academicJournals

Vol. 14(4), pp. 272-277, 28 January, 2015
DOI: 10.5897/AJB2014.14170
Article Number: 7CC3D8149951
ISSN 1684-5315

http://www.academicjournals.org/AJB

African Journal of Biotechnology

*Full Length Research Paper*

# Ascorbic acid, β-carotene, total phenolic compound and microbiological quality of organic and conventional citrus and strawberry grown in Egypt

**Hoda A. Khalil[1]* and Shimaa M. Hassan[2]**

[1]Department of Pomology, Faculty of Agriculture, Alexandria University, Aflaton street, 21545-El Shatby, Alexandria, Egypt.
[2]Department of Vegetable, Faculty of Agriculture, Alexandria, Egypt.

Received 9 September, 2014; Accepted 12 January, 2015

**A two year study at Alexandria University compared ascorbic acid, β-carotene, total phenolic compound, nitrite content and microbiological quality of orange and strawberry fruits grown under organic and conventional management techniques to see if producers concerns are valid. Organically grown oranges and strawberries had lower titratable acidity (TA); whereas, there was no significant difference in total soluble solid (TSS) of oranges and strawberries between two production systems. Higher ascorbic acid and β-carotene content was found in organically grown oranges and strawberries, compared to conventionally grown ones. Total phenol content (TPC) was significantly higher in conventional oranges compared to its organic production. Conversely, TPC was significantly higher in organic strawberries than the conventional ones. Comparative analyses of the microbial counts of organic and conventional oranges and strawberries fruit showed that *Escherichia coli* (*E. coli*) were not detected in any sample. However, conventional oranges and strawberries fruits have greater counts of yeasts and mold than organic ones. Nitrites were detected in all samples. The nitrites levels from organic production varied between 0.13 and 0.16 mg/kg fresh weight (FW), whereas those from conventional production ranged from 0.20 to 0.25 mg/kg FW. Our results show that the ascorbic acid, β-carotene, TPC, TA, nitrite content and biological quality were dependent on the agricultural production system, while for TSS%, this dependency was not pronounced.**

**Key words:** Ascorbic, β-carotene, organic, orange, strawberry, yeasts and molds.

## INTRODUCTION

Organic food is tasty, healthy and safe. Sales figures and popularity of organic food have been continuously rising for years. The Egyptian organic agriculture movement was started in the 1990s by SEKEM, a non-governmental organization which applied organic techniques. In Egypt, more than 95% of organic products are exported (IFOAM and FiBL, 2006). Egypt has one of the biggest organic sectors of all African nations and likewise one of the

*Corresponding author. E-mail: hodaagri@hotmail.com. Tel: +20 3 5908516. Fax: +20 3 4955104.

biggest domestic markets, though it is still on the whole quite small. Egypt grows a total of 24, 548 ha in organic agriculture, 0.72% of its total agricultural land. Main organic crops include fresh vegetables, tropical fruits, dried fruits, cotton, herbs and spices, medicinal plants and cereals (IFOAM and FiBL 2006). A private investor is currently seeking to certify over thirty million hectares of desert to be reclaimed for organic farming (Hashem, 2006).

Orange and strawberry are two from the most important fruits production, consumption and export in Egypt. Egypt is among the top four citrus producers in the Mediterranean Basin. Oranges are the main citrus fruit grown in Egypt, accounting for about 60% of total citrus production. Egypt is the sixth largest orange producer and the second biggest exporter (FAOSTAT, 2009). According to Food and Agriculture Organization (FAO) of the United Nations, in 2010, Egypt production of strawberries increased more than 3 times from 70,000 to 240,000 tons, and Egypt becomes the seventh largest strawberry producer in the world. Moreover, the identification of oranges and strawberries with high nutritive value represent a useful approach to select those fruits with better health-promoting properties.

Organic oranges and strawberries achieved higher prices than conventional ones, because these products are often linked to sew up the environment, better quality (taste, storage) and most people believe that they are healthier. Moreover, research results on the effects of organic and conventional production on quality sometimes are contradictory. In terms of quality, some studies report better taste, higher vitamin C contents and higher levels of other quality related compounds for organically grown products (Mitchell et al., 2007; Caris-Veyrat et al., 2004), whereas, several other studies have found the opposite or no differences in quality characteristics between organically and conventionally grown fruits and vegetables (Caris-Veyrat et al., 2004). In addition, based on the fact that organically grown fruit and vegetables often rely on manure as fertilizer, these products are perceived to pose a greater risk for foodborne disease (*Salmonella* spp., *Listeria monocytogenes* and *Escherichia coli*) than conventional crops (Johannessen et al., 2004). However, there have been very few scientist reports that have conducted microbiological analysis of organic fruit and vegetables.

People often buy organic fruits and vegetables because they consider organic fruits and vegetables to be more beneficial to both human health and environment, and with better flavor than conventional or integrated counterparts (Lester et al., 2007). Here we evaluated if there are significant differences in orange and strawberry fruit quality from commercial organic and conventional agroecosystems in Egypt. There is a scarcity of data on orange and strawberry fruit quality under organic farming system. The aim of the present study was to compare phytochemical characteristics, nitrite content and microbiological quality of Valencia orange and Festival strawberry produced under organic and conventional farming systems in Egypt in order to be able to address consumer's considerations.

## MATERIALS AND METHODS

### Sampling

A total of 100 orange and strawberry samples (50 organic and 50 conventional) were purchased in Carrefour hypermarket in the city of Alexandria, located in the south region of Egypt. The samples included: orange (*Citrus Sinensis* L., cv. Washington navel) and strawberry (Fragaria vesca L., var. Festival). Organic oranges and strawberries were produced from organic agriculture company located in Nobaria region. The organic fruits had a certificate issued by Demeter and/or Bio-Suisse certification. All samples were taken to laboratory in sterile plastic bags and they were processed immediately. Some samples were used for analysis of ascorbic acid, total soluble solid (TSS %) and titratable acidity on the same day and were therefore stored at room temperature. The other samples were stored in refrigerator at approximately 4°C until tested on the next day for β-carotene and total phenol content. Three replicates per treatment (each replicates contained 10 fruits of oranges and strawberries) were washed under running water and the non-edible parts (orange peel and leaves of strawberry) were removed. Oranges were hand squeezed and strawberries were cut and homogenized. Orange juice and strawberries homogenate were utilized for the ascorbic acid, TSS and acidity determination.

### Determination of total soluble solids (TSS) and titratable acidity (TA)

A portion of fresh orange juice and a small fraction of strawberries homogenate were centrifugated at 4000 *g* for 5 min and the supernatant was analyzed for TSS and TA. The percentage of total soluble solids (TSS) was measured by a hand refractometer (ATC-1E, Atago, Japan), and acidity as tartaric acid (TA) was determined by titration with 0.1 N NaOH according to AOAC (1995).

### Extraction and high performance liquid chromatography (HPLC) analysis of ascorbic acid and β-carotene

Ascorbic acid was extracted according to modified method described by Abdulnabi et al. (1997). Homogenized fresh sample (10 g) of strawberries and another sample of 5 ml of orange juice were extracted with a 5 ml solution of (0.3 M) meta-phosphoric acid and (1.4 M) acetic acid. The mixture was placed in a conical flask (wrapped with aluminum foil) and agitated at 100 rpm with the aid of an orbital shaker for 15 min at room temperature. The mixture was then filtered through a Whatman No. 4 filter paper to obtain a clear extract and then injected directly into Shimadzu HPLC (model CR4A, Japan).

β-carotene was extracted according to the slight modified method of Tee et al. (1996). A sample of strawberries (10 g) and another sample of 5 ml of orange juice were homogenized with 40 ml of 99.8% ethanol and 10 ml of 100% potassium hydroxide for 3 min by a blender. The mixture was heated for 30 min then cooled to room temperature. Exactly 50 ml of n-hexane was added to the texture and shaken strongly for a few seconds and the upper layer (hexan extract) allowed to separate and then removed. The aqueous layer was re-extracted twice with 50 ml of n-hexane in each time. The extract was filtered through anhydrous sodium sulphate to remove any water residue and exposure to reduced pressure at 45°C to

**Table 1.** Mean concentration of ascorbic acid, β-carotene, total phenolic content, TSS and acidity in orange fruits produced by organic and conventional farming in 2012 and 2013 seasons.

| Farming system | Ascorbic acid (mg/100 g) | β-Carotene (IU/100 g) | Total phenolic content (mg/100 g) | TSS (%) | Acidity (%) |
|---|---|---|---|---|---|
| **2012** | | | | | |
| Conventional | 55.57 ±0.57$^z$b | 543.67 ±1.52b | 165.28 ±0.34a | 9.98 ±0.12a | 1.40 ±0.05a |
| Organic | 77.62 ±1.18a | 582.77 ±1.45a | 126.20 ±0.57b | 10.00 ±0.15a | 0.90 ±0.12b |
| **2013** | | | | | |
| Conventional | 55.71 ±0.50$^z$b | 542.89 ±2.04b | 164.65 ±0.68a | 10.40±0.12a | 1.42±0.03a |
| Organic | 78.43 ±1.12a | 587.46 ±1.70a | 121.29 ±2.10b | 10.46±0.03a | 0.90±0.12b |

Means in a column followed by a different letter differ significantly at P = 0.05 by L.S.D test. $^z$Means ± SE.

**Table 2.** Mean concentration of ascorbic acid, β-carotene, total phenolic content, TSS and acidity in strawberry fruits produced by organic and conventional farming in 2012and 2013 seasons.

| Farming system | Ascorbic acid (mg/100 g) | β-Carotene (IU/100 g) | Total phenolic content (mg/100 g) | TSS (%) | Acidity (%) |
|---|---|---|---|---|---|
| **2012** | | | | | |
| Conventional | 31.12 ±0.32$^z$b | 351.55 ±1.02b | 7.65 ±0.18b | 6.78 ±0.05a | 0.39 ±0.02a |
| Organic | 51.27 ±1.01a | 407.21 ±0.29a | 16.05 ±0.36a | 6.80 ±0.05a | 0.23 ±0.01b |
| **2013** | | | | | |
| Conventional | 33.75 ± 0.61$^z$b | 351.57 ±2.50b | 8.24 ±0.18b | 6.78 ±0.05a | 0.38 ±0.02a |
| Organic | 51.27 ±1.01a | 413.50 ±2.59a | 17.04 ±0.12a | 6.80 ±0.05a | 0.22 ±0.01b |

Means in a column followed by a different letter differ significantly at P = 0.05 by L.S.D test. $^z$Means ± SE.

remove hexane residue then injected directly into a shimadzu HPLC.

HPLC analysis of ascorbic acid and β-carotene were performed on LC- 6A equipment consisting of LC- 6AD pumps, an in-line degasser, a CTO-6A column oven, a SCL-6A system controller, a SPD 6Avp, a photo diode array detector, a refractive index detector and operated by LC solution software (Shimadzu, Japan).

#### Determination of total phenol content

Homogenized fresh sample (0.5 g) of strawberries and another sample of 5 ml of orange juice were extracted with a 5 ml 75% (v/v) ethanol under periodical stirring at 45°C (Roussos et al., 2009). After centrifugation (4000 x *g* for 10 min), a quantity of 0.5 ml Folin-Denis reagent was added to 1 ml of the alcoholic extract and after 5 min, 7 ml saturated sodium carbonate solution was added, shaken and left for 0.5 h. Optical density was measured at 750 nm and total phenols were calculated from a standard curve of tannic acid. These data were expressed as the mg tannic acid equivalents per gram of fresh weight basis according to Slinkard and Singteton (1977).

#### Determination of nitrite

The nitrite contents in the oranges and strawberries were determined by a spectrophotometric method on foodstuff and water. The nitrite is determined by diazotizing with sulfanilamide and coupling with N-(1- naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye that is measured at 540 nm (Merino, 2009). Three replicates were analyzed; nitrite levels were expressed as mg/kg fresh weight (FW).

#### Microbiological analysis

Fruit were kept in refrigerator for no longer than 24 h prior to analysis. Each fruit was transferred to an individual, sterile plastic bag using gloves with 30 ml of 0.1% buffered peptone water (BPW). The sterile bags were hand- rubbed for a minute to remove surface microorganisms (Parish et al., 2001). Number of colony (yeasts and molds) was counted by methods (Beuchat and Cousin, 2001; Morton, 2001). *E. coli* were counted by the fast Petrifilm TM method (Kornacki and Johnson, 2001), and the results were reported as colony forming units per gram (CFU/g).

## RESULTS AND DISCUSSION

There was no significant difference in TSS content between organically grown oranges and strawberries (Tables 1 and 2). Compared with conventional production system, higher TSS content was reported in oranges, lemons and mandarin grown under organic production system (Duarte et al., 2010). Consistent with our results, no significant differences in TSS percentage were found for citrus and strawberries fruits between organic and conventional systems (Nunes et al., 2010; Camin et al., 2011 and Roussos, 2011).

Organically grown oranges and strawberries had lower TA than conventionally grown oranges and strawberries (Tables 1 and 2). This is in contrast to what was observed by Koneru (2013) who found that compared with conventional farming, higher TA content was reported in organically grown peaches. In agreement with our results, organic ‘Washington Navel’ oranges showed lower TA than organic ones (Candir et al., 2013). Based on previous reports, there is a slight difference on the organic acid concentration in the juice according to farming system. This could be attributed to the difference in fertilization system.

The data in Tables 1 and 2 clearly indicates that organically grown oranges and strawberries had higher ascorbic acid content than conventionally grown oranges and strawberries during both seasons. For example, in 2012 season, conventionally and organically grown oranges contained 55.57 and 77.62 mg/100 g, respectively. The corresponding values for strawberries were 31.12 and 51.27 mg/100 g, respectively. Many investigators also reported this increase in ascorbic acid content such as Duarte et al. (2010) on ‘Valencia late’ and ‘Baia’ oranges, Lester et al. (2007) on ‘Rio Red’ grapefruit, Asami et al. (2005) on Northwest Totem strawberry variety and (Jin et al., 2011) on Earliglow and Allstar strawberries. They concluded that a significantly higher ascorbic acid concentration for organically grown versus conventionally grown citrus and strawberries. A review in 2006 reported that organic foods had higher amounts of antioxidant (ascorbic acid) and lower levels of pesticide residues, nitrates and heavy metals contaminations than conventionally grown crops. Through that, organic crops had higher nutritional value and lower risk of causing disease due to contamination (Gyorene et al., 2006). Moreover, Duarte et al. (2012) demonstrated that the higher ascorbic acid content in citrus fruit juice from organic production system depend on species and cultivar.

According to previous studies, the possible interprettation for this finding is that nitrogen fertilizers under high rates seems to decrease the concentration of ascorbic acid content in fruits and vegetables (Lee and Kader, 2000) Besides Lee and Kader (2000) reported that the use of agrochemicals and pesticides may affect the nutritional quality of fruits and vegetables.

A greater β-carotene content in oranges and strawberries from organic compared to conventional farming systems was found (Tables 1 and 2). Roussos (2011) reported that organic management increased carotenoid concentration significantly compared to integrated farming system. The accumulation of carotenoid under organic farming system could be attributed to fertilization strategy. According to Gross (1987), soil fertilization is one of the factors that affects the biosynthesis of carotenoids in fruits.

A common explanation for reported differences in phytochemicals between organic and conventional produce is that organic systems are more stressful than conventional systems due to the limited and restricted use of pesticides in organic systems, thus allowing for greater incidence of biotic stresses (Tarozzi et al., 2006).

Among the TPC detected in the orange juice, significant differences were observed, where the juice of conventional produced fruits exhibited higher values (Tables 1 and 2). In contrast, the results indicated that there were significantly lower concentrations of TP in conventionally grown strawberry than the organically grown one. Jin et al. (2011) indicated that the TPC was significantly higher in organically cultivated strawberries than in conventionally cultivated strawberries. Biosynthesis of phenolic compounds in plants is strongly affected by the cultivator techniques, environmental conditions and the fertilizers used. Häkkinen and Törrönen (2000) reported that, of three strawberry cultivars tested by sampling from organic and conventional farms that increased, phenolic compounds only occurred in one cultivar under organic conditions, possibly due to pathogen attack. It has previously been reported that the phenol concentration is influenced by level of available nitrogen (Brandt and Molgaard, 2001). Increase in phenolic compounds is related to the defense role they play in plants under stressed conditions (Dixon and Paiva, 1995). In the absence of pesticides, plants could contain higher levels of antioxidant components as a result of enhanced synthesis of active phytochemicals produced in defense against biotic and abiotic stress (Tarozzi et al., 2006).

The microbiological quality of organic and conventional oranges and strawberries was determined by analysis of yeasts and molds and *E. coli* (Table 3). *E. coli.* (0.0 MPN/100 g) was not detected in oranges and strawberries fruits under organic and conventional production system.

In oranges, yeasts and molds were present in smaller accounts ($1.0 \times 10^2$ CFU/g) under organic production system whereas conventional oranges presented higher counts ($4.0 \times 10^2$ cfu/gm) than organic ones. Conventional samples of strawberries presented higher yeasts and molds counts than organic samples. In strawberries, yeasts and molds count ranged from 11x10 to 14x10 CFU/g under organic production system, whereas the count was from $60 \times 10^4$ to $77 \times 10^4$ CFU/g under conventional production system. These results contradict those of Maffei et al. (2013) who reported that *E. coli* was found in organic and conventional vegetables and higher microbial count of organic vegetables compared with conventional ones. Although yeasts and molds are associated with food spoilage, the mycotoxins produced by molds may be dangerous to health (Maffei et al., 2013). Mycotoxins caused many diseases, including carcinogen and immunosuppressive effects (Kovacs, 2004). Many other studies would be necessary to confirm these

**Table 3.** Yeasts and molds and *Escherichia coli* in orange and strawberry fruits produced by organic and conventional farming in 2012 and 2013 seasons.

| Sample | Yeasts and molds (cfu/g) | | | | *Escherichia coli* | | | |
|---|---|---|---|---|---|---|---|---|
| | Organic | | Conventional | | Organic | | Conventional | |
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Citrus | $1.0x10^2$ | 0.0x10 | $2.0x10^2$ | $4.0x10^2$ | 0.00 | 0.00 | 0.00 | 0.00 |
| Strawberry | 11.0x10 | 14.0x10 | $60x10^4$ | $77\ x10^4$ | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 4.** Mean concentrations of nitrates in orange and strawberry fruits produced by organic and conventional farming in 2012 and 2013 seasons.

| Sample | Nitrates (mg/l) | | | |
|---|---|---|---|---|
| | Organic | | Conventional | |
| | 2012 | 2013 | 2012 | 2013 |
| Citrus | 0.20 ±$0.01^z$a | 0.20 ±$0.01^z$a | 0.14 ±0.01b | 0.13 ±0.01b |
| Strawberry | 0.25 ±0.01a | 0.24 ±0.01a | 0.16 ±0.02b | 0.15 ±0.01b |

Means in a column followed by a different letter differ significantly at P = 0.05 by L.S.D test. $^z$Means ± SE.

observations. In addition, handling condition especially in Egypt should be considered, since they may impact the microbial profile of organic and conventional fruits.

To our knowledge, this is the first report that compares the nitrite level in oranges and strawberries fruit in organic and conventional production systems under Egypt conditions. The results obtained for nitrite levels are shown in Table 4. The results show a considerable significant variation in the average levels of nitrite contents between the two production systems. The average levels of nitrites were higher in conventional oranges and strawberries fruits. The nitrites levels from organic production varied between 0.13 and 0.16 mg/kg fresh weight (FW), whereas those from conventional production ranged from 0.20 to 0.25 mg/kg FW. Similar tendency was found by Gonzalez et al. (2010) and Aires et al. (2012); they reported significant differences in the average levels of nitrate contents from organic and conventional produce. The limits detected for nitrite in our samples are within the legal limits (0-1 mg/kg FW for orange and strawberry) recommended by European Union regulations (1995); thus, from the point of view of nitrites, this type of fruits are safe.

From this study, we can conclude that farm management techniques can affect the overall quality of orange and strawberry fruit. Organically grown oranges and strawberries had higher ascorbic acid and β-carotene content and lower titratable acidity than conventionally grown ones. Total soluble solid (TSS) of oranges and strawberries were not affected by the production systems. Total phenol content (TPC) was significantly higher in conventional oranges compared to its organic production. Conversely, TPC was significantly higher in organic strawberries than the conventional ones. Conventional oranges and strawberries fruits have greater counts of yeasts and mold than organic ones. The average levels of nitrites were lower in organic oranges and strawberries fruits. Organic fruits and vegetables seem to become popular because of the concerns over environmental contamination and health benefits. However, it is important to analyze a wide variety of fruit and vegetables to elucidate the possible benefits of the consumption of organic foods as part of a whole diet.

## Conflict of interests

The author(s) have not declared any conflict of interests.

## REFERENCES


AOAC (1995). Official Methods of Analysis, fifteenth ed. Association of Official Analytical Chemists, Washington, D.C., USA.

Abdulnabi AA, Emhemed AH, Hussein GD, Biacs PA (1997). Determination of antioxidant vitamins in tomatoes. Food Chem. 60: 207-212.

Aires AR, Carvalho EA, Rosa S, Saavedra MJ (2012). Effects of agriculture production systems on nitrate and nitrite accumulation on baby-leaf salads. Food Sci. Nutr.1: 3-7.

Asami DK, Hong YJ, Barrett DM, Mitchell AE (2005). Comparison of the total phenolic and AA content of freeze-dried and air-dried marionberry strawberry. J. Agric. Food Chem. 51: 1237-1241.

Beuchat LR, Cousin MA (2001). Yeasts and molds. In F. P. Downes, & K. Ito (Eds.), Compendium of methods for the microbiological examination of foods (4th ed.). (pp. 209e215) Washington, DC: American Public Health Association (APHA).

Brandt K, Molgaard JP (2001). Organic agriculture: Does it enhance or reduce the nutritional value of plant foods? J. Sci. Food Agric. 81(9):924-31.

Camin F, Perini M, Bontempo L, Fabroni S, Faedi W, Magnani S, Baruzzi G, Bonoli M, Tabilio MR, Musmeci S, Rossmann A, Kelly SD, Rapisarda P (2011). Potential isotopic and chemical markers for characterizing organic fruits. Food Chem. 123:1072-1082.

Candir E, Kamiloglu M, Ustiin D, Kendir GT (2013). Comparison postharvest quality of conventionally and organically grown 'Washington Navel' oranges. J. Appl. Bot. Food. Qual. 86: 59-65.

Caris-Veyrat C, Amiot MJ, Tyssander V, Grasselly D, Buret M, Mikolajczak M, Guilland JC, Bouteloup-Demange C, Borel P (2004). J Agric. Food Chem. 52(21):6503-6509.

Dixon RA, Paiva NL (1995). Stress-induced phenylpropanoid metabolism. Plant Cell. 7:1085-1097.

Duarte A, Caixeirinho D, Miguel MG, Sustelo V, Nunes C, Mendes M, Marreiros A (2010). Vitamin C content of citrus from conventional versus organic farming systems. Acta Hortic. 868: 389-394.

Duarte AM, Caixeirinho D, Miguel MG, Sustelo V, Nunes C, Fernandes MM, Marreiros A (2012). Organic acid concentration in citrus juice from conventional versus organic farming. Acta Hortic. 933: 601-606.

European Scientific Committee for Food (1995). Opinion on nitrate and nitrite (expressed on 22 September 1995), Annex 4 todocument III/56/95, CS/CNTM/NO3/20-FINAL. European Commission DG III, Brussels.

FAOSTAT (2009). Food and Agriculture Organization of the United Nations, October 29, www.fao.com.

Gonzalez MCM, Martı´nez-Tome MJ, Isasa MET (2010). Nitrate and nitrite content in organically cultivated vegetables. Food Addit. Contam. 3:19-29.

Gross J (1987). Pigments in fruits. London: Academic Press.

Gyorene KG, Vargaa A, Lugasi AA (2006). A comparison of chemical composition and nutritional value of organically and conventionally grown plant derived foods. Orvosi. Hetilap. 147(43): 2081-2090.

Häkkinen SH, Törrönen AR (2000). Content of flavonols and selected phenolic acids in strawberries and vaccinium species: influence of cultivar, cultivation site and technique. Food Res. Int. 33(6):517-24.

Hashem MY (2006). Organic agriculture in Egypt. The Organic Standard, 58.

IFOAM and FiBL (2006). The World of Organic Agriculture. Statistics and Emerging Trends 2006. International Federation of Organic Agriculture Movements (IFOAM), Bonn & Research Institute of Organic Agriculture FiBL, Frick, pp. 27-35.

Jin P, Wang SY, Wang CY, Zheng Y (2011). Effect of cultural system and storage temperature on antioxidant capacity and phenolic compounds in strawberries. Food Chem. 124:262-270.

Johannessen GS, Froseth RB, Solemdal L, Jarp J, Wasteson Y, Rorvik LM (2004). Influence of bovine manure as fertilizer on the bacteriological quality of organic Iceberg lettuce. J. Appl. Microbiol. 96 (4):787-794.

Koneru VC (2013). Peach fruit quality analysis in relation to organic and conventional cultivation techniques. M.Sc. Thesis, Utah State University, USA.

Kornacki JL, Johnson JL (2001). Enterobacteriaceae, coliforms, and *Escherichia coli* as quality and safety indicators. In: F. P. Downes, & K. Ito (Eds.), Compendium of methods for the microbiological examination of foods (4th ed.). Washington, DC: American Public Health Association (APHA). pp. 69-82.

Kovacs M (2004). Nutritional health aspects of mycotoxins. Orvosi hetilap. 145 (34):1739-1746.

Lee SK, Kader AA (2000). Preharvest and postharvest factors influencing vitamin C content of horticultural crops. Postharvest Biol. Technol. 20:207-220.

Lester GE, Manthley JA, Buslig BS (2007). Organic vs conventionally grown Rio Red whole grapefruit and juice: Comparison of production inputs, market quality, consumer acceptance, and human health bioactive compounds. J. Agric. Food Chem. 55:4474-4480.

Maffei DF, Silveira NF, Catanozi MD (2013). Microbiological quality of organic and conventional vegetables sold in Brazil. Food Control 29:226-230.

Merino L (2009). Development and validation of a method for determination of residual nitrite and nitrate in food stuffs and water after zinc reduction. Food Anal. Methods 2:212-220.

Mitchell AE, Hong Y, Koh E, Barrett DM, Bryant DE, Denison RF, Kaffka S (2007). Ten-Year Comparison of the influence of organic and conventional crop management practices on the content of flavonoids in tomatoes. J. Agric. Food Chem. 55:6154-6159

Morton RD (2001). Aerobic plate count. In F. P. Downes, & K. Ito (Eds.), Compendium of methods for the microbiological examination of foods (4th ed.). Washington, DC: American Public Health Association (APHA). pp. 63e67.

Nunes C, Duarte A, Manso T, Weiland C, Garcia JM, Cayuela JA, Yousfi K, Martinez MC, Salazar M (2010). Relationship between postharvest diseases resistance and mineral composition of citrus fruit. Acta Hortic. 868:417-422.

Roussos PA (2011). Phytochemicals and antioxidant capacity of orange (Citrus sinensis (L) Osbeck cv. Salustiana) juice produced under organic and integrated farming system in Greece. Sci. Hortic. 129: 253-258.

Roussos PA, Denaxa NK, Damvakaris T (2009). Strawberry fruit quality attributes after application of plant growth stimulating compounds. Sci. Hortic. 119:138-146.

Slinkard K, Singleton VL (1977). Total phenol analyses: automation and comparison with manual methods. Am. J. Enol. Vitic. 28: 49-55.

Tarozzi AS, Hrelia C, Angeloni F, Morroni P, Biagi M, Guardigli G, Cantelli-Forti P, Hrelia P (2006). Antioxidant effectiveness of organically and non-organically grown red oranges in cell culture systems. Eur. J. Nutr. 45:152-158.

Tee ES, Kuladevan R, Young SI, Khor SC, Zakiyah HO (1996). Nutrient analysis of foods. Kuala Lumpur: Institute Medical for Research.