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POSTHARVEST QUALITY AND SENSORY ATTRIBUTES OF 'PESCA DI BIVONA' PEACHES (*PRUNUS PERSICA* L.) DURING STORAGE

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Abstract

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'Pesca di Bivona', 'Murtiddara', 'Bianca', 'Agostina' and 'Settembrina' are non-melting white flesh peach landraces characterized by a persistent aroma and excellent flavour highly appreciated by Italian consumers. The aim of this work was to assess the persistence of their quality and sensory profiles after storage at 0°C for 28 days, using destructive and non-destructive analyses. The I_{AD} index, measured either at harvest or at fruit removal from cold storage, was correlated to TSS, TA and firmness of all the landraces. 'Settembrina' and 'Agostina' harvested at the commercial ripening time (50.5 ± 4.3 N) and stored at 0°C during 4 weeks kept harvest quality in terms of sensorial attributes, flesh firmness, chlorophyll content, TSS, TA and reduced weight loss.

Key words: ethylene; no melting; postharvest treatments; sensory panel; VISs/NIR measurement

Introduction

Texture properties together with flavour and aroma are the main attributes that account for peach (*Prunus persica* L.) fruit quality and consumer acceptance (Crisosto and Crisosto, 2005; Crisosto et al., 2005; Shinya et al., 2014). According to consistency level of flesh during ripening, peaches and nectarines are categorized in melting, non-melting (Bailey et al., 1949), or stony hard (SH); (Bassi et al., 1998). Flesh firmness of melting peaches ranges from very soft to very firm; SH peaches have a long lasting, very firm flesh, while the non-melting genotypes display a rubbery texture that never melts. Peach genetic pools in Southern Italy includes white-flesh non-melting fruit landraces, such as the 'Pesca di Bivona' group (Marchese et al., 2006) consisting of four landraces: 'Murtiddara', 'Bianca', 'Agostina' and 'Settembrina', whose fruit ripe from late June to the end of September (Liguori et al., 2016). These landraces are characterized by a persistent aroma, an excellent flavour, high lactone content and a balanced soluble solid content/titratable acidity ratio (Montevecchi et al., 2012; 2013). To get the best performances in terms of flavour and aroma, commercial harvest time of 'Pesca di Bivona' fruit is usually set at peel colour breakage, corresponding to 50–60 N of flesh firmness. However, 'Pesca di Bivona' fruit reach only regional markets, because of their sensitivity to decay during fresh-cut processing (Allegra et al., 2015 a,b). Considering that peach maturity stage at harvest has little or none significant effect on the evolution of most of the physico-chemical and/or sensory parameters during storage (Bordonaba et al., 2014) the rationale of this study was to investigate the suitability of white-flesh, non-melting peaches of the 'Pesca di Bivona' landraces to postharvest storage, using destructive and nondestructive analysis.

Materials and Methods

Plant material and storage protocol

The research was conducted during 2013-2015 harvesting seasons in a commercial orchard located at Bivona, Southern

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Italy (37°37′ N, 13°26′ E, 503 m a.s.l.). The orchard was made of 12-years old trees of the white flesh 'Pesca di Bivona' peach (*Prunus persica* L.) landraces: 'Murtiddara', 'Bianca', 'Agostina' and 'Settembrina' grafted on GF677 (P. *amigdalus* x *P. persica*), spaced 5 x 4 m apart and N-S oriented. Thirty-six trees (9 trees x 4 landraces) submitted to ordinary horticultural cares were chosen for fruit sampling. Fruit yield was 50 ± 2.7 kg tree^{-1}, 350 fruit per landrace (39 x tree) were harvested at commercial harvest time and selected on the basis of uniformity and the absence of defects, corresponding to peel colour breakage and 50.5 ± 4.3 N of flesh firmness measured on 50 fruits randomly chosen within 10 trees ('Murtiddara', June 28; 'Bianca', July 20; 'Agostina', August 10; 'Settembrina di Bivona', September 23). Mean fruit weight was 174.7 ± 21.6 g, 196.4 ±19.1 g, 201.3 ± 18.7 g, 198.2 ± 19.4 g, respectively for 'Murtiddara', 'Bianca', 'Agostina' and 'Settembrina di Bivona'. Fruit fresh weight, firmness, total soluble solid content (TSS), titratable acidity (TA) and adsorbance index (I_{AD}) were destructively measured on 40 fruit of each landrace, immediately after harvested and every 7 days during four weeks of storage at 0 ± 0.5°C and 90 ± 1% RH. Ethylene production rate was measured on three replicates of two single fruit of each landrace, stored at 20°C for five days to simulate shelf life conditions. Twenty-five fruit of each landrace were weighed every 7 days to measure weight loss. These lots were then placed in a 25 m^3 cold-storage chamber (21 kPa O_2/0.03 kPa CO_2) at 0 ±0.5°C and 90 ± 1% relative humidity for 28 days. Samples were removed from storage after 7, 14, 21 and 28 days and then transferred at 20°C to simulate a commercialization period. Analyses were carried out at day 0 (AS) and 3 days (3d SL) thereafter.

Chemical and physical analyses

Fresh weight was measured with an electronic balance (EU-C 2002 RS, Gibertini Milano, Italy); fruit firmness was measured with a digital penetrometer Model 53205 (Turoni, Italy) with an 8 mm plunger tip placed on both faces of every single fruit after the removal of a 1mm thick slice of skin. The results were expressed in Newtons (N). SSC and TA were measured in juice pressed from whole fruit. SSC was determined with a Palette-10 hand refractometer (Atago PR-32 Ltd., Japan) and the results were expressed as % sucrose equivalents. TA was measured with a compact titrator, model S (Crison Instruments, Spain) by titrating 10 mL juice with 0.1M NaOH to pH 8.1 and the results were given as g L^{-1} malic acid. Non-destructive analysis of adsorbance (I_{AD} = Index of absorbance difference between two wavelengths, 670 and 720 nm, close to the absorbance peak of the chlorophyll-α) were made with a portable Vis/NIR DA-meter (Sintéleia X Ltd. marketed by TR Turoni Srl, Italy), capable of measuring the amount of chlorophyll of the fruit and, consequently, the degree of fruit ripeness. At each measurement date, three I_{AD} measurements were taken in the same area of the skin on both cheeks of each marked fruit. The average of the two measurements per fruit was used for data analysis (Echeverrìa et al., 2015). Ethylene production rate (μL kg^{-1} h^{-1}) was measured immediately after harvest on single fruit placed in an acclimatized chamber at 20°C, to simulate shelf life conditions (Allegra et al., 2017). Three replicates of two fruit of each landrace were placed in 1.5 L flasks continuously ventilated with humidified air at a flow rate of 1.5 L h^{-1}. Gas samples (1 mL) were taken of effluent air from respiration jars, using a 1 mL syringe and injected into a gas chromatograph (Agilent Technologies 6890, Wilmington, Germany) fitted with a FID detector and an alumina column F1 80/100 (2 m × 1/8 × 2.1, Tecknokroma, Spain). The oven temperature was set at 140°C while the injector and detector were kept at 180°C and 280°C, respectively. For each sampling date, ethylene concentration was analysed after the removal of 1 mL sample from the headspace of each tray and injection into the same equipment with the same conditions as described above.

Sensory analysis

Fruit samples from each pre-storage and cold-storage time were kept in a room at 20°C for three days, prior to sensory evaluation. Flesh firmness was measured on both sides of each fruit. Two longitudinal wedges were used to determine quality measures as described above. The rest of the fruit was used for sensory evaluation. Sensory analysis was performed immediately after harvest and 7, 14, 21 and 28 days after storage at 0 ± 0.5°C and 90 ± 1% RH. Analyses were carried out at day 0 and 3 days at 20°C On fruit removed from storage after 7, 14, 21 and 28 days. Three fruit of each landrace, used as single replicate, were tested by each component of a trained panel of 10 judges (7 females and 3 males, aged between 25 and 45 years). All panelists were trained and developed a wide expertise in sensory evaluation of several kind of fruits (Farina et al., 2017; Gianguzzi et al., 2017; Gallotta et al., 2017). The judges in a preliminary meeting selected 9 attributes on the basis of the citation frequency (>60%): floral, herbaceous, or peach flavour; flesh colour, sweetness, hardness, juiciness, aroma and finally the overall liking assessment (Sortino et al., 2015). A discontinuous scale was utilized for evaluation. The left side of the scale corresponded to the absence of the sensation (value 1.0) and the right side corresponded to the highest intensity (value 9.0). The judges evaluated the intensity of each descriptor by assigning categorical scores of 1 (absence of sensation), 2 (just recognizable), 3 (very weak), 4 (weak), 5 (slight), 6 (moder-

ate), 7 (intense), 8 (very intense) and 9 (extremely intense) (Liguori et al., 2014). The evaluations were carried out from 10.00 to 12.00 a.m. in individual booths illuminated by white light (UNI EN ISO 8589, 2010). The order of presentation was randomized for each judge and water was provided for rinsing between fruit samples.

Statistical analysis

Data analysis was performed through a one-way analysis of variance (ANOVA) to evaluate the significance of differences between sampling times (i.e. storage time), using Systat software. The mean values of each variable were compared using Tukey's mean separation test ($P \leq 0.05$). Pearson's correlation analysis was performed using software SYSTAT, v.13.

Results and Discussion

Standard quality measures after cold storage

A significant decrease of TSS content during storage occurred only in fruit of 'Murtiddara' that showed the same trend in TA, I_{AD} and flesh firmness. 'Bianca', 'Agostina' and 'Settembrina' fruit showed a significant increase in TSS content during the first week of storage with no further significant changes occurring until the end of the storage period (Table 1).

All landraces except 'Settembrina' showed a significant decrease in TA from 7 to 28 days after storage. TSS and TA content were not significantly related each other. I_{AD} and firmness values were significantly correlated (Table 2) in all landraces and both values showed a consistent decrease throughout the

Table 1

Total soluble solid (TSS), titratable acidity (TA) and absorbance index (I_{AD}) of fruit of the white-flesh peach 'Pesca di Bivona' landraces during 28 days at 0°C and 90% RH

Landrace	Harvest data	Storage time, days	TSS (%)		TA (g L^{-1})		Adsorbance (I_{AD})		Firmness (N)	
			AS*	3d SL**	AS*	3d SL**	AS*	3d SL**	AS*	3d SL**
Murtiddara	20/07	0	13.3±0.2a	13.8±0.9a	0.60±0.09a	0.57±0.05a	0.86±0.1a	0.80 ±0.8a	50.7±0.9a	45.3±1.1a
		7	13.4 ±0.2a	13.6±0.5 a	0.61±0.05a	0.57±0.03a	0.74±0.1b	0.68±0.4b	38.1±1.0b	32.4±0.8b
		14	12.8±0.2b	12.3±1.2 b	0.53±0.07b	0.51±0.04b	0.72±0.1b	0.69±0.5b	33.7±0.4b	26.2 ±0.8b
		21	12.1 ±0.2 c	12.4 ±0.7c	0.46±0.06c	0.47±0.03c	0.50±0.1c	0.32±0.6c	20.5±0.5c	16.7±0.9c
		28	12.2±0.2c	12.4±0.4 c	0.45±0.02c	0.42±0.01c	0.41±0.1c	0.22±0.8c	18.7±0.7c	12.7±1.0c
Bianca	02/08	0	14.6 ±0.8b	14.9± 1.1b	0.70±0.03a	0.69±0.09a	0.89±0.1a	0.79±0.9a	51.8±0.7a	46.2±1.5a
		7	15.3 ±1.0a	15.3 ±1.4a	0.65±0.02b	0.62±0.05b	0.80±0.1b	0.72±0.6b	40.3±0.4b	37.3±0.7b
		14	15.5 ±1.1a	15.9 ±0.9a	0.48±0.05c	0.47±0.06c	0.76±0.1bc	0.66±0.5bc	35.5±1.1bc	30.0±0.9bc
		21	15.3 ±1,2a	15.4 ±0.7a	0.48±0.06c	0.46±0.01c	0.73±0.1c	0.63±0.9c	33.8±0.9c	27.2 ±0.8c
		28	15.5±1.0 a	15.6± 0.6a	0.46±0.01c	0.44±0.02c	0.55±0.1d	0.41±0.6d	25.9 ±0.4d	20.7±0.8d
Agostina	22/08	0	14.3 ±0.8b	14.6±1.3b	0.45±0.05a	0.42±0.05a	1.20±0.8a	0.92±0.5a	53.2±0.9a	45.8±1.2a
		7	14.9±0.8 a	15.3 ±1.2a	0.46±0.02a	0.44±0.08a	0.94±0.3a	0.85±0.7a	40.2±0.7b	37.0±0.6b
		14	15.0±0.8a	15.2 ±0.8a	0.38±0.05b	0.35±0.05b	0.87±0.2a	0.81±0.5a	41.5±0.4b	33.4±0.6b
		21	14.9±0.8a	15.4 1.4a	0.37±0.04b	0.35±0.04b	0.63±0.3ab	0.61±0.3ab	30.5±0.8c	28.9±0.9c
		28	14.9±0.8 a	14.8± 1.1a	0.37±0.02b	0.34±0.03b	0.32±0.6b	0.30±0.4b	18.9±0.8d	14.9±0.2d
Settembrina	19/09	0	12.5±0.8b	12.8± 1.4b	0.70±0.04ns	0.68±0.03ns	1.10±0.2a	1.1±0.5a	51.1±0.7a	46.1±0.4a
		7	13.4±0.8a	14,0 ±1.0a	0.71±0.05	0.68 ±0.07	0.84±0.1a	0.76±0.4a	40.2±0.8b	36.2±0.6b
		14	13.5±0.8a	14,2±1.1a	0.68±0.03	0.66±0.06	0.61±0.3b	0.60±0.7b	33.5±0.5c	27.1±0.9c
		21	13.3±0.8 a	14,0 ±0.5a	0.69±0.02	0.67±0.03	0.60±0.7b	0.52±0.4b	32.9±1.1c	24.7±0.5c
		28	13.4±0.8a	13.6±0.7a	0.69±0.07	0.66±0.07	0.54±0.2b	0.45±0.3b	24.7±1.3d	18.9±0.7d

Data are means ± SE; n = 40; different letters within the same landrace indicate values statistically different at $P \leq 0.05$, according to Tukey's test. * AS = value registered immediately after storage at each stage (0, 7, 14, 21 and 28 d.) at 20°C; ** value registered after storage at each stage (0, 7, 14, 21 and 28 d.) remaining further 3 days to simulate the shelf life at 20°C

storage period (Table 1). I_{AD} values halved from 0 to 28 days after storage in fruit of 'Murtiddara' and 'Settembrina', and decreased by 80% and 25% in 'Agostina' and 'Bianca' fruit, respectively (Table 1). I_{AD} and fruit firmness were related to TA in 'Murtidddara' and 'Bianca' fruit while no apparent correlation occurred in 'Agostina' and 'Settembrina' ones (Table 2).

Table 2
Pearson's coefficients of correlation between adsorbance (I_{AD}), total soluble solid (TSS), titratable acidity (TA) and firmness (F) in fruit of the white-flesh peach 'Pesca di Bivona' landraces

	I_{AD}	TSS	TA
Murtiddara			
I_{AD}			
TSS	0.136		
TA	0.876 *	-0.039	
F	0.933 *	0.169	0.958 *
Bianca			
I_{AD}			
TSS	0.118		
TA	0.874 *	-0.295	
F	0.856 *	-0.264	0.812 *
Agostina			
I_{AD}			
TSS	0.177		
TA	0.464	-0.237	
F	0.949 *	0.000	0.427
Settembrina di Bivona			
I_{AD}			
TSS	0.295		
TA	0.246	-0.196	
F	0.957*	-0.508	0.216

Values taken at 0, 7, 14, 21 and 28 days at 0°C and 90% RH; *significant at $P \leq 0.05$

Ethylene production in fruit stored at 20°C immediately after harvest and measured every day during seven days showed the typical behaviour of non-melting peach fruit (Mignani et al., 2006) with an ethylene production ranging from 13 µL/kg h to 28 µL/kg h. No significant differences among landraces were observed in ethylene production rate pattern, but three days after storage, when 'Murtiddara' and 'Bianca' fruit showed the highest rates (Figure 1).

No difference in weight loss occurred among fruit of different landraces 7 days after storage; 14 days after storage water loss still did not exceed 3% in all fruit with significant lowest values in 'Bianca' fruit. Weight loss dramatically increased 21 and 28 days after storage; at these stages significant differences among each cultivar occurred 'Murtiddara' fruit had the highest value, while 'Settembrina' ones had the lowest (Figure 2).

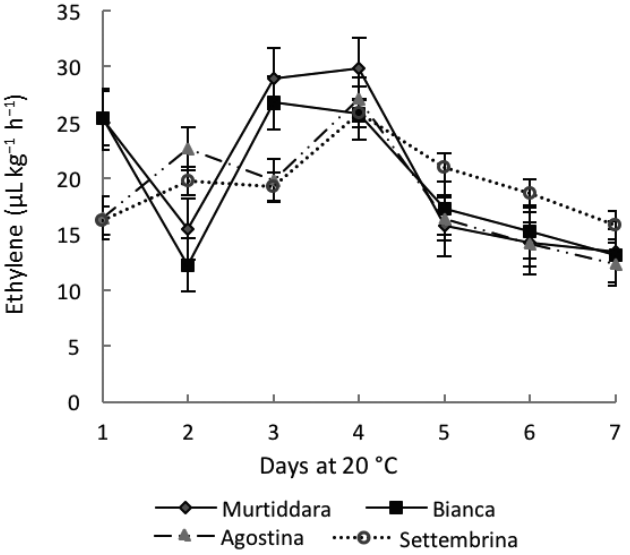

Fig. 1. Ethylene production of fruit of the withe-flesh peach 'Pesca di Bivona' landraces during 7 days of shelf life at 20°C (Error bars represent ± SE; n = 10)

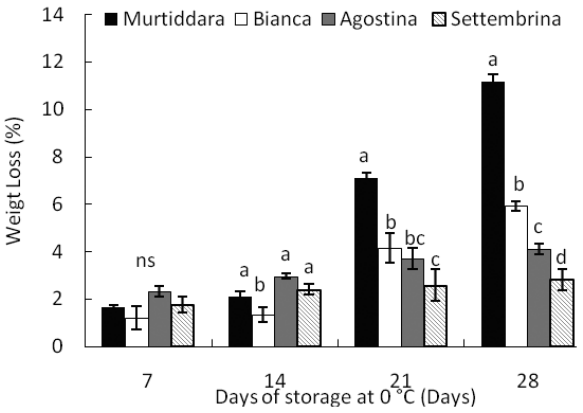

Fig. 2. Weight loss of fruit of the withe-flesh peach 'Pesca di Bivona' landraces during 28 days at 0°C and 90% RH. Different letters within the same day of storage indicate values statistically different at P ≤ 0.05, according to Tukey's test; error bars represent ± SE

Correlations between the I_{AD} index and the parameters involved in fruit maturity and ripening have been developed in nectarines (Ziosi et al., 2008) peaches (Costa and Noferini, 2013) plums (Infante et al., 2011) and apple (Nyasordzi et al., 2013), to cluster fruit in homogenous ripening classes, with a differential development of fruit quality traits during shelf-life (Costa et al., 2009; Shinya et al., 2013). We found good correlations between I_{AD} values and fruit firmness in the non-melting white peaches 'Pesca

di Bivona' landraces. I_{AD} was also correlated to sensory descriptors (aroma, crispness and overall liking) and this may be very useful to cluster fruit in relation to consumer perception. Physicochemical parameters such as fruit firmness, soluble solids content and titratable are important drives of consumer preference for peaches and nectarines (Infante et al., 2008). From this investigation, we obtained significant associations between I_{AD} and maturity variables, as similarly reported by Costa et al. (2009) on melting peaches, Costa et al. (2010) on apricot and Infante et al. (2011) on Japanese plum. These results confirm the value of I_{AD} as a reliable, non-destructive, and objective index to determine the state of maturity in non-melting peach cultivars (Pinto et al. 2015). With regard to the SSC, there was no relationship between the I_{AD} and the other parameters related to ripeness, in agreement with the results of Cantín et al. (2009) and Infante et al. (2011). It also confirms that SSC on melting fleshed peach is only a quality index, and not a harvest index (Crisosto and Crisosto, 2005).

The DA-meter has been mainly used for stone fruits, where the I_{AD} also correlated ethylene production and transcription of ripening-related genes (Marchese et al., 2006; Ziosi et al., 2008; Shinya et al., 2014). Indeed, I_{AD} is correlated to consumer satisfaction and sensory attributes at different fruit ripening stages (Bordonaba et al., 2014; Echeverrìa et al., 2015) have shown significant correlations between sensory attributes and degree of liking observed in fresh-cut peaches, underlining the importance of aroma. The results demonstrate that 'Settembrina', 'Bianca' and 'Agostina' can be stored for 4 weeks at 0°C and 90% RH with no major changes in their organoleptic attributes and overall satisfaction of the final consumer. Indeed, 'Bianca', 'Agostina' and 'Settembrina' fruit kept their aroma and overall liking with no appearance of flouriness or accumulation of red pigments as found in some cultivars (Crisosto and Crisosto, 2005). Correlations between sensory descriptors depended on genotype, but overall liking was strictly correlated to aroma and crispness more than to flavour or other descriptors.

Sensory analysis

Fruit flavour significantly decreased during the last week of storage (21 and 28 days) in 'Murtiddara', 'Agostina' and 'Settembrina' fruit, but kept constant values in 'Bianca' ones (Table 3).

Table 3
Sensory analysis applied to fruit of the white-flesh peach 'Pesca di Bivona' landraces during 28 days at 0°C and 90% RH

Landrace	Day of storage	Flavour	Juiciness	Sweetness	Crispness	Aroma	Overall liking
Murtiddara	0	4.1±0.3a	5.3±0.3a	6.2 ±0.3 ns	6.3 ±0.2a	6.2±0.4a	6.3 ±0.2a
	7	4.3±0.5a	5.3 ±0.6a	5.9±0.5	6.2 ±0.4a	6.3 ±0.8a	6.0 ±0.3a
	14	4.3 ±0.4a	5.3 ±0.3a	6.2±0.7	5.7 ±0.5b	6.0 ±0.5a	5.5 ±0.5b
	21	3.2 ±0.2b	3.9 ±0.2b	6.1±0.2	5.4 ±0.8b	5.7 ±0.4b	5.3 ±0.7b
	28	3.1 ±0.3b	3.2± 0.8c	6.0±0.4	4.9 ±0.9c	5.6 ±0.4b	5.0 ±0.5b
Bianca	0	3.7±0.5 ns	4.6 ±0.7a	6.4±0.7 ns	7.1 ±0.7a	5.6 ±0.5ns	6.9 ±0.4ns
	7	3.8±0.3	4.6 ±0.3a	6.2 ±0.3	6.8 ±0.5b	5.5±0.5	6.8±0.4
	14	3.7±0.7	4.6 ±0.2a	6.4±0.4	6.3 ±0.4c	5.5±0.4	6.7 ±0.5
	21	3.7±0.4	4.1 ±0.4b	6.4 ±0.3	6.4 ±0.3c	5.4±0.7	6.8 ±0.4
	28	3.9±0.2	4.2 ±0.9b	6.2±0.9	6.5 ±0.7c	5.3±0.2	6.7±0.3
Agostina	0	5.7 ±0.8a	3.2 ±0.4ns	6.6 ±0.5 ns	7.2±0.8a	6.7 ±0.7 ns	6.9 ±0.9ns
	7	5.8±0.4a	3.3±0.7	6.5±0.5	7.1 ±0.5a	6.7±0.7	6.8±0.4
	14	5.6±0.5a	3.2±0.3	6.6±0.6	6.9 ±0.5a	6.6±0.3	6.7±0.5
	21	5.1±0.9b	3.5±0.5	6.8±0.7	6.7 ±0.3ab	6.6±0.5	6.8±0.7
	28	5.1 ±0.7b	3.2±0.3	6.8±0.7	6.5 ±0.6b	6.5±0.7	6.8±0.7
Settembrina	0	6.5±0.9a	4.6 ±0.4 ns	7.0±0.5 ns	7.9 ±0.5a	7.3±0.6 ns	8.2±0.3 ns
	7	6.5 ±1.1a	4.7±0.3	7.0±0.4	8.2 ±0.3a	7.2±0.8	8.1±0.8
	14	6.8±0.4a	4.5±0.4	7.1±0.2	7.8 ±0.8a	7.4±0.7	7.8±0.7
	21	5.6±0.6b	4.6±0.3	7.2±0.9	7.9 ±0.8a	7.3±0.4	8.1 ±0.2
	28	5.2±0.7b	4.6±0.2	7.2±0.9	6.5 ±0.7b	7.3±0.5	7.6 ±0.3

Data are means ± SE; n =30; different letters within the same landrace indicate values statistically different at $P \leq 0.05$, according to Tukey's test

Table 4
Sensory analysis applied to fruit of the white-flesh peach 'Pesca di Bivona' landraces after cold storage (28 days at 0°C 90% RH) followed self-life 3 days

Landrace	Day of storage	Flavour	Juiciness	Sweetness	Crispness	Aroma	Overall liking
Murtiddara	0	4.3±0.2a	5.6±0.5 a	6.4 ±0.8 ns	5.7 ±0.9 a	7.1±0.5 a	6.7±0.7 a
	7	4.3±0.7a	5.7 ±0.8 a	6.2±0.9	5.6 ±0.4 a	7.0 ±0.9 a	6.5 ±0.5 a
	14	4.5 ±0.4a	5.5 ±0.6 a	6.2±0.6	4.5 ±0.5 b	6.8 ±0.5 a	5.9 ±0.9 b
	21	3.0 ±0.6b	3.1 ±0.4 b	6.1±0.5	4.0 ±0.8 b	5.9±0.6 b	5.0 ±0.4 b
	28	2.9 ±0.5b	2.8± 0.4 c	5.9±0.9	3.1 ±0.9 c	5.8 ±0.8 b	4.5 ±0.5b
Bianca	0	3.9±0.7 ns	4.3 ±0.6 a	6.1±0.7 ns	6.1 ±0.7 a	6.3 ±0.8 ns	7.3 ±0.4ns
	7	3.8±0.2	4.5 ±0.4 a	5.7 ± 0.5	5.6 ±0.5 b	5.8±0.7	7.8 ±0.4
	14	3.5±0.9	4.6 ±0.5 a	5.8±0.2	5.0 ±0.6 c	5.7±0.9	7.1 ±0.5
	21	3.4±0.5	4.3±0.5 b	5.4 ±0.7	4.0 ±0.3 c	4.8±0.8	6.3 ±0.4
	28	3.0±0.3	3.5 ±0.7 b	5.2±0.6	3.5 ±0.4 c	4.4±0.5	6.0±0.3
Agostina	0	6.3 ±0.9 a	3.3 ±0.4 ns	6.4 ±0.5 ns	6.5±0.8 a	7.2 ±0.5 ns	7.5 ±0.9ns
	7	5.9±0.6a	3.3±0.7	6.6±0.5	6.2 ±0.5 a	7.5±0.3	7.3±0.4
	14	5.9±0.5a	2.1±0.8	6.3±0.6	6.1 ±0.5 a	7.6±0.5	7.3±0.5
	21	4.5±0.9b	2.0±0.6	6.1±0.4	6.0 ±0.3 ab	6.3±0.3	6.9±0.7
	28	4.1 ±0.9b	1.8±0.7	6.2±0.5	5.5 ±0.6 b	6.0±0.6	6.5±0.7
Settembrina	0	6.9±0.5a	4.4 ±0.3 ns	7.3±0.5 ns	6.9 ±0.5 a	7.8±0.6 ns	8.5±0.3 ns
	7	6.6 ±1.1a	4.5±0.5	7.1±0.4	6.4 ±0.7 a	7.5±0.5	8.3±0.8
	14	6.4±0.4a	4.0±0.8	7.0±0.2	6.2 ±0.6 a	7.8±0.6	7.9±0.7
	21	5.3±0.6b	3.7±0.7	6.8±0.9	6.2 ±0.7 a	7.1±0.5	8.1 ±0.2
	28	5.0±0.7b	3.6±0.4	6.5±0.9	6.0 ±0.3 b	6.8±0.7	7.7 ±0.3

Data are means ± SE; n =30; different letters within the same landrace indicate values statistically different at $P \leq 0.05$, according to Tukey's test

Fruit juiciness significatively decreased in 'Murtiddara' and 'Bianca' fruit, but kept constant values in 'Agostina' and 'Settembrina' ones. Fruit sweetness did not change significantly during storage, though TSS content showed significant changes during storage (Tables 2 and 3). Aroma and overall liking decreased significantly only in 'Murtiddara' fruit (Table 2). 'Settembrina' had the highest values of overall liking, aroma, crispness, sweetness and flavour throughout the storage period (data not shown, significant at $P \leq 0.05$). Overall liking was correlated to aroma and crispness in all landraces and to fruit flavour only in 'Settembrina'; flavour was correlated to aroma in all landraces and to crispness in 'Murtiddara', 'Agostina ' and 'Settembrina'; juiciness was correlated only to aroma in 'Murtiddara', 'Bianca' and 'Settembrina' fruit; sweetness was not correlated to any of the sensory descriptors (Table 4).

Fruit I_{AD} values were in no case correlated to flavour, juiciness and sweetness, while significant ($P \leq 0.05$) correlations were found between I_{AD} and fruit crispness (R^2 = 0.760), aroma (R^2 = 0.775) and overall liking (R^2 = 0.763).

Other studies on peaches presented positive correlations between flavour, sweetness and aroma (Giacalone et al., 2006) and especially between aroma and flavour. Minguzzi and co-workers (2000) indicated that acceptability is mainly associated with aromatic intensity, in agreement with the high correlations obtained in this study (Table 5).

Conclusion

Our paper reported the first detailed study on correlation between I_{AD} and quality parameter, sensory profiles of the four landraces of 'Pesca di Bivona'.

The $I_{AD,}$ is correlated to consumer satisfaction and sensory attributes at different fruit ripening stages. In particular, we observed a significant correlation between sensory attributes and degree of liking of fresh peaches, underlining the importance of aroma.

Table 5
Pearson's correlation matrix among sensory descriptors applied to fruit of the white-flesh peach 'Pesca di Bivona' landraces

	Flavour	Juiciness	Sweetness	Crispness	Aroma
		Murtiddara			
Flavour					
Juiciness	0.384				
Sweetness	0.090	0.000			
Crispness	*0.703	0.386	0.222		
Aroma	*0.852	*0.882	0.356	*0.950	
Overall liking	0.479	0.392	0.103	*0.979	*0.868
		Bianca			
Flavour					
Juiciness	0.292				
Sweetness	0.225	0.421			
Crispness	0.051	0.485	0.326		
Aroma	*0.786	*0.828	0.225	0.630	
Overall liking	0.274	0.437	0.250	*0.885	*0.839
		Agostina			
Flavour					
Juiciness	0.331				
Sweetness	0.289	0.372			
Crispness	*0.846	-0.214	0.272		
Aroma	*0.735	0.046	0.302	*0.960	
Overall liking	0.155	0.000	0.000	*0.770	*0.723
		Settembrina di Bivona			
Flavour					
Juiciness	0.210				
Sweetness	0.267	0.354			
Crispness	*0.761	0.212	0.439		
Aroma	*0.810	*0.870	0.354	0.212	
Overall liking	*0.884	0.241	0.311	*0.874	*0.841

Data average values taken at 0, 7, 14, 21 and 28 days at 0°C and 90% RH; * significant at $P \leq 0.05$

The obtained data contributes to outlining a complete quality fruit profile for product comparison and shelf-life monitored under cold condition. Many analytical parameters are positive correlated with the sensory attributes, and for this reason, sensory evaluation is a precious tool for assessing quality of 'Pesca di Bivona' during 1 month of cold storage. It also confirms that SSC on melting fleshed peach fruit could be used only a quality index and not as a harvest index. Finally, our results demonstrated the value of local germplasm as a source of valuable quality features, with a positive effect on the local economy and agroecosystem.

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