Tomato quality parameters from organic greenhouse production

Nikolaos KAPOULAS¹, Zoran ILIĆ², Mihal DUROVKA³

¹Regional Development Agency of Rodopi, N. Plastera K. Antoniadi, 69100 Komotini, Greece
²Faculty of Agriculture Priština-Lešak, Kopaonicka bb, 38219 Lešak, Serbia, (e-mail: zoran_ilic63@yahoo.com)
³Faculty of Agriculture Novi Sad, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

Abstract

The aim of this study was to compare fruit quality parameters of tomato cultivars grown in organic and conventional growing system. Higher levels of TSS, sugars and vitamin C were determined in conventional tomatoes. Tomatoes grown organically contained substantial amounts of lycopene and carotenoids. Results have shown differences between cultivars and growing seasons. Cultivar Elpida achieved the highest TSS content (5.08 °Brix), sugar (4.10 mg·100-1 g f.w.) and lycopene (3.75 mg·100-1 g f.w.) among tested cultivars. Total sugar and acid ratio of organic tomato fruits ranged from 0.41 to 0.47% citric acid, which resulted with favorable fruits flavor in comparison to conventional tomato.

Key words: Lycopersicon esculentum Mill., growing system, total soluble solids, lycopene, vitamin C

Introduction

Tomato (Solanum lycopersicum, syn. Lycopersicon esculentum Mill.) is an annual horticultural fruit with a worldwide distribution and high economic value. Its consumption benefits human health because of its high antioxidant compounds content. Increased interest in organic tomato production imposed the need to evaluate the quality and nutritional value of organic tomato. Research has shown that organic agricultural plants contain more total and reducing sugars and flavonoids (Rembialkowska et al., 2003). French Agency for Food Safety (AFSSA) and Lairon (2010) in published studies of the nutritional and sanitary quality of organic food conclude that organic plant products contains more dry matter and minerals (Fe, Mg); contains more antioxidant compounds such as phenols and salicylic acid; 94-100% of organic food does not contain any pesticide residues and organic vegetables contains about 50% less nitrates. Other scientists have argued that a valid comparison of nutritional quality would require the same cultivars growing at the same location, in the same soil and with the same amounts of nutrients, conditions which all normally differ between the two systems (Magkos et al., 2003). Research results of organic and conventional production effects on quality sometimes were contradictory. In terms of quality, some studies reported better taste, higher vitamin C contents and higher levels of other quality related compounds for organically grown products Several other studies have found the opposite or no differences in taste or other measured quality characteristics between organically and conventionally grown fruits and vegetables (Caris-Veyrat et al., 2004). The aim of this study was to compare fruit quality parameters of tomato cultivars grown in organic and conventional growing system.

Material and methods

Three tomato varieties (Robin-F1, Amati-F1 and Elpida-F1) were grown in the greenhouse (plastic tunnel 3.5 m high, covered by termolux 180 μm) during 2008-2010 located in the Sapes, Nort-Eastern Greece, using organic and conventional growing system. Conventional greenhouse technology and horticultural practices were slightly different from organic greenhouse production. The main variations are concerned with pest control and fertility. In conventional cultivation mineral fertilizers and chemical plant protection were
Ripe tomato fruit samples were chemically analyzed twice: at the beginning of fructification period and at the end of cultivation. At pink stage of ripening by visual inspection, samples were collected for quality analyses (color, firmness, total soluble solids, total sugar, total acidity vitamin C content, carotenoids and lycopene content). For sensory evaluation fruits were evaluated by trained descriptive panelists on the harvest day. All analyzes were carried out in Technological Faculty of Novi Sad and Analytical Laboratory of Biolab Epirus (Tzimas s. Bioeipirus Ltd), Ioannina - Greece. Total soluble solids (TSS) were determined by refractometer and results were reported as °Brix at 20 °C. Titrable acidity (TA) was measured with aliquots (5ml) of juice that were titrated to pH 8.1 with 0,1N NaOH (required to neutralize the acids of tomatoes in phenolphthalein presence) and the results were expressed as citric acid percentages. Total and reducing sugars content was determined by the Luff-Shoorl's method, vitamin C content by Tillman's method, carotenoids (lycopene) by the liquid column chromatography method.

The qualitative fruits characteristics results were statistically calculated using the Statgraphics 4.1 program, specifically Tukey’s test at α =0.05.

**Results and discussion**

The results of the chemical analysis are presented in figures 1 to 4. Organically grown tomato fruits contained 4.73 °Brix of TSS while the fruits from conventional growing system contained 4.79 °Brix of TSS. Obtained results showed that the accumulation of TSS at organic and conventional cultivation system did not show any statistically significant difference (figure 1). Irrespective of the cultivation method used and tested tomato cultivars, 'Elpida' fruits contained the highest level of TSS (5.08 °Brix). Tomato fruits from conventional system contained more total sugars (3.80 mg·100⁻¹g f.w.) in comparison with organic fruits (3.75 mg·100⁻¹g f.w.) but difference is not statistically significant. Conventional tomato fruits 'Amati' and 'Robin' contained more total sugars (3.85mg 100⁻¹gf.w.) in both periods of analysis in comparison with 'Elpida' (3.71 mg·100⁻¹g f.w.) but 'Elpida' fruits from organic cultivation, contained more total sugars (4.1 mg·100⁻¹g f.w) in comparison to other tested cultivars (figure 2).

The concentration of sugars varies greatly as a function of the cultivar and cultivation conditions. According to Dorais et al. (2001), the concentration of sugars may vary from 1.66 to 3.99% and 3.05 to 4.65% of the fresh matter, as a function of the cultivar and cultivation conditions, respectively.
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independently from the used cultivation system (table 1). As with the sugars, the organic acids are crucial to the flavour of the fruits.

There is a continuous variation in the fruit acidity during its development and maturation, increasing with the fruit growth until reaching its maximum with the development of coloration and diminishing with the advance of maturation. Conventional tomatoes contained statistically higher level of vitamin C (11.9 mg·100⁻¹g f.w.) in comparison with organic ones (11.4 mg·100⁻¹g f.w.). It was also found that ‘Elpida’ contained more vitamin C in comparison to other two tomato cultivars. Vitamin C content in ‘Elpida’ fruits was 12.1 mg·100⁻¹g f.w. in organic tomatoes and significantly higher (12.5 mg·100⁻¹g f.w.) in conventional ones (table 1).

<table>
<thead>
<tr>
<th>Production system</th>
<th>Organic production</th>
<th>Conventional production</th>
</tr>
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<tbody>
<tr>
<td>Quality trait</td>
<td>Total acidity</td>
<td>Vitamin C mg·100⁻¹g f.w.</td>
</tr>
<tr>
<td>Amati</td>
<td>0.41 b</td>
<td>11.1</td>
</tr>
<tr>
<td>Robin</td>
<td>0.47 a</td>
<td>11.0</td>
</tr>
<tr>
<td>Elpida</td>
<td>0.47 a</td>
<td>12.1</td>
</tr>
<tr>
<td>Significance</td>
<td>*</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

* P < 0.05

The results obtained have shown that conventional tomatoes contained more total sugars and more organic acids. Carbohydrates, acids and their interactions are important components of sweetness, sourness, and flavor intensity in tomatoes. Carbohydrates and organic acids are major determinants of tomato quality (Helyes et al., 2006).

The results showed that the lycopene content in organic tomatoes was higher, in comparison to conventional ones. The average content of this pigment at the organic fruit was 2.92 mg·100⁻¹g f.w., while for conventional tomatoes was 2.84 mg·100⁻¹g f.w (figure 3). Different tomato cultivars obtained different lycopene levels. At the same time, it should be noted that at the ‘Elpida’ in organic production contained more lycopene in fruits (3.75 mg·100⁻¹g f.w.) than the other cultivars Red color is initiated by lycopene, which is the most abundant carotenoid in ripe tomatoes, that comprise up to 90% of the total carotenoids present. The most important isomers of lycopene are cis- and trans-lycopene (Clinton, 1998). The trans- configuration represents 95.4% of the lycopene in fresh tomatoes. Lycopene is the pigment principally responsible for the characteristic deep-red color of ripe tomato fruits and tomato products. According to Brandt et al. (2003) significantly higher lycopene content was observed in glasshouse-grown tomato (83.0 mg kg⁻¹ f.w.) compared to field-grown (59.2 mg kg⁻¹ f.w.), at different harvesting times. According to Farkas (1994) lycopene production is inhibited when environmental temperature is above 32 °C. Lycopene content changed significantly during maturation and accumulated mainly in the deep red stage (Helyes, 2006).

Tomatoes from organic cultivation contained more carotenoids compared to conventional cultivation (figure 4.). Cultivar Amati contained significantly lower carotenoids level in both cultivation systems.
Organic 'Robin' tomatoes contained the highest carotenoides level in fruits (4.03 mg·100 g f.w) than the other cultivars (figure 4.). So far, very few studies have been conducted about tomato fruit quality from organic cultivation. In Sweden, the impact of cultivation methods on tomato quality has been investigated for three years and organically produced tomatoes showed a higher vitamin C, lycopene and chlorine content (Lundegårdh, 2000). In our study, significantly higher content of carotenoids in organically grown tomato was found only in cultivar Elpida. These results can be only compared to similar results obtained earlier (Rembialkowska et al., 2003).

**Conclusions**

In general, significant differences between tomatoes grown under conventional or organic farming systems could not be identified. Organically produced tomato contained more carotenoids and lycopene while the conventionally produced one contained more TSS, sugars, vitamin C and had higher titratable acidity.

**References**


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