Antioxidant properties of some plants growing wild in Turkey

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1. INTRODUCTION
Fruits, vegetables and herbs are recommended at present as optimal sources of chemical constituents with antioxidant activity and supplementing the human diet with plants containing high amounts of compounds capable of deactivating free radicals may have beneficial effects (Madsen and Bertelsen, 1995, Velioglu, Mazza, Gao and Oomah, 1998; Lutomski, 2001).

Antioxidants are compounds which prevent some toxic materials in the body, especially free radicals. Free radicals which lead to oxidation are basically oxygen sourced metabolites (super oxide anions O₂⁻, hydrogen peroxide H₂O₂, hydroxide radical (OH), hypochloric acid, chloramines, nitrogen dioxide, ozone and lipid peroxides. Antioxidants such as beta, carotene, ascorbic acid, and alfa- tocopherol are proven to prevent the oxidation of free radicals by in vitro and in vivo studies (Cross et al. 1987; Aruoma, 1998; Peter, 1993; Brand-Williams et al. 1995; Stone and Papas, 1997; Zheng and Wang, 2001; Gümrükçüoğlu, 2003). Vitamin A takes part in the regulation of protective epitel in the lungs, stomach, urinary tract and other organs in the defense mechanism of the human body. Another antioxidant, tocopherol, protects cells from free radicals, heavy metals, poisonous compounds, medicines and radiation by stabilizing lipid parts of the cell membrane and transporting molecules. Tocopherols prevent the degenerative effects of free radicals in tissue, skin and blood vessels. Another antioxidant, ascorbic acid (Vitamin C) aids in the growth and well being of the body's cells in bones, ligaments and blood vessels. Besides, it helps the body to respond against infections and stress and assists in the proper use of iron (Cross et al. 1987; Aruoma, 1998; Peter, 1993; Brand-Williams et al. 1995; Stone and Papas, 1997; Zheng and Wang, 2001; Gümrükçüoğlu, 2003).

Afyonkarahisar is rich in a wide variety of flora and vegetation. This richness in flora and vegetation is especially notable in Sultan, Emir, Akda and the Kumular Mountains. For this reason, many native and foreign botanists collected plant samples from these mountains and other locations in Afyonkarahisar (Akçiçek, 2003).

Afyonkarahisar is in the middle zone of the Mediterranean and the Iran-Turan floristic regions
from the point of view of plant geography and there are plants which also represent the Europa-Syberia floristic region. Around Afyonkarahisar, there are approximately 2500 natural plant species, almost 350 of them endemic, because of its ecological conditions and especially its microclimate (Akçiçek, 2003; Karşıoğlu, 2003; Köse and Ocak, 2004).

The aim of the present work is to investigate the antioxidant properties of some plants growing wild in the Afyonkarahisar province of Turkey.

2. MATERIALS AND METHODS

2.1. Materials

Plants (Taxus baccata L., Pistacia terebinthus L. subsp. palaestina (Boiss.) Engler, Pistacia terebinthus L. subsp. terebinthus, Rhus coriaria L., Artemisia campestris L., Artemisia santonicum L., Berberis crataegina DC., Berberis integerrima Bur. Be., Berberis vulgara L., Gypsophila eriocalyx Boiss., Gypsophila parva Barkoudah, Gypsophila perforata L., Gypsophila pilosa Hudson, Gypsophila tubulosa (Jaub. & Spach) Boiss., Euonymus latifolius (L.) Mill. subsp. latifolius, Cistus laurifolius L., Cornus mas L., Cornus sanguinea L. subsp. australis (C. A. Meyer) Jav., Cornus sanguinea L. subsp. sanguinea, Mentha aquatica L., Mentha longifolia (L.) Huds. subsp. longifolia, Mentha longifolia L. subsp. typhoides (Briq.) Harley var. typhoides, Mentha pulegium L., Mentha spicata L. subsp. spicata, Mentha spicata L. subsp. tomentosa (Briq.) Harley, Ficus carica L. subsp. carica, Jasminum fruticans L., Achillea teretifolia Willd., Morus alba L., Morus nigra L., Cerasus mahaleb (L.) Miller var. mahaleb, Prunus divaricata Ledeb. var. divaricata, Sorbus torminalis (L.) Crantz var. torminalis, Sorbus torminalis (L.) Crantz var. pinnaflida Boiss., Chenopodium foliosum (Moench) Asch., Pyrus elaeagnifolia Pall, subsp. elaeagnifolia, Pyrus elaeagnifolia Pall, subsp. kotschyania (Boiss.) BROWicz, Viburnum lantana L., Malus sylvestris Mill. subsp. orientalis (Uglitzk.) BROWicz var. Orientalis) were obtained from several locations of the Afyonkarahisar province in Turkey in early spring, 2007. Materials from different periods and locations of the Afyonkarahisar province in Turkey were stored at 4 °C until analysis. 1.8 °C/H11002 Samples were kept in sealed containers at 4 °C/H11002 and incubated for 70 min at room temperature in the dark. The absorbance of the remaining DPPH was determined at 517 nm against a blank. The scavenging activity was expressed as IC50 (mg/ml). All analyses were carried out in duplicate. Linear regression equations of absorbance against concentration were determined by measuring the absorbance of seven different concentrations of DPPH (6 × 10⁻⁵ M) stock solution. A (515 nm) = 17.692 (C DPPH) - 0.0216 (R² = 0.9896)

The remained DPPH concentrations against absorbance values of the sample series of different concentrations were calculated and then the remaining DPPH percentage was calculated:

\[ \text{percentage} = \frac{\text{absorbance of sample} - \text{absorbance of control}}{\text{absorbance of control}} \times 100 \]

2.2. Preparation of extracts

The aerial parts of plants were dried in the shade at room temperature. About 2.5 g from each dried plant sample were extracted by homogenizing in a mixer (Ultra turrax) with 50 ml solvent (50% water-methanol). The extracts were centrifuged at 4000xg 3 min at 4 °C (Hettich Zentrifugen-Universal 32 R) after draining through coarse filter paper. The filtrate volume was completed to 50 ml and drained through blue band filter paper (No 589). The filtrats were stored at 4 °C until analysis.

2.3. Methods

Free radical scavenging effect

The radical scavenging activity against the DPPH radical was evaluated according to the method of Brand-Williams et al. (1995) and Lim and Murtijaya (2007) with some minor modifications. The assay mixture contained 1.5 ml of a 0.09 mg/ml of DPPH (Sigma Chem, Co, Str. Lous, USA) in methanol, 1 ml of acetate buffer solution (100 mM, pH 5.5). The dilutions between 0.4 to 4 mg/ml were prepared with methanol. 3.9 ml DPPH solution prepared with 6 × 10⁻⁵ M (molar) methanol was added to each 0.1 ml of dilutions and shaken well. The mixture was prepared and incubated for 60 min at room temperature in the dark. The absorbance of the remaining DPPH was determined at 517 nm against a blank. The scavenging activity was expressed as IC50 (mg/ml).

\[ \text{IC50} = \frac{\text{absorbance of } \text{DPPH}}{\text{absorbance of control}} \times 100 \]

The exponential regression equation was determined between the rate of the remaining DPPH percentage and the DPPH amount of sample in vitro and sample concentrations of plants which decreased their initial DPPH concentrations by 50% (efficient concentration [EC50]). Antiradical activity (AE) was calculated by dividing EC50 values into 1.

Fe²⁺ chelating activity

Modified methods of Lim and Murtijaya (2007) were used for the determination of Fe²⁺ chelating activities of samples. 1 ml of extract with different concentrations between 6-45 mg/ml and 3.7 ml deionized water were mixed. A 0.1ml 2 mM FeCl₂ solution was added, shaken and kept in the dark at room temperatures for 70 min. Then, 0.2ml 5 mM ferrozin were added and shaken again and the absorbance of obtained Fe²⁺-ferrozine complex after 10min was measured at 562 nm. 1 ml water was used instead of the sample for the control. The equation is given below (Yen and Wu, 1999).

Chelating activity (%) = \[ 1 - \left( \frac{\text{absorbance of sample}}{\text{absorbance of control}} \right) \times 100 \]

H₂O₂ inhibition effect

The H₂O₂ inhibition effect of spice and plant extracts can be determined by spectrophotometer
(Ruch et al. 1989). 1 ml (2.6 and 10 mg/ml) sample, 3.4 ml 0.1M phosphate buffer (pH 7.4) and 0.6 ml 43mM H$_2$O$_2$ were mixed and after 60 minutes the absorbance of the mixture was measured at 230 nm. Control solutions without H$_2$O$_2$ were prepared for each sample concentration. To determine the H$_2$O$_2$ mM concentration which did not involve the reaction, a linear repression equation was used. 3.4 ml phosphate buffer were added to 0.6 ml 10, 15, 25, 43 and 50 mM H$_2$O$_2$ at 230 nm. Linear regression equations were obtained by the diagram of concentration against absorbance.

Statistical analyses

Results of the research were analyzed for statistical significance by analysis of variance (Püskülcü and Ikiz, 1989). This research was performed in three duplicates with a replicate.

3. RESULTS AND DISCUSSION

3.1. Free radical scavenging activity

DPPH, as a partially organic radical, is used to determine the antioxidant activities of many plant extracts and compounds (Brand-Williams et al. 1995). This method is based on a decrease in alcoholic DPPH solution in the presence of H binding antioxidant (DPPH$^-$ + AH $\rightarrow$ DPPH$^-$ + H + A$^\cdot$). A DPPH solution is dark violet colored and has a strong absorption range at 517 nm. It loses its color when transformed to DPPH-H and the absorption level decreases. This decrease in absorption shows the cytochiometric decrease in DPPH.

The DPPH radical scavenging effects of plant leaf and fruit extracts are given in Tables 1 and 2, respectively. While the antiradical activity of the leaf extracts of plants varies from 0.258 (Gypsophila pilosa) to 0.693 (Cornus sanguinea L. subsp. australis), the activities of fruit extracts range from 0.503 (Taxus baccata) to 0.928 (Cornus mas). Generally, the antiradical activity of fruit extracts was found higher than those of leaf extracts. This effect is probably due to the high phenolic compound contents of fruit extracts. The antiradical

### Table 1

| Sample                              | EC$_{50}$ | AE     |
|-------------------------------------|-----------|--------|
| Artemisia campestris L.             | 2.467     | 0.405  |
| Artemisia santonicum L.             | 2.498     | 0.400  |
| Berberis crataegina DC.             | 2.145     | 0.466  |
| Berberis integerrima Bunge          | 2.423     | 0.413  |
| Berberis vulgaris L.                | 2.374     | 0.421  |
| Cistus laurifolius L.               | 2.892     | 0.345  |
| Cornus mas L.                       | 1.398     | 0.716  |
| Cornus sanguinea L. subsp. australis (C. A. Mey.) Jav. | 1.442 | 0.693 |
| Cornus sanguinea L. subsp. Sanguinea | 1.487   | 0.672  |
| Euonymus latifolius (L.) Mill. subsp. Latifolius | 2.421 | 0.413 |
| Ficus carica L. subsp. Carica       | 1.822     | 0.549  |
| Gypsophila eriocalyx Boiss.         | 3.678     | 0.272  |
| Gypsophila parva Barkdah             | 3.453     | 0.290  |
| Gypsophila perfoliata L.             | 3.126     | 0.320  |
| Gypsophila pilosa Hudson             | 3.873     | 0.258  |
| Gypsophila tubulosa (Jaub. & Spach) Boiss. | 3.098 | 0.323 |
| Jasminum fruticans L.               | 1.904     | 0.525  |
| Mentha aquatica L.                  | 1.634     | 0.612  |
| Mentha longifolia (L.) Huds. subsp. Longifolia | 1.678 | 0.596 |
| Mentha longifolia (L.) Huds. subsp. typhoides (Briq.) | 1.612 | 0.620 |
| Harley var. Typhoides               | 1.516     | 0.659  |
| Mentha pulegium L.                  | 1.656     | 0.604  |
| Mentha spicata L. subsp. Spicata     | 1.714     | 0.583  |
| Mentha spicata L. subsp. tomentosa (Briq.) Harley | 3.214 | 0.311 |
| Pistacia terebinthus L. subsp. palaestina (Boiss.) Engler | 2.972 | 0.336 |
| Pistacia terebinthus L. subsp. Terebinthus | 2.356 | 0.424 |
| Rhus coriaria L.                    | 3.456     | 0.289  |

* Efficiency coefficient (EC$_{50}$) (mg sample / mg DPPH): sample amount needed to decrease the DPPH concentration at the beginning by 50%. "Antiradical activity (AE): 1 / EC$_{50}$.

* mean ± standard deviation.
activity of Cornus spp. and Morus spp were compared to those of other fruit extracts (Table 2). These plant extracts may be accepted as having a higher antioxidative activity, with an antioxidant score (%) as between 225.9-537.6 µg (IC50). Effective scavenging concentration (EC50) on DPPH radicals was 0.70 µg/ml in ethyl acetate and tannin fractions and 5.33 µg/ml in the anthocyanin rich fraction of sumac extracts (Koflar et al. 2007). Emami, Asili, Mohagheghi & Hassanzadeh (2007) reported that the methanol extracts of the leaves of Taxus baccata L. from Armaniolan, Arasbaran and East Azerbaijan, contained high amounts of alkaloids, tannins and flavonoids while the fruit extracts contained high amounts of tannins and these extracts possessed high antioxidant activity (%) as approximately 90, using the TBA method. According to Cao et al. (1996) among the 22 common vegetables studied, garlic had the highest antioxidant activity, with an antioxidant score (automated oxygen radical absorbance capacity assay) of 23.2 based on fresh weight of the vegetable. However, according to Miller et al. (2000), garlic is very high in antioxidants, its activity being about sixfold that of yellow onion (1300 Trolox equivalents/100 g vs. 200 Trolox equivalents /100 g). The difference is probably at least partially due to the different methods used. The radical scavenging and antioxidant results for blackcurrant plants obtained in this study are not in agreement with the earlier literature (Cao et al.,1996; Gazzani et al.,1998). However these contradictory results

Table 2
DPPH radical scavenging effects of plant (fruit) extracts *

| Sample                     | EC50  | AE       |
|----------------------------|-------|----------|
| Achillea teretifolia Willd.| 1.765 | 0.567 ± 0.04 efgh |
| Berberis crataegina DC.    | 1.345 | 0.743 ± 0.12 bcde |
| Berberis integerrima Bunge | 1.412 | 0.708 ± 0.06 bcdefg |
| Berberis vulgaris L.        | 1.456 | 0.687 ± 0.16 cdefgh |
| Cerasus mahaleb (L.) Miller var. Mahaleb | 1.645 | 0.608 ± 0.04 efgh |
| Chenopodium foliosum (Moench) Asch. | 1.458 | 0.686 ± 0.12 cdefgh |
| Cistus laurifolius L.       | 1.724 | 0.580 ± 0.08 efgh |
| Cornus mas L.               | 1.078 | 0.928 ± 0.13 a |
| Cornus sanguinea L. subsp. australis (C. A. Mey.) Jav. | 1.156 | 0.665 ± 0.09 abc |
| Cornus sanguinea L. subsp. Sanguinea | 1.205 | 0.629 ± 0.14 abcd |
| Euonymous latifolius (L.) Mill. subsp. Latifolius | 1.646 | 0.608 ± 0.06 efgh |
| Ficus carica L. subsp. Carica | 1.562 | 0.640 ± 0.07 defg |
| Jasminum fruticans L.       | 1.876 | 0.533 ± 0.03 gh |
| Malus sylvestris Mill. subsp. orientalis (Uglitzk.) | 1.367 | 0.732 ± 0.12 bcddef |
| Browicz var. Orientalis     | 1.123 | 0.690 ± 0.05 ab |
| Morus alba L.               | 1.212 | 0.825 ± 0.10 abcd |
| Morus nigra L.              | 1.412 | 0.687 ± 0.12 bcd |
| Pistacia terebinthus L. subsp. palaestina (Boiss.) Engler | 1.875 | 0.553 ± 0.07 gh |
| Pistacia terebinthus L. subsp. Terebinthus | 1.912 | 0.523 ± 0.05 gh |
| Prunus divaricata Lede. subsp. Divaricata | 1.692 | 0.591 ± 0.07 efgh |
| Pyrus elaeagnifolia Pall. subsp. Elaeagnifolia | 1.512 | 0.661 ± 0.07 defg |
| Pyrus elaeagnifolia Pallias subsp. kotschyana (Boiss.) Browicz | 1.467 | 0.682 ± 0.04 cdefgh |
| Rhus coriaria L.            | 1.822 | 0.548 ± 0.08 efgh |
| Sorbus terminalis (L.) Crantz var. pinnatifida Boiss. | 1.674 | 0.534 ± 0.09 gh |
| Sorbus terminalis (L.) Crantz var. terminalis | 1.842 | 0.543 ± 0.04 gh |
| Taxus baccata L.            | 1.968 | 0.503 ± 0.08 h |
| Viburnum lantana L.         | 1.523 | 0.667 ± 0.09 defg |

* Efficiency coefficient (EC50) (mg sample / mg DPPH): sample amount needed to decrease the DPPH concentration at the beginning by 50%. * Antiradical activity (AE): 1 / EC50
* mean ± standard deviation.
are most likely due to differences in methodology and experimental conditions used in the different studies. Due to the wide variety of potential antioxidant compounds, such as vitamins, flavonoids, phenolic acids and sulphur compounds present in plants, differences in the method of sample extraction can results in a wide variation in the antioxidant activity of the extract (Nuutila et al. 2003).

The radical scavenging and antioxidant activity results for these plants show some differences from the earlier reported results above. However these contradictory results are most likely due to differences in methodology and experimental conditions used in the different studies. Due to the wide variety of potential antioxidant compounds, such as vitamins, flavonoids, phenolic acids and sulphur compounds present in plants, differences in the method of sample extraction can results in a wide variation in the antioxidant activity of the extract (Nuutila, Puupponen-Pimia, Aarni & Oksman-Caldentey, 2003). In our study, there was a noticeable correlation between high radical scavenging / antioxidant activity and high amounts of total phenolics. More plants have been used as a source of food, remedy and animal fodder in Turkey (Baytop, 1984). The antioxidant activities of spices and herbs are attributed to their polar phenolic and essential oil contents (Tsimidou and Boskou, 1994; Shahidi, 1997; Özkan and Özcan, 2006).

### 3.2. Fe$^{2+}$ chelating activity

Chelating agents may have great importance for rancidity of oily foods; even though they are not antioxidant materials. Because iron catalyzes this reaction during lipid peroxidation, Ferrozin forms a complex with Fe$^{2+}$. The amounts of complex and red color decrease in the presence of the other chelating agents. A decrease in absorption values can be determined by changes in the color. The decrease in absorption shows the effectiveness of chelating agent added with the exception of ferrozin.

Table 3 and 4 show the chelating activities of plant leaf and fruit extracts. The Fe$^{2+}$ chelating activity of fruit extracts of plants was established as higher than that of leaf extracts. The highest chelating activity was found in *Cornus mas* fruit extracts. The Chelating activities of *Cornus* spp. fruit extracts were found higher compared with other fruit extracts (Table 4). The highest chelating activity was observed in the *Cornus* species ranging from 44.64-45.72%. The lowest chelating activities were obtained from the *Gypsophila* species (16.34-20.32%), *Taxus baccata* L. (18.93%) and *Pistacia terebinthus* L .subsp. *palaestina* (Boiss.) Engler (19.26%).

The highest Fe$^{2+}$ chelating activity was determined in the fruit extracts of the *Cornus* species; while the lowest values belong to the *Pistacia* species.

| Sample                                      | Chelating activity (%) |
|---------------------------------------------|------------------------|
| Artemisia campestris L.                     | 25.42 ± 1.63 ij        |
| Artemisia santonicum L.                     | 26.02 ± 2.01 hi        |
| Berberis crataegina DC.                     | 28.36 ± 2.45 fghi      |
| Berberis integerrima Bunge                  | 27.12 ± 2.9 fghi       |
| Berberis vulgaris L.                        | 28.02 ± 2.71 fghi      |
| Cistus laurifolius L.                       | 28.43 ± 2.79 fghi      |
| Cornus mas L.                               | 45.72 ± 3.55 a         |
| Cornus sanguinea L. subsp. australis (C. A. Mey.) Jav. | 44.64 ± 3.58 ab        |
| Cornus sanguinea L. subsp. sanguinea        | 44.92 ± 3.86 ab        |
| Euonymus latifolius (L.) Mill. subsp. latifolius | 30.26 ± 2.58 fghi     |
| Ficus carica L. subsp. carica               | 32.86 ± 1.96 efg       |
| Gypsophila eriocalyx Boiss.                 | 17.34 ± 2.2 k          |
| Gypsophila parva Barkoudah                  | 19.32 ± 1.99 k         |
| Gypsophila perfoliata L.                    | 20.32 ± 2.54 jk        |
| Gypsophila pilosa Hudson                    | 16.34 ± 1.80 k         |
| Gypsophila tubulosa (Jaub. & Spach) Boiss.  | 18.51 ± 1.79 k         |
| Jasminum fruticans L.                       | 31.24 ± 1.71 fgh       |
| Mentha aquatica L.                          | 38.96 ± 2.2 cd         |
| Mentha longifolia (L.) Huds. subsp. longifolia | 37.23 ± 2.13 cde      |
| Mentha longifolia (L.) Huds. subsp. tvphoides (Briq.) Harley var. tvphoides | 38.23 ± 2.8 cd |
| Mentha pulegium L.                          | 40.22 ± 3.54 bc        |
| Mentha spicata L. subsp. spicata            | 39.64 ± 2.12 bcd       |
| Mentha spicata L. subsp. tomentosa (Briq.) Harley | 34.42 ± 2.24 def      |
| Pistacia terebinthus L. subsp. palaestina (Boiss.) Engler | 19.26 ± 1.76 k       |
| Pistacia terebinthus L. subsp. terebinthus   | 24.65 ± 2.28 ij        |
| Rhus coriaria L.                            | 26.34 ± 2.51 hi        |
| Taxus baccata L.                            | 18.93 ± 1.63 k         |

* mean ± standard deviation.
### Table 4

| Sample                                      | Fe$^{2+}$ chelating activity (%) |
|---------------------------------------------|----------------------------------|
| Achillea teretifolia Willd.                 | 35.96 ± 3.04 ijkl                |
| Berberis crataegina DC.                     | 44.76 ± 2.76 cdef                |
| Berberis integerrima Bunge                  | 35.96 ± 3.05 def                 |
| Berberis vulgaris L.                        | 42.98 ± 3.99 ef                  |
| Cerasus mahaleb (L.) Miller var. mahaleb    | 35.49 ± 2.27 ghijk               |
| Chenopodium foliosum (Moench) Asch.         | 43.76 ± 2.90 def                 |
| Cistus laurifolius L.                       | 36.27 ± 4.42 ghiij               |
| Cornus mas L.                               | 54.24 ± 3.41 a                   |
| Cornus sanguinea L. subsp. australis (C. A. Mey.) Jav. | 52.34 ± 2.54 ab               |
| Cornus sanguinea L. subsp. sanguinea        | 51.24 ± 4.29 bc                  |
| Euonymus latifolius (L.) Mill. subsp. latifolius | 38.65 ± 2.98 fhgij            |
| Ficus carica L. subsp. carica               | 40.69 ± 2.91 fghij               |
| Jasminum fruticans L.                       | 33.54 ± 2.68 ikj                |
| Malus sylvestris Mill. subsp. orientalis (Uglitzk.) Browicz var. orientalis | 45.32 ± 2.46 cdef            |
| Morus alba L.                               | 49.98 ± 3.69 bcd                |
| Morus nigra L.                              | 48.32 ± 2.96 bcde               |
| Pistacia terebinthus L. subsp. palaestina (Boiss.) Engler | 30.65 ± 3.13 kl             |
| Pistacia terebinthus L. subsp. terebinthes  | 39.42 ± 2.05kl                  |
| Prunus divaricata Ledebe. subsp. divaricata | 34.29 ± 1.41 hijkl               |
| Pyrus elaeagnifolia Pall. subsp. elaeagnifolia | 41.83 ± 3.25 efg            |
| Pyrus elaeagnifolia Pallas subsp. kotschyan | 43.74 ± 1.72 def                |
| Rhus coriaria L.                            | 31.82 ± 2.95 jk                  |
| Sorbus terminalis (L.) Crantz var. pinnatifida Boiss. | 32.61 ± 1.39 jkl             |
| Sorbus terminalis (L.) Crantz var. terminalis | 33.65 ± 2.39 jk                |
| Taxus baccata L.                            | 28.33 ± 2.67 fgh                 |
| Viburnum lantana L.                         | 39.43 ± 2.69 fghi               |

* mean ± standard deviation.

### Table 5

| Sample                                      | H$_2$O$_2$ inhibition activity (%) |
|---------------------------------------------|----------------------------------|
| Artemisia campestris L.                     | 28.32 ± 2.87 gh                  |
| Artemisia santonicum L.                    | 26.17 ± 2.26 hi                  |
| Berberis crataegina DC.                    | 32.76 ± 1.78 efg                |
| Berberis integerrima Bunge                 | 30.46 ± 3.16 fgh                |
| Berberis vulgaris L.                       | 35.54 ± 2.95 def                 |
| Cistus laurifolius L.                      | 41.54 ± 3.74 bcd                |
| Cornus mas L.                              | 65.42 ± 5.04 a                   |
| Cornus sanguinea L. subsp. australis (C. A. Mey.) Jav. | 62.32 ± 3.82 a               |
| Cornus sanguinea L. subsp. sanguinea       | 61.28 ± 4.43 ab                  |
| Euonymus latifolius (L.) Mill. subsp. Latifolius | 38.03 ± 3.01 cde            |
| Ficus carica L. subsp. carica              | 39.62 ± 2.32 cd                  |
| Gypsophila eriocalyx Boiss.                | 18.64 ± 2.80 jk                  |
| Gypsophila parva Barkoudah                 | 25.43 ± 2.23 hi                  |
| Gypsophila perfoliata L.                   | 32.65 ± 2.33 efg                 |
| Gypsophila pilosa Hudson                   | 21.54 ± 1.98 ijk                 |
| Gypsophila tubulosa (Jaub. & Spach) Boiss. | 24.27 ± 2.22 hij                 |
| Jasminum fruticans L.                      | 37.02 ± 1.63 de                  |
| Mentha aquatica L.                         | 46.32 ± 2.91 b                   |
| Mentha longifolia (L.) Huds. subsp. longifolia | 44.29 ± 2.08 bc               |
| Mentha longifolia (L.) Huds. subsp. typhoides (Briq.) Harley var. typhoides | 47.32 ± 2.70 b             |
| Mentha pulegium L.                         | 59.22 ± 4.74 ab                  |
| Mentha spicata L. subsp. spicata           | 54.32 ± 2.57 ab                  |
| Mentha spicata L. subsp. tomentosa (Briq.) Harley | 56.31 ± 3.53 ab               |
| Pistacia terebinthus L. subsp. palaestina (Boiss.) Engler | 16.78 ± 1.76 jk                |
| Pistacia terebinthus L. subsp. terebinthus | 21.67 ± 2.09 jk                  |
| Rhus coriaria L.                           | 24.41 ± 2.44 hj                  |
| Taxus baccata L.                           | 13.44 ± 1.36 l                   |

* mean ± standard deviation.
The H₂O₂ inhibition activities of fruit extracts of Taxus baccata L. and Pistacia species were the lowest among the other fruit extracts (21.28-24.65%). The fruit extracts of Cornus and Morus species had the highest H₂O₂ inhibition activities ranging from 66.21-74.35%.

4. CONCLUSIONS

The present study demonstrates the antioxidant potential of some herbs and fruits from Turkey which could protect against free radical damage. The information might be useful for the development of food products and additives with appropriate antioxidant properties. It may be noted that Cornus, Morus and Mentha species examined in the assay (Cornus mas L. Cornus sanguinea L. subsp. australis (C. A. Mey.) Jav., Cornus sanguinea L. subsp. sanguinea, Morus alba L., Morus nigra L., Mentha spicata L. subsp. spicata, Mentha spicata L. subsp. tomentosa (Briq.) Harley) show higher antioxidant activities compared to the other plants studied.

The highest antiradical activity (AE) was observed in the Cornus and Mentha species with values ranging from 0.549-0.716 (P<0.05). These plant extracts may be accepted as having higher H binding capacity against DPPH radical. The highest DPPH radical scavenging effects were determined in fruit extracts from the Cornus and Morus species.
with values varying from 1.078-1.212 (EC₅₀). The highest chelating activity was observed for the *Cornus* species ranging from 44.64-45.72%. It is believed that the detection of natural antioxidant sources and proper consumption of them in the daily diet or the use of isolated compounds in clinical practices would be beneficial for a healthy life.

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