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Effect of rootstocks and harvesting time on the nutritional quality of peel and flesh of peach fruits

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Abstract

The influence was evaluated of four rootstocks (Ishtara, Mr. S 2/5, GF 677 and Barrier 1) and of harvesting time (early, middle, late) on the quality characteristics and nutritional value (vitamin C, phenols, carotenoids, total antioxidant capacity) of 'Flavorcrest' peach. The better rootstocks were Mr. S 2/5 (low-vigour) and Barrier 1 (high-vigour). In particular, Flavorcrest fruit on Mr. S 2/5 and on Barrier 1 rootstocks had higher antioxidant capacities and also higher phytochemical content, although fruits on Mr. S 2/5 were less firm.

Flesh firmness was best for fruits at mid-harvest (H2, 7 July 2006), whereas phytochemical contents were best at late harvest (H3, 13 July 2006), when, for all rootstocks, the best nutritional characteristics were also recorded. Total antioxidant capacity and phytochemical content were determined for the peel and flesh. The results show that removal of peel from peach results in a significant loss of total antioxidant capacity.
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Keywords: Carotenoids; Flesh; Harvesting time; Peach; Peel; Rootstock; Total antioxidant capacity; Vitamin C

1. Introduction

Stone fruits play an important role in human health due to the range of phenolic compounds and carotenoids they contain. Peaches, even though having a total antioxidant capacity (TAC) lower than some other fruits, such as strawberry, kiwifruit, apple, orange (Szeto, Tomlinson, & Benzie, 2002), are economically and nutritionally important because they can form a significant component of the diet during the spring and summer months because serving sizes are often larger (mass consumed per person, per day). Phenolic compounds represent the major sources of antioxidant capacity in peaches (Chang, Tan, Frankel, & Barrett, 2000); vitamin C and carotenoids also contribute to antioxidant activity (Gil, Tomas-Barberan, Hess-Pierce, & Kader, 2002).

The phytochemical content of fruit tissues is influenced by numerous pre-harvest factors, including genotype, rootstock, climatic conditions, agronomic practices and harvesting time, but also by post-harvest factors, including storage conditions and processing procedures (Cevallos-Casals, Byrne, Okie, & Cisneros-Zevallos, 2006; Gil et al., 2002; Lee & Kader, 2000; Tavarini, Degl'Innocenti, Remorini, Massai, & Guidi L., in press). Key to the commercial expansion of peach production is the promotion and maintenance of the highest possible standards of fruit quality. This involves the accurate evaluation of genotype and rootstock responses to growth conditions and management, and the identification of their best combinations (Giorgi et al., 2005). In a recent study, we showed that peach genotype plays an important role in determining total antioxidant capacity in peach fruits (Tavarini et al., in press). Moreover, Gil et al. (2002), in a study of antioxidant composition in a range of peach cultivars, showed that phenolic compounds were the main source of antioxidants. Certainly, also the rootstock is a very important

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factor in determining fruit quality. For example, it is known that dwarf rootstocks are able to direct more nutrients to the fruit because less competition for nutrients is provided by vegetative growth (Chalmers, Mitchell, & Van Heek, 1981). Also Giorgi et al. (2005) reported that rootstock has a significant role in determining the nutritional attributes of peaches.

In peach, the time of harvest influences total antioxidant capacity particularly strongly as during ripening a large number of biochemical, physiological and structural changes takes place. These include changes in background colour, sugar storage, decreases in organic acids, development of volatile and aromatic substances, fruit softening, increases in nutritional and healthful compounds, and, taken together, these determine fruit quality. Meanwhile, to ensure maximum resistance to mechanical damage and good shelf life, fruits are usually harvested well before physiological ripening, and at a stage characterised by high flesh firmness. For these reasons, it is difficult to identify a harvesting time that represents a best compromise between optimal quality and nutritional attributes on the one hand and good resistance to handling damage and shelf life on the other.

The peel of fruits and vegetables is commonly rejected because it is thought to be indigestible or possibly contaminated by sprays or by human disease agents. However, it has been reported that apple peels contain a higher amount of phenolic compounds and antioxidant activity (Wolfe, Wu, & Liu, 2003). Meanwhile, tomato skins contain high levels of lycopene, compared to the pulp and the seeds (Al-Wandawi, Abdul-Rahman, & Al-Shaikhly, 1985; Toor & Savage, 2005). This is true for peach too, where it has been reported that the peel contains higher amounts of phenols (Tomas-Barberan et al., 2001), carotenoids and total ascorbic acid than the flesh (Gil et al., 2002) on mass-per-mass basis.

Our objective was to evaluate different rootstocks grafted to Flavorcrest peach scions and different harvesting times on some phytochemical compounds and on the total antioxidant capacity in the peel and flesh fractions of the fruits. Determining the relationship between rootstock and harvesting time and levels of antioxidant compounds in fruits is essential, if we are to understand how to maximise levels of beneficial bioactive compounds in fresh fruits.

2. Materials and methods

2.1. Plant material

The peach rootstocks GF 677 (*Prunus persica* × *Prunus amygdalus*), Barrier 1 (*P. persica* × *Prunus davidiana*), Ishtara [(*Prunus cerasifera* × *P. salicina*) × (*P. cerasifera* × *P. persica*)] and Mr. S 2/5 (natural hybrid of *P. cerasifera*) were grafted to scions of 'Flavorcrest', a common yellow-pulp peach cultivar. The rootstocks GF 677 and Barrier 1 are considered 'high-vigour', while Mr. S 2/5 and Ishtara are considered 'low-vigour'. Trials were performed during 2006 at the experimental farm of the Department of Coltivazione e Difesa delle Specie Legnose "G. Scaramuzzi" of the University of Pisa (Italy), on a peach orchard, cv. 'Flavorcrest', planted in February 2000, having 4.5 × 2.5 m tree spacings and trained to a free spindle. A total of 50 trees were grafted onto each of GF 677, Barrier 1, Mr. S 2/5 and Ishtara rootstocks. In all trees, fruits were thinned 4 weeks after full bloom and before Stage II of fruit growth. Intensity of thinning depended on the size of the trees and on the number of long fruiting shoots remaining after winter pruning (one fruit every 15 cm along the bearing shoots). Conventional commercial irrigation and summer pruning treatments were performed. Fruits were selected for harvest that had been exposed to a 50–70% global solar irradiation, and 20 fruits were picked at three different times: early, 30 June 2006 (H1), middle, 7 July 2006 (H2) and late, 13 July 2006 (H3). The H2 time corresponded to the standard commercial stage for Flavorcrest cultivar. The evaluation of qualitative parameters (fresh weight, flesh firmness, soluble solids content, titratable acidity and skin over colour) was conducted on whole fruits. The nutritional characteristics (total antioxidant capacity, phenols, carotenoids) were determined at the same harvesting time in the same fruits used for quality characteristics, but in two different fractions – peel and flesh. At H1 and H3, vitamin C content was also determined in the two fractions. Fruits were peeled with a sharp knife, peel and flesh were frozen separately in liquid nitrogen, and kept at −80 °C until analysed.

2.2. Quality parameters

Flesh firmness (FF) was measured with a digital penetrometer having an 8-mm probe (Model 53205, TR, Forlì, Italy) on a flat surface, by removing the skin from two sides of the fruit. The measure was performed on two opposite faces in the equatorial zone. Flesh firmness was expressed in kg. Soluble solids content (SSC) was measured with a digital refractometer (Model 53011, TR) at the same sites as FF and was expressed as °Brix. The method for analysis of titratable acidity was based on neutralisation of the acids present in the fruit juice with a basic solution (NaOH 0.1 N). Values of titratable acidity were expressed as meq NaOH/100 mL.

The fruit colour was evaluated by visual assessment and expressed as percentage of skin surface covered by red pigment.

2.3. Total antioxidant capacity evaluation

To determine the total antioxidant capacity, the FRAP (Ferric-reducing antioxidant power) assay was used. The method measures the iron-reducing capacity of antioxidant substances in the extract of the two fractions. The procedure used was reported in Tavarini, Degl'Innocenti, Pardossi and Guidi (2007). The final value of total antioxidant

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