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# Fruit quality, bioactive compounds and antioxidant capacity of 6 Iranian peach cultivars

**Jafar Hajilou[1*], Shabnam Fakhimrezaei[1] and Gholamreza Dehghan[2]**

[1]Department of Horticulture, Faculty of Agriculture, University of Tabriz, 51664 Tabriz, Iran
[2]Department of Biology, Faculty of Natural Science, University of Tabriz, 51664 Tabriz, Iran
*Corresponding author e-mail: J_Hajilou@tabrizu.ac.ir

**Knowledge of fruit biochemical properties is very important for perception of product behavior during harvesting, transportation, packaging, storing and regeneration programs. In this study, physicochemical properties of fruit in 6 Iranian peach cultivars: 'Tak-daneh', 'Zoodras', 'Anjiri-ye-khouni', 'Haj-kazemi', 'Zaferani' and 'Kosari' were determined. For evaluation of antioxidant capacity and its relation with total phenolics and flavonoids, total antioxidant capacity [measured with 3 methods: ferric-reducing antioxidant potential (FRAP), 1,1-diphenyl-2-picrylhydrazyl (DPPH) and 2, 2-azinobis (3-ethylbenzothiazoline-6- sulfonic acid) radical scavenging assay (ABTS)] and total phenolics and flavonoids in fruits extracts of aforementioned peach cultivars were measured and then, correlation of these parameters were evaluated. The highest °Brix and dry matter content among the studied cultivars corresponded to 'Anjiri-ye-khouni' and the highest fruit humidity correlated to 'Zoodras' and 'Haj-kazemi'. The highest values of vitamin C corresponded to 'Anjiri-ye-khouni' and 'Zoodras' had the lowest vitamin C. Total ascorbic acid content was higher, then reported for other peach cultivars in the literature cited. Results revealed that 'Anjiri-ye-khouni' among the studied cultivars had the best antioxidant activity, flavonoid content and fruit quality attributes.**

**Keywords:** Fruit quality properties, *Prunus persica*(L.) Batsch, Total antioxidant activity**,** Total phenolics, Vitamin C

Peach is produced extensively in China, Italy, United States, Spain, Greece and Iran. Worldwide production of peach is over 20,530,000 tones. In Iran, approximately 500,000 tons of peach fruit were produced in 2010 (FAO, 2010). It is well known that peach fruit contains carbohydrates, organic acids, pigments, phenolic compounds, volatile compounds, antioxidants and trace amounts of proteins and lipids. It is a rich source of potassium, iron, fiber, vitamin A, vitamin C and other vitamins (Crisostoand Valero, 2008; Hancock andScorza,2008;Scorzaand Okie, 1991). However, processing and production units and consumers need to have more information about fruit physicochemical properties. This information is very important for understanding the product behavior during the harvesting, transporting, packaging and storing of fruit crops.

Furthermore, according to clinical and epidemiological studies, dietary intake of fruits and vegetables is strongly associated with a reduced risk of developing some chronic diseases, such as various types of cancer and cardiovascular disease. It has been hypothesized that this association may be partially attributable to the presence of high content of natural antioxidant compounds in fruits (such as phenolic compounds) which demolish the free-radical oxidative agents involved in the cellular damage (Sun *et al.,* 2002). Fruit phenolic compounds also participate in quality parameters such as visual appearance (pigmentation and browning), taste (astringency), and health-promoting properties (free-radical scavengers) of different fruit products (Shahidi, 1997). Vitamin C as an antioxidant has the capacity to scavenge several reactive oxygen species (Arrigoniand De Tullio, 2002).

Nowadays there is an increasing interest in selection of crops with higher antioxidant contents, within blueberries (Prior *et al.,* 1998), strawberries and apples (Scalzo*et al.,*2005), plums and peaches (Cevallos-Casals *et al.,* 2006). The consumption of peach fruit may have potential health benefits due to the range of nutrition component, phenolic compounds, carotenoids and other antioxidant compounds they contain. Previous researches about antioxidant capacity have revealed that, ascorbic acid (vitamin C), carotenoids and phenolic compounds represent the main sources of antioxidants in peaches (Byrne, 2002; Chang *et al.,* 2000; Gil *et al.,* 2002; Tomas-Barberan*et al.,*2001).

However, detailed information about the health-promoting components of peach fruit could lead to increase the consumption of this fruit as ingredients in medicine. Because of high consumption and attraction of peach fruit, selection, breeding and realizing of cultivars which contain high antioxidant properties is imperative. East Azarbaijan province is a top state in peach production (21,561.4 tons) in Iran and has wide cultivar diversity (MAJ, 2008). The goal of this study was to evaluate the fruit quality attributes, total phenolics, flavonoids and antioxidant capacity of some Iranian peach cultivars. To our knowledge, this is the first study about antioxidant capacity of Iranian peach cultivars.

## Materials and methods

### *Plant materials*

Six peach (*Prunus persica* L.) cultivars contained early seasons ('Zoodras', Kosari'), Middle seasons ('Haj-kazemi') and late seasons ('Tak-daneh', 'Anjiri-ye-khouni' and 'Zaferani') grown in the collection orchard of Tabriz University, were harvested at a commercial maturity stage.

### *Assessment of fruit quality characteristics*

Six fruits for each cultivar were homogenized using household mixer, and the homogenate samples analyzed. That total soluble solids content was measured by using a digital refractometer (Atago Model PR-1, Tokyo). The method for analysis of titratable acidity was based on neutralization of the acids present in the fruit juice with a basic solution (NaOH 0.1 N). Values of titratable acidity were expressed as percentage of malic acid on fresh weight basis (AOAC, 1990) method No. 981.12. To determine water and dry matter content (%) thin slices of the fruit were heated in an oven (65 °C, 24 - 72 h) until a constant weight was obtained and the weight loss was used to calculate the water and dry matter content in fruit. Ash content was measured according to AOAC methods (AOAC, 1984). The ash content was determined by heating a sample of the air-dried plant material in a muffle furnace at 550 °C to constant weight. It is expressed as a percentage of the oven-dry weight of the sample before heating.

### *Bioactive Compound Determination*

*Vitamin C content*

Vitamin C content of fruit juice was determined using 2, 6 - Dichloroindophenol titration according to AOAC (1990) method No. 967.21 and results were expressed as mg ascorbic acid 100 $g^{-1}$ fresh weight (FW).

*Total phenolics content*

Six fruits randomly selected from each cultivar were crushed and homogenized in a homogenizer. A small fraction of the homogenous mixture was centrifuged at 4000 g for 6 min. The supernatant clear juice was analyzed for total phenolics and flavonoids contents and antioxidant activity. The total phenolics content in fruit extracts was determined according to Folin-Ciocalteu's method described by Singleton and Rossi (1965). The extracts were mixed with 0.75 ml of 1:10 diluted Folin-Ciocalteu's reagent and after 5 min at room temperature, 0.75 ml of a sodium bicarbonate solution (60 mg $ml^{-1}$) was added. This mixture was stored at room temperature for 2 h, and its absorbance was measured at 725 nm. The analysis was performed in triplicate, and phenolics content was expressed as micro molar quercetin equivalents (QE) per 100 µl of extract (µM QE 100 $\mu l^{-1}$ extract).

*Total flavonoids content*

Total flavonoids content of fruit extracts was determined using the colorimetric method reported by Kaijv*et al.* (2006). The extracts were prepared as mentioned for total phenolics assay and mixed with $NaNO_2$ (5% w $v^{-1}$), $AlCl_3$ (10% w $v^{-1}$) and NaOH (1 M) and its absorbance was measured at 507 nm, after 5 min. The results were expressed in µM QE 100 $\mu l^{-1}$ extract of sample as mean of 3 replicates.

***Total Antioxidant Activity Determination***

*Ferric reducing antioxidant power (FRAP)*

The total antioxidant capacity of fruit extracts was measured by the ferric reducing antioxidant potential (FRAP) method (Benzie and Strain, 1999). FRAP assay measures the ability of the antioxidants contained in a sample to reduce ferric-tripyridyltriazine ($Fe^{3+}$-TPTZ) to a ferrous form ($Fe^{2+}$-TPTZ) which absorbs light at 593 nm. The FRAP solution was prepared freshly by mixing 25 ml of 0.3 M acetate buffer (pH 3.6) plus 2.5 ml of 10 mM TPTZ (2, 4, 6 - tripyridyl -S-triazine) solution in 40 mMHCl and 2.5 ml of 20 mM ferric chloride ($FeCl_3.6H_2O$). The sample was incubated in various concentrations (25, 50, 70 and 100 µl $ml^{-1}$) at 37 °C for 10 min and the absorbance was measured at 593 nm. The antioxidant power was calculated from a standard curve prepared by using different concentrations of $FeSO_4$ in the range of 100 - 1000 mM. The final FRAP values of samples were the mean of 3 replications. Results were expressed as mmol $Fe^{2+}$ $L^{-1}$.

*DPPH free radical scavenging activity*

Hydrogen atoms or electron-donation ability of the corresponding extracts were measured from the bleaching of the purple-colored methanol solution of 1, 1 - diphenyl- 2 -picrylhydrazyl (DPPH). The DPPH radical scavenging effect was determined according to the method reported by Blois (1958). Briefly, 20 µl of extracts in various concentrations (10, 30, 50, 70, and 100 µl $ml^{-1}$) were added to DPPH solution (0.1 mM in methanol) to bring the final volume to 2 ml and the reaction mixture was shaken vigorously. After incubation at room temperature for 10 min, the absorbance of the solution was measured at 517 nm using a spectrophotometer. Radical scavenging activity was expressed as $IC_{50}$ Value. This experiment was carried out 3 times.

*ABTS radical scavenging assay*

The ABTS assay is based on the ability of the antioxidants to scavenge the long life radical cation $ABTS^+$ (2, 2 – azinobis -3-ethylbenzothiazoline -6- sulfonic acid). ABTS (54.2 mg) was dissolved in phosphate buffer (pH 7, 0.5 mM) and activated to $ABTS^+$ radical by addition of 1 g $MnO_2$ with occasional stirring time of activation 30 min. Then the solution was centrifuged (5 min, 7,000 x g), filtered (25 µm) and diluted with Na-phosphate buffer, so that $A_0$ = ($t_0$) 0.700 ± 0.01. Sample addition was 10, 15 and 20 µl $ml^{-1}$ and time of reaction was 20 min. Absorbance of the solution was measured at a wavelength of 734 nm and quercetin (0.5

mM) was used as the standard (Lachman *et al.,* 2009). The ABTS radical-scavenging activity (%) was calculated as:

$$ABTS = (AA - AAA)/AA \times 100$$

AA: Absorbance of ABTS radical treatment
AAA: Absorbance of Antioxidants with ABTS radical treatment

***Statistical analysis***

Statistical analyses were performed using the software SPSS 16. Mean values were compared by Duncan's multiple range tests. Correlation coefficients (r) for polyphenols and antioxidant activity were calculated using the statistical software SPSS 16.

**Results**

***Fruit quality characteristics***

The highest total soluble solids (TSS) belonged to 'Anjiri-ye-khouni', which had significant difference with other cultivars except 'Tak-daneh'. The lowest content of total soluble solids was recorded in 'Haj-kazemi' (Table 1). As seen in Table 1, the highest values of titratable acidity belonged to 'Tak-daneh', and the lowest value of this attribute corresponded to 'Anjiri-ye-khouni'.

'Anjiri-ye-khouni' contained the highest dry matter content and the lowest water content. The lowest value of dry matter content and the highest content of water corresponded to 'Zoodras' and 'Haj-kazemi'. About the ash content and pH, no significant differences were observed. The pH of studied cultivars ranged from 3.60 to 4.90. The highest and lowest values of pH corresponded to 'Anjiri-ye-khouni' and 'Kosari', respectively (Table 1).

Table1. Physicochemical characteristics of 6 Iranian peach cultivars

| Cultivars | TSS (˚Brix) | Titratable acidity (%) | Dry matter (%) | Water content (%) | Ash (%) | pH |
|---|---|---|---|---|---|---|
| **'Tak-daneh'** | $13.7^{ab}$ | $0.90^{a}$ | $16.03^{b}$ | $84.00^{c}$ | $0.6^{ns}$ | $4.1^{ns}$ |
| **'Zoodras'** | $10.5^{d}$ | $0.57^{b}$ | $13.25^{d}$ | $86.68^{a}$ | - | $4.5^{ns}$ |
| **'Anjiri-ye -khouni'** | $14.1^{a}$ | $0.22^{c}$ | $21.10^{a}$ | $78.90^{d}$ | $0.8^{ns}$ | $4.9^{ns}$ |
| **'Haj-kazemi'** | $8.1^{e}$ | $0.51^{b}$ | $13.32^{d}$ | $86.68^{a}$ | $0.53^{ns}$ | $4.45^{ns}$ |
| **'Zaferani'** | $13.5^{b}$ | $0.59^{b}$ | $14.97^{c}$ | $85.03^{b}$ | $0.47^{ns}$ | $4.40^{ns}$ |
| **'Kosari'** | $11.2^{c}$ | $0.53^{b}$ | $16.73^{b}$ | $83.27^{c}$ | $0.47^{ns}$ | $3.60^{ns}$ |

Each value represents the mean of 3 replicates, Means followed by the same lower-case letters are not significantly different for $p \leq 0.05$ by Duncan's multiple range test

Table 2.Vitamin C (mg 100 $g^{-1}$ FW), total phenolics (μM QE100 $\mu l^{-1}$ extract) and flavonoid contents (μM QE100 $\mu l^{-1}$ extract) in 6 Iranian peach cultivars

| Cultivars | Vitamin C (mg 100 $g^{-1}$ FW) | Total phenolics (μM QE100 $\mu l^{-1}$ extract) | Total Flavonoids (μM QE 100 $\mu l^{-1}$ extract) |
|---|---|---|---|
| **'Tak-daneh'** | $10.50^{bc}$ | $2.72^{a}$ | $2.13^{b}$ |
| **'Zoodras'** | $5.40^{d}$ | $1.74^{e}$ | $1.10^{e}$ |
| **'Anjiri-ye -khouni'** | $22.50^{a}$ | $2.62^{b}$ | $2.38^{a}$ |
| **'Haj-kazemi'** | $6.00^{cd}$ | $1.87^{d}$ | $1.91^{d}$ |
| **'Zaferani'** | $12.60^{b}$ | $1.35^{f}$ | $1.08^{f}$ |
| **'Kosari'** | $9.90^{bcd}$ | $2.09^{c}$ | $2.07^{c}$ |

Each value represents the mean of 3 replicates, Means followed by the same lower-case letters are not significantly different for $p \leq 0.05$ by Duncan's multiple range test

Table 3.Antioxidant activity [FRAP (mmol $Fe^{2+}$ $L^{-1}$), DPPH ($IC_{50}$=μmol $g^{-1}$ FW), ABTS (%)] in 6 Iranian peach cultivars

| Cultivars | DPPH ($IC_{50}$=μmol $g^{-1}$ FW) | FRAP (mmol $Fe^{2+}$ $L^{-1}$) | ABTS (%) |
|---|---|---|---|
| **'Tak-daneh'** | 72.77[c] | 6.72[b] | 24.96[c] |
| **'Zoodras'** | 60.55[d] | 3.69[c] | 5.43[e] |
| **'Anjiri-ye -khouni'** | 14.36[e] | 6.91[a] | 47.19[a] |
| **'Haj-kazemi'** | 212.23[a] | 5.22[bc] | 41.28[b] |
| **'Zaferani'** | 103.87[b] | 4.44[c] | 3.54[f] |
| **'Kosari'** | 73.12[c] | 4.25[c] | 8.65[d] |

Each value represents the mean of 3 replicates, Means followed by the same lower-case letters are not significantly different for $p \leq 0.05$ by Duncan's multiple range test

***Bioactive Compounds and Total Antioxidant Activity***

Regarding vitamin C, significant differences were recorded among the studied cultivars. 'Anjiri-ye-khouni' had the highest content of vitamin C which was up to 4.17–fold higher than 'Zoodras'. 'Zaferani' had the next highest vitamin C content among the studied cultivars (Table 2).

About the total phenolics and flavonoids contents, significant differences were recorded among studied cultivars (Table 2). Total phenolics and flavonoids contents of the studied cultivars ranged from 1.35 to 2.72 (μM QE 100 $μl^{-1}$ extract) and 1.08 to 2.38 (μM QE 100 $μl^{-1}$ extract), respectively. 'Zaferani' contained the lowest amount of phenols and flavonoids. The highest phenolics content was found in 'Tak-daneh', while the highest value of total flavonoids corresponded to 'Anjiri-ye-khouni' (Table 2).

FRAP values of the studied cultivars ranged from 3.69 to 6.91 mmol $Fe^{2+}$ $L^{-1}$ and ABTS values ranged from 3.54 to 47.19% (Table 3). The highest FRAP and ABTS values corresponded to 'Anjiri-ye-khouni', which contains the highest value of total flavonoids (Table 2 and 3).

The evaluation of the contribution of total phenolics and flavonoids to total antioxidant capacity in fruits was performed by correlation analysis between total antioxidant capacity and phytochemicals. Total flavonoids were the group of compound that correlated significantly with ABTS radical scavenging assay ($r$ =0.829, Figure 1. F). FRAP values of extracts correlated both with total phenolics content ($r$ = 0.657, Figure 1. A), and total flavonoids content ($r$ = 0.714, Figure 1. B). A similar correlation ($r$ = 0.714) was observed between the ABTS values and total phenolics content (Figure 1. E). DPPH free radical scavenging activity have negative correlation with total phenolics and flavonoids contents ($r$ = -0.429, $r$ = -0.543, Figure 1. C and D, respectively). In general, correlation between total flavonoids and total antioxidant capacity was greater than correlation of total phenolics content, and antioxidant capacity (Figure 1. A - F).

**Discussion**

Crisosto and Crisosto (2005) reported that degree of consumer acceptance was significantly related with total soluble solids, although maximum consumer acceptance was attained at different total soluble solid levels depending on the cultivar. Besides, it is well known that TSS content of early season cultivars is lower than late season cultivars (Byrne, 2002; Crisostoand Valero, 2008; Souza *et al.*, 1998; Souza *et al.*,2000). It is very interesting that 'Zoodras' and 'Kosari' (which is an early season cultivar) had higher TSS content in contrast with 'Haj-kazemi' (a Middle season cultivar).

As mentioned above, the pH of studied cultivars ranged from 3.60 to 4.90. According to reports by Moing*et al.* (1998) and Yoshida (1970), the pH of the Low Acidity peach fruits ranges above 4.0. Thus, most of the studied cultivars except 'Kosari' in grouping characterized as low acidity peach.

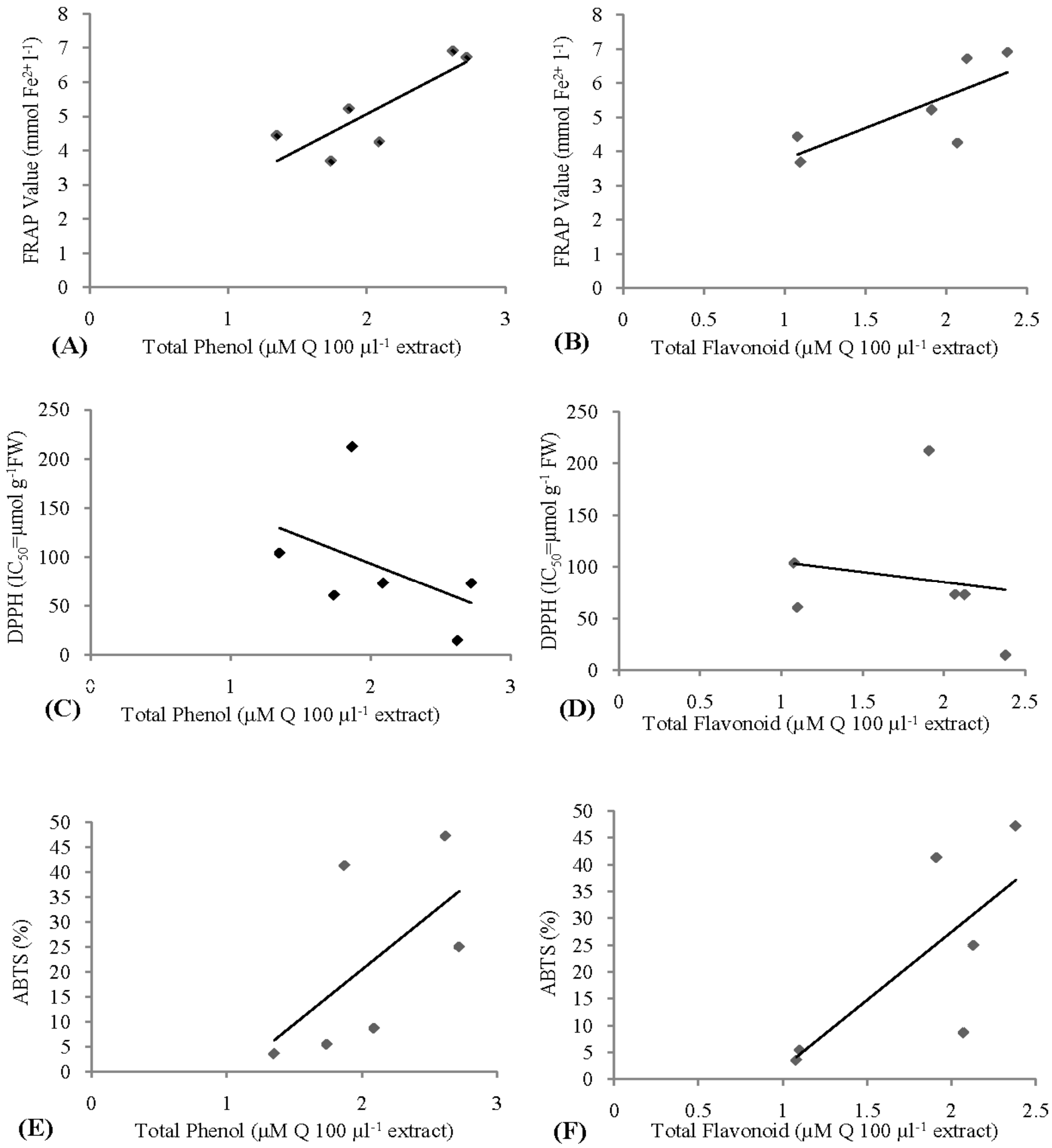


**Figure 1. Correlation between FRAP value and total phenolics content (*r*= 0.657, Panel A). FRAP value and total flavonoids content (*r*= 0.714, Panel B), DPPH value and total phenolics. (*r*= -0.429, Panel C), DPPH value and total flavonoids content (*r*= -0.543, Panel D), ABTS value and total phenolics content (*r*= 0.714, Panel E), ABTS value and total flavonoids content (*r*= 0.829, Panel F) in 6 Iranian peach cultivars.**

The native peach cultivars of the present study showed higher TSS and vitamin C content compared to other peach cultivars, which had total soluble solids ranging from 8.5 to 12.5 °Brix and vitamin C content ranging from 6 to 16 mg 100 $g^{-1}$ FW (Wills *et al.,* 1983). Vitamin C content in a survey of ten cultivars of California peach ranged from 6 to 9 mg 100 $g^{-1}$ in white fleshed and from 4 to 13 mg 100 $g^{-1}$ FW in yellow fleshed peaches (Gil *et al.,* 2002). Accordingly, similar concentrations of ascorbic acid (5 – 6 mg 100 $g^{-1}$ FW) have been found in European peach cultivars (Carbonaro *et al.,* 2002; Proteggente *et al.,* 2002).

Previous works revealed that, the phenolics content of fruit tissues is influenced by numerous pre-harvest parameters, including genotype, climatic conditions, agronomic practices (crop load, culture in greenhouses or fields, biological culture, etc.), harvesting time, processing procedure and degree of ripening (Drogoudi *et al.,* 2009; Gonçalves *et al.,* 2004 a, 2004b; Lee and Kader, 2000; McGhie *et al.,* 2005; Serrano *et al.,* 2005;). Gil *et al.* (2002) showed that a wide diversity of phytochemical levels exist within genera of peach, as the total phenolics concentration expressed as mg 100 $g^{-1}$ FW varied from 28 to 111 for white-fleshed and from 21 to 61 for yellow-fleshed California cultivars. European cultivars had values of 38 mg 100 $g^{-1}$ FW (Proteggente *et al.,* 2002), while the Spanish cultivar 'Caterina' showed values of 240 and 470 mg 100 $g^{-1}$ FW for flesh and peel, respectively (Goristein *et al.,* 2002). However, the results of the current study showed a non-significant difference among the studied cultivars on the phenolics contents.

According to Sanchez-Moreno *et al.* (1998), the lower $IC_{50}$ values indicate the higher antioxidant activity. 'Anjiri-ye-khouni' showed a very low $IC_{50}$. Thus, the mentioned cultivar has the highest antioxidant capacity among the studied cultivars. Tavarini *et al.* (2008) in the study for characterization of peach cultivars for antioxidant capacity showed that peach genotype plays an important role in determining antioxidant capacity. Our results are in agreement with reports of other researchers (Cevallos-Casals *et al.,* 2006; Prior *et al.,* 1998; Wang *et al.,* 1996) who claimed that the antioxidant activity in peaches depends on the genotype.

Supporting the current study, a linear relationship between total phenolics content and total antioxidant capacity has been reported by Wang and Lin (2000) for blackberry ($r$=0.961) and raspberry (r= 0.911). Kalyoncu *et al.* (2009) also showed a negative correlation between DPPH and total phenolics content in apricot cultivars. Our results are in agreement with those reported by other researchers (Vizzotio *et al.,* 2007) who postulated that antioxidant capacity was strongly correlated with total phenolics content ($r$ = 0.85*, $p \leq 0.05$). Also, Gil *et al.* (2002) found a strong correlation ($r$ = 0.93 - 0.96) between total phenolics content and antioxidant capacity of different peach, nectarine and plum cultivars. The correlation between antioxidant capacity and total phenolics content has also been reported in fruits of cornelian cherry (Hassanpour *et al.,* 2011; Pantelidis *et al.,* 2007), red grape cultivars (Hulya-Orak, 2007), strawberry genotypes (Sara *et al.* 2008), red-flesh peaches and plums (Cevallos-Casals *et al.,* 2006).

Correlation between total flavonoids and total antioxidant capacity was greater than correlation of total phenolics content and antioxidant capacity, which indicates that flavonoids are the most active antioxidant compounds in peaches. Thus, the phytochemicals responsible for the antioxidant capacity of peach fruit are mainly due to phenolic acids and flavonoid compounds.

Consumption of fruits with high phytochemical content and antioxidant activity can prevent chronic degenerative diseases such as tumors, cardiovascular diseases and atherosclerosis. The results of current study suggest that peach fruits represent an important source of antioxidant compounds. In this regard, Tomas-Barberan *et al.* (2001) reported that the total antioxidant capacity of peach fruits ranged from 13 to 107.3 mg of ascorbic acid equivalents when evaluated by the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical method and from 19 to 119.6 mg of ascorbic acid equivalents when evaluated by the FRAP method. Results revealed that, 'Anjiri-ye-khouni' among the studied cultivars had the best antioxidant activity, flavonoid content and fruit quality attributes. Also, this cultivar showed the highest value of total flavonoids. The mentioned cultivar is a 'Red blood flesh' cultivar, and this confirm the results of Vizzotio *et al.* (2007) who indicated that anthocyanin content, phenolics content, and antioxidant activity are higher in red-flesh than in light-colored flesh peaches. Szamosi *et al.* (2007) reported a close correlation between flesh color and antioxidant power within red fleshed varieties. These authors showed that cultivars with deepest red flesh color at the same time had highest antioxidant activity.

**Conclusion**

Human health and nutrition are still one of the most studied and interesting topics. Natural compounds, including those coming from plants, are nowadays under detailed investigation due to their potentially beneficial effects. Stone fruits are a significant source of phenolic compounds and ascorbic acid. In this study, we aimed at characterization of various cultivars of Iranian peaches.

Antioxidant activity varied greatly among the peach cultivars used in this study and was highly correlated with their contents of phenolic compounds. The present study indicates that the peach grown in the North-East area of Iran is an extremely rich source of ascorbic acid, phenols and antioxidants, demonstrating its potential use as a food additive. It was concluded from the present study that total ascorbic acid content of studied cultivars was higher than reported for other peach cultivars in the literature cited, especially for 'Anjiri-ye-khouni'. Finally, the associations found in this study can give information to consumers in helping to recognize a more nutritional peach.

Peach is found at relative high altitude, only in the Mediterranean area and to the best of our knowledge, few data exist regarding the quality attributes of native peach cultivars. Further studies should be conducted among native cultivars, in order to determine those high in antioxidant properties, which could be used as breeding material. Increasing the phenolic content of peaches by genetic manipulation will increase their antioxidant capacity. However, there is a limit beyond which increased phenloic concentration may cause undesirable levels of astringency in these fruits. Meanwhile, peaches should be included in the range of fruits selected by consumers to meet the recommended 2 to 4 servings of fruits per day.

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