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Post-harvest quality of 'BRS Kampai' peach submitted to different pruning times

Qualidade pós-colheita de pêssegos 'BRS Kampai' oriundos de plantas submetidas a diferentes épocas de poda

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Abstract

The present study aimed to evaluate pruning time and refrigerated storage influence in 'BRS Kampai' peach cultivar. Fruits coming from plants that were pruned during winter (WP), summer (SP) and winter plus summer (WSP), which were stored in a refrigerated chamber for 0, 10, 20 and 30 days at 1 °C ± 0,5 °C and 90% ± 5% RH. Pruning only in the summer provided higher SS/TA ratio, higher firmness and red intensity in the fruit evaluated. At the end of 30 days, acidity reduction reached 20% compared to the initial value. In the same period, fruits showed 50% of the initial firmness. Matter loss during the storage period was described by a positive linear equation, with 12.0% loss at day 30, after removal from the chamber, and 17% loss after two days at room temperature. Under the conditions in which the experiment was conducted, it was concluded that summer pruning alone provides high SS/TA ratio, as well as increased red color in fruits. In addition, storage period increase causes chemical and physical changes in 'BRS Kampai' cultivar fruits. During the storage period, fruits kept acceptable firmness levels, even after 30 days of storage.

Additional keywords: cold storage; conservation; firmness; maturation; *Prunus persica*.

Resumo

O presente estudo teve por objetivo avaliar a influencia da época de poda e do armazenamento refrigerado de frutos de pessegueiro da cultivar 'BRS Kampai'. Utilizou-se frutos oriundos de plantas submetidas a poda de inverno (PI), verão (PV) e inverno mais verão (PIV), sendo os mesmos armazenados em câmara refrigerada por 0, 10, 20 e 30 dias à 1 °C ± 0,5 °C e 90% ± 5% UR. A poda somente no verão proporcionou maior relação SS/AT, maior firmeza de polpa e intensidade de vermelho nos frutos avaliados. Ao final dos 30 dias a redução da acidez chegou a 20% em relação ao valor inicial, neste mesmo período os frutos apresentaram 50% da firmeza inicial. A perda de massa durante o período de armazenamento foi descrita por uma equação linear positiva, sendo a perda aos 30 dias de 12% na saída da câmara e de 17% após dois dias de temperatura ambiente. Nas condições que o experimento foi conduzido foi possível concluir que o uso da poda de verão isoladamente proporciona elevada relação SS/AT, assim como maior coloração vermelha nos frutos, já o aumento do período de armazenamento proporciona alterações químicas e físicas em frutos de 'BRS Kampai'. No decorrer do período do armazenamento os frutos mantiveram níveis aceitáveis de firmeza, podendo os mesmos serem armazenados por até 30 dias.

Palavras-chave adicionais: armazenamento refrigerado; conservação; firmeza; maturação; *Prunus persica*.

Introduction

Peach [*Prunus persica* (L) Batsch] is the most cultivated stone fruit in Brazil's Southeast and South regions (Fachinello et al., 2011.), where approximately 19,000 hectares are cultivated and 216,000 tons are produced annually (AGRIANUAL, 2012). The South region has the largest production

in the country, 160,000 tons grown in 16,000 hectares (AGRIANUAL, 2012). Therefore, peach tree cultivation has significant socioeconomic importance in the region.

In general, Brazil's peach production has increased in recent years. The main contributor to this scenario has been the increasing production of fruit directed towards fresh consumption. Consequently,

producers have increased the demand for fruit cultivars with low acidity (Raseira et al., 2010).

The release of new cultivars with early maturing that can adapt to different climatic conditions in Brazil has been the strategy adopted by breeding programs. Thus, the peach supply period in the domestic market increased without the need to compete with peach from other producing regions in the Southern hemisphere. In this context, in 2009, the BRS Kampai cultivar was released, which was the first peach cultivar to obtain a protection certificate under the Cultivar Protection Act (Scaranari et al., 2009). The cultivar aforementioned is the same obtained by crossing 'Chimarrita' and 'Flordaprince' cultivars. 'BRS Kampai' has early maturation cycle and low chilling (200 hours ≤ 7.2 °C). Low-chill allows for normal germination and flowering in subtropical regions of the states of SP, MG and ES, Brazil. 'BRS Kampai' fruit have soluble solid contents from 9 to 13 °Brix and low acidity (Raseira et al., 2010).

Peach is a highly perishable climacteric fruit, and refrigeration is the primary way to increase storage period (Cunha Junior et al., 2010; Pinto et al., 2012), since the use of low temperatures slows respiratory metabolism speed (Chitarra & Chitarra, 2005). Refrigerated storage helps to keep fruit firmness and matter, which are inversely proportional to respiratory activity. On the other hand, studies that relate fruit post-harvest quality maintenance and management techniques employed in the orchard, such as pruning, are needed.

Given that the peach tree has distinct responses to different pruning types, research has been conducted regarding plant manipulation, which is aimed at farming mechanization, (Barbosa et al., 2000), harvest anticipation (Chalfun et al., 2002), improvements in fruit development and quality (Trevisan et al., 2008; Rodrigues et al., 2009; Gonçalves et al., 2014) and pest control (Grechi et al., 2010). Pruning carried out in different periods may change cultivar plant and production balance. Peach trees that are only subjected to winter pruning have lower light incidence inside the plant canopy. Summer pruning controls plant vigor, reducing labor in winter pruning (Raseira, 1992). In addition, plants pruned only in the summer have higher yields (Gonçalves et al., 2014b).

In this context, the present study aimed to evaluate pruning time and refrigerated storage influence in 'BRS Kampai' peach cultivar.

Material and methods

The experiment was conducted at Embrapa Temperate Agriculture, Pelotas, RS (31°40' South latitude and 52°26' West longitude, 60 m elevation). Peach fruit of cv. BRS Kampai were used and grafted on 'Capdeboscq' rootstock derived from plants submitted to different pruning times. The orchard used was planted in 2006 and conducted in the double Y-shaped system. Spacing used was of 1.5 x 5.0m

(1.5 m between plants in the row and 5.0 m between cultivation rows). Climate is "Cfa" according to Köppen classification, i.e., humid temperate with warm summers. The soil where the experiment was installed belongs to the Camaquã mapping unit and is moderately deep, with medium texture in the A horizon and clay texture in the B horizon, classified as Red-Yellow Argisol (Embrapa, 2006).

The experimental design was completely randomized in a 3x4 factorial (three pruning times and four storage periods), totaling 12 treatments. For each pruning period in the field, 15 plants were used. In the laboratory, each treatment was repeated three times, with 20 fruits in each repetition, totaling 36 plots.

Pruning Application - Pruning was applied in two different times: only in winter (WP) and only in the summer (SP), besides the combination of winter and summer pruning (WSP). Summer pruning was performed immediately after collection of the previous harvest, and winter pruning was conducted in the rest period (dormancy), about 15 days before flowering. Both pruning were carried out with the aim of balancing plants, without cutting shoot tips and only selecting shoot of interest.

Refrigerated storage - Fruits were collected on November 24, 2011, in commercial maturity, and background color was used to determine harvest point. Harvest was conducted manually and fruit were packed in plastic boxes, sanitized beforehand. Immediately after harvest, fruit were transported to the Embrapa Temperate Agriculture post-harvest physiology laboratory, where selection was carried out, discarding fruit with mechanical damage and discrepancies regarding maturation point, in order to obtain uniformity in experimental plot.

After this step, fruits were distributed in polyethylene trays and stored in a refrigerating room at 1 °C \pm 0.5 °C and 90% \pm 5% relative humidity (RH), where they were kept for 0, 10, 20 and 30 days. After each period, marketing simulation was conducted, keeping fruits in a controlled temperature environment (± 20 °C) for 24 hours, and fruit physicochemical quality was assessed.

Fruit Characterization - At the time of entry and at each storage period in the cold chamber, fruits were assessed regarding soluble solids (SS) content, using the ATAGO-PAL1 refractometer (0-30 °Brix range), and regarding titratable acidity (TA), which was determined from 10 mL of peach juice diluted with 90 mL of distilled water. The solution was titrated with 0.1N NaOH by potentiometric method until reaching the pH of 8.1, and results were expressed as citric acid %. Analyses were performed according to Adolfo Lutz Institute standards (Pregnoatto & Pregnoatto, 1985). SS/TA ratio was obtained by the ratio between total soluble solids and value obtained for titratable acidity.

Peach skin color was assessed with the help of Minolta CR 300 colorimeter, which allowed for determining brightness (L) and Hue angle (H°)

(MINOLTA CORP, 1994). For pulp firmness (PF), the Effe-Gi mod.FT-011 manual penetrometer, 8-mm diameter ferrule, was used, measuring two opposite points in the equatorial region of each fruit. Weight loss was determined by the difference between chamber entry and exit values, as well as matter values two days after removal from the chamber in each storage period.

Statistical analysis - Treatment effect verification was carried out by the data analysis of variance (F test). When significant, means were compared by Tukey's test at 5% error probability. When necessary, polynomial regression analysis was performed using Winstat 2.0 statistical software.

Results and discussions

There was no significant interaction ($p \leq 0.05$) between studied factors, pruning times and storage period on variables studied. However, the main effect of each factor was found.

Pruning influence on 'BRS Kampai' fruit physicochemical variables - Pruning times caused little variation in fruit SS content, with higher values for plants that were only subjected to SP and WP. In addition, SP statistically differed from the WSP treatment (Table 1). According to Hossain et al. (2006), summer pruning in peach trees promotes SS content increase in apricots, as described by Demirtas et al. (2010).

Table 1 - Physicochemical characteristics of 'BRS Kampai' peaches at harvest, obtained from plants submitted to different pruning times. Embrapa Temperate Climate, Pelotas, RS, Brazil, 2010.

Pruning Times	SS (°Brix)	SS/TA	Firmness (N)	Epidermis color	
				L	H°
Winter	12.32 ab	34.11 b	35.71ab	55.08 b	55.64 ab
Winter + Summer	12.26 b	34.26 b	36.38 a	57.52 a	58.29 a
Summer	12.68 a	37.46 a	32.51 b	54.60 b	51.81 b
CV (%)	3.13	7.47	10.11	3.91	8.25

Means followed by different lowercase letters in the same column differ at 5% error probability by Tukey's test.

Legend: Soluble solids (SS); titratable acidity (TA); SS/TA ratio; luminosity (L); Hue angle (H°) - (0° = red, 90° = yellow, green = 180°, 360° = blue).

SS/TA ratio indicates fruit flavor, as it is related to the balance between sugars and acids (Klugue et al., 2002). Therefore, SS/TA ratio is related to palatability, an important factor for fresh consumption (Mayer et al., 2008). Fruits coming from plants pruned only in summer (SP) had higher SS/TA ratios than the other treatments (Table 1). Higher soluble solids content compared to acidity content is favorable for peaches, since consumers have preference for sweet fruit (Trevisan et al., 2006).

Plants treated with the WSP combination showed more firmly fruits, differing from fruits of plants in which only SP was conducted (Table 1). Pulp firmness is represented by pectic substances that form cell walls (Kluge et al., 2002). Cell wall degradation can promote SS increase and pulp firmness decrease (Pinto et al., 2012), which was observed in this study for plants subjected to SP.

In general, SP treatment fruits showed lower L and H° parameter values (Table 1). According to Amarante et al. (2007), anthocyanin accumulation causes reduction in the values of these parameters, what is reflected in fruit skin color, changing from green to red. These authors found that the 'Fuji' apple side exposed to the sun has lower L and H° values compared with the shaded side. Therefore, in this study, the reddest fruits were observed in plants in which only SP was held, providing less growth vigor and more light into the tree canopy. According to Raseira (1992), SP controls peach tree vigor, reducing labor in WP. Plant vigor reduction favors light penetration into the canopy, providing the production of more colorful peaches (Gullo et al., 2014). To-

gether, red epidermis color predominance and sweet flavor are among the key quality attributes taken into account by the consumer at the time of fresh peach purchasing (Trevisan et al., 2006).

'BRS Kampai' fruit behavior during cold storage - SS content dynamics during the storage period was described by a positive linear equation (Figure 1A), with initial and final values of 11.5 and 13.2 °Brix, respectively. Seibert et al. (2008) observed similar behavior in 'Chimarrita' peaches under refrigeration at 0 °C and 90% RH. SS concentration increases during cold storage due to fruit weight loss by transpiration (Pinto et al., 2012).

From ten days after cold room storage, there was marked TA reduction (Figure 1B). At the end of 30 days, TA content reduction reached 20% compared to the initial value. Similar behavior was observed by Seibert et al. (2008). According to Chitarra & Chitarra (2005), TA reduces ripening evolution. This dynamics occurs due to acid consumption as respiratory substrate (Kasat et al., 2007).

SS/TA ratio increased during storage (Figure 1C), indicating that fruits had maturation evolution during the storage period due to TA reduction and SS content increase (Figures 1A and 1B). The behavior aforementioned was also observed in peaches stored at 0.5 °C and 93% RH (Cano et al., 2012).

Pulp firmness (PF) decreased over the storage period (Figure 1D), and the highest loss occurred within the first 10 days of storage (33%), which was probably caused by the high degradation rate of the pectic substance that forms cell walls (Klug et al., 2002). Similar dynamics was observed by Seibert et

al. (2007), where, after 10 days under refrigeration (0.5°C and 90% RH), ‘Chimarrita’ peaches had a PF loss between 25 and 30%. At the end of the refrigerated storage period (30 days), ‘BRS Kampai’ fruits had 24.5N firmness, which is 50% of initial firmness

(Figure 1D). Taking into account that 20N is usually considered the value that corresponds to crispy and juicy fruits, it can be inferred that, in this study, ‘BRS Kampai’ peaches showed proper firmness for marketing purposes after 30 days under refrigeration.

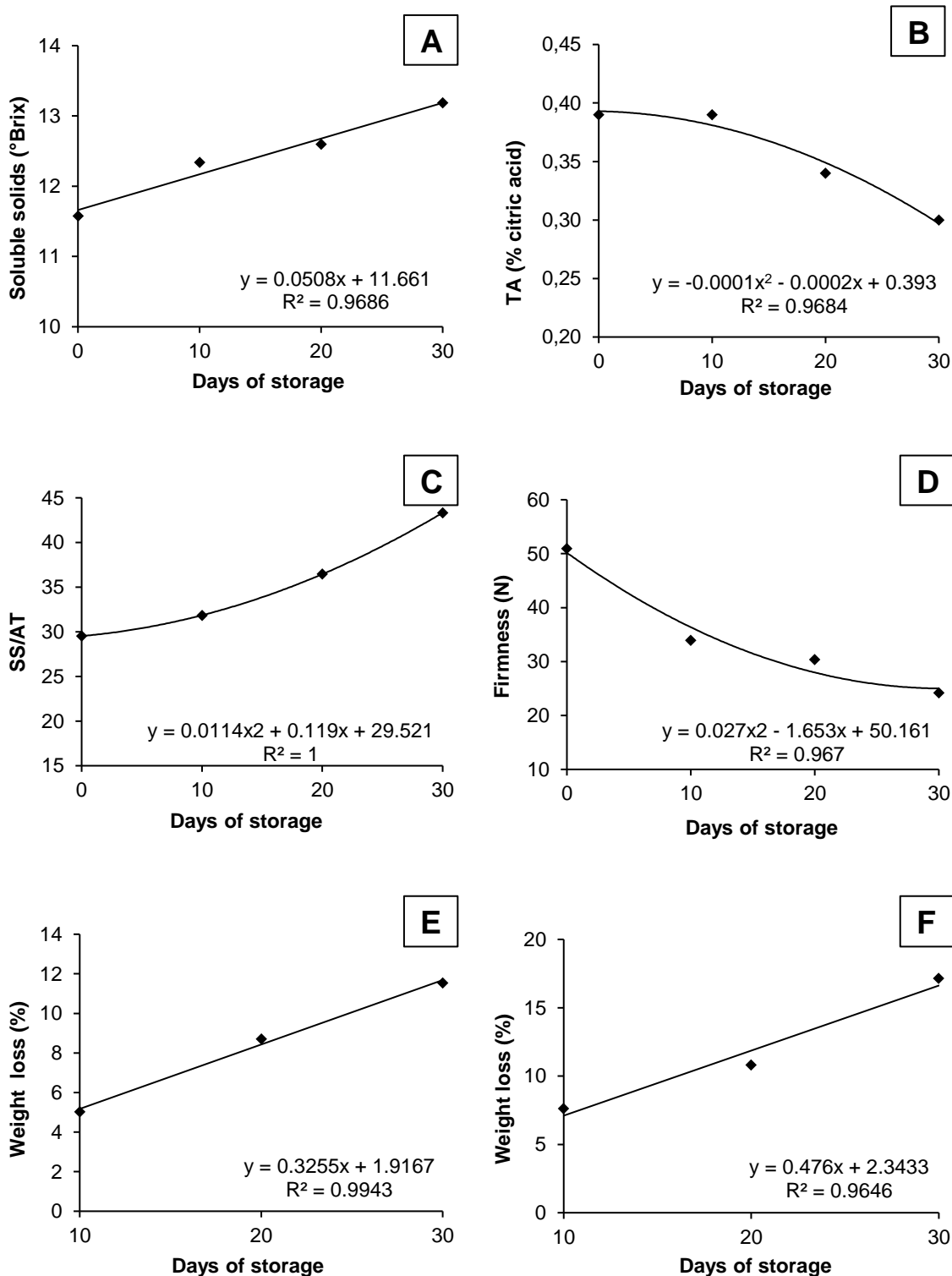


Figure 1 - Physicochemical characteristics of “BRS Kampai” peaches during cold storage at 1±0.5°C and 90±5% RH. Embrapa Temperate Climate, Pelotas, RS, Brazil, 2010. Legend: A - Soluble solids (SS); B - titratable acidity (TA); C - SS/TA ratio; D – pulp mean firmness; E – weight loss after removal from the chamber; and F - weight loss two days after removal from the chamber.

The weight loss percentage recorded was described by a positive linear equation throughout the refrigeration period (Figures 1E and 1F). After 30 days in the refrigeration chamber, weight losses were of 12% after removal from refrigeration (Figure 1E), and of 17% after two days at room temperature (Figure 1F). Therefore, values were high if compared to those obtained by Seibert et al. (2008), 5.5 and 8.1%, respectively (0 °C and 90% RH), as well as by Seibert et al. (2007), who obtained 3.5 and 10.3%, respectively (0.5 °C and 90% RH). Thus, the results obtained in this study are probably related to storage temperature (1 °C ± 0.5 °C). Weight loss is a consequence of fruit perspiration through structures such as stomata, lenticels and cuticles. Weight loss is also influenced by environmental factors that are intrinsic to the genotype, and temperature and relative humidity the most important (Grierson & Wardowsky, 1978).

It is noteworthy that 'BRS Kampai' fruits showed weight losses higher than 10% after refrigerated storage for 20 and 30 days. According to Kluge et al. (2002), peach fruit with weight losses higher than 5% show wither and consistency loss signals. However, these characteristics were not detected in the present study.

Conclusion

Under the conditions in which the experiment was conducted, it was concluded that summer pruning alone provides high SS/TA ratio, as well as increased red color in fruits. In addition, storage period increase causes chemical and physical changes in "BRS Kampai" cultivar fruits.

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