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# Investigation of Radioactivity Concentration in Olive Oil

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## ABSTRACT
It is obvious that healthy eating will only be with healthy foodstuffs, and the foods consumed can affect social life and religious life in addition to physical and mental health. The concentration of radioactivity that may be in basic foodstuffs such as oil can increase the dose rate taken with food. In the study, no measurable U-238, Ra-226, Th-232, K-40, Cs-137 and Cs-134 concentrations were found in olive oils obtained from olives grown in Osmaniye, Düziçi and Erzin regions. The absence of measurable radionuclide concentrations in olive oils is a positive result. It is a desirable property that the olive oil that people consume as food is clean and does not contain radioactivity.

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## Zeytinyağında Radyoaktivite Konsantrasyonun İncelenmesi

## ÖZET
Sağlıklı beslenmenin, ancak sağlıklı gıda maddeleri ile olacağı aşikar olup tüketilen gıdalar, beden ve ruh sağlığının yanında, sosyal hayatı ve dini yaşamı etkileyebilmektedir.Yağ gibi temel gıda maddelerinde olabilecek radyoaktivite konsantrasyonu, besinler ile alınan doz oranını arttırabilir. Yapılan çalışmada Osmaniye, Düziçi ve Erzin bölgelerinde yetiştiriciliği yapılan zeytinlerden elde edilen zeytinyağlarında, ölçülebilir U-238, Ra-226, Th-232, K-40, Cs-137 ve Cs-134 konsantrasyonuna rastlanılmadı. Zeytin yağlarında ölçülebilir radyonüklid konsantrasyonuna rastlanılmaması olumlu bir sonuçtur. İnsanların gıda olarak tükettiği zeytinyağının temiz ve radyoaktiviteden arı olması istenen bir özelliktir.

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## INTRODUCTION

Living things need nutrients to survive. Although plants produce the nutrients they need, humans cannot. They take it ready from the outside. Foods taken can affect an individual's physical and mental health, even his social life and personality (Kahraman, 2012). In this regard, the content of the foods taken is very important. In daily life, basic foodstuffs such as flour and oil form the basis of other foods. More or less fat is used in the preparation of almost every food. Oils can be of vegetable or animal origin.

Olive is the fruit of the 'Olea europaea' tree from the 'Oleaceae' family. The homeland of olive, a typical Mediterranean plant, is Anatolia. Over time, it spread to Greece, Italy, Africa, Spain, France and America. Today, it is cultivated between 25-45 north and 15-35 south latitudes (Öztürk, Yılmaz and Özer, 2020). The olive tree blooms in March-May. Olive fruits reach the size of hazelnuts in mid-August. The color of the olive fruit is green at first and turns black as it ripens. The ripening of olive fruits can be followed with the color change in the fruits. As the ripening increases in olive fruits, the oil content in the fruits also increases. When there is no green fruit left on the tree, the oil content reaches the highest level (Menduh, 2015). Olive oil is obtained from olive fruits by physical methods such as pressing, centrifugation and filtration. The color of the oil can vary from clear green to yellow. The oil has a unique smell and taste (Öztürk, Yılmaz and Özer, 2020). Since olive oil is produced from olive fruits without chemical processing, it can be consumed like fruit juice. In addition, it ranks first among vegetable oils in terms of prefer ability (Canik, 2020).

Olive oil is defined as a physically obtainable, clear yellow colored, natural consumable product with a pleasant smell and taste. 98% of olive oil is free fatty acids and glycerides (major components), 2% is phenolic compounds, sterols, sequalene, triterpenes form pigments (minor components). Approximately 98% of the chemical composition of olive oil consists of saponifiable substances and 2% of non-saponifiable substances. Unsaponifiable (sterol, phenols, pigment, flavonoid, volatile components etc.) substances give flavor to olive oil. Since the minor components in olives differ according to the species, there are also differences in olive oil quality. There are many factors that affect the quality of olive oil. The quality of olive oil may vary depending on factors such as the type of olive tree, growing conditions (climatic conditions of the region where it grows, precipitation, agricultural activities), harvesting, storage and processing of the olive fruit (Canik, 2020).

Radionuclides in the air, soil and water where the plant is located can pass to humans by means of plants and animals. The transition of radionuclides from soil to plant can vary considerably according to soil and plant types (Karahan, 1997). The reason for this difference is the soil's clay and organic matter content, pH and cation exchange capacity. The high clay content in the soil provides retention of cesium, reducing its uptake by the roots (Karataşlı and Özer, 2017). In the literature review, it was seen that studies were conducted to determine natural radionuclides in soil, water and food. Distribution of terrestrial radio nuclides in surface soil samples in Osmaniye province and its surrounding (Ugur *et al.*, 2013), measurement of environmental gamma radiation in Osmaniye (Özer *et al.*, 2018), radiation activity of peanuts grown in Osmaniye (Karataşlı and Özer, 2017), from Osmaniye Heavy metal and basic elements found in the collected peanut samples (Kurnaz *et al.*, 2018) and the nutritional content of peanuts (Arachis hypogaea L.) grown in Adana province (Turfan *et al.*, 2018) were investigate. We could not find a study on determining the radioactivity of olive oil from the literature review. Considering the olive and olive growing potential of the region, it is aimed to contribute to the literature in determining the radioactivity of olive oil.

## MATERIALS and METHODS

Olive oil samples used in radioactivity measurements were obtained from olives produced in Osmaniye Korkut Ata University central campus, Düziçi Vocational School campus and in the garden of farmers in Erzin district of Hatay province in 2019. Three olive oil samples from each region were taken directly from the producer. Olive oils were kept in closed glass containers covered with aluminum foil in places that do not receive sunlight until the measurement and analysis. Before sending the oils in these containers to the laboratory for radioactivity analysis, approximately 400 g of each sample was placed in plastic containers and coded according to the location of the place where they were taken. Before the measurements were made, the samples were kept in suitable sample containers for one month under storage conditions in the laboratory for radioactive stability. Before the analysis, the energy and absolute efficiency calibration of the detector was made.

### Area of Investigation:

Osmaniye in southern Turkey, in the Çukurova region, at the foot of the Amanos Mountains, 20 km from the Mediterranean Sea, is 121 m above sea level. It is an Anatolian city established between 35 52' and 36 42' Eastern Meridians, 36 57' and 37 45' northern parallels. On the west side of the city, the Adana plain has plains extending to the east. In the south are Amanos Mountains (Gâvur Mountains) extending from Iskenderun Bay to the east, Taurus Mountains in the north and northwest direction, Dumanlı, Düldül and Tırtıl Mountains in the east. Height increases from south to north and east. Most of the surface shapes are available in Osmaniye (Çevre ve Şehircilik İl Müdürlüğü, 2019). The annual average temperature of the study area is Osmaniye 18.5, Düziçi 17.1 and Erzin (Hatay) 18.3 $^{0}$C (Canik, 2020). 77% of Osmaniye agricultural land is located in the center and 5% is in Düziçi district. 76% of olive production is done in the center and 2% in Düziçi district (Canik, 2020). Many agricultural products, including peanuts, wheat and olives, are grown in the city (Karataşlı and Özer, 2017). The number of olive trees planted in Osmaniye province, the amount of olives and olive oil produced is given in Table 1.

According to the 2020 TUIK data, 32.30% of olive oil, 62.49% of the table olives produced in the Eastern Mediterranean, where the provinces of Hatay, Kahramanmaraş and Osmaniye are located, were produced in the province of Osmaniye. Of table olives produced in Turkey 6.18%, 3.87% of the olive oil production is realized in Osmaniye. In terms of the number of olive trees, 20.8% of the olive trees in the Eastern Mediterranean region and 2.7% of the olive trees in Turkey are located in Osmaniye (TUİK, 2020). Table 1 clearly shows that the yield rate of table olives and olive oil grown in Osmaniye is higher than that of the region and Turkey.

As can be seen from Figure 1, the province of Osmaniye is located in the Taurus belt, between the Yumurtalık Fault and the Amanos Mountains. Figure 1-b shows the simplified geology of Osmaniye and the generalized stratigraphic columns of the geological units in the vicinity of Osmaniye. The stratigraphy of the province of Osmaniye and its surrounding area presents an accumulation extending from the lower Paleozoic to the upper Cretaceous, Eocene, Miocene and Plio-Quaternary. The Osmaniye region is one of the interesting aspects of the Taurus Mountains, as it has rock stratigraphic units representing all systems of the Cambrian-tertiary range. The stratigraphy of the province of Osmaniye and its surrounding area presents units from the lower Paleozoic to the upper Cretaceous, Eocene and Plio-quaternary. The middle-upper Devonian age, which forms the lower level of the Paleozoic units, consists of coral limestone, sandstone and silt stone-shale. Carbonates and ophiolite complex are observed in the Mesozoic unit (Ugur *et al.*, 2013).

Table 1. Olives and olive oil produced throughout the Eastern Mediterranean region and Turkey (TUİK, 2020)
*Çizelge 1. Doğu Akdeniz bölgesi ve Türkiye genelinde üretilen zeytin ve zeytinyağı*

| | Osmaniye (80) | Hatay, Kahramanmaraş, Osmaniye (TR63) | Turkey (TR) |
|---|---|---|---|
| Number of Table Fruiting Trees (Number) | 2 017 223 | 5 380 986 | 50 469 104 |
| Number of Fruit Trees for Olive Oil Production (Number) | 1 871 894 | 13 292 399 | 108 912 926 |
| Table Olive Number of Non-Fruiting Trees (Number) | 480.604 | 1 386 213 | 9 337 984 |
| The Number of Trees Without Fruit for Olive Oil Production (Number) | 654 288 | 4 085 182 | 18 443 238 |
| Table Olives Collective Fruit Orchards Area (decare) | 77 186 | 229 381 | 2 334 583 |
| Area of Collective Fruit Orchards for Olive Oil Production (decare) | 83 074 | 605 481 | 6 536 185 |
| Yield (Table Olive) | 16 | 9 | 10 |
| Yield (Olive Oil Production) | 17 | 7 | 7 |
| Table Olives Production Amount (Ton) | 31 703 | 50 735 | 513 140 |
| Production Amount for Olive Oil Production (Ton) | 31 089 | 96 261 | 803 486 |

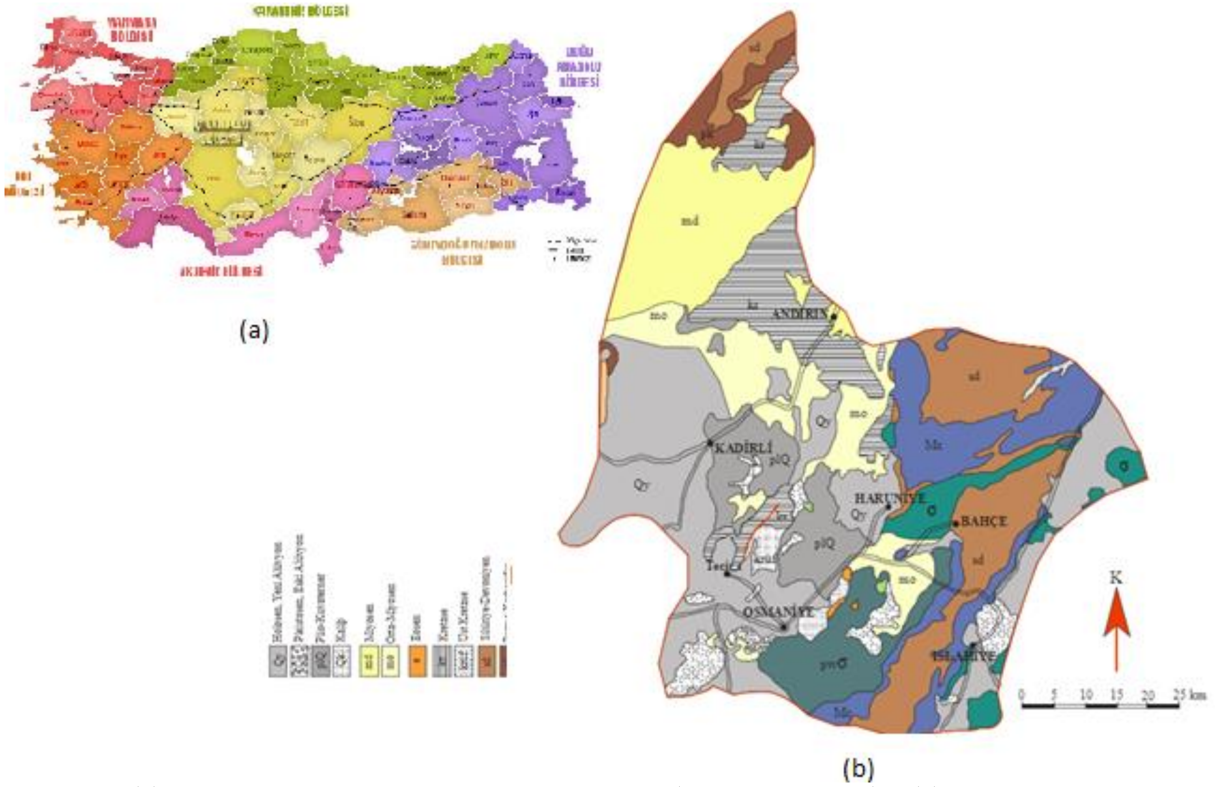


*Figure1. (a) Map of Turkey Provinces and Cities* (Anonim1, 2021)*, (b) Osmaniye Province Geological Map* (Karataşlı ve Özer, 2017; Anonim2, 2021)

Şekil 1. (a) Türkiye Bölgeler ve İller Haritası, (b) Osmaniye İli Jeoloji Haritası

## FINDINGS and DISCUSSION

The radioactivity analyzes of U-238, Ra-226, Th-232, K-40, Cs-137 and Cs-134 were performed using Gamma-Ray spectrometry analysis method in three olive oil samples taken from different parts of Osmaniye, Osmaniye Düziçi and Hatay Erzin regions. Measurements were made with Ortec GMX70P4-S

HPGe detector at Ankara University Nuclear Sciences Institute. The detector's efficiency percentage is set at 78.5%. Olive oil samples prepared were taken in Marinelli bottles. The radioactivity concentration unit was determined in Bq / kg. The amount and times of samples taken for analysis are given in Table 2.

Table 2 Mass and time values of olive oil samples used in radioactivity analysis
*Çizelge 2. Radyoaktivite analizinde kullanılan zeytin-yağı örneklerinin kütle ve süre değerleri*

| Zone | Mass (g) | Duration (s) |
|---|---|---|
| Osmaniye | 387.05 | 248 690 |
| Düziçi | 374.45 | 338 469 |
| Erzin | 372.77 | 259 099 |

Radioactivity concentration values of olive oil samples taken from three different regions of Osmaniye, Düziçi and Hatay Erzin were determined below the MDA criteria and at an acceptable level for health. The radioactivity results of the substances U-238, Ra-226, Th-232, K-40, Cs-137 and Cs-134 are given in Table 3. Measurable activity concentrations of radionuclides in olive oil samples were not found. Therefore, it was not necessary to calculate the annual effective dose in order to determine the radioactive risk value. In the literature study, no study was found to determine the radioactivity concentration of olive oil. However, studies to determine radioactivity concentrations on soil, water and peanuts have been carried out before in the study area. These studies are important in terms of giving an idea to the reader. Therefore, the concentration values in soil, peanut and black nuts are given in Table 3. The MDA shown in Table 3 represents the Minimum measurable activity value. MDA values for the device used in this study: 0.6 Bq / kg (Ra-226), 0.7 Bq / kg (Th-232), 0.35 Bq / kg (K-40), 0.1 Bq / kg. (Cs-137), 0.1 Bq / kg (Cs-134) and 1.7 Bq / kg (U-238).

Table 3 Activity concentrations in olive oil samples (Bq / kg)
*Çizelge 3. Zeytinyağı örneklerinde aktivite konsantrasyonları (Bq/kg)*

| **Sample Area** | | **U-238** | **Ra-226** | **Th-232** | **K-40** | **Cs-137** | **Cs-134** |
|---|---|---|---|---|---|---|---|
| Osmaniye | This work | <MDA | <MDA | <MDA | <MDA | <MDA | <MDA |
| Osmaniye Düziçi | This work | <MDA | <MDA | <MDA | <MDA | <MDA | <MDA |
| Hatay Erzin | This work | <MDA | <MDA | <MDA | <MDA | <MDA | <MDA |
| Osmaniye Düziçi | Peanut [a] | -- | 7.6±1.0 | 3.2±1.0 | 289.6±5.5 | <MDA | -- |
| Rize Pazar | Blackberry [b] | -- | 5.17±0.28 | 0.87±0.21 | 234.81±10.95 | 0.27±0.01 | -- |
| Osmaniye | Soil [c] | 10.4 | -- | 12.2 | 243.4 | -- | -- |

[a] (Karataşlı and Özer, 2017), [b] (KIRIŞ, 2019), [c] (Ugur *et al.*, 2013)

When Table 3 is examined, it is seen that the Th-232 activity concentration is 12.2 in the soil sample taken from Osmaniye and 3.2 Bq / kg in the peanut taken from Osmaniye-Düziçi, but less than 0.7 Bq / kg in olive oil. This situation is a normal and understandable result. We cannot expect a linear relationship for every radioisotope in the transition to olive oil. After all, the chemical behavior of U and Th and other elements are different. Therefore, it is extremely normal that the activity in olive oil and peanut is lower than the value in the soil where these plants are grown. When the literature is reviewed, it is seen that these discussions were made in tea samples after the Chernobyl nuclear accident, and even theses were prepared on this subject. For example, it has been determined that the activity of Cs-137, Cs-134 that passes into the tea according to the brewing conditions (time, temperature, etc.) of the tea and even the amount of potassium (K-40 activity) taken by the tea plant with the intention of fertilizer (nutrient) has been found to change. Demirel (1990) examined the transition of Cs-137 activity in the soil to wheat, barley, bean, lettuce, corn and grass plants in his doctoral thesis. In the study carried out, the East Black Sea region teas containing Cs-137 activity were given to the soil and it was observed that the Cs-137 activity was transferred to the plants between 0.041% and 1.057% in the measurements made on wheat, barley, corn, lettuce, beans and grasses grown in this soil (Demirel, 1990). The activity in the soil did not pass to the plants linearly, it varied from plant to plant. In this respect, the study is in accordance with the literature.

The most valuable aspect of this study is that the olive oil that people consume as food is clean and free from radioactivity. In addition, Cs-137 in peanuts is also very low and a good result that is desired to be under MDA.

## CONCLUSION

Natural and artificial radioactivity in the regions where people live and in the environments where plants and animals are grown can adversely affect human health. Today show increased consumption of olive oil, studies towards recognition of olives and olive oil produced in Turkey has made it important to examine the radioactivity concentration. As a result of the analysis, the radioactivity concentrations of U-238, Ra-226, Th-232, K-40, Cs-137 and Cs-134 in olive oil samples were determined to be lower than the MDA values. The fact that the radioactivity concentrations in the olive oil samples used in the study are below acceptable levels is seen as positive for the olive and olive oil production in the region.

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### Researchers' Contribution Rate Statement Summary

The authors declare that they have contributed equally to the article.

### Conflict of Interest Statement

The article authors declare that there is no conflict of interest between them.

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