and Characterization*, 13(1), 187-195.
[24] Korkmaz, A. (2023). Characterization and comparison of extra virgin olive oils of Turkish olive cultivars. *Molecules*, 28(3), 1483.
[25] Özcan, M.M., Motuk, F. (2023). Physico-chemical properties, tocopherol contents, fatty acid composition and phenolic compounds of olive oil as affected by papain and cellulase application. *Journal of Food Measurement and Characterization*, 17(1), 1021-1032.
[26] Fraga, H., Moriondo, M., Leolini, L., Santos, J.A. (2021). Mediterranean olive orchards under climate change: A review of future impacts and adaptation strategies. *Agronomy*, 11(1), 56.
[27] Sevim, D., Köseoğlu, O., Çetin, Ö. (2016). Determination of minor components and the antioxidant activity of olive oils extracted from important olives cultivars. *Zeytin Bilimi*, 6(1), 1-7.
[28] Kelebek, H., Kesen, S., Sabbağ, Ç., Selli, S. (2012). Determination of phenolic compounds and antioxidant capacity of virgin olive oil obtained from cv. Gemlik (*Olea europaea*). *Gıda,* 37(3), 133-140.
[29] Comlekcioglu, S., Elgudayem, F., Nogay, G., Kafkas, N.E., Ayed, R.B., Ercisli, S., Assouguem, A., Almeer, R., Najda, A. (2022). Biochemical characterization of six traditional olive cultivars: A comparative study. *Horticulturae*, 8(5), 416.
[30] Özdemir, Y., Tangu, N.A., Yavaş, H., Güven, E. (2016). Functional and sensory properties and shelf life determination of olive oil of different clones of Gemlik cultivar. *Gıda*, 41(4), 205-212.
[31] Köseoğlu, O., Güngör, F. Ö., Kaya, Ü., Çamoğlu, G., Akkuzu, E., Sevim, D., Aşık, Ş. (2025). Effect of different irrigation treatments on quality and antioxidant compounds of virgin olive oils from cv.“Memecik”. *Akademik Gıda*, 23(2), 91-100.
[32] Gorzynik-Debicka, M., Przychodzen, P., Cappello, F., Kuban-Jankowska, A., Marino Gammazza, A., Knap, N., Wozniak, M., Gorska-Ponikowska, M. (2018). Potential health benefits of olive oil and plant polyphenols. *International Journal of Molecular Sciences*, 19(3), 686.
[33] Cicerale, S., Lucas, L., Keast, R. (2010). Biological activities of phenolic compounds present in virgin

olive oil. *International Journal of Molecular Sciences*, 11(2), 458-479.

[34] Özdel, M. M. (2025). The impact of climate change on olive agriculture in Türkiye: Determination of vulnerability and adaptation strategies. Balıkesir University Graduate School of Social Sciences Department of Geography Ph. D. Thesis. Date accessed: 24.12.2025. https://tez.yok.gov.tr/UlusalTezMerkezi/TezGoster?key=P3dtmmHrq-mzEcmCLi1CqS0jBzzV7kTPzeXQeF4oD9r7B3Ij-vZ-T-Oe1skkS4pb.