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Postharvest changes in quality characteristics, antioxidant activity and bioactive compounds of peach and nectarine cultivars [*Prunus persica* (L.) Batsch]

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Abstract: Three peach ('Honora', 'Dr. Davis' and 'Fairtime') and five nectarine ('Maria Anna', 'Diamond Ray', 'Fairline', 'Nectaross', 'Sweet Red') cultivars were analyzed at harvest and after a postharvest ripening period. Physicochemical characteristics [peel ground color (L*,C*, *h*°), soluble solids content (SSC), flesh firmness and titratable acidity (TA)], the concentration of some bioactive compounds [total phenol content (TPC) and total carotenoids (TC)] and the total antioxidant activity (TAA) were evaluated at harvest and after a shelf-life period of five days at 20 °C. Phenolic compounds and antioxidant activity were assayed on two different extracts of each sample: ethanol/HCl and ethanol/acetone. After shelf-life, all the cultivars showed a decrease in firmness and an increase in the ratio SSC/TA. The *h*° parameter of the peel background color had a good correlation with firmness, SSC, TA and the ratio SSC/TA in some of the cultivars, but no relationships were found in the white-fleshed varieties and in two of the nectarines evaluated. The trend of the carotenoids content after postharvest ripening was found to be cultivar-dependent, while TAA or TPC showed an increase in nectarines and remained unchanged in peaches. The ethanol/acetone mix was able to extract almost the double of antioxidant compounds with respect to the ethanol/HCl extract.

1. Introduction

Peaches and nectarines are widely-consumed summer fruit and, in the last few years, there has been an increasing interest in their nutritional value (Ramina *et al*., 2008; Wolfe *et al*., 2008). Peach fruit contains a wide range of chemical compounds but, from a dietary point of view, the most important fruit constituents are carotenoids, phenolics and fibre (Ramina *et al*., 2008). Yellow-fleshed peaches are considered a good source of β-carotene and β-cryptoxanthin (Gross, 1987) while flavonols, that are glycosilated forms of quercetin and kampferol, are the most abundant phenolics in peaches and other stone fruit (Young *et al*., 1989). All these compounds are reported to have antioxidant activity (Fu *et al*., 2011; Haminiuk *et al*., 2012) and, when added to the human diet, have a protective action against cancer and cardiovascular diseases (Steinmetz and Potter, 1996). After harvest, firmness, acidity and other quality parameters of peaches and nectarines are subjected to important changes (Crisosto, 2006; Ramina *et al*., 2008). Fruit nutritional quality varies greatly among cultivars (Gil *et al*., 2002) and often decreases after refrigerated storage (Di Vaio *et al*., 2001; Tsantili *et al*., 2010). After storage at low temperatures, sensory characteristics, and especially aroma, of peach decreases (Infante *et al*., 2008) while in fruit ripened at 18°C, the level of volatile compounds was found to be similar to tree-ripened fruit (Aubert *et al*., 2003). The aim of this work was to study the evolution of qualitative characteristics and the concurrent change in bioactive compound concentrations in eight peach and nectarine cultivars during postharvest ripening at 20°C.

2. Materials and Methods

A white- ('Honora') and two yellow-fleshed ('Dr. Davis', Fairtime) peach cultivars and a white- ('Maria Anna') and four yellow-fleshed ('Diamond Ray', 'Fairline', 'Nectaross', 'Sweet Red') nectarines were harvested in the experimental field of the CRA-fruit tree culture of Rome. Immediately after harvest, all fruits were sent to the CRA-food technology research unit of Milan where 30 fruits

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per cultivar were selected for size uniformity and absence of damage. Fruits of each cultivar were randomly divided into two sets of 15 fruits each and analyzed immediately [harvest (HR)] or after five days of shelf-life at 20°C (75-80% RH) in a temperature-controlled ripening room (SL).

Quality characteristics

Color (L*, a*, b*, CIE values), soluble solids content (SSC) and titratable acidity (TA) were analyzed on each fruit. Skin background color was measured by a spectrophotometer (CM-2600d, Konica Minolta, Japan) on the two cheeks of each fruit (15 fruit/sampling); flesh color was assessed on two opposite sides of each fruit after removing 2.5 mm of peel and flesh. Hue value ($h°$) was calculated as arctangent of b*/a* and expressed in degrees, while the color saturation index (C*) was calculated as $\sqrt{a^{*2}+b^{*2}}$. SSC was measured by a digital refractometer (RFM 81, Bellingham+Stanley, UK). TA was measured by titrating 10 ml of fruit juice with 0.1 N NaOH to pH 8.1 and calculating TA as g of malic acid/100 g fresh weight. The maturity index (Artés and Salmerón, 1996; Crisosto *et al*., 2001; Crisosto, 2006) was calculated as the ratio SSC/TA.

Bioactive compounds and antioxidant activity

Three replicates (five fruits/replicate), were analyzed at each sampling. Each extract was prepared in duplicate.

Total carotenoids (TC) were assessed by the method of Picchi *et al*., (2012) with some modification. Briefly, 5 g of homogenized flesh were added to 150µL of butylated hydroxytoluene (BHT) (1% in methanol w/v), 0.05 g of ammonium sulphate and 10 mL of extracting solution (hexane: ethyl acetate: ethanol, 2:1:1 v/v). Samples were vortexed for 10 s and then centrifuged (15 min, 4°C, 15000xg) and the supernatant was filtered through cheesecloth and stored at -20°C until analysis. Absorbance was recorded at 450 nm (UV-UVIDEC 320 spectrophotometer, Jasco, Japan) and total carotenoids were estimated by comparison with a standard curve obtained with different amounts of β-carotene. The results were expressed as µg β-carotene equivalent (β-carotene EQ) /100 g F.W.

Total phenolic content (TPC) and total antioxidant activity (TAA) were analyzed preparing two different extracts: 5g of homogenized flesh to 20 mL of Ethanol (96%): HCl 0.04N (1:1 v/v) (E extract) or 20 mL of Ethanol (96%): Acetone (1:1 v/v) (E/A extract). Samples were vortexed for 10 s and centrifuged (15 min, 4°C, 10000xg), and the supernatant was filtered through cheesecloth and stored at -20°C until analysis.

TPC was measured using the Folin-Ciocalteu method (Singleton *et al*., 1999) with some modifications: 150 µL of sample extract, 5 mL of deionized water and 1 mL of Folin-Ciocalteu reagent were put in 10 mL test tubes and, after 5 min, 2 mL of 20% sodium carbonate solution were added. Samples were kept 120 min in the dark and the absorbance at 730 nm was read against a blank (the same reaction mix but without the sample extract). TPC was calculated from a calibration curve, using gallic acid as standard. Results were expressed as mg of gallic acid equivalent (GAE)/100 g F.W.

TAA was measured using the DPPH assay. The effect of peach extracts on the content of 2.2-diphenyl-1.picrylhydrazyl radical (DPPH•) was estimated according to the method of Lo Scalzo *et al*., (2004) with some modifications: 100 µL of sample extract or Trolox standard solution (0.01 to 0.5 mg/mL) were added to 2 mL of ethanol and 500 µL of DPPH• (0.5mM in ethanol) and the decrease in absorbance at 517 nm was recorded after 3 min. Each reading was done against its blank (2.5 mL ethanol, 100 µL of sample extract). The DPPH scavenging capacity of the samples was calculated using a standard curve of Trolox, and expressed as mg Trolox EQ/100 g F.W.

3. Results and Discussion

Quality characteristics

Based on 'Redhaven' peach maturity (July 10 in central Italy) the evaluated varieties were considered (Table 1) as "middle-late" (Honora, Maria Anna, Nectaross), "late" (Dr. Davis, Diamond Ray, Sweet Red) or "very late" (Fairline, Fairtime) maturity cultivars. Firmness at harvest differed considerably from cultivar to cultivar but, as reported by other authors (Gil *et al*., 2002), peach cultivars have, on average, lower flesh firmness than nectarines (40.6 N and 51.1 N respectively, $P<0.01$). After five days of shelf-life, firmness of all the cultivars was comparable, with the exception of 'Dr. Davis' (yellow peach) and 'Fairtime' (yellow nectarine) which showed the highest values (13.7 and 18.8 N, respectively). Flesh firmness alone is not considered a satisfactory maturity index because it can vary among varieties, fruit size or climatic conditions (Crisosto, 1994). In general, mature fruit of early-season peach or nectarine is less firm than late season varieties (Crisosto, 1994).

At harvest all cultivars reached the SSC (10%) proposed by Kader (1997) as the minimum quality standard. All the nectarines and, above all, the "very late" cultivar 'Fairline', had higher SSC than peaches, both at harvest and after shelf-life. After shelf-life the SSC showed a slight increase in 'Fairline' while it remained unchanged in all the other cultivars. TA was higher in nectarines than in peaches (1.3 and 0.7 g/100 g fresh weight respectively, $P<0.01$) and decreased in all the cultivars after shelf-life. In peaches, SSC was shown to correlate well with consumer acceptance (Crisosto and Crisosto, 2005), but SSC and TA can be determined by several factors (Crisosto, 2006) and large differences are reported among peach varieties (Crisosto, 1994).

The ratio SSC/TA (maturity index) was judged by some authors (Lill *et al*., 1989; Artés and Salmerón, 1996) to be a more reliable quality index. In the present work, the maturity index increased in all cultivars after shelf-life and, on average, was higher in peaches than in nectarines (17.7 and 10.8% respectively, $P<0.01$).

Color changes that are associated with ripening strongly influence visual and eating quality of peaches (Ramina *et*

al., 2008). In our experiment, peel background color was affected by postharvest ripening. Almost all the cultivars had a lower (more yellow) h° value after shelf-life (Table 2), except for the white peach 'Honora' and for the nectarine 'Diamond Ray'. In this latter, the red color covered the whole fruit surface and it was very difficult to measure the background yellow color. L* and, above all, C* values of the peel background color markedly differed from cultivar to cultivar but seemed not to be affected by shelf-life.

Hue of the flesh decreased slightly after shelf-life in all the cultivars but not in white-fleshed peaches 'Honora' and 'Maria Anna' and in the nectarine 'Diamond Ray'. *h*° and L* values of the flesh were similar between white- and yellow-fleshed cultivars. The color of the white-fleshed peach ('Honora') and nectarine ('Maria Anna') differed from the yellow cultivars only for a lower C* value, which indicates a lower saturation of the color, rather than a real difference in the hue.

Table 1 - Physical and chemical characteristics (means ±standard error) of different peach and nectarine cultivars at harvest (HR) or after five days of shelf-life (SL) at 20°C

Fruit type	Flesh color	Cultivar	Harvest date	Time	Firmness (N)	SSC	TA (g/100 g F.W.)	SSC/TA
Peach	White	Honora	Aug. 4	HR	41.2±5.2	10.8±0.3	1.1±0.04	9.8±0.2
				SL	4.30±0.1	11.2±0.5	0.9±0.03	12.4±0.2
	Yellow	Dr. Davis	Aug. 18	HR	38.8±1.4	13.1±0.1	0.7±0.00	19.9±0.1
				SL	13.7±0.5	13.1±0.2	0.5±0.01	25.6±0.2
		Fairtime	Sept. 23	HR	41.8±2.8	11.2±0.2	0.7±0.02	16.6±0.2
				SL	7.20±0.3	10.7±0.6	0.5±0.02	20.4±0.3
Nectarine	White	Maria Anna	Aug. 4	HR	25.6±3.1	14.1±0.3	1.7±0.02	8.5±0.2
				SL	2.30±0.2	14.9±0.2	1.0±0.06	15.3±1.1
	Yellow	Diamond Ray	Aug. 10	HR	43.4±2.5	11.8±0.5	1.2±0.05	9.9±0.3
				SL	4.00±0.3	12.4±1.1	1.0±0.02	13.0±0.8
		Fairline	Sept. 16	HR	72.0±2.3	17.3±0.3	1.3±0.02	13.7±0.3
				SL	18.8±2.6	19.8±0.8	1.3±0.03	14.7±0.2
		Nectaross	Aug. 4	HR	56.8±4.8	13.7±0.2	1.6±0.02	8.7±0.0
				SL	4.60±0.4	14.5±0.5	1.5±0.05	9.9±0.6
		Sweet Red	Aug. 18	HR	57.6±3.6	11.1±0.4	1.3±0.05	8.4±0.1
				SL	7.00±0.7	11.4±0.4	1.2±0.04	9.2±0.2

Table 2 - Peel and flesh color parameters (means ±standard error) of peach and nectarine cultivars at harvest (HR) or after five days of shelf-life (SL) at 20°C

Fruit type	Flesh color	Cultivar	Time	Peel background color			Flesh color		
				L*	h°	C*	L*	h°	C*
Peach	White	Honora	HR	62.1±3.0	55.5±5.5	33.3±0.9	77.9±1.6	77.7±6.2	23.7±0.3
			SL	60.2±0.8	52.9±3.5	36.9±1.2	74.8±2.7	76.6±2.0	26.8±0.8
	Yellow	Dr. Davis	HR	75.1±0.2	83.5±0.4	60.3±1.3	82.2±0.4	85.4±0.5	50.3±1.6
			SL	74.7±0.6	79.3±0.7	62.6±0.3	81.6±0.3	83.8±0.3	51.5±0.4
		Fairtime	HR	76.6±0.4	89.7±0.3	51.8±1.4	82.6±0.2	87.4±0.3	47.8±0.9
			SL	75.4±0.7	84.8±0.5	56.3±1.2	80.1±0.4	84.1±0.3	51.3±1.2
Nectarine	White	Maria Anna	HR	70.3±1.7	65.2±3.9	31.3±1.0	78.4±0.7	64.7±3.5	19.5±0.8
			SL	64.8±2.2	54.7±3.6	37.5±1.2	77.2±1.3	73.2±6.1	20.8±0.7
	Yellow	Diamond Ray	HR	41.7±0.7	31.9±0.8	47.6±1.7	69.4±3.3	68.3±4.6	49.8±1.7
			SL	44.5±2.2	35.8±2.3	47.7±1.8	66.8±4.5	68.0±5.8	48.1±2.5
		Fairline	HR	75.3±0.1	87.6±0.3	58.7±0.2	80.5±0.6	86.4±0.3	51.3±0.2
			SL	71.9±0.3	81.2±1.0	61.9±0.6	78.2±0.5	83.0±0.7	55.5±0.6
		Nectaross	HR	71.2±1.2	79.7±1.7	51.8±0.4	79.3±0.7	85.4±0.9	50.4±0.9
			SL	70.4±1.2	75.1±1.9	58.3±1.0	75.0±1.2	79.8±2.1	50.8±0.6
		Sweet Red	HR	72.3±1.5	82.7±2.5	50.6±1.0	79.2±0.5	85.7±0.2	52.3±0.9
			SL	73.2±1.2	77.3±1.0	53.9±0.9	77.8±0.7	81.9±0.7	51.1±0.5

Flesh or peel background color are reported by different authors (Delwiche and Baumgardner, 1985; Byrne *et al*., 1991; Crisosto, 1994; Lewallen and Marini, 2003) to be highly correlated with firmness and other quality parameters of peaches and nectarines, so that background color is often used as maturity index (Kader, 1997). Peel background color or flesh color are not affected by sunlight and, thus, are more dependable indices of maturity than red color (Crisosto, 1994). In this work we found good correlations between peel background color or flesh color ($h°$) and different quality parameters in some of the evaluated cultivars (Table 3). In particular, peel background color of the yellow peaches 'Dr. Davis' and 'Fairtime' showed good correlations with firmness, TA or SSC/TA and, in 'Fairtime', these parameters were also related with flesh color. With regard to the yellow nectarines, peel and flesh color of 'Fairline' and 'Nectaross' were related with different quality parameters but without showing very high *r* values. Good correlations were found only in 'Nectaross' between $h°$ of the flesh and SSC or SSC/TA. 'Sweet Red' nectarine had a high correlation coefficient between flesh color and firmness, without showing any significant correlation coefficient with the other parameters. Similar, but slightly lower, *r* values were found for a* color parameter (*data not shown*). No relationships were found between flesh or peel color and any of the quality characteristics in the white peach ('Honora') and nectarine ('Maria Anna') while 'Diamond Ray' showed only a low correlation coefficient between flesh color and TA and between flesh color and SSC.

Bioactive compounds and antioxidant activity

Peaches and nectarines are rich in bioactive compounds such as carotenoids and phenolics (Gil *et al*., 2002). The major carotenoids in peaches are β-carotene and β-cryptoxanthin (Ramina *et al*., 2008). White and yellow peaches show different levels of carotenoids production, especially in the last phase of maturity (Brandi *et al*., 2011). In our experiment we found a lower level of total carotenoids in the two white-fleshed cultivars (Fig. 1). Carotenoid content increased, after shelf-life, in the two yellow peaches ('Dr. Davis' and 'Fairtime') and in the nectarine 'Diamond Ray', while it remained constant in the other nectarine cultivars ('Fairtime', 'Nectaross' and 'Sweet Red'). Carotenoid content showed a rather good correlation coefficient with the chroma (C*) of the flesh (r=0.64, P<0.01) and of the peel (r=0.62, P<0.01) but not with the $h°$ values (r=0.29 and r=0.33 with the flesh and peel hue values, respectively, P<0.05). The literature is inconsistent regarding the trend of TC after harvest. A decrease is reported by Ramina *et al*. (2008) while other authors (Caprioli *et al*., 2009, Bianchi *et al*., 2015) described an increase in carotenoids after shelf-life at 20°C. As is shown also by our results, the evolution of carotenoids after harvest could be cultivar-dependent.

Phenolic compounds were measured on two different extracts of each sample. In general, the extraction of phenolic compounds in alcoholic solution provides satisfactory results (Perva-Uzunalić *et al*., 2006); on pomegranate, some authors reported that the extraction in a mixture with methanol, ethanol, acetone and water had better results (Li *et al*., 2006). For this reason we decided to perform the classic ethanol/HCl (E) extraction plus an ethanol/acetone (E/A) extraction.

Total phenolic content (Fig. 2), evaluated by the two extraction methods, remained almost unchanged after shelf-life in the peach cultivars while it increased in nectarines, with the only exception being 'Diamond Ray' that

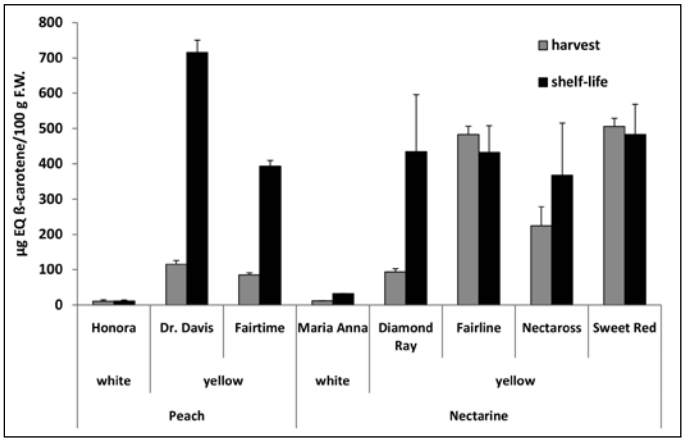

Fig. 1 - Total carotenoids content of the flesh of peach and nectarine cultivars at harvest and after five days of shelf-life at 20°C. Bars refer to standard error.

Table 3 - Correlations among peel background color or flesh color and different quality parameters in yellow or white-fleshed peaches and nectarines

Fruit type	Flesh color	Cultivar	Peel background color				Flesh color			
			Firmness	SSC	AC	SSC/AC	Firmness	SSC	AC	SSC/AC
Peach	White	Honora	NS	NS	NS	NS	NS	NS	NS	NS
	Yellow	Dr. Davis	0.73**	-0.59**	0.76**	-0.82**	NS	NS	0.38*	-0.39*
		Fairtime	0.70**	NS	0.76**	-0.81**	0.77**	NS	0.83**	-0.82**
Nectarine	White	Maria Anna	NS	NS	NS	NS	NS	NS	NS	NS
	Yellow	Diamond Ray	NS	NS	-0.48*	NS	NS	-0.52*	NS	NS
		Fairline	0.58**	-0.68**	NS	-0.56**	0.56**	-0.77**	NS	-0.66**
		Nectaross	0.42*	-0.38*	0.58**	-0.61**	0.52**	-0.45*	0.53**	-0.82**
		Sweet Red	NS	NS	NS	NS	0.82**	NS	NS	NS

Significance of r= P<0.05 (*), P<0.01(**), NS= not significant.

showed a very low TPC content. Between the two methods used, the ethanol/acetone mix (31.4 mg GAE/100g F.W, on average, against 26.4 mg of the ethanol extract, P<0.01) was able to extract a higher quantity of phenolics. Phenolic compounds are a class of compounds that is very broad and complex. In stone fruit the most abundant phenolics are flavonols and cinnamic acids, including chlorogenic and neochlorogenic acids (Ramina *et al*., 2008), but phenolic extracts of plants are always a mixture of different classes of compounds which are selectively soluble in the solvents (Koffi *et al*., 2010). Furthermore, solvent polarity plays a key role in increasing phenolic solubility (Naczk and Shahidi, 2004).

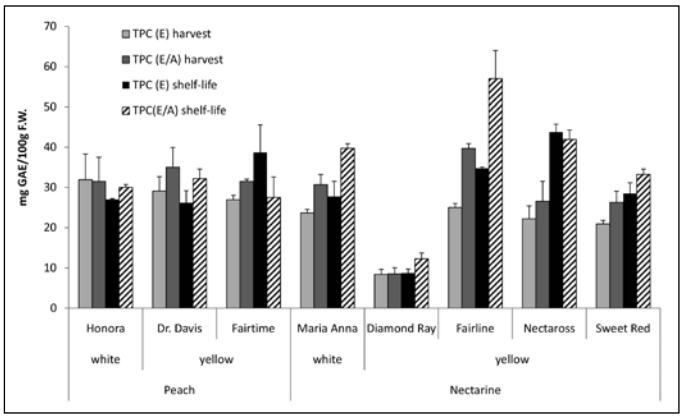

Fig. 2 - Total phenol content (TPC) of ethanol/HCl (E) or ethanol/acetone (E/A) extracts from flesh of different peach and nectarine cultivars at harvest and after five days of shelf-life at 20°C. Bars refer to standard error.

Since there were differences in TPC extraction between ethanol/HCl and ethanol/acetone solution, total antioxidant activity was also assayed on both extracts. As for phenolic compounds, peaches and nectarines showed different behaviors after shelf-life (Fig. 3): in peach fruit, total antioxidant activity, measured on E or E/A extracts, remained unchanged, while in nectarines it showed an increase after five days at

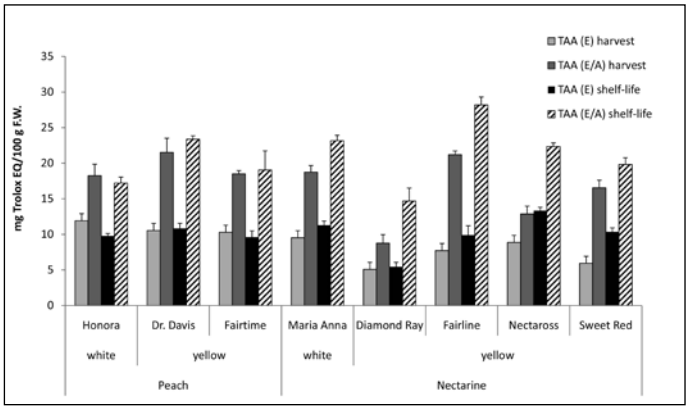

Fig. 3 - Total antioxidant activity (TAA) of ethanol/HCl (E) or ethanol/acetone (E/A) extracts from flesh of different peach and nectarine cultivars at harvest and after five days of shelf-life at 20°C. Bars refer to standard error.

20°C. Other authors also showed a significant increase in TAA in several nectarine cultivars after refrigerated storage (seven days at 2°C) while the increase was not significant or there was a decrease in peaches (Di Vaio *et al*., 2001, 2008).

Antioxidant activity of peaches and nectarines measured on E/A extract was more than double that measured on ethanol/HCl extract (19 mg Trolox EQ/100 g F.W., on average, with respect to 9.4 of the E extract, P<0.01). This fact indicates that probably more antioxidant compounds can be extracted by the combined action of the solvent mix ethanol/acetone. Acetone is a polar aprotic solvent that solvates ions without making bonds. Having also a lipophilic portion [-C-$(CH_2)_2$], it probably allows a better extraction of non-polar compounds like lipophilic phenols or carotenoids with respect to the ethanol/HCl extract. The correlation coefficient between the difference in TAA values measured on the two extracts (TAA ethanol/acetone-TAA ethanol/HCl) showed a slight correlation with total carotenoids (r=0.34, P<0.05), while there was no relationship between TAA measured on E extract and total carotenoids. As shown by Gil *et al*. (2002), total antioxidant activity was highly correlated with TPC (r=0.81 between TAA and TPC measured on E extract and r=0.87 between TAA and TPC measured on E/A extract, P<0.01).

Principal component analysis

To obtain a global picture of the difference in quality and nutritional characteristics of the different cultivars, all the data were subjected to PCA. Four functions were extracted, explaining 84.7% of total variance. Considering the first two principal components (Fig. 4) PC1 (39.2% of total variance) was positively related to all the evaluated

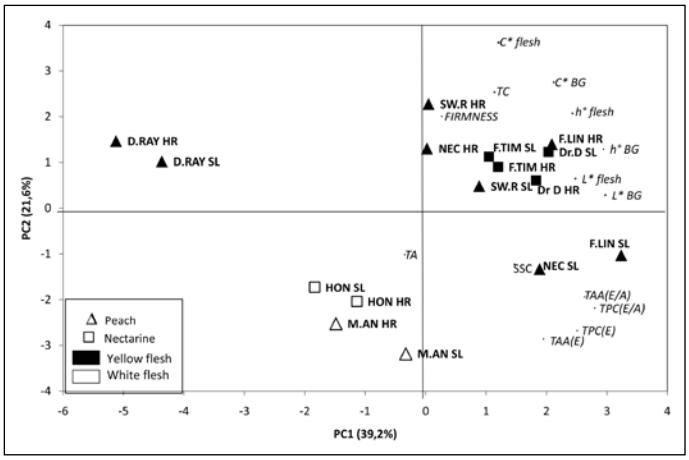

Fig. 4 - Principal component analysis of quality characteristics and bioactive compounds of eight peach and nectarine cultivars at harvest (HR) and after shelf-life (SL). Cultivars: HON= Honora; Dr.D= Dr. Davis; F.TIM=Fairtime; M.AN= Maria Anna; D.RAY= Diamond Ray; F.LIN=Fairline; NEC=Nectaross; SW.R=Sweet Red. Factors: SSC= soluble solids content; *h*°, C*, L*= color parameters; BG= peel background; TC= total carotenoids content; TA= titratable acidity; TAA= total antioxidant activity; TPC= Total phenol content; (E) ethanol/HCl extract; (E/A)=Ethanol/acetone extract.

factors, except for firmness and TA; PC2 (21.6%) grouped C* and *h*° color parameters, firmness and total carotenoids, opposite to SSC and TA. The biplot of PC1 versus PC2 (Fig. 4) revealed four distinct groups. The first group was formed by the two white-fleshed cultivars that showed negative values for both PC1 and PC2 and, hence, were negatively related to C* and total carotenoids. The second group was made up of the two 'Diamond Ray' samples, which showed very negative scores on PC1, probably because of their low values of bioactive compounds. The third group is composed of the two ripe samples (after shelf-life) of 'Nectaross' and 'Fairline' that had positive values on PC1 and negative on PC2 and, hence, linked mainly with a high content of antioxidant compounds. The last group was formed by the remaining yellow peaches and nectarine samples that showed positive values on PC1 and PC2, which are linked with high values in color parameters and high carotenoids content.

The scores of the all the samples on PC1 and PC2 showed important differences from cultivar to cultivar (Fig. 5). After shelf-life PC1 scores increased in all the nectarines but remained unchanged in the peach cultivars, while PC2 scores did not show important changes, except for 'Nectaross' and 'Fairline'.

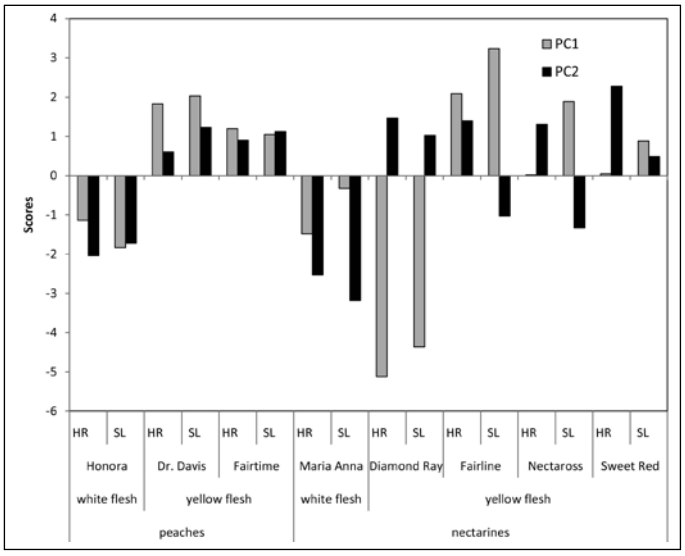

Fig. 5 - PCA scores on PC1 and PC2 of peach and nectarine cultivars evaluated at harvest (HR) and after shelf-life (SL). Bars represent standard error.

4. Conclusions

This study has shown a high variability in peach and nectarine characteristics after postharvest ripening. Peel background color, that is often used as maturity index (Kader, 1997) had, after shelf-life, a good correlation with firmness, SSC, TA and SSC/TA in some of the cultivars, but no relationships were found in the white-fleshed varieties and in two of the nectarines evaluated. For these cultivars it could be desirable to evaluate other nondestructive parameters such as Near infrared spectrometry (NIR) or Time-resolved reflectance spectroscopy (TRS) (Carlomagno *et al*., 2004; Zerbini *et al*., 2006), which might be better related with the ripening stage.

The trend of carotenoids content after postharvest ripening was found to be cultivar-dependent, while TAA and TPC measured on two different extracts (ethanol/HCl and ethanol/acetone) showed an increase in nectarines and remained unchanged in peaches. The E/A mix was able to extract almost double the antioxidant compounds with respect to the simple ethanol/HCl extract, probably because of the higher extraction of non-polar compounds due to the presence of acetone.

With principal component analysis, the nectarine 'Diamond Ray' was grouped differently from the other cultivars, probably because of its low content in bioactive compounds. In general, all the evaluated cultivars did not show, after postharvest ripening, a significant decrease in quality parameters other than firmness. On the contrary, all the cultivars maintained or increased their antioxidant activity and their initial content in bioactive compounds.

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