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Effect of prolonged cold storage on the sensory quality of peach and nectarine

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ABSTRACT

To maintain peach and nectarine quality after harvest, low temperature storage is used. Low temperatures induce physiological disorders in peach, but the effect of cold storage on the sensory quality of the fruit before it is damaged by chilling injury syndrome remains unclear. To evaluate the cold storage effect on the sensory quality two peach cultivars ('Royal Glory' and 'Elegant Lady') and two nectarines ('Ruby Diamond' and 'Venus') were harvested at a standardized firmness level and subjected to quality evaluations and sensory analysis at harvest and after storage at 0 °C for 35 d. For both time points, a supplementary ripening followed such that homogeneous flesh firmness and suitability for consumption was achieved.

The fruit segregation through the Durofel firmness (DF), evaluated using a non-destructively method (Durofel device), allowed the formation of a uniform group of fruit in terms of flesh firmness (FF), showing scores between 45.1 and 55.9 N. The average FF in fruit ripened immediately after harvest was 22.9 N and 25.6 N in fruit ripened after cold storage for 35 d.

The "acceptability" of fruit is highly correlated with "aroma", "sweetness", "juiciness", "texture" and "flavor". Only the "acid taste" parameter had no significant correlation with "acceptability" or with the other parameters evaluated.

It is possible to conclude that the sensory quality and acceptability of peach and nectarine are characteristic of each cultivar and change, depending on the time elapsed after harvest. In general, it was confirmed that nectarine cultivars have a more consistent quality than peach cultivars.

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1. Introduction

Peach ripening is a complex process that cannot be measured by a single factor. Many parameters change during the final phase of fruit development; therefore, the challenge is to define an appropriate approach that can identify parameters of the peach ripening process that may predict fruit quality after harvest.

Peach firmness is a significant characteristic in terms of quality; it is important for determining the optimum harvest date (Infante, 2012), and during postharvest, it is useful to follow maturity evolution during storage (Zhang et al., 2010). The classical method to evaluate firmness objectively destroys the fruit because it consists of penetrating a cylindrical probe through the pulp and registering the maximum load necessary to overcome the fruit resistance (Magness and Taylor, 1925).

From the sensory point of view, the ripeness stage of peach at harvest is the basis of a high-quality product and is meant to ensure the best balance between consumer satisfaction and fluid logistic management; however, such balance is not easy to achieve. An early harvest produces a product that can be easily handled along the commercial chain but does not allow for optimal eating quality (Bonghi et al., 1999; Crisosto et al., 2006). A tree-ripe fruit guarantees consumer acceptance but is highly susceptible to bruising and rapid deterioration during harvest and packaging. Infante et al. (2012) demonstrated that three peach cultivars and two nectarine cultivars harvested between 30 and 70 N flesh firmness and evaluated at an equal firmness (18–22 N) were indistinguishable to a trained sensory panel. These results indicate that certain genotypes can be harvested with firmer flesh without affecting sensory quality. However, this response is true only over a certain flesh firmness range. This response is also cultivar-dependent; therefore, it cannot be extrapolated to all genotypes.

In general, fruit quality traits, such as soluble solids concentration (SSC) and titratable acidity (TA) are related to maturation and to the sensory quality of the fruit (Kader, 1999). Crisosto and Crisosto (2005) investigated the minimum "ripe SSC" required

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for peach and nectarine cultivars to reach high consumer acceptance with similar firmness, as well as low (0.30–0.50%) and high (0.70–0.90%) TA (i.e., malic acid). The concepts of "ripe SSC" and "ripe TA" are related to the state of fruit maturity at consumption. At "ripe SSC" and "ripe TA" the flesh firmness is approximately 4.5–17.8 N, and the consumer's acceptance potentially reaches its maximum (Crisosto and Crisosto, 2005). It was observed that the degree of acceptance was significantly associated with "ripe SSC" but not with "ripe TA". Furthermore, there was no significant interaction between these two parameters.

To maintain the quality of fruit during postharvest, low temperatures are used to reduce the speed of the metabolic processes associated with ripening. Unfortunately, low temperatures adversely affect the sensory quality and induce some postharvest physiological disorders, such as chilling injury (Lurie and Crisosto, 2005).

One means of assessing the quality of a product is through sensory analysis, a discipline used to measure, analyze and interpret reactions of food characteristics perceived by sight, sound, taste, smell and touch (Szczesniak, 2002). Sensory evaluation cannot be performed instrumentally; instead, the instruments are well-trained people.

The aim of this research was to evaluate the cold storage effect on the sensory quality of 'Elegant Lady' and 'Royal Glory' peach and 'Venus' and 'Diamond Ruby' nectarine harvested at a standardized firmness level and measured non-destructively through a uniaxial probe using a Durofel device.

2. Materials and methods

2.1. Materials

Yellow-fleshed peach 'Royal Glory' and 'Elegant Lady' and yellow-fleshed nectarine 'Ruby Diamond' and 'Venus' were harvested from a commercial orchard near Santiago, Chile. The postharvest evaluations were performed at the Fruit Quality & Breeding Lab that belongs to the University of Chile, Santiago, Chile.

2.2. Methods

Two methods for assessing firmness were used: (1) "Durofel firmness" (DF), which corresponds to the uniaxial firmness measured non-destructively through a Durofel device (Agrotechnology, Tarascon, France) and expressed in Durofel firmness units (Vangdal et al., 2007), and (2) "Flesh firmness" (FF), which corresponds to the firmness measured through a typical Magness–Taylor test using a 7.9-mm diameter plunger (Effegi FT-327, Milan, Italy) that penetrates 10 mm into the flesh after the skin has been removed with a scalpel and is expressed in Newtons (N). The first method is related to the elastic modulus of the fruit during non-destructive compression (Harker et al., 2010).

Homogeneous sized fruit of the four cultivars were harvested when the ground color changed from green to light yellow. Fruit were transferred to the lab, and the DF of each fruit was assessed. Sixty fruit that showed a uniaxial firmness score between 52.3 and 58.1 Durofel firmness units were chosen for following the postharvest assay. From this total, 12 fruit were used to characterize the ripeness stage at harvest (i.e., quality parameters).

In addition, 24 fruit were kept in a chamber at 21 °C and 70–75% relative humidity (RH) until they reached a DF equal to 40–50 Durofel firmness units. Lastly, 24 fruit per cultivar were subjected to a prolonged cold storage period (0 °C and 80–90% RH) lasting 35 d and then followed by a period to induce flesh softening (21 °C and 80–90% RH) until the fruit reached 40–50 Durofel firmness units.

2.3. Quality parameters after ripening

The individual fruit mass (g) was determined using a precision electronic balance (Tech Masters, California, USA). The FF was measured on both "cheeks" of the fruit. Longitudinal slices from five fruit per sample were used to extract juice. The soluble solids concentration (SSC) was measured with a temperature-compensated ATC PAL-1 refractometer (Atago, Tokyo, Japan). The TA was assessed by means of an automatic Titroline Easy Titrator (Schott, Mainz, Germany). A 10 mL juice sample was titrated with NaOH 0.1 N until the organic acids were neutralized at pH 8.2–8.3. The results were expressed as percentage of malic acid.

The ground color was measured with a CR-400 portable tristimulus colorimeter (Minolta, Osaka, Japan), using illuminant D65, 2° observation angle and the CIELab system. In addition, the values of a^* (green/red axis component) and b^* (yellow/blue axis component) were transformed to hue values ($\text{Hue} = \tan^{-1}(b^*/a^*)$).

2.4. Sensory analysis

A descriptive analysis was carried out on ripe fruit not subjected to cold storage and ripe fruit after 35 d in cold storage. Evaluations were performed in individual booths by a trained panel of judges. For each sample, a 1/4 slice of fruit with skin was cut and placed onto a white porcelain dish. The samples were tested within 5 min from cutting to ensure glossiness and avoid flesh browning. Each dish containing the sample was randomly marked by a three-digit code that corresponded to the same code presented on the individual's evaluation guideline. The evaluation score sheet contained a continuous scale for each attribute, ranging from 0 to 15 and marked with the following three anchors: 0 = lowest level for that specific attribute; 7.5 = medium level for that specific attribute; and 15 = highest level for that specific attribute. This guideline was used previously for stone fruit quality evaluation (Infante et al., 2008a). The quality attributes evaluated were the following: "aroma", "sweetness", "acid taste", "juiciness", "texture" and "flavor". Twelve trained evaluators assessed the samples.

Acceptability was determined by a group of 24 adults. The evaluation guideline for acceptability used a hedonic scale marked with the following two anchors: 0 = extremely dislike, and 15 = extremely like.

2.5. Experimental design and statistical analysis

Data obtained at harvest was subjected to an ANOVA test with four treatments that correspond to the cultivars. Data obtained from the ripe fruit were compared using a Student's t-test analysis with two treatments (0 and 35 d of storage). A total of 12 repetitions were used for each storage time, excluding TA, where only three composite samples containing four fruit per sample were used.

For the sensory evaluation, a principal components analysis (PCA) was performed. The results were presented in a two-dimensional figure. Correlations between variables were also determined and displayed. Additionally, the sensory analysis results were compared through a t-test analysis between treatments per cultivar (at 0 and 35 d of cold storage). Significant differences were set at the 5% level ($p < 0.05$), and means were separated with the multiple-range Tukey test. The statistical program Infostat v2004 (Cordoba, Argentina) was used in all cases.

3. Results and discussion

3.1. Fruit characterization at harvest

The fruit segregation using a DF range of 50–70 Durofel firmness units allows the formation of a uniform group of fruit in terms of

Table 1
Maturity parameters of peach varieties 'Royal Glory' and 'Elegant Lady', and of nectarine varieties 'Ruby Diamond' and 'Venus' at the moment of harvest.

Parameters	Varieties			
	Royal Glory	Elegant Lady	Ruby Diamond	Venus
Flesh firmness (N)	49.13 ab[z]	55.11 a	49.81 ab	45.11 b
Compression strength (Durofel units (U))	54.75 ab	52.17 a	53.33 ab	56.50 b
Weight (g)	161.40 a	225.88 b	162.29 a	273.59 c
SSC (%)	8.51 a	12.34 b	15.26 c	12.58 b
pH	4.28 c	3.75 b	3.70 b	3.57 a
TA (% malic acid)	0.37 a	0.90 b	1.20 c	0.91 b
SSC/TA	24.48 b	13.60 a	12.71 a	13.75 a
Background color Hue	53.73 b	52.70 b	52.38 b	56.97 a

[z] Different letters within the same row indicate significant differences ($p < 0.05$) separately for each parameter measured.

FF, showing scores between 45.1 and 55.9 N (Table 1). This result indicates that the Durofel device is an appropriate non-destructive method for selecting a homogeneous FF sample from an unevenly ripe batch of fruit for performing postharvest assays. Firmness testing of fruit is mostly used for scientific purposes and provides information on the storability and resistance to injury of the product during storage and marketing. However, most of these methods measure the force needed to puncture or penetrate the fruit (Harker et al., 2010; Valero et al., 2007). For this reason the Durofel appears to be a promising method for the non-destructive evaluation of fruit firmness. The Durofel does not require a large investment in money and is easy to use. The ripeness stage of stone fruit at harvest is naturally heterogeneous. On the tree, each individual fruit is at a different stage of development/maturity because bloom time can span two weeks or more. Fruit are also exposed to uneven light and temperature conditions, depending on spacing and position within the canopy. Therefore, biochemical reactions related to the ripening of each fruit will occur at different times and rates (Marini et al., 1991).

'Elegant Lady' was the only cultivar with slightly higher FF (Table 1). The DF is more related with the elastic phase of compression of the stress/strain curve (García-Ramos et al., 2005), whereas FF assessed with the traditional penetrometer (a destructive method) is based on the collapse of the tissue, which corresponds to the maximum force of the curve (Magness and Taylor, 1925; Harker et al., 2010). FF is affected by many physiological factors that affect intercellular adhesion and cell wall strength (Goulao and Oliveira, 2008; Fischer and Bennett, 1991), meanwhile DF is primarily measures the elastic modulus. Different studies have tried to establish a relationship between them in different products, finding low correlations (Valero et al., 2007; Zhang et al., 2010). The observed h° scores were within the normal range of ripeness at harvest for peach as defined by local industry. 'Venus' had a higher h° component of the skin ground color than other cultivars, which could be associated with the lower firmness observed (Table 1). In our experience working with stone fruit, the variability in maturity parameters can be notably high, even if fruit samples appear visually equal. The observed ripeness level of the fruit in this experiment can be considered to be homogeneous among cultivars.

Major differences in mass, SSC and TA were reported between cultivars. This finding demonstrates that there is not a single parameter that can serve as a reliable universal index for determining the best time to harvest all peach and nectarine genotypes. 'Royal Glory' exhibited the lowest SSC at harvest, most likely due to its precocity, and the lowest TA. Overall, 'Royal Glory' had the highest SSC/TA ratio (Table 1).

The mass of stone fruit is affected less by the genetic base of the genotype and more by farming practices, particularly the rootstock used, the crop load and the thinning intensity (Rato et al., 2008). Fruit mass is a parameter associated with fruit ripening on-tree. The longer the fruit ripens on-tree, the higher its mass should be (Dejong and Goudriaan, 1989). This statement is easily verified when the mass is examined on a single fruit during its final phase of development on the tree. Due to the high heterogeneity of ripening among fruit on the same tree, this effect is not always clearly evident in a mean of samples. The SSC, even if it is clearly associated with the advancement of maturation on-tree, is not an informative enough index for monitoring the maturity of undetached stone fruit (Infante et al., 2011a,b). The changes observed during the final ripening phase are slight because the potential SSC level depends more on climate conditions, position in the canopy and orchard management than on the genetic background of the genotype (Infante et al., 2008a).

3.2. Characterization of ripe fruit

The FF measurements were undertaken as traditionally performed by the fruit industry, and the same trends were observed (Table 2). The FF was slightly above that recommended for peach at consumption. Crisosto et al. (2006) identified the importance of the maturity stage in fruit marketing and consumption and proposed that FF is the most appropriate maturity index. This study suggests a FF range of approximately 26.5–35.3 N as "ready for market" and between 8.8 and 13.2 N as "ready for consumption".

In this experiment, the average FF in fruit ripened immediately after harvest was 22.9 N and 25.6 N in fruit ripened after cold storage for 35 d (Table 2). According to the fruit maturity ranges proposed by Crisosto et al. (2006), the samples in this assay could be classified between phases of marketing and consumption ripeness. It is important to highlight that the observed FF scores were homogeneous for all cultivars and points of evaluation. Although the values were slightly high, this phenomenon did not affect the validity of the experiment because all genotypes showed this deviation; therefore, no bias was introduced.

It has been reported that the h° component of the skin allows segregation of peach into distinct ripeness classes (Crisosto, 1994; Ferrer et al., 2005), and this parameter decreases as flesh softens throughout ripening (Ferrer et al., 2005; Kao et al., 2012). In this experiment, the capacity of h° in predicting ripeness and flesh firmness was not evaluated. The initial h° at harvest (Table 1) and the h° observed between ripened fruit not submitted to cold storage and fruit kept for 35 d in a cold chamber (Table 2) are inconsistent. In the case of 'Calanda' peaches, Ferrer et al. (2005) determined that h° decreases as fruit ripens. 'Calanda' is a cultivar characterized by its anthocyanin-free skin and yellowish color. The increase in a^* is exclusively due to a loss of chlorophyll. In the present trial, all tested cultivars possessed a red blush, which interferes with the association between the softening of the flesh and the change in ground skin color. The ground color is an informative harvest index, as it reflects the chlorophyll content of the fruit (Kader, 1999), although not in certain cultivars in which the ground color is masked by the blush; in these cases, this parameter is not an adequate index for assessing ripeness. In general, plant tissue with high chlorophyll content is associated with unripe fruit. The absorbance difference

Table 2
Comparisons of maturity parameters measured after storage at 0 °C over a maturation period of 2–3 d at 21 °C in peach and nectarine fruit.

Parameters	Days at 0 °C + days at 21 °C							
	Royal Glory		Elegant Lady		Ruby Diamond		Venus	
	0 + 3	35 + 2	0 + 3	35 + 2	0 + 3	35 + 2	0 + 3	35 + 2
Firmness (N)	23.22 a[z]	29.01 a	21.75 a	23.72 a	20.38 a	21.36 a	26.26 a	28.42 a
Firmness (Durofel firmness unit)	43.54 a	44.54 a	42.29 a	43.96 a	42.67 a	43.67 a	42.25 a	43.38 a
Weight (g)	146.97 a	136.99 a	229.45 a	220.46 a	152.68 a	146.80 a	292.19 a	294.75 a
SSC (%)	9.99 a	9.17 a	11.94 a	12.24 a	14.62 a	15.57 a	12.50 a	12.27 a
pH	4.30 a	4.37 b	3.65 a	3.90 b	3.60 b	3.46 a	3.70 a	3.90 b
TA (% malic acid)	0.36 b	0.33 a	0.88 b	0.63 a	0.96 b	0.94 a	0.88 b	0.65 a
SSC/TA	27.69 a	25.82 a	13.85 a	19.23 b	15.41 a	16.06 a	14.03 a	19.08 b
Background $h°$	52.76 a	50.61 a	78.41 a	80.50 a	63.07 a	63.15 a	64.89 a	85.24 b

[z] Different letters within the same row indicate significant differences ($p < 0.05$) between treatments by parameter and variety.

of the chlorophyll between 670 and 720 nm (I_{AD}) is highly correlated with ripeness in peach (Ziosi et al., 2008); therefore, it could be considered to be a novel and useful parameter for monitoring maturation.

In this trial, fruit subjected to treatment had the same FF and $h°$ scores, independent of whether the fruit was ripened immediately after harvest or subjected to a 35 d cold storage. The only exception was 'Venus', in which fruit maintained for 35 d in cold storage had an equal firmness and a higher $h°$ (85.24) than samples ripened immediately after harvest (64.89) (Table 2).

3.3. Sensory characterization of ripe fruit

The "aroma" of all cultivars differed between treatments. Higher scores were observed in fruit not submitted to cold storage; this parameter was rated between 'slightly high' and 'high' for the first treatment (Table 3). 'Venus' was considered the most fragrant. Even after 35 d at 0 °C, 'Venus' did not reach a rating lower than "slightly high" with a decrease in "aroma" of only 22.9% (Table 3). 'Elegant Lady' had the greatest loss in the "aroma", with a 50.5% reduction being observed between fruit assessed right after harvest and fruit assessed after 35 d in cold storage. 'Royal Glory' and 'Ruby Diamond' had intermediate "aroma" losses of 32 and 34%, respectively (Table 3). Aroma is an essential factor for evaluating peach and nectarine quality. Volatile composition is cultivar dependent; the volatile profile of nectarine includes alcohols, aldehydes, esters, ketones, terpenes and lactones, mainly δ- and γ-decalactones.

The "sweetness" was maintained after 35 d at 0 °C, except in 'Elegant Lady'. This cultivar was significantly different, dropping 44% (Table 3). During postharvest, in stone fruit in general, and particularly in peach and nectarine, the SSC increases slightly due to flesh dehydration (Borsani et al., 2009). "Sweetness" is a complex factor and could, to a certain extent, be associated with SSC, as has been reported by Crisosto and Crisosto (2005) and Lopez et al. (2011). These authors determined minimum SSC thresholds to achieve a high level of customer acceptability. Nevertheless, this factor depends on the interaction of different attributes, i.e., the SSC:TA ratio. In the case of 'Elegant Lady', the sharp drop in "sweetness" after cold storage cannot be attributed to a change in SSC as no remarkable change was observed in this attribute (Table 2). This drop in "sweetness" was instead due to an increase in the SSC:TA ratio. When this ratio is high, as is the case in fruit stored for 35 d in a cold chamber, the overall flavor of the fruit becomes flat, tasteless, and lacking in high notes and particular nuances that make it palatable. It was reported that the low-acid peach cultivar 'Sweet September' showed similar levels of 'acceptability' among different maturity levels, but the "tree ripe" fruit had more unsatisfied consumers (Infante et al., 2012).

The panel detected no significant differences in "acid taste" among treatments (Table 3). However, TA was significantly different between treatments. Fruit subjected to the 35 d storage contained less TA than fruit not subjected to cold storage. This result is foreseeable because organic acids are an easily oxidable substrate that can withstand long periods at low temperature (Table 2). TA in 'Dixieland' peaches did not change significantly during 7 d of postharvest (Borsani et al., 2009), but when fruit was held at 0 °C for a six-week period, as observed in 'Radiant', 'Shiro' and 'Gulfruby' Japanese plums, the TA decreased in all cultivars (Abdi et al., 1997). It is important to highlight that the "acid taste" was consistently lower in fruit subjected to 35 d of cold storage; the exception being 'Elegant Lady', in which this trend was reversed. In 'Elegant Lady', this result could be attributed to the general decay in flavor observed in this cultivar (Table 3).

The "juiciness" parameter decreased significantly in peach between 0 and 35 d postharvest. The decrease in the "juiciness" measurement was 34.6 and 64% in 'Royal Glory' and 'Elegant Lady', respectively. By contrast, the loss of "juiciness" was not significant in nectarine during the same period of cold storage; a loss of 13.1 and 1.3% of "juiciness" was observed in 'Ruby Diamond' and 'Venus', respectively (Table 3). In general, the loss of "juiciness" in peach is most frequently associated with a syndrome called "chilling injury" (Lurie and Crisosto, 2005). "Chilling injury" is triggered when a stone fruit is subjected to low temperatures in the so called "killing temperature range" (Crisosto, 2002) for varying periods (Lurie and Crisosto, 2005). Between the "mealiness" and "reduction or lack of juice" zones exists a gray zone, which cannot be defined as the "mealiness zone". Even in non-melting peach genotypes, in which no mealiness symptoms are observed, there is a reduction in free juice after cold storage (Infante et al., 2008b). This reduction could be much more related to dehydration or to the aging of tissues than to mealiness. In this trial, mealiness symptoms were observed only after 35 d in cold storage. This allowed for the isolation of the effect of this syndrome on the overall sensory quality evaluation. Fruit that are already mealy or contain brown flesh after a long postharvest are considered not appropriate for sensory analysis, either by a trained panel or by a consumer test. It was confirmed that the fruit was not affected by chilling injury syndrome before being presented for evaluation. A focus group comprising two to five assessors from the lab that was specifically trained to evaluate juiciness and mealiness were responsible for segregating the samples for analysis (Infante et al., 2008b). In our experience, 'Venus' and 'Ruby Diamond' could be kept for 50 d in cold storage without showing symptoms of chilling injury. 'Elegant Lady' and 'Royal Glory' peach could withstand cold storage with no symptoms up to 40 d, in some seasons.

The "texture" parameter is associated with the force needed for chewing the flesh. "Texture" was not significantly different between treatments, except in 'Elegant Lady', which shows a drop of 43.5% between fruit ripened after harvest and fruit subjected to 0 °C for 35 d (Table 3). This remarkable drop in "texture" is linked

Table 3
Comparisons of acceptability and sensory quality by means of an unstructured pattern from 0 to 15 cm measured, after storage at 0 °C after a softening period of 2–3 d at 21 °C.

Parameters	Days at 0 °C + days at 21 °C							
	Royal Glory		Elegant Lady		Ruby Diamond		Venus	
	0 + 3	35 + 2	0 + 3	35 + 2	0 + 3	35 + 2	0 + 3	35 + 2
Aroma	9.7 b[z]	6.6 a	9.3 b	4.6 a	9.1 b[z]	6.0 a	10.9 b	8.4 a
Sweetness	6.6 a	6.3 a	9.1 b	5.1 a	7.3 a	8.2 a	8.2 a	8.9 a
Acid taste	6.4 a	4.3 a	7.8 a	8.9 a	9.1 a	8.1 a	8.7 a	8.2 a
Juiciness	8.1 b	5.3 a	11.4 b	4.1 a	8.4 a	7.3 a	7.6 a	7.5 a
Texture	7.8 a	7.4 a	11.5 b	6.5 a	9.8 a	8.8 a	9.8 a	9.7 a
Flavor	7.7 a	6.7 a	9.7 b	5.7 a	8.6 a	8.6 a	9.3 b	8.1 a
Acceptability	8.7 b	7.2 a	11.0 b	6.0 a	10.6 b	8.5 a	9.9 b	8.1 a

[z] Different letters within the same row indicate significant differences ($p < 0.05$) between treatments by parameter and variety.

neither with DF nor with FF and no significant differences were observed in the texture parameters between treatments (Table 2).

'Elegant Lady' exhibited the lowest "flavor" score after 35 d at 0 °C, dropping 42.3% (Table 3). 'Venus' also had a 12.9% decline in "flavor". Both 'Royal Glory' and 'Ruby Diamond' cultivars had no statistically significant loss in "flavor" (Table 3).

Significant differences in "acceptability" were observed between treatments for all cultivars (Table 3). 'Elegant Lady' again stands as a paradigmatic genotype; this cultivar had a high "acceptability" when the fruit was ripened just after harvest (11/15) but also shows the greatest loss in "acceptability" after 35 d at 0 °C, dropping 45.5%. In 'Ruby Diamond' and 'Venus', "acceptability" was always lower after 35 d postharvest; however, in general, nectarine had greater levels of "acceptability" than peach (Table 3).

3.4. Acceptability and sensory quality

The first principal component (PC1: *X* axis) is associated with "acceptability", "aroma", "sweetness", "juiciness", "texture" and "flavor" and corresponds to 73.4% of the total variance. The second principal component (PC2: *Y* axis) is associated only with the parameter "acid taste" and only represents 13.7% of the total variance. Both components together explain 87.1% of the model (Fig. 1).

It was confirmed through PCA that 'Elegant Lady' fruit not subjected to cold storage were the most prominent and best represented by the vectors of "sweetness", "texture", "flavor", "juiciness" and "acceptability" (Fig. 1). However, the same cultivar subjected to 35 d of storage exhibited the lowest overall assessment in all quality vectors. After 35 d at 0 °C, the 'Royal Glory' peach did not show any association with the quality parameters (Fig. 1).

It was observed that the vector "acid taste" is independent of "acceptability" and all of the other parameters in general (Fig. 1). The vector "Acid taste" was not represented by any group, not even by the closest group that corresponds to 'Ruby Diamond' fruit not subjected to cold storage. 'Royal Glory' exposed to 35 d at 0 °C were the furthest from the "acid taste" vector; however, it was not the cultivar with the greatest "acceptability". This indicated that low acidity did not largely determine consumer preference (Fig. 1).

The preservation of fresh peach and nectarine for 35 d in cold storage always resulted in a lower level of "acceptability" (Fig. 1). However, 'Ruby Diamond' and 'Venus' nectarines had the highest "acceptability" scores, appearing closest to the quality vectors (Fig. 1).

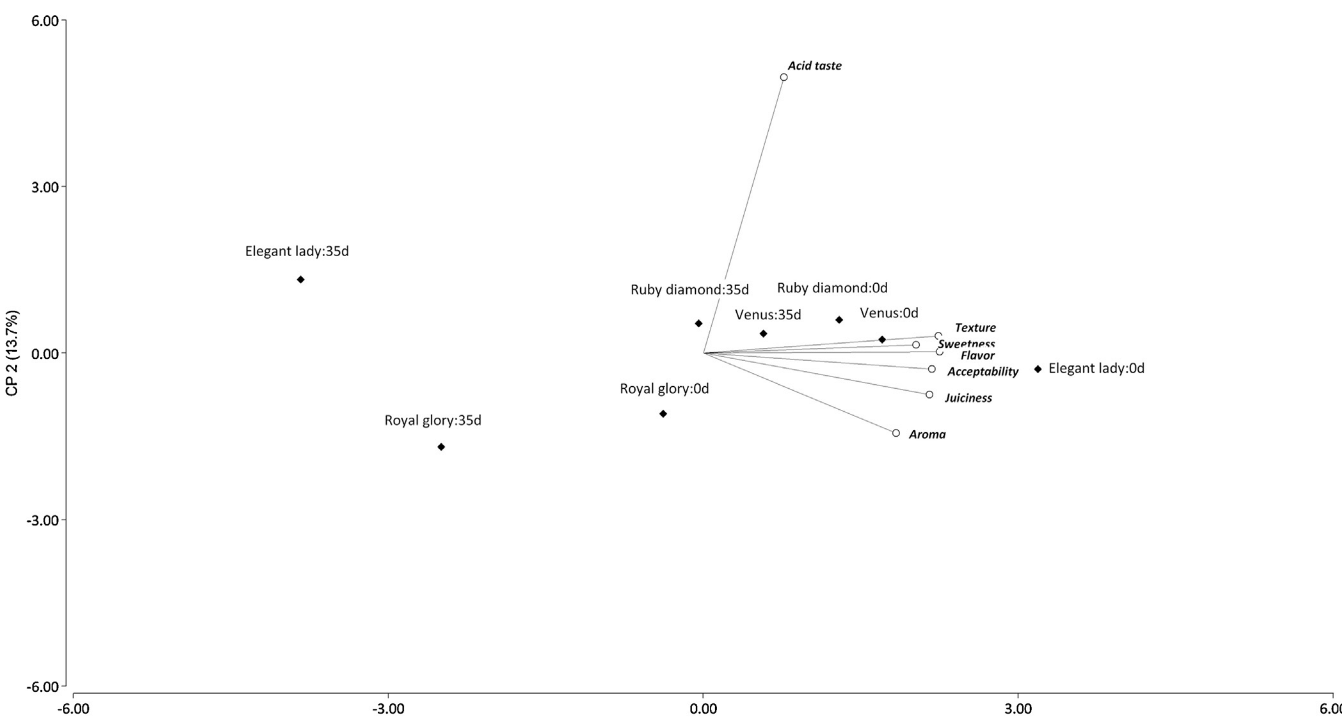

Fig. 1. Principal Component Analysis of sensorial attributes on peach cultivars evaluated at harvest and 35 days after postharvest cold storage at 0 °C.

4. Conclusions

The sensory quality and acceptability of peach and nectarine harvested with homogenous DF score are characteristic of each cultivar and change, depending on the time elapsed after harvest. In general, it was confirmed that nectarine cultivars have a more consistent quality than peach cultivars, both when fruit is preserved for distant markets and when fruit is stored to seek a better price or due to a particular logistic decision.

'Elegant Lady' is an old but relevant cultivar that has a high sensory quality and acceptability after harvest. This cultivar performs poorly when it is cold-stored for 35 d, exhibiting significant losses in virtually all parameters related to sensory quality. 'Elegant Lady' remains a valid choice for farmers who are focused on nearby markets that will consume the crop within a few days after harvest.

In peach and nectarine, it was confirmed that the "acceptability" correlates with "texture", "juiciness", "sweetness" and "flavor". The "acid taste" parameter was shown to be independent of "acceptability", as well all other quality parameters studied.

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