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Profile and total content of phenolics and antioxidant activity of commercial table olives from Turkey

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RESEARCH ARTICLE

Abstract

Phenolic compounds, total phenolic content and antioxidant activity of five commercial table olives (Domat, Edremit green, Kalamata, Edremit black and Gemlik) from Turkey were investigated. Quantitative analysis of phenolic compounds was done by high-performance liquid chromatography and 11 compounds were identified in table olives. The major phenolic compounds detected in olive samples were hydroxytyrosol and tyrosol, respectively. In general, Domat type table olive had higher levels of phenolic compounds, while dry salted Gemlik olives were poor in phenolic compounds compared to other table olives. Total phenolic content of the olive samples (wet basis) range between 229.12 and 415.34 mg caffeic acid/100 g. Antioxidant activity of olives (wet basis) was not related to their phenolics content, the latter showing more variation depending on the olive type. Domat olives (10.01 μmol Trolox equivalents/g) had significantly (P<0.05) higher antioxidant activity than the other table olives.

Keywords: antioxidant activity, hydroxytyrosol, phenolic compounds, table olive, Gemlik

1. Introduction

Phenolic compounds, also referred as polyphenols, are wide and complex group of secondary metabolites derived from shikimic acid pathway and phenylpropanoid metabolism (Ryan *et al.*, 1999a). Chemically, they are possessing at least one aromatic ring which is attached one or more hydroxyl groups and can vary from simple phenolic molecules to highly polymerised compounds (Balasundaram *et al.*, 2006; Shahidi and Naczk, 1995). Nowadays, there is a growing interest in phenolic compounds because of their multiple biological effects such as antioxidant activity, anti-inflammatory, anti-allergic, antimicrobial and anticancer activities (Huang *et al.*, 2010; Ignat *et al.*, 2011; Owen *et al.*, 2000; Shahidi and Naczk, 1995; Wong *et al.*, 2010). Antioxidant activity of phenolic compounds is related to their ability to scavenging free radicals, chelating transition-metals involved in free radical production and inhibiting the enzymes participating in free radical generation (Aruoma, 2003; Hensley *et al.*, 2004). Phenolic compounds are widely found in plant-derived foods and constitute an essential part of the human diet (Kris-Etherton *et al.*, 2002; Motilva *et al.*, 2013).

The olive and olive products are good sources of biologically active phenolic compounds (Boskou *et al.*, 2006; Cicerale *et al.*, 2010; Montano and Casado, 2005). The olive fruit, a basic ingredient of the Mediterranean diet, is the most widespread and economically important agricultural product in Mediterranean countries, especially in Spain, Italy, Greece and Turkey. The positive effects on human health of olive products, beside the unsaturated fatty acid content rich in oleic acid, are related to phenolic compounds (Charoenprasert and Mitchell, 2012; Sakouhi *et al.*, 2011). Ben Othman *et al.* (2008) reported that the consumption of 50 g of table olives provides about 152 mg of phenolic compounds. Recent findings support that olive phenolic compounds have *in vitro* and *in vivo* antioxidant activity (Owen *et al.*, 2000). In addition to contributing to high antioxidant levels, phenolic compounds give olives important characteristics and properties, such as colour, taste and texture (Marsilio *et al.*, 2001). Phenolics include thousands of compounds with different chemical structures and can basically be classified into different groups (Motilva *et al.*, 2013). There are at least thirty different simple and complex phenolic compounds have been identified in table olives (Ben Othman *et al.*, 2008; Boskou *et al.*,

2006; Malheiro *et al.*, 2012; Marsilio *et al.*, 2001). The most important classes of phenolic compounds present in olives are phenolic acids, phenolic alcohols, flavonoids and secoiridoids (Esti *et al.*, 1998; Vinha *et al.*, 2005). Phenolic acids consist of two classes: (1) hydroxybenzoic acids such as gallic, p-hydroxybenzoic, protocatechuic, vanillic and syringic acids; and (2) hydroxycinnamic acids such as caffeic, ferulic, p-coumaric and sinapic acids (Bravo, 1998). Hydroxytyrosol and tyrosol are the major phenolic alcohols present in olive fruits (Ben Othman *et al.*, 2008; Blekas *et al.*, 2002). Flavonoids found in olive are luteolin-7-glucoside, cyanidin-3-glucoside, cyanidin-3-rutinoside, rutin, apigenin-7-glucoside, quercetin-3 rhamnoside, and luteolin (Vinha *et al.*, 2005). Phenolic compounds of secoiridoids class in olive include oleuropein, demethyloleuropein, and ligstroside (Servili *et al.*, 1999; Sivakumar *et al.*, 2005). Oleuropein, a bitter component, is generally the most prominent phenolic compound in olive fruit and its concentration decreases with fruit maturation and give rise to hydroxytyrosol and other simple phenolic compounds (Amiot *et al.*, 1986; Esti *et al.*, 1998; Ryan *et al.*, 1999b).

The main purpose of table olive processing is to make olives palatable and acceptable to the consumers by completely or partially removing the bitter taste of the olive fruit. There are many table olive processing methods, depending on olive cultivar, degree of ripeness, fruit size, processing technology, cultural and traditional factors (Therios, 2009). The most commonly used methods to process olives are: (1) Spanish-style green olives in brine; (2) Greek-style naturally black olives in brine; (3) Californian black ripe olives; and (4) Gemlik-style naturally fermented black olives in dry salt (Uylaser and Yıldız, 2014). Processing methods affect both the content and profile of the phenolic compounds in table olives (Brenes *et al.*, 1995; Marsilio *et al.*, 2001).

Several studies have presented phenolic composition, total phenolic content and antioxidant activity of olives from different countries, including Turkey (Aktas *et al.*, 2014; Blekas *et al.*, 2002; Dağdelen *et al.*, 2013; Keceli, 2013; Lanza *et al.*, 2013; Pistarino *et al.*, 2013; Sahan *et al.*, 2013; Sezai, 2009; Soufi *et al.*, 2014). In addition, while the phenolic content of olive oil has been under investigation for many years (Arslan and Özcan, 2011; Franco *et al.*, 2014; Gençer *et al.*, 2009; Gouvinhas *et al.*, 2014; Owen *et al.*, 2000; Visioli *et al.*, 1998), the phenolic compounds of table olives have not been studied to the same extent. As far as we know, there is no study available regarding to phenolic composition of commercial table olives commonly consumed in Turkey. From this point, the purpose of this work was to determine phenolic compounds of different table olives obtained from Turkish markets. Antioxidant activity and total phenolic content of table olives were also investigated.

2. Materials and methods

Materials

In this study, five widely consumed commercial types of Turkish table olives (Domat, Kalamata, Edremit green, Edremit black and Gemlik) which were separated according to preparation method were chosen. Three samples for each type of commercial ready-to-eat table olive samples that belong to the 2010 olive harvest season were purchased directly from the local markets in Bursa, Turkey in 2011, where they were packed in plastic bags and stored at room temperature. Basic characteristics of the studied table olives are listed in Table 1 along with their processing techniques. Domat olives with green-yellow surface colour were harvested by beginning of October. Olives treated with a dilute sodium hydroxide solution (2-5%, w/v) and then washed in tap water for removing of sodium hydroxide completely. Domat olives were brined (10%, w/v) where they undergo a typical lactic acid fermentation and packed in brine as whole. To prepare to Kalamata olive, fruits were harvested when its colour turned from pink to purple (beginning of November) and to remove the bitter taste, olives were placed in brine consisting 2-3% salt. The brine was changed every day or every two days until the bitter taste was removed. Afterwards, olives were placed in vinegar together with brine (8-10%, w/v) and required sour and taste was provided. At the end of this period, olives were packed with 8% brine as whole. Edremit olives were used for Edremit black and Edremit green table olives. Fully ripened Edremit black olives were harvested at the end of

Table 1. Basic characteristics of commercial table olives.

Type	Cultivar	Processing technique	Characteristics	Olive harvest location	Moisture content (%)
Domat	Domat	Spanish type	Large, green olives stored in brine	Manisa-Akhisar	64.82
Kalamata	Kalamata	Kalamata type	Large, elongated olives with a red-brown colour stored in brine	İzmir-Ödemiş	64.64
Edremit green	Edremit	scratched	Small, scratched olives with a green colour stored in brine	Balıkesir-Ayvalık	62.72
Edremit black	Edremit	naturally fermented	Small black olives in brine and packing with oil	Balıkesir-Ayvalık	46.76
Gemlik	Gemlik	dry salted	Intermediate olives with a black colour	Bursa-Gemlik	54.33

November and placed directly into the brine (8-10%, w/v) for fermentation and packed with oil as whole. Edremit green olives, which were harvested between October and November, scratched on 2 or 3 sides and placed in water and the water was changed every other day to remove bitter taste. Olives, in which bitter taste was removed, were transferred to the fermentation tanks and brines salt ratio was increased progressively and reaches to 5-6%. After the fermentation, olives were packed with brine (8-10%, w/v) as whole. Gemlik variety olives were harvested in the middle of December and placed in basket as of one layer olive and one layer big salts in the rate of 15 kg salt for 100 kg olive. Gemlik olives were became edible after 3-4 weeks and packed as whole.

Chemicals

High-performance liquid chromatography (HPLC) grade methanol, acetic acid, and hexane were purchased from Merck (Darmstadt, Germany). The phenolic compound standards (hydroxytyrosol, tyrosol, protocatechuic acid, p-coumaric acid, cinnamic acid, syringic acid, caffeic acid (CA), ferulic acid, 4-hydroxybenzoic acid, 4-hydroxyphenlyacetic acid and vanillic acid) were supplied from Sigma-Aldrich (St. Louis, MO, USA) and Fluka Chemie GmbH (Buchs, Switzerland). The chemicals Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) and Folin-Ciocalteu's phenol reagent were obtained from Merck; and 2,2-diphenyl-1-picrylhydrazyl (DPPH) was from Sigma-Aldrich.

Preparation of sample extracts

Table olive extracts for phenolic compounds analysis were prepared based on the method described by Arslan and Özcan (2011) with some modifications. The extracts obtained by homogenizing 15 g of olive flesh in 20 ml of 80% aqueous methanol until uniform consistency, using Ultra-Turrax homogeniser (T25 Digital; Ika Works Inc., Wilmington, NC, USA). The homogenates were centrifuged at 15,000×*g* at 4 °C for 10 min (Sigma 3K30; SciQuip Ltd., Newtown, UK). The pellet was re-extracted as above and obtained extracts were combined. The collected supernatants washed with hexane (2×10 ml), in order to remove the lipid fraction. After separation of hexane phase, the phenolic compounds extracts were passed through 0.45 µm prior to HPLC analysis. The extracts obtained were used also for total phenolic content and antioxidant activity determination of table olive samples.

Determination of total phenolic content

Total phenolic contents were analyses with Folin-Ciocalteu's phenol reagent method, based on Singh *et al.* (2002). First, 0.3 ml of methanolic extracts diluted at a 1:10 ratio was added to 1.5 ml Folin-Ciocalteu reagent (diluted at a 1/10 ratio). The mixture was allowed to react for 5 min then 1.2 ml 1 M sodium carbonate solution was added. The mixture was vortexed for 5 sec and incubated in the darkness at room temperature for 90 min. Absorbance values of samples were measured at 765 nm (Optizen 3220 UV; Mecasys, Daejeon, Republic of Korea). The calibration curve was prepared with CA and the results were expressed as CA equivalents (mg CA/100 g) on wet basis.

Determination of antioxidant activity

The DPPH radical scavenging assay was done according to the method of Boskou *et al.* (2006) with minor modifications. The DPPH radical was dissolved in methanol to a concentration of 6×10^{-5} M. 3 ml of methanolic solution of DPPH radical was added to 1 ml of 3 mg/ml concentration of methanolic extracts from the table olive samples. The tubes were vortexed for 15 to 30 sec and allowed to stand in the dark at room temperature for 60 min. Then the decrease in absorbance at 515 nm was recorded in Optizen 3220 UV spectrophotometer (Mecasys). The standard curve was prepared using different concentrations of Trolox and the antioxidant activity of each sample was expressed in terms of µmol Trolox equivalents (TE)/g on wet basis.

HPLC analysis of phenolic compounds

Analyses of the phenolic composition of table olives were conducted using a Flexar HPLC system (PerkinElmer, Waltham, MA, USA) equipped with a diode array detector and a 4.6 mm × 250 mm i.d., 5 µm particle size, reversed-phase C18 column (PerkinElmer ODS-2). The solvent system consisted of water:acetic acid (98:2, v/v) as solvent A and methanol as solvent B, starting with 5% methanol and installing a gradient to obtain 15% B at 5 min, 20% B at 15 min, 25% B at 27 min, 30% B at 37 min, 35% B at 43 min, 40% B at 53 min, 50% B at 58 min, 60% B at 60 min and 100% B at 74 min. The column was maintained at 30 °C, the flow rate was set at 1 ml/min with injection volume of 40 µl and the detection was performed at 280 and 320 nm. Phenolic compounds were identified and quantified by comparison of their retention times those of standards and were expressed as mg/100 g on wet basis.

Statistical analysis

The data were analysed using the JMP (Version 7.0; SAS Institute Inc., Cary, NC, USA) software program. Values are given as the mean ± standard deviation of three measurements. Mean differences were tested with a least significant difference test at a 5% level of significance.

3. Results and discussion

Total phenolic content and antioxidant activity of table olives

The total phenolic content and antioxidant activity of studied table olives are presented in Figure 1 and 2. The total phenolic content of the table olives ranged 229.12 mg CA/100 g in Edremit green olives to 415.34 mg CA/100 g in Domat olives. There was no significant difference between Domat and Edremit black (405.98 mg CA/100 g); Kalamata (229.01 mg CA/100 g) and Gemlik (277.86 mg CA/100 g); and Edremit green (229.01 mg CA/100 g) and Gemlik olives (P>0.05). Total phenolic values obtained by the HPLC method were lower than those estimated by the Folin-Ciocalteu method. The lower total phenolic content of samples could be explained by that some phenolic compounds may escape determination by chromatography (Santos-Buelga and Scalbert, 2000). In addition, this difference may have resulted from interference of other reducing substance in the colorimetric Folin-Ciocalteu method (Ben Othman *et al.*, 2009; Schieber *et al.*, 2001). Ben Othman *et al.* (2008) estimated the total phenolic content in black table olives as 219-459 mg gallic acid/100 g, in green olives as 329-461 mg gallic acid/100 g and in dry salted black olives as 144 mg gallic acid/100 g.

Among all table olives studied, Domat olives (10.01 μmol TE/g) had the highest antioxidant activity, and Gemlik olives (6.49 μmol TE/g) had the lowest antioxidant activity. There were no significant differences between antioxidant activity among the Edremit green (7.38 μmol TE/g) and Kalamata (7.38 μmol TE/g) olives (P>0.05). Antioxidant activity of table olives follows the order: Domat > Kalamata > Edremit black > Edremit green > Gemlik olives. Hydroxytyrosol is known as nutritionally important phenolic compound belonging to o-diphenol group with the special antioxidant activity. The antioxidant activity of hydroxytyrosol is related to its ability to improve radical stability. Domat olives showed the highest hydroxytyrosol content and Gemlik olives had the lowest hydroxytyrosol content (Table 2). Several authors have reported that antioxidant activity of olives related to their hydroxytyrosol levels (Gonzales-Hidalgo *et al.* 2012; Issaoui *et al.* 2011). The antioxidant activity of the olive samples were proportional to their total

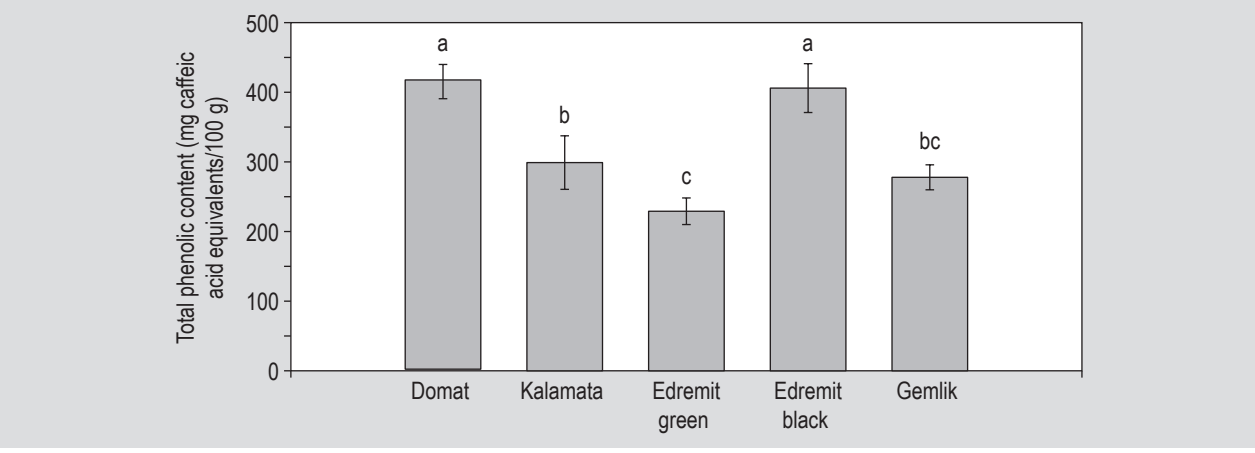

Figure 1. Total phenolic content of table olives (wet basis). Bars with different letters are significantly different (P<0.05).

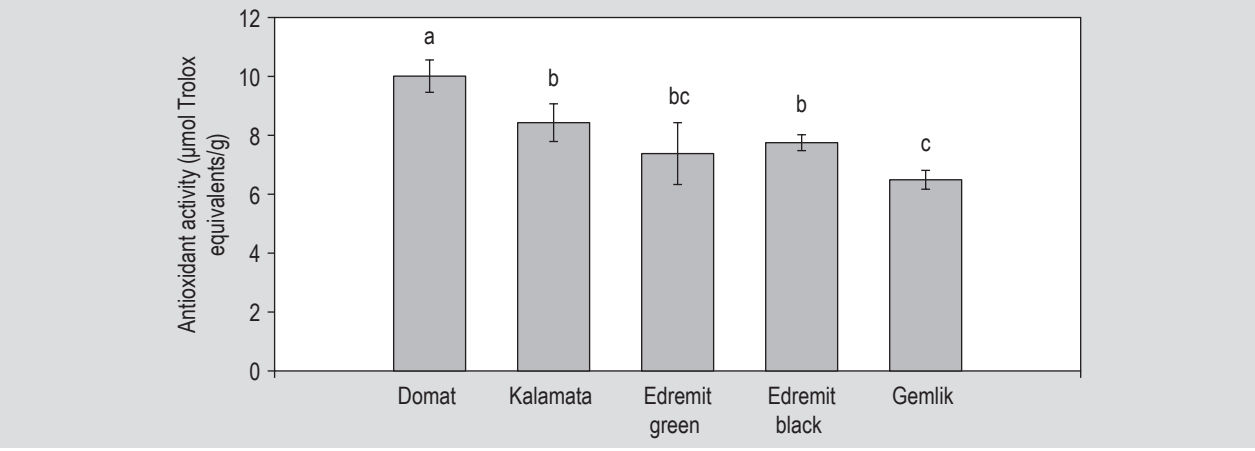

Figure 2. Antioxidant activity of table olives (wet basis). Bars with different letters are significantly different (P<0.05).

Table 2. Phenolic profile of table olives expressed in mg/100 g on wet basis.[1]

Phenolic compound	Retention time (min)	Domat	Kalamata	Edremit green	Edremit black	Gemlik
Hydroxytyrosol	9.76	61.10±0.60^{a}	47.02±0.53^{b}	15.64±0.34^{d}	43.03±0.53^{c}	9.71±0.24^{e}
Tyrosol	11.17	29.36±0.96^{a}	16.86±0.82^{c}	16.54±0.50^{c}	21.45±1.44^{b}	8.46±0.09^{d}
4-hydroxybenzoic acid	14.06	4.23±0.11^{a}	3.59±0.20^{b}	0.29±0.04^{c}	0.13±0.04^{cd}	Nd
4-hydroxyphenlyacetic acid	18.79	Nd[2]	Nd	Nd	3.09±0.11^{a}	Nd
Vanillic acid	22.12	5.25±0.10^{b}	6.06±0.28^{a}	0.05±0.02^{e}	2.61±0.15^{c}	0.59±0.10^{d}
Syringic acid	23.74	0.07±0.02^{c}	0.64±0.06^{a}	Nd	0.14±0.03^{b}	Nd
Protocatechuic acid	25.62	17.18±0.37^{a}	0.86±0.10^{e}	2.76±0.10^{d}	8.99±0.31^{b}	3.85±0.11^{c}
p-coumaric acid	28.43	5.28±0.27^{a}	5.39±0.10^{a}	0.09±0.03^{c}	5.53±0.47^{a}	0.35±0.08^{b}
Caffeic acid	31.86	13.99±0.07^{a}	Nd	Nd	2.44±0.14^{b}	0.47±0.04^{c}
Ferulic acid	35.69	Nd	5.65±0.16^{a}	4.07±0.11^{b}	3.14±0.17^{c}	Nd
Cinnamic acid	60.33	0.35±0.07^{a}	0.07±0.02^{cd}	0.24±0.04^{b}	0.15±0.07^{c}	Nd
Total		136.81	86.14	39.68	90.7	23.43

[1] Means with different superscript letters in the same row differ significantly (P<0.05).
[2] Nd = not detected.

phenolic contents, except Edremit green and Gemlik olives. Gemlik olives had higher phenolic content according to Folin-Ciocalteu method than Edremit green olive samples while Gemlik olives showed a lower antioxidant activity than Edremit green olives (P>0.05). This result might be caused by lower percentage of humidity as well as the lower content of hydroxytyrosol. DeJong and Lanari (2009) noted that the there was a positive relationship between phenolic content and antioxidant activity. In contrast, Boskou *et al.* (2006) reported that table olive sample that showed highest polyphenol content did not exhibited highest antioxidant activity. Thus, phenolic content and antioxidant activity of table olives depend on processing technique and cultivar.

Phenolic compounds profile of table olives

The quantities of phenolic compounds in five different commercial table olives are reported in Table 2. There were significant differences in phenolic compounds among table olives. Among the identified phenolic compounds hydroxytyrosol, tyrosol, vanillic acid, protocatechuic acid and p-coumaric acid were detected in all table olive samples. Hydroxytyrosol and tyrosol were major phenolic compounds identified in methanolic extracts, which was also stated in previous studies (Ben Othman *et al.*, 2008; Boskou *et al.*, 2006; Brenes *et al.*, 1995). The amount of hydroxytyrosol ranged from 9.71 to 61.10 mg/100 g, corresponding to Gemlik and Domat, respectively. Green Domat table olives contain significantly much higher concentrations of hydroxytyrosol than either black table olives or Kalamata table olive (P<0.05). This compound results from the hydrolysis of oleuropein, which is the main phenolic compound in unprocessed olive fruits. The debittering process in table olive production is aim to remove the natural bitterness of fruit, caused by the oleuropein (an ester of hydroxytyrosol with elenoic acid glucoside) (Charoenprasert and Mitchell, 2012). Debittering process causes diffusion of phenolic compounds and other soluble constituents from the fruit to the water, brine or lye and *vice versa*. When lye is used sodium hydroxide and constituents with carboxylic and hydroxyl groups react and the hydrophilic derivatives are washed away. Oleuropein and verbascoside are hydrolyzed to a great extent during the lye treatment. Acid hydrolysis of hydroxytyrosol, tyrosol and luteolin glycosides takes place during the fermentation in brine when naturally black olives are prepared. Thus, the prevailing phenols in table olives are hydroxytyrosol, tyrosol, luteolin and phenolic acids (Blekas *et al.*, 2002; Boskou *et al.*, 2006). The phenolic alcohol hydroxytyrosol, becomes the major phenolic compound in the final product (Brenes *et al.*, 1995). Black dry salted Gemlik type olive had the lowest hydroxytyrosol and in general was poor in phenolic compounds, when compared to other table olives. This could be explained by during dry salting process important water loss occurred that lead to high water solubility hydroxytyrosol decrease in olive. Boskou *et al.* (2006) reported the following hydroxytyrosol levels: 22-66 mg/100 g in black table olives (Kalamon, Amfissa, and Tsakistes), 114 mg/100 g in green table olives (Crete) and 2 mg/100 g in varicoloured table olives (Throubes Crete). According to another study, hydroxytyrosol levels (on dry basis) were ranged between 219.8-283.2 mg/100 g in green table olives, 35.55-83.34 mg/100 g in black table olives and 85.78 mg/100 g in varicoloured table olive. In addition, hydroxytyrosol is not detected in dry salted table olive (Ben Othman *et al.*, 2008). Other phenolic alcohol tyrosol is a hydrolysis product of ligstroside and it is less abundant than hydroxytyrosol. The highest tyrosol content

was observed in the Domat, which had 29.36 mg/100 g. The tyrosol and hydroxytyrosol contents reported by Rodriguez *et al.* (2009) with ranged from 90-195 mg/kg and 278-543 mg/kg, respectively, for Kalamata olives; and 41 mg/kg and 25-116 mg/kg, respectively, for black dry salted olives (Thassos).

Domat type olives contained the highest cinnamic acid (0.35 mg/100 g) compared to the other table olive types ($P<0.05$). Cinnamic acid was not detected in Gemlik type olive. Vanillic acid is a one of the primary phenolic acid present in olives. The vanillic acid levels of the table olives ranged from 0.05 mg/100 g in Edremit green olives to 6.06 mg/100 g in Kalamata olives. All studied table olives also contained phenolic acids: protocatechuic acid (0.86-17.18 mg/100 g) and p-coumaric acid (0.09-5.53 mg/100 g). The samples with significantly higher syringic acid content were obtained from Kalamata (0.64 mg/100 g) olives ($P<0.05$). 4-hydroxybenzoic acid level was significantly higher ($P<0.05$) in the Domat type olives (4.23 mg/100 g). This phenolic acid was not detected in Gemlik olives. Other phenolic acids detected in some of five table olives were CA (0.47-13.99 mg/100 g) and ferulic acid (3.14-5.65 mg/100 g). However, 4-hydroxyphenlyacetic acid was detected only in Edremit black olive with 3.09 mg/100 g.

Compared to previous studies, differences were observed on both quantitative and qualitative fractions of phenolic compounds in the studied commercial table olives. There are many factors that can affect the phenolic composition of table olives including the cultivar (Malheiro *et al.* 2012; Romero *et al.*, 2004; Vinha *et al.*, 2005), maturation degree (Ben Othman *et al.*, 2009), irrigation regimes (Romero *et al.*, 2002) and importantly, the methods used for curing and processing table olives. Ben Othman *et al.* (2009) investigating the changes in simple phenolic compounds during olive processing of Chetoui cultivar and reported that both spontaneous and controlled fermentations led to an important loss of total phenolic compounds, with a reduction rate of 32-58%. According to the results of this study, the hydroxytyrosol (in black olives increased from 165 mg/100 g to 312 and 380 mg/100 g on dry basis after spontaneous and controlled fermentations, respectively) and CA concentrations increased, whereas the protocatechuic acid, ferulic acid, and oleuropein (in green olives decreased from 266 mg/100 g to 30.7 and 16.1 mg/100 g on dry basis after spontaneous and controlled fermentation, respectively) concentrations decreased after fermentation.

Processing methods influenced the phenolic composition of olives via hydrolysis of phenolics that can be catalysed either chemically (as with base or acid) or with enzymes (e.g. glycosidases), oxidation of phenolic compounds by phenoloxidases and polymerisation of free phenolics. In present study obtained results showed that there were differences among the phenolic composition of the commercial table olives depending on type. Green Domat olives showed much higher concentration of phenolic compounds (except vanillic and syringic acid) than other table olives can be attributed to cultivated variety, maturation degree of olives and debittering process (in a sodium hydroxide solution) that was used for this olive type. Morello *et al.* (2004) reported that the phenolic content of olives decreases during maturation. However, Edremit green olives showed lower amounts of phenolic compounds from Edremit black olives, which are producing same cultivar. These significant differences between Edremit green and Edremit black olives can be strongly related to scratching process (applied in Edremit green olive production). In addition higher phenolic compound levels (except ferulic acid) in Green Domat table olives than Edremit green olives can be explained by different cultivar and the scratching process which is simplify the diffusion of phenolic compounds of the olive fruit to the brine. Obtained data on table olives may also vary according to brine (and vinegar concentration) due to soaking solution extracted a significant concentration of phenolic compounds.

4. Conclusions

There are differences among the both quantitative and qualitative phenolic profile according to olive cultivar, maturation degree and processing method. Domat olives appear to be the most important source of both phenolic compounds and antioxidants. The main phenolic compounds were hydroxytyrosol and tyrosol. Furthermore, difference in phenolic profile of table olive influenced the antioxidant activity and total phenolic content. In addition, there was no direct relationship between the phenolic acids content and the antioxidant activity in the five types of olives tested. Since the growing interest in natural phenolic compounds in recent years, obtained results provide evidence about table olives. However, in order to complement these findings, further studies would be needed on the bioavailability these olive phenolic compounds and on consumer preferences. In addition, further studies on the effects of location and processing methods on the phenolic composition of table olives that are producing same cultivar are under investigation.

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