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ARTICLE

3,4-Dihydroxyphenylglycol (DHPG): An Important Phenolic Compound Present in Natural Table Olives

Guillermo Rodríguez, Antonio Lama, Sara Jaramillo, José María Fuentes-Alventosa, Rafael Guillén, Ana Jiménez-Araujo, Rocío Rodríguez-Arcos, and Juan Fernández-Bolaños*

Departamento de Biotecnología de los Alimentos, Instituto de la Grasa (CSIC), Avenida Padre García Tejero 4, Apartado 1078, 41012 Sevilla, Spain

The presence of 3,4-dihydroxyphenylglycol (DHPG) was studied in 32 samples and 10 different cultivars of natural table olives, using an accurate method to avoid wrong quantification. Hydroxytyrosol (HT), tyrosol, and verbascoside were also quantified, as these four compounds comprise the majority of the chromatographic profile. Analyses were carried out by HPLC-DAD-UV after extraction of all phenolics, and hydroxytyrosol was the major component in nearly all samples. High levels of DHPG (up to 368 mg/kg of dry weight) were found in the pulp of natural black olives independent of cultivar and processing method, similar to its concentration in the brine in almost all of the samples. The presented data for this antioxidant indicate that natural table olives are a rich source of DHPG and hydroxytyrosol, compounds with interesting nutritional and antioxidant properties.

KEYWORDS: Natural table olives; hydroxytyrosol; 3,4-dihydroxyphenylglycol; phenolics; HPLC analysis; antioxidants

INTRODUCTION

The consumption of table olives is a widespread tradition in the Mediterranean basin. The nutritive benefits of olive fruit are related to unsaturated fatty acid content rich in oleic acid (*1*), dietary fiber (2−5 g/100 g of edible portion) (*2*), proteins (*3*), minerals (*4*), antioxidants [provitamin A carotenoids (*5*) and α-tocopherol (*1*,*6*)], and considerable amounts of polyphenols (*7*). There is increasing interest in olive phenolic compounds. They present significant free radical and reactive oxygen species scavenging properties that may contribute to the prevention of coronary heart diseases and certain kinds of cancer (breast, colon) (*8*, *9*).

Fresh olives are subjected to fermentation or cured with lye or brine to make them more edible. Numerous studies about the initial phenolic content and the changes during processing in olive oil and table olives have been carried out (*10*−*13*). Undoubtedly, processing of olives changes the profile of phenolic compounds and therefore both the organoleptic properties and the antioxidant capacity of the final product. Also, the final content of phenolics in the pulp depends on cultivar and maturation of the fruit (*7*, *14*−*16*). In addition, there are several studies about the quantity and quality of phenolic compounds in table olives, which show hydroxytyrosol and tyrosol as major phenols present in the final product (*7*, *13*, *17*−*22*). However, there are only a few studies that show 3,4-dihydroxyphenylglycol (DHPG) in table olives (*23*), despite the importance that this compound may have from quantitative and nutritional points of view (**Figure 1**).

*Corresponding author (telephone 34-954691054; fax 34-954691262; e-mail jfbg@cica.es).

Recently, our research group has demonstrated the strong antioxidant activity of DHPG, even higher than that of hydroxytyrosol (*24*). We have also reported that the quantities of recovered DHPG, in free or bound forms, in olive drupe tissue (212−1300 mg/kg of wet pulp) (*25*) exceed widely the values indicated in the literature (125 mg/kg of wet pulp for unprocessed olive) (*23*). This compound was also described as a component of vegetation water of the olive fruit (*26*), and it has been recently detected in olive oil (*27*). However, DHPG has not been reported or recognized as an important phenolic compound in table olives (2−24 mg/kg of wet pulp) (*23*, *28*).

The more frequently used procedures for the extraction, separation, and identification of phenolic compounds from olives by reversed phase HPLC (*29*−*32*) may play an important role in the estimated low levels of DHPG. In this investigation, the appearance of two peaks when pure DHPG is injected in alcoholic medium has been demonstrated.

The metabolic or biosynthetic origin of this antioxidant is unclear because it has never been reported as a free plant metabolite. Nevertheless, compounds recently identified in olive tissues, such as dimers composed of hydroxytyrosol-DHPG or tyrosol-DHPG, isolated and identified in olive mill wastewater (*33*), or two diastereoisomers of β-OH-acteoside (*34*) or the 2″-hydroxyoleuropein (*35*) are good candidates of possible DHPG precursors.

DHPG seems to be unstable due to the alkali treatment (reported during DHPG purification process from byproduct of the olive-processing industry, Spanish patent request no. P200803630) that is commonly used in the two most important industrial preparations of table olives, Spanish-style green olives and California-style oxidized black olives. For this reason, the

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present study has dealt with table olives processed without chemical treatment and naturally fermented. In recent years, this type of olive treated according to natural systems has progressively gained the favor of consumers and is increasing their industrial production (*36*).

The aim of this study is to determine the levels of valuable DHPG in different types of natural table olives and to examine if these table olives are a good source of this antioxidant, contributing in this way to their nutritional properties.

MATERIALS AND METHODS

Samples. Thirty-two samples of natural table olives were purchased from local markets in Seville, Spain. Eight different olive cultivars from Spain, particularly suitable for table olives, and two important cultivars from Greece were studied. Samples were selected according to market availability and packaging date from eight different companies.

The characteristics of the olive samples studied are presented in **Table 1**. All samples were treated according to the natural system, as most were processed by natural fermentation in brine, according to the Greek-style of olives. Apart from black mature fruit, with distinct organoleptic characteristics and high oil content, naturally turning color and green olives have also been studied, many of them proceeding from ecological (biological) production. A mixed microflora of bacteria and yeast is required for the fermentation process, although the traditional system, under anaerobic conditions, is driven primarily by yeast due to the high salt content utilized (8−14%) (*21*, *37*).

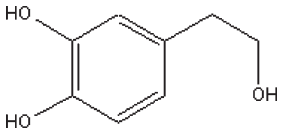

Figure 1. Chemical structure of 3,4-dihydroxyphenylglycol (DHPG).

Empeltre and Cuquillo cultivars are typically used for olive oil production, but their use as table olives is increasing in Spain. They are processed as small black olives, with a low pulp/stone ratio of approximately 2, although they are appreciated for their flavor. The Empeltre variety, known as Aragon or Bajo Aragon table olives, is utilized in the form of olive paste or pâté (sample 7E) and is packed with or without brine.

Samples 27A and 28A in **Table 1** represent a traditional table olive elaboration known as a broken "seasoned" Aloreña table olive. These olives are typically prepared after being broken, with the addition of a natural product (i.e., garlic, paprika, aromatic herbs) at the beginning of their preparation.

Thassos table olives are known as naturally black dry-salted olives. These fully ripe fruits are debittered by the gradual effect of high osmotic pressure exerted by alternating layers of dry salt. A significant loss of water is produced by this process, so the final product appears wrinkled and is fully edible (*38*).

Kalamata olives are the second most important variety used in the production of Greek table olives. They are a special type of Greek-style black olive in brine. Incisions are made in the fruits lengthwise and the brine is changed two or three times each day during a 5−8 day period. The olives are then preserved in virgin olive oil and wine vinegar (*17*). These samples had the highest pulp/stone ratios and medium water content.

Manzanilla and Hojiblanca cultivars are most commonly used in Spain for table olive production as green (Spanish-style) or ripe (California-style), although the samples utilized in our study for natural fermentation had the highest water content and a very low pulp/stone ratio of 2−4, whereas they typically have a pulp/stone ratio of 5−8.

Pulp/Stone Ratio and Humidity Content. Table olives (20−30 fruits per sample) were weighed, the pulp was separated from the stone, and then the two components were weighed separately to calculate the pulp/stone ratio. Next, the pulp was crushed in an Ultraturrax for 2 min

Table 1. Characteristics of Natural Table Olive Samples

sample	cultivar	type of table olive	style and characteristics	humidity %	pulp/stone ratio
1E	Empeltre	Aragon olives in brine	small black in brine, flavored with vinegar, from ecological farming	52	1.63
2E	Empeltre	Aragon olives in brine	small black in brine, flavored with vinegar, from ecological farming	52	2.14
3E	Empeltre	Aragon olives in brine	small black in brine, flavored with vinegar, from ecological farming	52	1.85
4E	Empeltre	Aragon olives in brine	small black in brine, flavored with vinegar, from ecological farming	52	1.84
5E	Empeltre	Aragon olives in brine	small black in brine, flavored with vinegar, from ecological farming	52	1.63
6E	Empeltre	Aragon olives in brine	small black in brine, flavored with vinegar, from ecological farming	50	1.20
7E	Empeltre	Aragon olives in brine	black olives pâté	45	
8E	Empeltre	Aragon olives in brine	black, packing without liquid	52	1.29
9E	Empeltre	Aragon olives in brine	black, packing without liquid	51	1.94
10E	Empeltre	Aragon olives in brine	small black, packing without liquid	43	1.57
11E	Empeltre	Aragon olives in brine	black, flavored with virgin olive oil, garlic, onion, oregano, thyme, paprika	58	4.51
12E	Empeltre	Aragon olives in brine	black, flavored with virgin olive oil, garlic, onion, oregano, thyme, paprika	59	3.42
13K	Kalamata	Kalamata olives in brine	black, incised, flavored with virgin olive oil, wine vinegar	63	4.90
14K	Kalamata	Kalamata olives in brine	black, incised, flavored with virgin olive oil, wine vinegar	64	4.10
15K	Kalamata	Kalamata olives in brine	black, incised, flavored with virgin olive oil, wine vinegar	66	4.80
16T	Thassos	black dry-salted olives	wrinkled, packing without liquid	31	2.29
17T	Thassos	black dry-salted olives	wrinkled, packing without liquid	28	2.56
18T	Thassos	black dry-salted olives	wrinkled, packing without liquid	22	2.23
19T	Thassos	black dry-salted olives	wrinkled, packing without liquid	20	2.45
20T	Thassos	black dry-salted olives	wrinkled, packing without liquid	18	1.94
21C	Cuquillo	naturally black olives in brine	small, flavored with wine vinegar, aromatic herbs	57	1.94
22C	Cuquillo	naturally black olives in brine	small, flavored with wine vinegar, aromatic herbs	53	2.69
23C	Cuquillo	naturally black olives in brine	small black in brine	52	2.20
24Co	Cornicabra	naturally black olives in brine	incised, flavored with wine vinegar, aromatic herbs	68	2.63
25H	Hojiblanca	naturally black olives in brine	plain, flavored with wine vinegar, aromatic herbs	70	3.95
26H	Hojiblanca	naturally turning color olives in brine	plain, flavored with vinegar, oregano, cumin, pimento, from ecological farming	70	2.45
27A	Aloreña	broken "seasoned" turning color olives	broken, flavored with paprika, aromatic herbs	70	5.52
28A	Aloreña	broken "seasoned" turning color olives	broken, flavored with wine vinegar, aromatic herbs	72	3.44
29Ma	Marteña	naturally turning color olives in brine	incised, flavored with wine vinegar, aromatic herbs	72	5.00
30Mz	Manzanilla	naturally turning color olives in brine	plain, flavored with vinegar, oregano, garlic, from ecological farming	75	2.01
31Mz	Manzanilla	naturally green olives in brine	plain, flavored with aromatic herbs	77	1.82
32V	Verdial	naturally green olives in brine	incised, flavored with vinegar, pimento, garlic, from ecological farming	62	7.45

for determination of humidity. A 15 g sample of crushed olive pulp was then dried in an air stove at 80 °C until constant weight was achieved.

Extraction of Phenolic Compounds. Phenolic compounds were analyzed in the brine and juice of olive pulp after a mild aqueous extraction. Then, 5−7 g of homogeneous olive paste was mixed with 10−15 mL of water. After 30 min of stirring at room temperature, an aliquot of the suspension was added to an Eppendorf (1.5 mL capacity) and centrifuged at 12000 rpm for 5 min. Approximately 0.5 mL of the juice was then separated from the oil with a pipet, centrifuged at 12000 rpm for 10 min, and then passed through a 0.45 μm nitrocellulose filter. A 20 μL aliquot was directly analyzed by RP-HPLC. All extracts were made in duplicate.

The corresponding brines were analyzed directly after centrifugation at 12000 rpm and filtration through a 0.45 μm filter.

The aqueous extraction procedure previously described was compared with the procedure described by Servili et al. (*29*), conducted in a methanol/water extraction. Briefly, 10 g of olive paste was extracted six times with 20 mL of methanol/water (80:20). The samples were blended at maximum speed for 2 min and then filtered through filter paper. The extracts were then combined, and the solvent was evaporated under reduced pressure 30 °C. Each methanol-free fraction was collected and adjusted to 10 mL with water in a volumetric flask. Finally, each extract was filtered through a 0.45 μm pore size filter and analyzed by RP-HPLC.

HPLC Analysis of Phenolic Compounds. For sample analysis the phenolic compounds were detected and quantified by HPLC using a reverse phase column, 250 × 4.6 mm i.d., RP-18, particle size = 5 μm, Spherisorb ODS-2 (Tecnokroma, Barcelona, Spain). Separation was achieved by a gradient elution using a mobile phase of 20 mM trifluoroacetic acid in water (pH 2.5) and acetonitrile, ranging from 5 to 25% acetonitrile over 30 min.

Besides the previous one another two different HPLC method were used for the study of the two DHPG peaks that were observed when the pure compound was analyzed in an ethanolic or methanolic solution. On the one hand, the detection and quantification of pure DHPG were carried out under conditions similar to those described above on a 250 × 4.6 mm i.d., RP-18, particle size = 5 μm, Lichrospher 100 (Merck, Darmstadt, Germany). On the other hand, a 250 × 4.6 mm i.d., RP-18, particle size = 4 μm (Phenomenex, Macclesfield, Cheshire, U.K.) reverse phase column and another gradient elution were employed. For the Phenomenex column the gradient profile was formed using solvent A [10% (v/v) aqueous acetonitrile plus 2 mL/L acetic acid] and solvent B (40% methanol, 40% acetonitrile, 20% water, plus 2 mL/L acetic acid) with the following setup: the proportion of B was increased from 10 to 42.5% for the first 17 min and then returned to the initial conditions in 5 min. The injection volume was 20 μL, the flow was 1 mL/min, and the temperature was set at 30 °C. Chromatograms were recorded at 280 and 320 nm.

Phenolics were detected using Hewlett-Packard series 1100 and Jasco-LC-Net II ADC liquid chromatography systems equipped with diode array detectors (DAD) and Rheodyne injection valves (20 μL loop). The identification of the chromatographic peaks was made by comparison of the retention times with those of reference compounds and by recording the UV spectra of the peaks in the range of 200−360 nm. Quantification was carried out by integration of peaks at 280 nm for DHPG, hydroxytyrosol, and tyrosol and at 320 nm for verbascoside, with reference to calibrations made using external standards (regression curve in triplicate with $r^2 \geq 0.99$). DHPG and tyrosol were purchased from Sigma-Aldrich Química (Madrid, Spain); verbascoside was provided by Extrasynthese S.A. (Lyon Nord, Genay, France); and hydroxytyrosol was isolated from olive oil waste (*39*).

RESULTS AND DISCUSSION

DHPG is a very polar compound and, therefore, the procedures frequently used for the extraction of polyphenols from olives with methanol, ethanol, or a water/alcohol mixture are not adequate to extract DHPG. To achieve optimal extraction

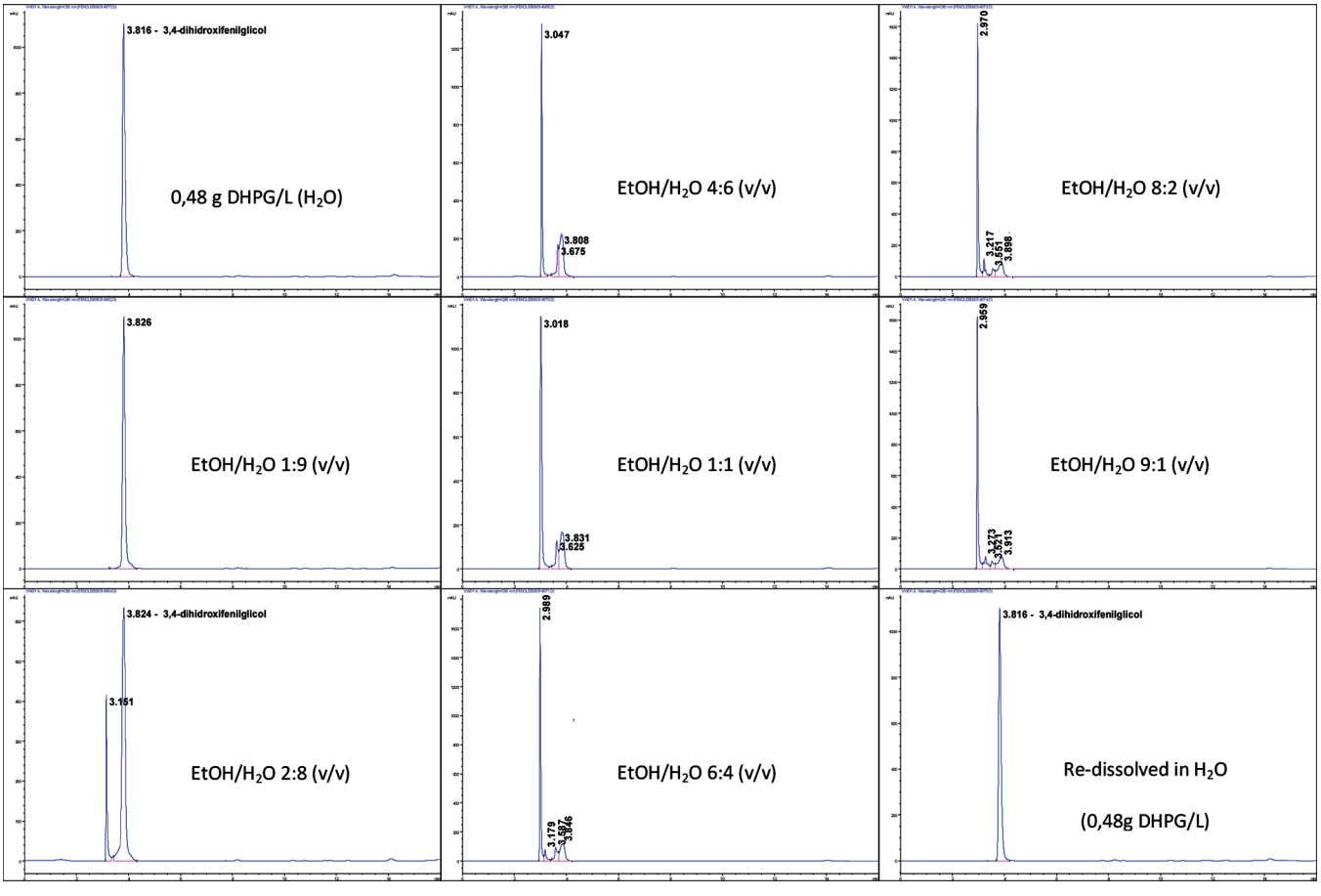

Figure 2. HPLC chromatograms at 280 nm of pure dihydroxyphenylglycol (DHPG) in ethanolic solutions: evolution of DHPG peak to increasing concentrations of ethanol and when redissolved in water.

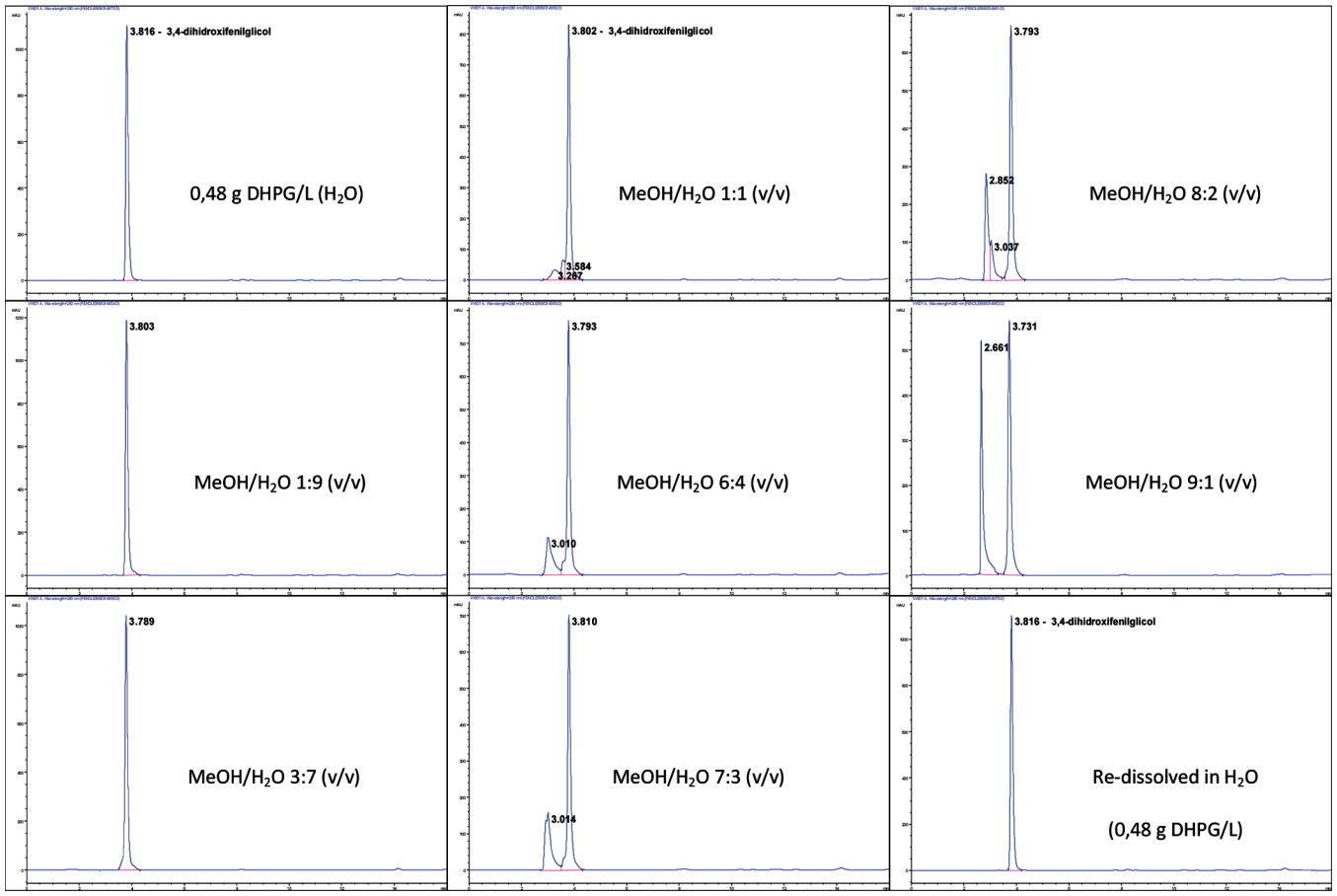

Figure 3. HPLC chromatograms at 280 nm of pure dihydroxyphenylglycol (DHPG) in methanolic solutions: evolution of DHPG peak to increasing concentrations of methanol and when redissolved in water.

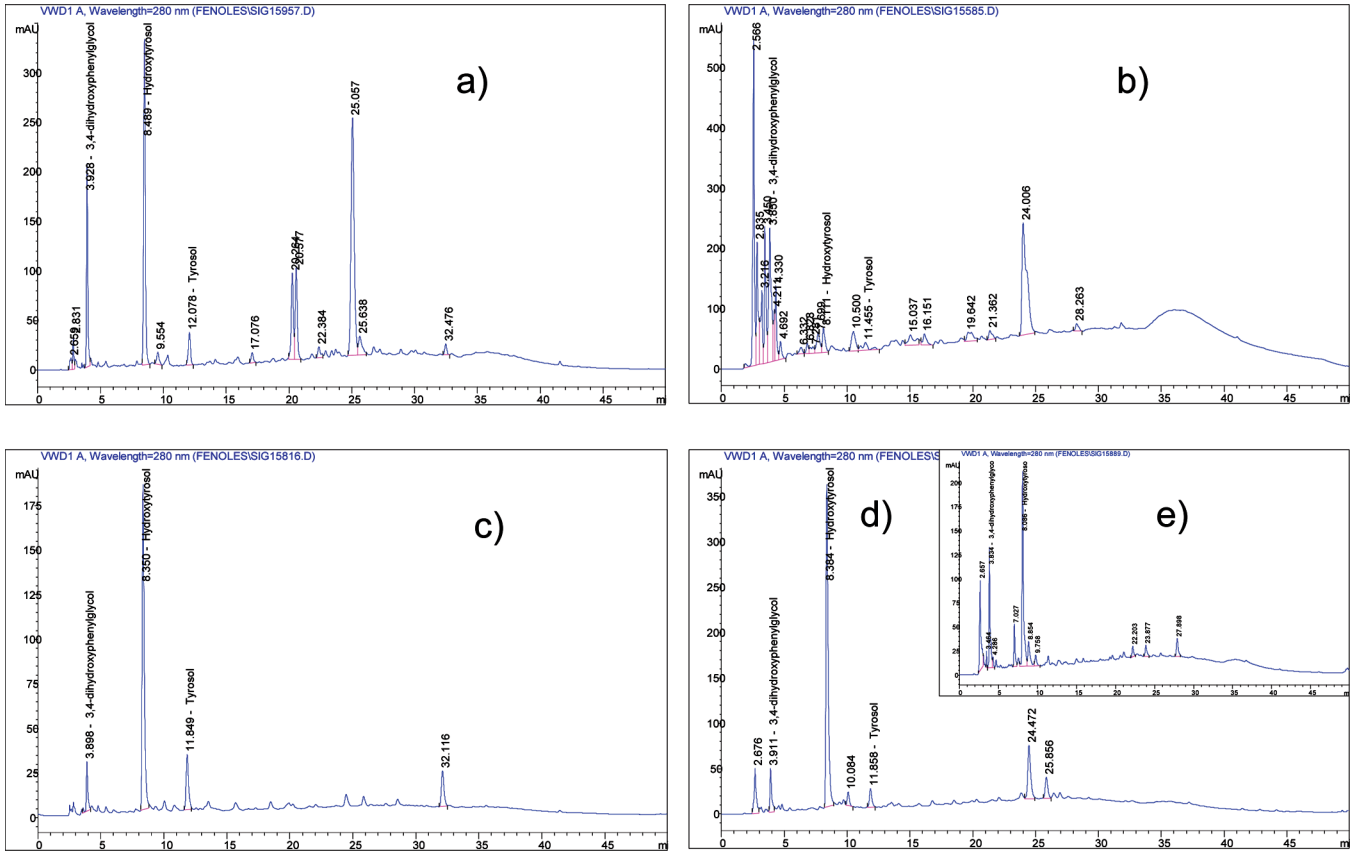

Figure 4. HPLC phenolic profile of Cuquillo (**a**), Thassos (**b**), Kalamata (**c**), and Aragon olives in brine (**d**) or in pâté (**e**) samples. Detection was at 280 nm.

Table 2. Levels of Dihydroxyphenylglycol (DHPG), Hydroxytyrosol (HT), Tyrosol, and Verbascoside in Fresh and Dry Olive Pulp[a] and Their Relationship to HT/DHPG

	[DHPG]		[HT]		[tyrosol]		[verbascoside]		
sample	mg/kg of fw	mg/kg of dw	mg/kg of fw	mg/kg of dw	mg/kg of fw	mg/kg of dw	mg/kg of fw	mg/kg of dw	HT/DHPG ratio
1E	53	110	471	982	64	133	81	168	8.9
2E	177	368	367	762	74	154	33	69	2.1
3E	61	127	418	871	48	100	115	240	6.8
4E	49	102	395	823	40	83	174	362	8.1
5E	51	107	404	842	31	64	56	117	7.9
6E	52	100	450	900	89	178	80	160	8.6
7E	106	193	271	493	nd	nd	nd[b]	nd	2.6
8E	60	124	593	1235	56	117	nd	nd	9.9
9E	32	66	592	1208	35	70	110	224	18.5
10E	147	259	199	350	34	60	51	89	1.4
11E	50	120	540	1286	82	194	nd	nd	10.8
12E	32	79	142	347	26	63	nd	nd	4.4
13K	28	75	543	1467	195	526	67	180	19.4
14K	13	36	449	1248	105	291	33	92	34.5
15K	34	99	278	819	90	266	nd	nd	8.2
16T	232	336	56	82	41	60	nd	nd	0.24
17T	223	309	116	161	nd	nd	nd	nd	0.52
18T	127	163	65	84	nd	nd	nd	nd	0.51
19T	94	117	112	140	nd	nd	nd	nd	1.2
20T	45	55	25	31	nd	nd	nd	nd	0.53
21C	97	227	601	1397	55	129	359	835	6.2
22C	171	353	685	1457	100	212	nd	nd	4.0
23C	139	290	317	660	60	125	nd	nd	2.3
24Co	43	134	257	803	nd	nd	37	117	6.0
25H	42	140	496	1653	31	105	230	765	11.8
26H	21	69	764	2547	70	235	24	78	36.4
27A	8	26	318	1059	99	328	nd	nd	39.7
28A	8	31	203	725	51	183	60	213	25.4
29Ma	11	39	589	2103	55	195	nd	nd	53.5
30Mz	12	50	971	3883	141	565	25	98	80.9
31Mz	12	54	310	1349	63	274	nd	nd	25.8
32V	11	30	652	1716	128	336	150	395	59.3

[a] Values are the means of duplicate analyses; the coefficient of variation is <7%. fw, fresh weight; dw, dry weight. [b] nd, not detected.

conditions, the DHPG content was evaluated using two different extraction solvents (water and methanol) at room temperature. Under our study conditions, water was determined to be the most effective solvent for DHPG, at a solubility of 124 mg of DHPG/kg of dry pulp, significantly higher than the 74 mg of DHPG/kg of dry pulp reached by using an aqueous methanolic solution.

The use of ethanol/methanol to redissolve samples prior to injection could therefore cause an underestimation of DHPG. Many researchers redissolve the polyphenolic extract in a mixture of methanol/H_2O (1:1, v/v) (*18*) or ethanol/H_2O (7:3, v/v) (*40*) or in 100% methanol (*16*, *19*, *32*) prior to injection. The chromatographic peaks of synthesized DHPG (commercial) and purified DHPG from olive oil mill waste (patent pending) were divided into two peaks or even distorted when injected as a redissolved solution in ethanol/methanol. This was not observed when DHPG was redissolved in water.

To this end, the influence of various concentrations of methanol and ethanol was therefore studied (**Figures 2** and **3**). The DHPG peak was divided in two at concentrations above 20% ethanol or 40% methanol. Furthermore, the initial peak of DHPG nearly disappeared at low ethanol levels (40%). Nevertheless, when ethanol or methanol was evaporated and the DHPG was redissolved in water, the DHPG chromatogram profile returned to its initial form. The UV spectra of the two peaks were identical. First, we hypothesized that this could be a mobile phase or column problem, but the double peaks were also detected with three different brands of C18 reverse-phase columns and for two different elution solvents. As such, a specific interaction between DHPG and ethanol or methanol must be present, leading to an underestimation of the levels of this compound.

Analyses of phenolic compounds in the different table olives were performed on samples from both brine and olive juice. The phenolic chromatograms of the studied samples indicated different profiles. The following profiles were most representative: Aragon olives in brine, black olive pâté, Kalamata olives in brine, Thassos black dry-salted olives, and Cuquillo naturally black olives in brine (**Figure 4**). The various processing treatments, based on spontaneous fermentation in brine, may produce changes in the phenolic composition of the processed fruits. This and the fact that some analyzed samples come from different companies explain why samples belonging to the same cultivar, having the same ripening degree, have different phenolic profiles. Their HPLC-DAD analyses subsequently revealed that the primary phenols identified and quantified in brine and juice were DHPG, hydroxytyrosol, tyrosol, and verbascoside (**Tables 2** and **3**). The presence of hydroxytyrosol and tyrosol glucosides was also detected in some samples. Hydroxytyrosol was the major phenolic compound found in all samples apart from the Thassos cultivars, which had significantly lower levels of hydroxytyrosol, in agreement with previous studies (*7*, *13*, *17*, *20*−*22*, *40*). However, this is the first time that the presence of high DHPG concentrations has been reported in natural olives. Low values in the ratio HT/DHPG indicate a good presence of this phenolic compound in table olives.

The levels of DHPG found in all samples of natural black olives, independent of cultivar type or processing method, were higher than in natural turning color or natural green olives. The

Table 3. Dihydroxyphenylglycol (DHPG), Hydroxytyrosol (HT), Tyrosol, and Verbascoside Contents[a] of Natural Table Olive Brine and Juice

	[DHPG] (μmol L^{-1})		[HT] (μmol L^{-1})		[tyrosol] (μmol L^{-1})		[verbascoside] (μmol L^{-1})	
sample	brine	juice	brine	juice	brine	juice	brine	juice
1E	611	599	4683	5877	543	890	94	250
2E	1810	1998	3749	4566	615	1028	56	102
3E	429	688	3425	5215	427	673	102	354
4E	517	552	4904	4930	449	550	125	266
5E	588	582	4028	5040	427	666	96	173
6E	470	588	4268	5838	391	644	nd	256
7E	–[c]	1387	–	3911	–	nd	–	nd
8E	–	676	–	7394	–	782	–	nd
9E	–	370	–	7531	–	492	–	344
10E	–	2016	–	3010	–	579	–	189
11E	517	511	4930	6039	767	1020	nd	nd
12E	270	323	1349	1563	166	318	nd	nd
13K	247	259	4923	5585	1527	2236	99	170
14K	106	118	4313	4553	1064	1187	32	83
15K	259	300	2400	2821	695	992	nd	nd
16T	–	4402	–	1170	–	963	–	nd
17T	–	4672	–	2692	–	nd	–	nd
18T	–	3403	–	1920	–	nd	–	nd
19T	–	2762	–	3633	–	nd	–	nd
20T	–	1469	–	915	–	nd	–	nd
21C	940	1005	5098	6837	673	702	459	1009
22C	172	1892	5650	8380	514	1360	nd	nd
23C	113	1569	4450	3950	410	832	nd	nd
24Co	311	370	2504	2452	224	nd	61	88
25H	253	353	4514	4599	362	326	259	525
26H	170	176	6726	6824	615	1491	51	387
27A	65	65	2945	2945	745	1020	nd	nd
28A	71	71	1816	1849	550	514	74	133
29Ma	94	88	5195	5306	434	550	nd	nd
30Mz	100	100	7933	8393	1020	1361	27	53
31Mz	65	94	1784	2614	398	593	nd	nd
32V	88	106	6181	6824	1114	1491	245	387

[a] Values are the means of duplicate analyses; the coefficient of variation is <7%. [b] nd, not detected. [c] –, samples without brine.

values of the latter (8–21 mg of DHPG/kg of fresh weight) were close to those reported by Marsilio et al. (*23*, *28*) for the green Ascolana variety (2–26 mg of DHPG/kg of fresh weight) and, therefore, the highest DHPG values were observed in Thassos and Empeltre cultivar samples. These values significantly exceeded the trace–125 mg of DHPG/kg of fresh weight reported by Marsilio et al. (*23*, *28*) for unprocessed olives of Ascolana variety in a number of our samples (samples 2E, 10E, 16T, and 17T). The ratio HT/DHPG in all of the black olive samples was below 20 and well below 10 for the majority of the samples, varying from 0.2 to 1.2 in Thassos cultivars. However, in turning color or green olives, the ratio ranged from 25 to 81. According to these results, the highest proportion of DHPG found in these samples appears to be more related to the level of ripeness of the olive than to the cultivar or the processing method, although the specific concentrations of each compound varied across seasons. Therefore, further studies comparing ripeness and season within the previously established parameters are required to further elucidate these differences.

The data in **Table 3** indicate that whereas DHPG and HT contents were very similar in the brine and olive juice of nearly all samples examined, the tyrosol (1.5-fold) and verbascoside (2–7-fold) contents in olive juice were significantly higher than in brine. During the natural olive processing and/or the period of packing for commercial preparation, a diffusion of polar phenolic compounds from the pulp into the brine takes place. Equilibrium between brine and pulp for the most polar compounds (HT and DHPG) is established, so the analysis of phenols from brine is adequate for the quantification of these phenols in natural table olives.

To date, DHPG had not been reported as an important phenolic compound in any type of table olive. However, according to the results obtained in the present study, the naturally processed olives, especially black olives, are very good sources of this compound, which exhibits important antioxidant and radical scavenging properties (*24*). This quantity of additional phenolic compounds is in accordance with previously published data on the high quantities of DHPG recovered from olive drupe (*25*).

Today, consumers demand high-quality products with specific sensory and nutritional properties. Natural table olives comply with these requirements because they have appreciable organoleptic taste and are considered to be healthy from the point of view of both potential antioxidant phenolic composition and unsaturated fatty acid content. Data on the DHPG content in these important table olive preparations may be useful for nutritionists or consumers and will contribute directly to providing a better understanding of the contribution of olives to dietary antioxidant intake.

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