Organik ve Konvansiyonel Olarak Yetiştirilen ‘Camarosa’ Çilek Çiçesinin Bazı Fizikokimyasal Özellikleri ve Antioksidan Kapasiteleri

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Özet

Organik ve konvansiyonel sistemlerde yetiştirilen Camarosa çilek çiçesinin meyve ağırlığı, meyve eni, meyve kalınlığı, meyve uzunluğu, meyve en/boy oranı, toplam kuru maddde, titre edilebilir asitlilik ve antioksidan kapasiteleri gibi bazı fizikokimyasal özellikleri kıyaslanmıştır. Organik yetiştirme sistemi istatistiksel olarak toplam kuru maddenin daha etkili bulunduştur. Organik olarak yetiştirilen çiçekler konvansiyonel olarak yetiştirilenleré göre daha koyu renklidir. Ek olarak, organik olarak yetiştirilen Camarosa çilek çiçesinin meyvelerinin toplam antioksidan aktivitesi konvansiyonel olarak yetiştirilenlerden daha yüksek değerlerde bulunmuştur.

Anahtar Kelimeler: Fragaria x ananassa Duch., Camarosa, organik yetiştirme tekniği, konvansiyonel yetiştirme tekniği, fiziko-kimyasal özellikler, antioksidan aktiviteleri

Introduction

Although commercial strawberry (FragariaX-ananassa Duch.) cultivation started towards the end of 1970 in Turkey, the country is currently one of the biggest strawberry producer in the world with 250,000 tons production annually (FAO, 2009). Recently some vegetable production areas of the Mediterranean region of Turkey have been converted to strawberry farms because of increased rentability of the Turkish strawberry production. The increased strawberry production in Turkey has initiated an increased interest to grow organic strawberries by farmers (Eşiţken et al. 2010).

Several studies have shown that consumers have positive attitude towards organic food (Loureiro et al., 2001; Magnusson et al., 2001). Organic foods are associated with no concern, no risks and are seen as healthy (Tönutare et al. 2009). In the past 10 years, so many review studies of the scientific literature comparing the nutrition of organic and conventional foods have been published. Many of these review studies (Reganold et al. 2010, Balci & Demirsoy 2008, Polat & Çelik 2008, Abu-Zahra et al. 2006, Brandt & Møgaard 2001, Worthington 2001, Williams 2002, Magkos et al. 2003, Rembialkowska 2007, Benbrook et al. 2008, Lairon 2010) found some evidence of organic food being more nutritious, whereas a few review articles (Dangour et al. 2009, Doran & Parkin 1994) concluded that there were no consistent nutritional differences between organic and conventional foods.

The objective of the current study was to elucidate the effect of organic and conventional cultivation technology on some physico-chemical properties and antioxidant activities of strawberry ‘Camarosa’ fruits.

Materials and methods

Materials

Strawberry fruits from one-year-old plantations were hand-harvested on 1 June 2010 from organic and conventional orchards in Akcami-Bozyazı-Mersin-Turkey.
Total soluble solids: The total soluble solids (TSS), determined by an electronic balance with an accuracy of 0.01 g. Each measurement was replicated 10 times.

Determination of fruit mass: Fruit weight was measured by an electronic balance with an accuracy of 0.01 g. Each measurement was replicated 10 times.

Determination of size: From the samples, 10 fruits were selected at random for determining the physical characteristics. For each fruit, three linear dimensions were measured, that is length, width and thickness, using a digital caliper.

Acidity: Titratable acidity (TA), expressed as % of citric acid, was determined in 10 ml of juice plus 50 ml of distilled water by titration to pH 8.1 with 0.1 N NaOH.

pH: The pH value was measured using a digital pH meter.

Total soluble solids: The total soluble solids (TSS), expressed as %, was determined in the juice of each sample using a portable refractometer at 21 °C.

Ratio (total soluble solids/titratable acidity): The ratio was calculated using the relation between the total soluble solids by titratable acidity.

Colour: Fruit color was evaluated by measuring the ratio was calculated using the relation between the total soluble solids by titratable acidity.

Methods

Physico-chemical analysis

Sampling: Ten fruits of each treatment were used for all analysis.

Determination of fruit mass: Fruit weight was measured by an electronic balance with an accuracy of 0.01 g. Each measurement was replicated 10 times.

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Free radical scavenging effect: The radical scavenging activity against the DPPH radical was evaluated according to the method of Serteser et al. (2008), with some minor modifications. The assay mixture contained 1.5 ml of 0.09 mg/ml DPPH (Sigma Chemical Co., St Louis, MO, USA) in methanol, 1 ml acetate buffer solution (100 mM, pH 5.5). The dilutions between 0.4 and 4 mg/ml were prepared with methanol. Then 3.9 ml DPPH solution prepared with 6x10⁻⁵ M methanol was added to each 0.1 ml dilution 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 the IC₅₀ value (mg/ml). All analyses were carried out duplicate.

Linear regression equations of absorbance against concentrations were determined by measuring the absorbances of seven different concentrations of DPPH (6x10⁻⁵ M) stock solution:

A (515 nm)=16,264 (C DPPH)-0.0192 (R²=0.972)

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

% Remaining DPPH=[DPPH] sample/[DPPH] control

Exponential regression equation was obtained between the rate of the remaining DPPH percentage and the DDPH amount of sample in vitro, and the sample concentrations of plants that decrease the initial DPPH concentrations by 50% (efficient concentration [EC₅₀]). The antiradical activity (AE) was calculated by dividing EC₅₀ values into 1.

Fe²⁺ chelating activity: The modified methods of Lim and Murtijaya (2007) were used for determination of the Fe²⁺ chelating activities of samples. One millilitre of extracts with different concentrations between 6 and 45 mg/ml and 3.7 ml deionizer water were mixed. 0.1 ml of 2 mol FeCl₃ solution was added and shaken and kept at dark and room temperature for 70 min. Then, 0.2 ml of 5 mM ferroin was added and shaken again, and the absorbance of the obtained Fe²⁺-ferroin complex after 10 min was measured at 562 nm. One millilitre of water was used instead of sample for the control. The equation is as follows (Yen and Duh 1999):

Chelating activity (%)=[1-(absorbance of sample/absorbance of control)]x100
**H₂O₂ inhibition effect:** The H₂O₂ inhibition effect of spice and plant extracts can be determined by spectrophotometer (Ruch et al. 1989). One millilitre (2.6 and 10 mg/ml) of sample, 3.4 ml of 0.1 M phosphate buffer (pH 7.4) and 0.6 ml of 43 mM H₂O₂ were mixed and after 60 min the absorbance of mixture was measured at 230 nm. Control solutions without H₂O₂ were prepared for each sample concentration. To determine the H₂O₂ concentration that was not involved in the reaction, a linear repression equation was used. Phosphate buffer (3.4 ml) was added to 0.6 ml 10.15, 25.43 at 230 nm. Linear equation formulas were obtained by the graphic of Standard curve of absorbance vs. different concentrations of (+)-Catechin A (230)=0.0132 x C (H₂O₂, mM)+0.0971 (R²=0.985)

(+)-Catechin was used as the reference antioxidant. The equation used is as follows:

\[ \text{H₂O₂ inhibition capacity (%) =} (1 - \frac{\text{H₂O₂ conc. of sample}}{\text{H₂O₂ conc. of control}}) \times 100 \]

**Statistical analyses**

Statistical analysis was done using the JAMP. The experiment was performed in completely randomized blocks design, with three replications. Differences between means were analysed by ANOVA test (p<0.05) (Püskülcü & İkiz, 1989).

**Results and Discussion**

In this study, some physico-chemical properties in terms of fruit weight, fruit width, fruit length, fruit width/length, SSC, pH, titratable acidity, fruit color and antioxidant content in organically and conventionally cultivated strawberry ‘Camarosa’.

Table 1. Some physico-chemical properties of “Camarosa” strawberry fruit

<table>
<thead>
<tr>
<th>Properties</th>
<th>Camarosa Strawberry Variety</th>
<th>LSD Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic</td>
<td>Conventional</td>
</tr>
<tr>
<td>Fruit weight (g)</td>
<td>16.634 a</td>
<td>18.584 a</td>
</tr>
<tr>
<td>Fruit width (mm)</td>
<td>33.096 b</td>
<td>36.210 a</td>
</tr>
<tr>
<td>Fruit thickness (mm)</td>
<td>28.525 b</td>
<td>31.344 a</td>
</tr>
<tr>
<td>Fruit length (cm)</td>
<td>34.304 a</td>
<td>33.405 a</td>
</tr>
<tr>
<td>Fruit width/length</td>
<td>0.965 b</td>
<td>1.084 a</td>
</tr>
<tr>
<td>SSC (%)</td>
<td>10.200 a</td>
<td>9.433 b</td>
</tr>
<tr>
<td>pH</td>
<td>4.133 a</td>
<td>4.200 a</td>
</tr>
<tr>
<td>TA (%)</td>
<td>0.9187 a</td>
<td>0.932 a</td>
</tr>
<tr>
<td>SSC/TA</td>
<td>11.104 a</td>
<td>10.127 b</td>
</tr>
<tr>
<td>Fruit Colour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>31.837 a</td>
<td>28.357 a</td>
</tr>
<tr>
<td>a</td>
<td>33.927 a</td>
<td>29.067 b</td>
</tr>
<tr>
<td>b</td>
<td>12.443 a</td>
<td>5.523 b</td>
</tr>
</tbody>
</table>

*Values in all the lines not connected by same letter are significantly different (P<0.05).*

According to the Table 1, fruit weight did not show statistically significant difference in growing system (organic or conventional). Fruit width and length values of conventionally grown fruits were higher than organically grown. Total soluble solids and TSS/TA ratio were statistically higher in organically grown fruits. Tönutare et al. (2009) elucidate the effect of cultivation technology and plant age on fruit composition of strawberries (Fragaria × ananassa Duch.) ‘Polka’. Strawberry fruits from two- and three-year-old plantations were harvested on two conventional and two organic farms in South Estonia in 2008. The results indicate that the strawberries cultivated under organic farming conditions had higher TSS (11.5%), compared to the conventionally grown strawberries (9.5%). Strawberry TA ranged from 0.92 to 1.07%, and was affected by the cultivation technology. In this study, the results were obtained Tönutare et al. (2009)’s is consistent with that obtained. Also, Gunnes et al.(2009) reported that investigations showed that the ratio SSC/TA is one of the predictors of the sweetness, sourness and flavour intensity of strawberry fruit (Tönutare et al. 2009). Tönutare et al. (2009) indicate that the conventionally-strawberry taste tends to be more acidic and less sweet compared to organically-strawberries. Similar results were obtained in my study. Schöpplein et al. (2002) found that the sensory popularity of strawberry cultivars correlated positively with fruity odour, sweet and aromatic taste, but negatively with watery taste. Abu-Zahra et al. (2006), carried out to determine the effect of four doses (1.5, 3.0, 4.5, and 6.0 kg/m²) of fermented organic matter comparing with a conventional system on fruit quality of the strawberry cultivar in plastic house conditions during the 2004/2005 season at Abu-Ghannam's farm in Kreimeh in the northern Jordan Valley. They found that fruit titratable acidity (TA) percentage and size the conventionally produced fruits were higher than in
the organically produced fruits and the organic treatments tended to produce fruits with higher total soluble solids (TSS) percentage, compared to the control and conventionally produced fruits. Results in my study were in parallel with Abu-Zahra et al. (2006)’s results. Balcı & Demirsoy (2008) carried out to determine yield and fruit quality of cvs. Sweet Charlie and Camarosa in conventional and organic growing systems in 2003-2005. Their study consisted of the following eight treatments: (1) Sweet Charlie using the conventional system mulched with a black plastic (SC-CL-BP), (2) Sweet Charlie using conventional system mulched with a floating sheet (SC-CL-FS), (3) Sweet Charlie using organic system mulched with a black plastic (SC-Or-BP), (4) Sweet Charlie using organic system mulched with a floating sheet (SC-Or-FS), (5) Camarosa using conventional system mulched with a black plastic (CAM-CL-BP), (6) Camarosa using conventional system mulched with a floating sheet (CAM-CL-FS), (7) Camarosa using organic system mulched with a black plastic (CAM-Or-BP), (8) Camarosa using organic system mulched with a floating sheet (CAM-Or-FS). They found that the yield was higher in the conventional system than in the organic system in 2004, but no significant difference between the two was found in 2005. Soluble solid and vitamin C contents were higher in fruits grown using the organic system in both years. There was no difference between the two growing systems in terms of high quality and high efficiency via organic farming practices. I support the results of Polat & Çelik (2008) in terms of high quality and high efficiency via organic farming practices.

Table 2. DPPH radical scavenging effects, Fe$^{2+}$ chelating activity (%) and H$_2$O$_2$ inhibition activity (%) of fruit extracts

<table>
<thead>
<tr>
<th></th>
<th>Camarosa Strawberry Variety</th>
<th>LSD value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic</td>
<td>Conventional</td>
</tr>
<tr>
<td>EC$_{50}$</td>
<td>2,113</td>
<td>2,243</td>
</tr>
<tr>
<td>AE</td>
<td>0,473 a</td>
<td>0,446 b</td>
</tr>
<tr>
<td>Fe Chelating Activity (%)</td>
<td>40,987 a</td>
<td>39,993 a</td>
</tr>
<tr>
<td>H$_2$O$_2$ Inhibition (%)</td>
<td>45,787 a</td>
<td>43,773 b</td>
</tr>
</tbody>
</table>

*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$_{50}$.
*Values in all the lines not connected by same letter are significantly different (P<0.05).

The DPPH radical scavenging assay is commonly employed to evaluate the ability of antioxidant to scavenge free radicals. The use of the DPPH free radical is advantageous in evaluating antioxidant effectiveness because it is more stable than the hydroxyl and super oxide radicals (Layina-Pathirana et al., 2006). Radical scavenging activity, expressed as EC$_{50}$, ranged from 2.113 mg g$^{-1}$ to 2.243 mg g$^{-1}$. The inverse relationship was found between Antiradical activity and EC$_{50}$ values in the fruit grown by different growing system. Because of a lower EC$_{50}$ value indicates greater antioxidant activity. Between two strawberry fruit types have different results. According to Table 2, higher antiradical activity was found organically grown fruit (0.473) than conventionally grown fruit (0.446). Because of different growing system, statistically significant differences were observed in terms of antiradical activity. According to the Table 2, the chelating activity was found to be statistically the same group. H$_2$O$_2$ inhibition activity method is used to eliminate O$_2$$^{•-}$, even though the superoxide radical anion (O$_2$$^{•-}$) does not initiate lipid oxidation directly.
Super reactive hydroxyl radical (.OH) may be formed from the Fenton Reaction ($Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + .OH$) in the presence of metal ions. For this reason, $H_2O_2$ inhibition activity is an important method for the determination of antioxidant characteristics (Serteser et al. 2009a, Serteser et al. 2009b, Serteser et al. 2008). In terms of $H_2O_2$ inhibition activity of fruit extracts were found statistically different. This value was obtained in organically grown fruit to be 45.787%; conventionally grown fruit to be 43.773%. Kovacevic et al. (2008) compared to conventional cultivation to organic cultivation, organic cultivation had effect on slightly higher levels of total phenolics, flavonoids and nonflavonoids in Elsanta and Marmolada strawberry cultivars. In spite of this, conventional strawberries showed higher antioxidant activity. Among fresh samples it is observed that cv. Elsanta contains higher amounts of total phenolics and flavonoids while cv. Marmolada contains higher amounts of nonflavonoids. According to my research, organically grown fruit has high antioxidant content than conventional. Therefore, the results obtained by Kovacevic et al. (2008) were in contrast with this research results. Reganold et al. (2010) investigated to strawberry ($Fragaria \times ananassa$ Duch.) varieties grown on the study farms included ‘Diamante’ and ‘San Juan’ in 2004 and ‘Diamante’, ‘San Juan’, and ‘Lanai’ in 2005. Strawberry fruit were collected from each of 13 pairs of organic and conventional strawberry farm fields in June and September 2004 and April, June, and September 2005. Organic strawberries had significantly higher total antioxidant activity (8.5% more), ascorbic acid (9.7% more), and total phenolics (10.5% more) than conventional berries, but significantly less phosphorus (13.6% less) and potassium (9.1% less). Specific polyphenols, such as quercetin and ellagic acid, showed mixed or no differences. Results in my study were in parallel with Reganold et al. (2010)’ s results. Jin et al. (2011) investigated the effects of cultural systems and storage temperatures on antioxidant enzyme activities and nonenzyme antioxidant components in two cultivars (‘Earliglow’ and ‘Allstar’) of strawberries. They found that strawberries grown from organic culture exhibited generally higher activities in antioxidant enzymes. Moreover, the organic culture also produced fruits with higher level of antioxidant contents. In conclusion, they expressed that strawberries produced from organic culture contained significantly higher antioxidant capacities and flavonoid contents than those produced from conventional culture. Jin et al. (2011) emphasized that strawberries grown in organic culture had significantly higher ORAC, .OH and DPPH radicals scavenging capacities than those in conventional culture. Similar results were found in this research.

**Conclusions**

In conclusion, the data presented in this paper indicated that the cultural systems significantly affect the some physico-chemical properties and antioxidant capacity of strawberries. Strawberries produced from organic culture contained significantly higher level of total soluble solids and antioxidant capacities than those produced from conventional culture. Because of these findings organically grown strawberry fruits can be more delicious and healthy.

**References**


