Scientia Horticulturae 129 (2011) 253–258

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Phytochemicals and antioxidant capacity of orange (*Citrus sinensis* (l.) Osbeck cv. Salustiana) juice produced under organic and integrated farming system in Greece

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ARTICLE INFO

Article history:
Received 18 November 2010
Received in revised form 18 March 2011
Accepted 22 March 2011

Keywords:
Amino acids
Antioxidant capacity
Ascorbic acid
Carbohydrates
Integrated farming system
Orange
Organic culture
Phenols

ABSTRACT

Organically and integrated produced orange (*Citrus sinensis* (l.) Osbeck cv. Salustiana) fruits were assayed in terms of fruit characteristics and juice phytochemicals over a period of two years. Fruit size and juice volume were higher under organic farming system. There were not any significant differences concerning either the carbohydrates' or organic acids' concentrations of the juice. Similar results were obtained concerning the total phenol, the total o-diphenol and the total flavonoid concentration of the juice, while neither hesperidin nor narirutin differentiated significantly. However, β-carotene concentration was detected in higher concentration in organically produced fruit (0.43 mg L^{-1}). Juice extracted from both integrated and organically produced fruits exhibited similar antioxidant capacity values (based on 2,2-diphenyl-1-picryl hydrazyl and ferric reducing/antioxidant power assays), while correlation analysis revealed the significant contribution of phenolic compounds to antioxidant capacity (r = 0.75–0.86). Most of the amino acids determined were quantified in similar concentration in the juice of both organic and integrated produced fruits (approximately 1600 mg L^{-1}). The present results indicate that integrated oranges cv Salustiana, under the cultivation management implemented in this experiment, present similar antioxidant and nutritional values to the organically produced ones.

1. Introduction

Currently, there is much biomedical interest in citrus fruits because their consumption appears to be associated with lower risk of colorectal, esophageal, gastric and stomach cancers and stroke (Peterson et al., 2006; Tripoli et al., 2007). Citrus species are rich sources of vitamin C, folate, dietary fibre, and minerals as well as many phytochemicals, including flavonoids, amino acids, triterpenes, phenolic acids and carotenoids (Di Majo et al., 2005; Li-ying et al., 2008). Among fruit products, orange juice must be highlighted, as this product is a major source of flavanones (mainly hesperidin and narirutin) intake in the diet. Citrus flavonoids possess health-promoting properties and have been suggested as one of the possible cancer-preventing agents (Peterson et al., 2006). Both *in vitro* and *in vivo* studies described anticarcinogenic, antitumor, and antimutagenic activities of these compounds (Di Majo et al., 2005; Rapisarda et al., 2008). Thus, in addition to ascorbic acid and amino acids, orange fruits and their constituents are proposed to be an important dietary source of biologically active compounds such as phenolic compounds and their consumption may exert health beneficial effects (Rapisarda et al., 2008).

Organic agriculture procedures have become one of the fastest growing sectors of North American and European agriculture (Beltran-Gonzalez et al., 2008). Organic farming can be considered as "a holistic view of agriculture that aims to reflect the profound interrelationship that exists between farm biota, its production and the overall environment" (Pacini et al., 2003). On the other hand integrated farming system could be defined as "a holistic pattern of land use which integrates natural regulation processes with farming activities to achieve maximum replacement of off-farm inputs and to sustain farm income" (Pacini et al., 2003). This is partly opposed to conventional farming system where chemical fertilizers and pesticides are used intensively, without taking into consideration the possible integration of natural resources and products (manures, composts, plant residues, etc.) to the farm management strategy and environmental protection.

It is thought that in the absence of pesticides, plants could contain higher levels of antioxidant components as a result of enhanced synthesis of active phytochemicals produced in defence against biotic and abiotic stress (Tarozzi et al., 2006). Brandt and Molgaard (2001) suggested that organic produce could contain 10–50% more phytochemicals than non-organic one, while Woese et al. (1997) and Bourn and Prescott (2002) reviews reported contradictory findings.

With respect to product quality, surveys indicate that consumers consider organic foods to be more beneficial to both human

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doi:10.1016/j.scienta.2011.03.040