

**SUPPLEMENTARY INFORMATION:**

Evaluation of phenolic profile and antioxidant activity of eleven pistachio cultivars  
(*Pistacia vera* L.) cultivated in Andalusia

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**Table S1.** UHPLC-HRMS Characteristics of the polyphenols identified among pistachios varieties

RT (min)	Compound	Chemical Formula	[m/z] <sup>-</sup> Theoretical	Error (ppm)	MSIMI level <sup>a</sup>
<i>Hydroxybenzoic acids</i>					
3.27	Gallic acid	C <sub>7</sub> H <sub>6</sub> O <sub>5</sub>	169.0131	-1.18	1
3.49	Pyrogallol (Benzene-1,2-diol)	C <sub>6</sub> H <sub>5</sub> O <sub>3</sub>	125.0233	-0.80	1
3.8	Theogallin (3-Galloyl-quinic acid)	C <sub>14</sub> H <sub>16</sub> O <sub>10</sub>	343.0663	-0.87	2
6.48	3,4-Dihydroxybenzoic acid	C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	153.0182	-1.31	2
6.88	Galloylshikimic acid	C <sub>14</sub> H <sub>14</sub> O <sub>9</sub>	325.0554	3.38	2
8.75	Digallic acid	C <sub>14</sub> H <sub>10</sub> O <sub>9</sub>	321.0241	2.18	2
8.81	Methylgallic acid derivative I	C <sub>8</sub> H <sub>7</sub> O <sub>5</sub>	183.0287	1.64	2
11.88	Methylgallic acid derivative II	C <sub>8</sub> H <sub>7</sub> O <sub>5</sub>	183.0287	1.64	2
10.09	Vanillic acid hexoside	C <sub>14</sub> H <sub>18</sub> O <sub>9</sub>	329.0867	3.34	2
11.08	Ellagic acid	C <sub>14</sub> H <sub>6</sub> O <sub>8</sub>	300.9978	2.99	1
10.46	Benzoic acid derivative I	C <sub>8</sub> H <sub>7</sub> O <sub>4</sub>	167.0338	2.39	1
11.97	Benzoic acid derivative II	C <sub>8</sub> H <sub>7</sub> O <sub>4</sub>	167.0338	2.39	1
14.04	Benzoic acid derivative III	C <sub>8</sub> H <sub>7</sub> O <sub>4</sub>	167.0338	2.39	1
<i>Galloyl derivatives</i>					
2.67	Mono-galloyl-glucose I	C <sub>13</sub> H <sub>16</sub> O <sub>10</sub>	331.0659	3.02	2
6.63	Mono-galloyl-glucose II	C <sub>13</sub> H <sub>16</sub> O <sub>10</sub>	331.0659	3.02	2
3.6	Galloyl dihexose	C <sub>19</sub> H <sub>26</sub> O <sub>15</sub>	493.1188	0.20	2
8.46	Digalloyl hexose I	C <sub>20</sub> H <sub>20</sub> O <sub>14</sub>	483.0769	2.28	2
9.02	Digalloyl hexose II	C <sub>20</sub> H <sub>20</sub> O <sub>14</sub>	483.0769	2.28	2
9.05	Hydroxy-methoxyphenylgalloyl hexoside I	C <sub>20</sub> H <sub>22</sub> O <sub>12</sub>	453.1027	2.43	2
9.75	Hydroxy-methoxyphenylgalloyl hexoside II	C <sub>20</sub> H <sub>22</sub> O <sub>12</sub>	453.1027	2.43	2
9.96	Tetra-O-galloyl glucoside I	C <sub>34</sub> H <sub>28</sub> O <sub>19</sub>	787.0994	1.40	2
10.7	Tetra-O-galloyl glucoside II	C <sub>34</sub> H <sub>28</sub> O <sub>19</sub>	787.0994	1.40	2
11.23	Pentagalloylglucose	C <sub>41</sub> H <sub>32</sub> O <sub>26</sub>	939.1098	0.64	2
<i>Hydroxycinnamic acids</i>					
8.19	Chlorogenic acid I	C <sub>16</sub> H <sub>18</sub> O <sub>9</sub>	353.0867	0.28	1
9.17	Chlorogenic acid II	C <sub>16</sub> H <sub>18</sub> O <sub>9</sub>	353.0867	0.28	1
8.59	Ferulic acid derivative	C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	193.0516	1.55	1
9.02	Sinapic acid derivative	C <sub>11</sub> H <sub>12</sub> O <sub>5</sub>	223.0600	2.24	1
10.83	<i>p</i> -Coumaric acid	C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	163.0395	0.61	1

*Flavones*

8.65	Luteolin hexoside	C <sub>21</sub> H <sub>20</sub> O <sub>11</sub>	447.0921	1.79	2
14.27	Luteolin	C <sub>15</sub> H <sub>10</sub> O <sub>6</sub>	285.0393	3.16	1
11.14	Apigenin hexoside	C <sub>21</sub> H <sub>20</sub> O <sub>10</sub>	431.0972	1.16	2
13.71	Apigenin	C <sub>15</sub> H <sub>10</sub> O <sub>5</sub>	269.0444	3.35	2

*Flavonols*

10.87	Rutin	C <sub>27</sub> H <sub>30</sub> O <sub>16</sub>	609.145	0.82	1
10.35	Myricetin hexoside	C <sub>21</sub> H <sub>20</sub> O <sub>13</sub>	479.082	1.67	2
12.65	Myricetin	C <sub>15</sub> H <sub>10</sub> O <sub>8</sub>	317.0291	1.89	1
10.69	Quercetin hexoside I	C <sub>21</sub> H <sub>20</sub> O <sub>12</sub>	463.0871	1.73	2
11.15	Quercetin hexoside II	C <sub>21</sub> H <sub>20</sub> O <sub>12</sub>	463.0871	1.73	2
10.76	Quercetin galloyl glucoside I	C <sub>28</sub> H <sub>24</sub> O <sub>16</sub>	615.098	1.46	2
11.57	Quercetin galloyl glucoside II	C <sub>28</sub> H <sub>24</sub> O <sub>16</sub>	615.098	1.46	2
14.32	Quercetin	C <sub>15</sub> H <sub>10</sub> O <sub>7</sub>	301.0342	3.32	1
14.85	Isorhamnetin	C <sub>16</sub> H <sub>12</sub> O <sub>7</sub>	315.0499	4.76	1

*Flavan-3-ols*

6.72	Gallocatechin	C <sub>15</sub> H <sub>14</sub> O <sub>7</sub>	305.0655	3.61	2
8.81	Catechin	C <sub>15</sub> H <sub>14</sub> O <sub>6</sub>	289.0707	2.77	1
9.69	Epicatechin	C <sub>15</sub> H <sub>14</sub> O <sub>6</sub>	289.0707	2.42	2
9.82	Epigallocatechin gallate	C <sub>22</sub> H <sub>18</sub> O <sub>11</sub>	457.0765	0.44	1
11.18	Epicatechin gallate	C <sub>22</sub> H <sub>18</sub> O <sub>10</sub>	441.0816	2.27	1
12.05	Epiafzelechin 3-gallate	C <sub>22</sub> H <sub>18</sub> O <sub>9</sub>	425.0867	1.88	2
12.64	Afzelechin I	C <sub>15</sub> H <sub>14</sub> O <sub>5</sub>	273.0757	2.93	2
13.14	Afzelechin II	C <sub>15</sub> H <sub>14</sub> O <sub>5</sub>	273.0757	2.93	2
15.47	Afzelechin III	C <sub>15</sub> H <sub>14</sub> O <sub>5</sub>	273.0757	2.93	2

*Flavanones*

11.2	Eriodictyol hexoside	C <sub>21</sub> H <sub>22</sub> O <sub>11</sub>	449.1078	1.11	2
14.07	Eriodictyol	C <sub>15</sub> H <sub>12</sub> O <sub>6</sub>	287.055	2.79	2
12.18	Naringenin hexoside	C <sub>21</sub> H <sub>22</sub> O <sub>10</sub>	433.1129	1.39	2
15.59	Naringenin	C <sub>15</sub> H <sub>12</sub> O <sub>5</sub>	271.0601	3.32	2

*Flavanonols*

11.59	Taxifolin	C <sub>15</sub> H <sub>12</sub> O <sub>7</sub>	303.0499	3.63	2
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*Stilbenes*

11.04	Resveratrol hexoside	$C_{20}H_{22}O_8$	389.1231	2.31	2
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<sup>a</sup> Annotation from the Summer et al. Compounds identified at MSIMI level 1 means there was a commercially available standard. Compounds identified at MSIMSI level 2 means it was tentatively identified. RT: retention time.

**Table S2.** Influence of the cultivar and harvesting season on the galloyl derivatives group ( $\mu\text{g}/100\text{ g}$ )

	Mono-galloyl-glucose I	Mono-galloyl-glucose II	Galloyl dihexose	Digalloyl hexose I	Digalloyl hexose II	Hydroxy-methoxy phenyl galloyl hexoside I	Hydroxy-methoxy phenyl galloyl hexoside II	Tetra-O-galloyl glucoside I	Tetra-O-galloyl glucoside II	Penta galloyl glucose	Total
<b>Values<sup>a</sup></b>											
<b><u>Variety</u></b>											
Aegina	0.32 cd	2.01 ab	0.27 abc	0.18 bc	0.14 ab	0.178 cd	0.49 b	0.134 a	0.73 ab	0.58 ab	5.0 abc
Avdat	0.47 cd	1.90 ab	0.22 abc	0.20 bc	0.14 ab	0.26 4b	0.52 ab	0.124 b	0.64 bc	0.55 bc	5.0 abc
Golden Hills	0.63 cd	1.95 ab	0.30 a	0.15 bc	0.22 ab	0.128 efg	0.15 c	0.099 d	0.31 de	0.23 de	4.2 bcd
Joley	0.20 d	1.51 bc	0.21 bc	0.20 bc	0.14 ab	0.143 def	0.19 c	0.109 c	0.38 d	0.29 d	3.4 d
Kaleghouchi	0.23 cd	1.77 b	0.27 abc	0.13 c	0.11 b	0.094 g	0.10 c	0.097 d	0.23 e	0.16 e	3.2 d
Kastel	1.32 ab	2.46 a	0.26 abc	0.18 bc	0.13 ab	0.099 fg	0.12 c	0.098 d	0.37 d	0.25 de	5.3 ab
Kerman	1.96 a	2.15 ab	0.28 ab	0.32 a	0.26 a	0.152 de	0.24 c	0.099 d	0.43 d	0.29 d	6.2 a
Larnaka	0.88 bc	2.01 ab	0.24 abc	0.22 b	0.15 ab	0.354 a	0.61 ab	0.130 ab	0.7 6ab	0.67 a	6.0 a
Lost Hills	0.35 cd	1.52 bc	0.27 ab	0.16 bc	0.16 ab	0.130 efg	0.18 c	0.104 cd	0.43 d	0.33 d	3.6 cd
Mateur	0.42 cd	2.00 ab	0.27 abc	0.20 bc	0.15 ab	0.177 cd	0.54 ab	0.132 ab	0.79 a	0.63 ab	5.3 ab
Sirora	0.76 bcd	0.95 c	0.19 c	0.21 b	0.13 ab	0.209 c	0.68 a	0.112 c	0.58 c	0.48 c	4.3 bcd
<b><u>Season</u></b>											
2019	0.51 b	1.89	0.26	0.18 b	0.15	0.159 b	0.31 b	0.117 a	0.51	0.41	4.5
2020	0.86 a	1.79	0.24	0.21 a	0.16	0.191 a	0.38 a	0.108 b	0.51	0.41	4.9
<b>Significance<sup>b</sup></b>											
Variety (V)	***	***	***	***	*	***	***	***	***	***	***
Season (S)	***	ns	ns	*	ns	***	**	***	ns	ns	ns
V x S	*	ns	ns	***	ns	*	***	**	***	**	*

<sup>a</sup>Average values. <sup>b</sup>Level of significance: \* $p \leq 0.05$ , \*\* $p \leq 0.01$ , \*\*\* $p \leq 0.001$ , ns: non-significant. Values with different letters are significantly different as determined through Tukey test.

**Table S3.** Influence of the cultivar and harvesting season on the hydroxycinnamic acids group ( $\mu\text{g}/100\text{ g}$ )

	Chlorogenic acid I	Chlorogenic acid II	Ferulic acid derivative	Sinapic acid derivative	p-Coumaric acid	Total
<b>Values<sup>a</sup></b>						
<b><u>Variety</u></b>						
Aegina	0.152 abc	0.156 b	< LOQ b	0.035 cd	< LOQ	0.344 b
Avdat	0.155 a	0.155 bc	< LOQ b	0.091 a	< LOQ	0.399 b
Golden Hills	0.147 d	0.154 bcd	< LOQ b	0.063 b	< LOQ	0.365 b
Joley	0.152 abc	0.150 de	< LOQ b	0.030 cd	< LOQ	0.328 b
Kaleghouchi	0.149 bcd	0.153 bcde	< LOQ b	0.006 e	< LOQ	0.308 b
Kastel	0.148 cd	0.149 e	3.065 a	0.040 c	< LOQ	1.870 a
Kerman	0.147 d	0.155 bc	< LOQ b	0.007 e	< LOQ	0.308 b
Larnaka	0.153 ab	0.153 bcde	< LOQ b	0.073 ab	< LOQ	0.379 b
Lost Hills	0.146 d	0.156 b	< LOQ b	0.007 e	< LOQ	0.310 b
Mateur	0.149 bcd	0.161 a	< LOQ b	0.017 de	< LOQ	0.327 b
Sirora	0.146 d	0.151 cde	< LOQ b	0.035 cd	< LOQ	0.332 b
<b><u>Season</u></b>						
2019	0.150	0.155 a	3.065 a	0.050 a	< LOQ	0.632 a
2020	0.149	0.153 b	< LOQ b	0.024 b	< LOQ	0.325 b
<b>Significance<sup>b</sup></b>						
Variety (V)	***	***	***	***	ns	***
Season (S)	ns	*	***	***	ns	***
V x S	*	ns	***	***	ns	***

<sup>a</sup>Average values. <sup>b</sup>Level of significance: \* $p \leq 0.05$ , \*\* $p \leq 0.01$ , \*\*\* $p \leq 0.001$ , ns: non-significant. Values with different letters are significantly different as determined through Tukey test.

**Table S4.** Influence of the cultivar and harvesting season on the flavones group (µg/100 g)

	Luteolin hexoside	Luteolin	Apigenin hexoside	Apigenin	Total
<b>Values<sup>a</sup></b>					
<b><u>Variety</u></b>					
Aegina	3.28 abc	0.024 e	< LOQ	0.012 ab	3.31 ab
Avdat	4.09 ab	0.016 e	< LOQ	0.008 c	4.12 a
Golden Hills	0.32 g	0.109 cde	< LOQ	0.011 abc	0.44 f
Joley	1.97 def	0.066 de	< LOQ	0.008 bc	2.04 cde
Kaleghouchi	2.01 def	0.294 b	< LOQ	0.009 abc	2.32 bcde
Kastel	1.76 ef	0.191 bc	< LOQ	0.009 abc	1.96 de
Kerman	1.87 ef	0.144 cd	< LOQ	0.011 abc	2.03 cde
Larnaka	4.33 a	0.017 e	< LOQ	0.009 abc	4.36 a
Lost Hills	0.87 fg	0.519 a	< LOQ	0.011 abc	1.40 ef
Mateur	2.87 cde	0.032 de	< LOQ	0.012 a	2.91 bcd
Sirora	3.07 bcd	0.102 cde	< LOQ	0.008 bc	3.18 abc
<b><u>Season</u></b>	3.28 abc	0.024 e	< LOQ	0.012 ab	3.31 ab
2019	1.89 b	0.122 b	< LOQ	0.011 a	2.03 b
2020	2.91 a	0.153 a	< LOQ	0.009 b	3.08 a
<b>Significance<sup>b</sup></b>					
Variety (V)	***	***	ns	***	***
Season (S)	***	*	ns	*	***
V x S	**	***	ns	ns	**

<sup>a</sup>Average values. <sup>b</sup>Level of significance: \*p ≤ 0.05, \*\*p ≤ 0.01, \*\*\*p ≤ 0.001, ns: non-significant.

Values with different letters are significantly different as determined through Tukey test.

**Table S5.** Influence of the cultivar and harvesting season on the flavonols group (µg/100 g)

	Rutin	Myricetin hexoside	Myricetin	Quercetin hexoside I	Quercetin hexoside II	Quercetin galloyl glucoside I	Quercetin galloyl glucoside II	Quercetin	Isorhamnetin	Total
<b>Values<sup>a</sup></b>										
<b><u>Variety</u></b>										
Aegina	0.37 bc	0.69 a	0.038 ab	0.226 a	2.71 a	0.071 d	0.019 ab	0.17 b	0.012	4.31 a
Avdat	0.31 cde	0.60 ab	0.025 bcd	0.180 abc	2.49 ab	0.195 b	0.005 cd	0.13 b	0.010	3.95 abcd
Golden Hills	0.23 f	0.14 d	0.020 cd	0.089 de	1.21 d	0.003 e	0.005 cd	0.19 b	0.013	1.89 f
Joley	0.61 a	0.16 d	0.012 d	0.126 cd	2.00 bc	0.091 cd	< LOQ	0.14 b	0.012	3.14 de
Kaleghouchi	0.27 def	0.36 c	0.026 bcd	0.043 e	1.49 cd	0.138 c	nd	0.15 b	0.010	2.49 ef
Kastel	0.22 f	0.41 c	0.027 bcd	0.151 bcd	1.52 cd	0.011 e	< LOQ	0.13 b	0.012	2.49 ef
Kerman	0.26 ef	0.45 bc	0.021 cd	0.144 bcd	2.35 ab	0.043 de	< LOQ	0.14 b	0.015	3.42 bcd
Larnaka	0.32 bcd	0.63 a	0.031 bc	0.187 abc	2.57 ab	0.288 a	0.015 ab	0.16 b	0.012	4.22 abc
Lost Hills	0.25 ef	0.12 d	0.019 cd	0.161 abcd	2.29 ab	0.000 e	0.005 cd	0.28 a	0.017	3.15 de
Mateur	0.38 b	0.76 a	0.052 a	0.201 ab	2.59 ab	0.075 d	0.023 a	0.19 ab	0.018	4.30 ab
Sirora	0.33 bcd	0.37 c	0.018 cd	0.126 cd	2.35 ab	0.017 e	0.011 bc	0.15 b	0.013	3.38 cd
<b><u>Season</u></b>	0.37 bc	0.69 a	0.038 ab	0.226 a	2.71 a	0.071 d	0.019 ab	0.17 b	0.012	4.31 a
2019	0.35 a	0.37 b	0.017 b	0.142	2.05 b	0.072 b	0.003 b	0.15 b	0.010 b	3.16 b
2020	0.30 b	0.49 a	0.035 a	0.155	2.24 a	0.098 a	0.012 a	0.18 a	0.016 a	3.52 a
<b>Significance<sup>b</sup></b>	0.35 a	0.37 b	0.017 b	0.142	2.05 b	0.072 b	0.003 b	0.15 b	0.010 b	3.16 b
Variety (V)	***	***	***	***	***	***	***	***	ns	***
Season (S)	***	***	***	ns	*	***	***	**	***	**
V x S	***	***	***	*	*	ns	***	ns	*	**

<sup>a</sup>Average values. <sup>b</sup>Level of significance: \*p ≤ 0.05, \*\*p ≤ 0.01, \*\*\*p ≤ 0.001, ns: non-significant.  
Values with different letters are significantly different as determined through Tukey test.



**Table S6.** Influence of the cultivar and harvesting season on the flavanones group ( $\mu\text{g}/100\text{ g}$ )

	Eriodictyol hexoside	Eriodictyol	Naringenin hexoside	Naringenin	Total
<b>Values<sup>a</sup></b>					
<b><u>Variety</u></b>					
Aegina	6.7 3a	1.04 a	0.286 a	0.043 bcd	8.10 a
Avdat	5.04 b	0.89 ab	0.273 a	0.049 b	6.24 b
Golden Hills	0.90 c	0.32 d	0.063 b	0.049 b	1.34 cd
Joley	4.05 b	0.85 abc	0.256 a	0.069 a	5.22 b
Kaleghouchi	0.91 c	0.58 bcd	0.054 b	0.052 b	1.60 cd
Kastel	0.77 c	0.21 d	0.037 b	0.026 e	1.05 d
Kerman	1.32 c	0.32 d	0.059 b	0.022 e	1.72 cd
Larnaka	4.88 b	0.86 abc	0.253 a	0.046 bcd	6.04 b
Lost Hills	1.13 c	0.48 cd	0.066 b	0.034 cde	1.70 cd
Mateur	6.92 a	1.03 a	0.311 a	0.047 bc	8.31 a
Sirora	1.76 c	0.55 bcd	0.079 b	0.033 de	2.42 c
<b><u>Season</u></b>					
2019	2.83 b	0.71 a	0.144 b	0.042	3.73 b
2020	3.42 a	0.58 b	0.172 a	0.044	4.22 a
<b>Significance<sup>b</sup></b>					
Variety (V)	***	***	***	***	***
Season (S)	***	*	**	ns	**
V x S	***	ns	***	*	***

<sup>a</sup>Average values. <sup>b</sup>Level of significance: \* $p \leq 0.05$ , \*\* $p \leq 0.01$ , \*\*\* $p \leq 0.001$ , ns: non-significant.

Values with different letters are significantly different as determined through Tukey test.

**Table S7.** Influence of the cultivar and harvesting season on the flavanonols group (µg/100 g)

Taxifolin	
<b>Values<sup>a</sup></b>	
<b><u>Variety</u></b>	
Aegina	1.15
Avdat	0.90
Golden Hills	0.44
Joley	0.68
Kalehghouchi	1.23
Kastel	0.46
Kerman	0.83
Larnaka	0.76
Lost Hills	0.78
Mateur	0.95
Sirora	0.88
<b><u>Season</u></b>	
2019	1.11 a
2020	0.54 b
<b>Significance<sup>b</sup></b>	
Variety (V)	ns
Season (S)	***
V x S	ns

<sup>a</sup>Average values. <sup>b</sup>Level of significance: \*p ≤ 0.05, \*\*p ≤ 0.01, \*\*\*p ≤ 0.001, ns: non-significant. Values with different letters are significantly different as determined through Tukey test.

**Table S8.** Influence of the cultivar and harvesting season on the stilbenes group (µg/100 g)

	Resveratrol hexoside
<b>Values<sup>a</sup></b>	
<b><u>Variety</u></b>	
Aegina	4.20 b
Avdat	5.22 a
Golden Hills	1.40 d
Joley	2.12 cd
Kalehghouchi	1.66 cd
Kastel	2.00 cd
Kerman	2.47 c
Larnaka	4.92 ab
Lost Hills	1.88 cd
Mateur	4.08 b
Sirora	2.41 c
<b><u>Season</u></b>	
2019	2.81 b
2020	3.08 a
<b>Significance<sup>b</sup></b>	
Variety (V)	***
Season (S)	*
V x S	*

<sup>a</sup>Average values. <sup>b</sup>Level of significance: \*p ≤ 0.05, \*\*p ≤ 0.01, \*\*\*p ≤ 0.001, ns: non-significant.  
Values with different letters are significantly different as determined through Tukey test.