Chilling injuries and fruit quality of ‘Chimarrita’ peaches harvested at two ripeness stages

Injúrias por frio e qualidade dos frutos de pêssegos 'Chimarrita' colhidos em dois estádios de maturação

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Recepción: 05 Noviembre 2024
Aprobación: 21 Noviembre 2024
Publicación: 31 Diciembre 2024

Acceso abierto diamante

Abstract

Cultivar Chimarrita peaches at the mature green and tree ripe ripening stages were cold stored at 0.5ºC for 10, 20 or 30 days. After retrieval from storage, the peaches were maintained for 1 or 2 more days at 20ºC to complete ripening and then evaluated for chilling injury incidence, fresh weight losses, decay incidence and quality parameters: flesh firmness, epidermal color, total soluble solids and titratable acidity. In two evaluation seasons no differences in weight losses between mature-green and tree-ripe peaches were determined. However, weight losses in the second evaluation season were higher than losses observed in the first evaluation season. Decay losses were observed only in the first season. Flesh firmness of both ripeness stages decreased continuously in both seasons, though with less intensity in the second season. Mature-green peaches were firmner than tree-ripe peaches. Both reached eating firmness after complete ripening at 20°C. Woolliness occurence was the major chilling injury symptom of ‘Chimarrita’ peaches. In the first season, woolliness was observed in mature-green as well as in tree-ripe peaches at retrieval from cold storage. During the transfer period to 20°C the percentage of chilled fruit increased. In the second season of evaluation, woolliness was observed only in tree-ripe peaches during the ripening period. Leatheriness was determined in the second evaluation season already after 10 days of storage of mature-green peaches and peaches of both ripeness stages were leathery after 20 days of cold storage.

Keywords: **Cold storage, leatheriness, physiological disorder, woolliness..**

Resumo

Pêssegos da cultivar Chimarrita nos estádios de maturação verde e maduro foram armazenados refrigerados a 0,5ºC por 10, 20 ou 30 dias. Após a retirada do armazenamento, os pêssegos foram mantidos por mais 1 ou 2 dias a 20ºC para completar o amadurecimento e, em seguida, avaliados quanto à incidência de injúria por frio, perdas de massa fresca, incidência de podridão e parâmetros de qualidade: firmeza da polpa, cor epidérmica, sólidos solúveis totais e acidez titulável. Em duas épocas de avaliação, não foram determinadas diferenças nas perdas de peso entre pêssegos verdes maduros e maduros. No entanto, as perdas de peso na segunda temporada de avaliação foram maiores do que as perdas observadas na primeira temporada de avaliação. As perdas de decaimento

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foram observadas apenas na primeira safra. A firmeza da polpa de ambos os estádios de maturação diminuiu continuamente em ambas as estações, porém com menor intensidade na segunda safra. Os pêssegos verdes maduros eram mais firmes do que os pêssegos maduros das árvores. Ambos atingiram firmeza alimentar após maturação completa a 20°C. A ocorrência de lanosidade foi o principal sintoma de lesão por frio dos pêssegos 'Chimarrita'. Na primeira estação, a lanosidade foi observada em pêssegos verdes maduros, bem como em pêssegos maduros na recuperação do armazenamento refrigerado. Durante o período de transferência para 20°C a porcentagem de frutos resfriados aumentou. Na segunda época de avaliação, a lanosidade foi observada apenas em pêssegos maduros durante o período de maturação. O coriáceo foi determinado na segunda safra de avaliação já após 10 dias de armazenamento dos pêssegos verde-maduros e os pêssegos de ambos os estádios de maturação estavam coriáceos após 20 dias de armazenamento refrigerado.

Palavras-chave: **Câmaras frigoríficas, couro, distúrbio fisiológico, lanosidade..**

Introduction

Peach production is very important for south Brazilian fruit growers, especially in the state of Rio Grande do Sul (Fachinello et al., 2011). The very short harvesting season, high perishability and the distance between production areas to the major consumer markets motivates the need for better use of the cold chain.

The benefits of refrigerated transport and storage are unquestionable (Hardenburg et al., 1986), but there are as well problems attributable to prolonged refrigerating periods of stone fruit (Shinya et al., 2014). Low juiciness, dry or woolly flesh, flesh browning, uneven ripening and poor flavor after cold storage or after ripening at room temperatures are indications of cold induced flesh disorders (Lurie and Crisosto, 2005).

The lack of juicy flesh or woolliness and poor fruit quality are the main consumer claims against stone fruits. Adequate harvesting period indications could help to reduce problems related to low fruit quality (Fernández-Cancelo et al., 2021). The ripeness stage at harvest is an important factor influencing postharvest fruit quality. Harvesting indexes have to be determined for each cultivar to assure adequate quality to the consumer (Luchsinger and Walsh, 1997). Fruits harvested too early are more prone to dehydration and internal disorders. On the other hand, late harvested fruits are less firm and senesce more rapidly (Kader and Mitchell, 1989).

The cultivar Chimarrita produces good-sized fruit with good color coverage and flavor, attributes well accepted on the market (Cuquel at al., 2012). There is, however, little information on its storage potential and susceptibility to chilling injuries.

Material and methods

Cultivar Chimarrita peaches were harvested along two seasons, in December, from a private orchard located 80Km west of Porto Alegre, the capital city of the southernmost state in Brazil. Immediately after harvest, the peaches were classified as either mature-green or tree-ripe fruit. Mature-green peaches present a green ground color and with little red superficial epidermal color. Tree-ripe fruit have more red epidermal color and a more yellowish ground color.

The peaches were stored at 0.5ºC e 90% UR for up to 30 days in the first trial year and for 20 days in the second trial year. Peaches were evaluated at harvest and at 10-day intervals. Samples retrieved from storage were divided into two sub-samples: one was immediately analysed and the other one was maintained for one or two more days at 20°C. Peaches were analyzed for weight losses, juiciness, chilling injuries, decay incidence, flesh firmness, titratable acidity and soluble solids.

Firmness was determined through measurements with a hand-held penetrometer equipped with a 5/16" Magness-Taylor probe at two opposite equatorial sites and one measurement on the shoulder, suture and distal end of each individual fruit. Total soluble solids (ºBrix) and titratable acidity (% malic acid) were as well determined from each individual fruit according to Seibert et. al. (2010).

Extractable juice was determined in a subjective and an objective form. To determine subjectively juice contents, peaches were cut along the longitudinal axis into two halves. One half was hand-squeezed and four classes of juice contents subjectively assigned according to the scale: 1 = high juice contents (abundant juice liberation); 2 = moderate (moderate juice liberation); 3 = low (slight juice liberation); 4 = null (without juice). For the objective determination, the method suggested by Lill and Van der Mespell (1988) and modified by Luchsinger (2000a) was used. Segments of flesh tissues were placed in 5mL disposable syringes. The tissue was pressed by the plunger through the syringe tip to achieve a coarse homogenization. The homogenate was collected into to a centrifuge tube, weighed and centrifuged at 12.000*g* for 20 minutes. The supernatant juice was weighed and the weight expressed as percentage of sample weight.Juice viscosity was determined by visual analysis at the moment of extractable juice collection. Peaches were classified as viscous or not viscous.

Chilling injuries (internal browning) were determined visually by observation of flesh appearance. The peaches were cut in halves and classified as 1 = healthy (flesh pulp with no browning signs); 2 = slight chilling injuries (very slight browning); 3 = moderate chilling injuries (moderate browning); or 4 = severe chilling injuries (severe browning of the flesh). Leatheriness was also determined subjectively at the time of firmness evaluation. Peaches with a corky appearance of the flesh and firmness beyond 30N during the transfer period to 20°C were classified as leathery. Woolliness was determined subjectively and objectively. The peaches were cut in halves along the longitudinal axis. One half was hand squeezed and classified as 1 = healthy (abundant juice liberation); 2 = slight woolliness (good amounts of juice liberation); 3 = moderate woolliness (moderate juice liberation); or 4 = severe woolliness (without juice). Objectively woolliness was determined according the methodology of Luchsinger (2000a).

A flesh firmness *versus* extractable juice content curve was calculated. Firmness values were obtained from peaches harvested and stored for 4 days at 20°C. Daily 15 to 30 peaches were analysed for firmness and extractable juice contents to run regression analysis of freshly harvested and not chilled fruit.

Woolliness index was estimated for each storage period according to the equation 1:

$$X = 100 - [100 \text{ x (juice content at 0.5ºC or 20ºC)} \div \text{(juice content at 20ºC at harvest]}$$

[equation 1]

where X = 0 is a fruit with normal juice content and X = 100 is a totally dry fruit. Juicy fruits without signs of woolliness, flesh browning or leathery flesh were classified as healthy. Based on losses as a consequence of chilling injuries, the market life potential was subjectively defined as the number of weeks 'Chimarrita' peaches could be stored at 0.5ºC before damages would become limiting.

The experiment was conducted in a complete randomized design with 13 replicates in the first trial year and 15 replicates in the second trial year per treatment and evaluation day. The experimental units consisted of only one fruit. The SANEST program (Zonta and Machado, 1986) was used for analysis of variance and Tukey test at $p < 0.05$ applied to compare averages.

Results and discussion

Fresh weight losses of mature-green and tree-ripe peaches did not differ significantly in the two years of evaluation (Table 1). Weight losses were beyond 5% after 20 days of storage in the first trial year. In the following season, there was a weight loss beyond 5% after 10 days at 0.5ºC and beyond 10% after 20 days of storage. Because of high losses, the peaches had clear signs of peel shrinkage. In mature-green peaches, the symptoms were more evident.

Table 1

Fresh weight losses and decay incidence of cv. Chimarrita peaches harvested at two ripeness stages after up to 30 days of storage at 0.5ºC and ripening period at 20ºC in two trial years.

	Weight losses				Decay incidence	
Storage (Days at 0.5ºC)	First trial year		Second trial year		First trial year	
	Mature-green	Tree-ripe	Mature-green	Tree-ripe	Mature-green	Tree-ripe
10	3.9 a [1]	2.8 a	6.8 a	4.5 a	4.0 a	9.1 a
20	7.2 a	6.9 a	12.2 a	10.8 a	17.1 b	24.0 a
30	10.2 a	12.0 a	--- [2]	---	36.9 a	35.4 a
Average	7.1 a	7.3 a	9.5 a	7.7 a	19.3 b	26.2 a
Ripening (Days at 0.5º+ at 20ºC)	First trial year		Second trial year		First trial year	
	Green	Mature	Green	Mature	Green	Mature
0 + 2	4.9 a	4.5 a	3.2 a	2.9 a	0.0 a	0.0 a
10 + 2	6.5 a	6.5 a	4.6 a	3.9 a	22.5 a	27.5 a
20 + 1	4.7 a	3.4 a	3.3 a	2.3 a	5.0 a	10.0 a
30 + 1	3.0 a	3.0 a	---	---	11.9 a	0.0 b
Average	4.8 a	4.4 a	3.7 a	3.0 a	9.9 a	9.4 a

[1] Averages followed by the same letter in line, inside each parameter year and storage time, are not statistically different by Tukey test ($p<0.05$).
[2] In the second trial year peaches were stored for only 20 days.

According to Mitchell (1992) weight losses of more than 5% result in defective appearance of the fruits. Crisosto et al. (1994) on the other hand set the threshold at 10% to visualize symptoms of shrinkage. Independently of percentages of fresh weight losses the higher the value the worse the visual quality.

In the second trial season, no decay incidences were determined. In the first year of evaluation, an average of 19.3% of mature-green peaches and 26.2% of tree-ripe peaches were decayed with significant differences amongst ripeness stages along storage periods. There was a significant increase of incidence of decay after 20 days of storage at 0.5ºC. *Monilinia fructicola* (brown rot) was the causal agent of decay. Bernat et al. (2019) concluded that brown rot is the most important pathogen for stone fruits. Infections occur during the flowering period or during fruit development stages, but decay symptoms may be visualized only after harvest (Larena et al., 2005). The few weeks before harvest is the period in which peaches become more susceptible to brown rot incidence and, therefore, in the field control measures are highly recommended to reduce percentages of decayed fruits after harvest (Casals et al., 2021). Wet and warn environments along the ripening period favor infection (Biggs and Northover, 1988) and that could be an explanation for varying percentages of decay incidence after harvest observed in the trial years.

Tree-ripe peaches were larger and with better red color cover than peaches harvested at the mature-green ripeness stage in both years of evaluation (Table 2). On average, tree-ripe peaches were 0.5cm larger and about 31 gram heavier than mature-green peaches, which may result in a 22% higher overall income to the grower.

Mature-green fruit, on average values, have significantly lower contents of soluble solids and higher titratable acidity. These differences impart a sweeter taste to the peaches harvested at the tree-ripe stage. In a previous work with the same cultivar (Seibert et al., 2007) determined higher soluble solids contents (13.9 Brix) and similar contents of titratable acidity. Andrade et al. (2015) and Miranda et al. (2019) also determined higher soluble solids and similar malic acid concentrations in trials with the same cultivar. The observed differences in fruit quality of the same cultivar may be ascribed according to conclusions of Minas et al. (2018) to the different environmental conditions at every trial location.

Table 2

Weight, diameter, epidermal color, total soluble solids (TSS), titratable acidity (TA) of 'Chimarrita' peaches harvested at two ripeness stages in 2002 and 2003.

Year	Weight (g)		Diameter (cm)		Color (%)		TSS (ºBrix)		TA (%malic acid)	
	Mature-green	Tree-ripe	Mature-green	Tree-ripe	Mature-green	Tree-ripe	Mature-green	Tree-ripe	Mature-green	Tree-ripe
2002	114,6 b[a]	142,4 a	5,8 b	6,2 a	25,7 b	60,3 a	11,6 a	12,2 a	0,32 a	0,23 b
2003	106,3 b	140,3 a	5,9 b	6,6 a	30,0 b	69,3 a	10,9 a	12,2 a	0,33 a	0,27 a
Average	110,5 b	141,4 a	5,9 b	6,4 a	27,9 b	64,8 a	11,3 b	12,2 a	0,33 a	0,25 b

[a] Same letter in line, inside each year and parameter, were not significantly different (Tukey test; $p<0,05$).

Chimarrita peaches start ripening from the distal end. The tip end is the part of the fruit where the lowest values of flesh firmness were determined in both seasons of evaluation. In the second trial year at the suture, firmness values were similar to the firmness values of the distal end (Figure 1A and 1B). That observation held through the 30 days of cold storage. During ripening at 20ºC, however, firmness values start to become equal. In the first trial year a reduction of flesh firmness along with storage time was determined (Figure 2A) while in the second trial year firmness stayed close to the values measured at harvest (Figure 2C). In both trial years, peaches harvested at the tree-ripe ripeness stage were less firm than peaches harvested mature-green. During the transfer period to 20°C firmness values of mature-green and tree-ripe peaches dropped to almost the same levels (Figure 2B). Zhou et al. (2001) observed the same behavior during ripening at 20°C of 'Hermoza' peaches. During ripening at 20°C in the second season, firmness of Chimarrita peaches was higher e remained higher during the evaluation days compared to the previous season (Figure 2D). Probably a consequence of a more intense dehydration observed after 10 days of storage. Overall firmness values in the present trials are similar to firmness values referred to by authors like Cremasco et al. (2016) and Miranda et al. (2019).

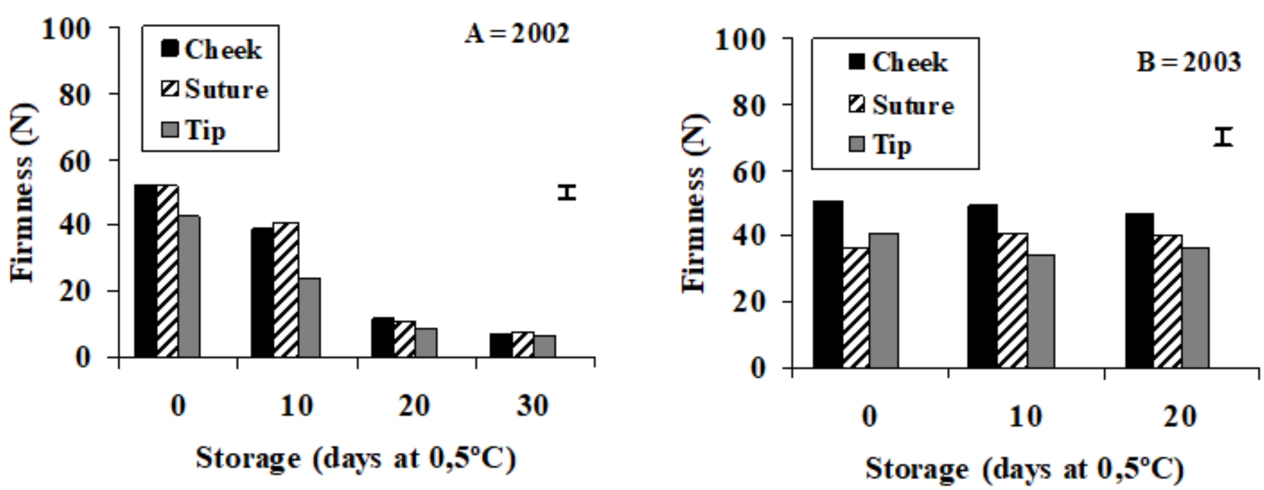

Figure 1

Cheek, shoulder, suture and distal end (tip) firmness of tree-ripe cv. Chimarrita peaches after up to 30 days cold storage at 0.5ºC in two years of evaluation. A = first trial year (2002) and B = second trial year (2003). Vertical bars (I) indicate Least Significant Difference ($p<0.05$).

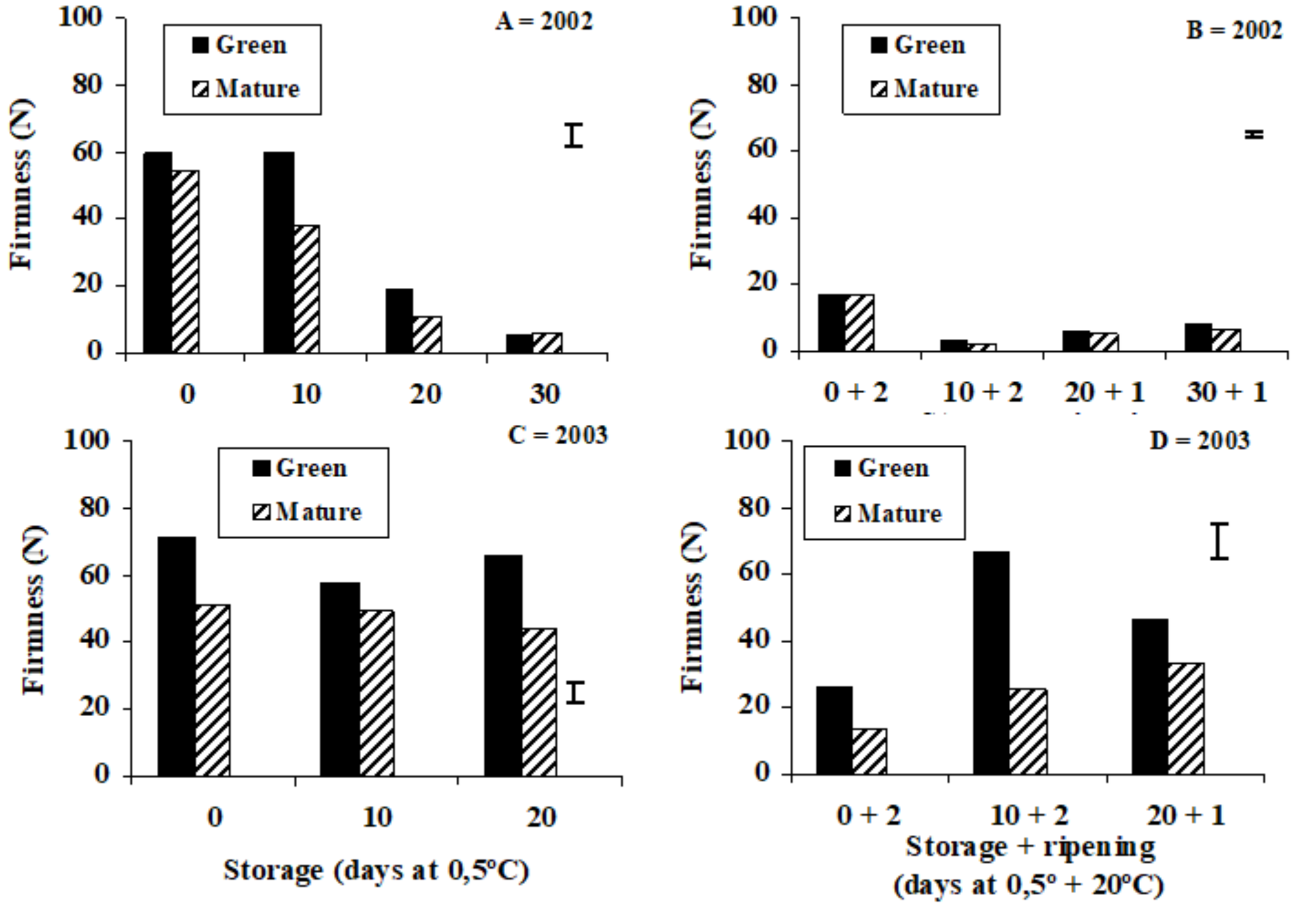

Figure 2

Cheek firmness of 'Chimarrita' peaches after up to 30 days of cold storage at 0.5ºC (A and C) and plus two more days at 20ºC (B and D) in two years of evaluations. Vertical bars (I) indicate Least Significant Difference (p<0.05).

Juiciness determined subjectively of the stored peaches diminished with storage time (Table 3). That observation is confirmed by objective juice determinations. Mature-green peaches had 35% of extractable juice at harvest and the contents dropped to 22% after 30 days of storage while tree-ripe peaches had 30% of juice at harvest that dropped to 24% after the same 30 days of storage (Figure 3A). During ripening at 20°C after 20 or 30 days of storage juice contents dropped to percentages determined at harvest concurrently with high percentages of wolly peaches (Figure 3B). Von Mollendorff et al. (1989) reported the same behavior of 'Independence' nectarines.

Table 3
Subjective evaluations of juice intensity (1 = high juice contents; 2 = moderate; 3 = low juice and 4 = without juice) and juice viscosity (viscous or not viscous juice) of cv. Chimarrita peaches determined subjectively after storage at 0.5°C for up to 30 days and 2 more days of ripening at 20ºC along two trial years.

Days at 0.5° + 20°C	Juice intensity				Juice viscosity (% fruits)			
	First trial year		Second trial year		First trial year		Second trial year	
	Mature -green	Tree-ripe	Mature -green	Tree-ripe	Mature -green	Tree-ripe	Mature -green	Tree-ripe
0 + 2	1.3 a[a]	1.2 a	2.1 a	1.2 b	0 a	15 a	0 a	6.7 a
10 + 2	1.8 a	1.5 a	3.8 a	1.5 b	0 a	0 a	0 a	0 a
20 + 1	3.6 a	2.9 a	3.5 a	3.0 a	100 a	85 a	20 b	73 a
30 + 1	3.3 a	3.3 a	---	---	85 a	92 a	---	---

[a] Averages followed by the same letter in lines, inside each trial year and parameter, do not differ statistically (Tukey test; p<0,05).

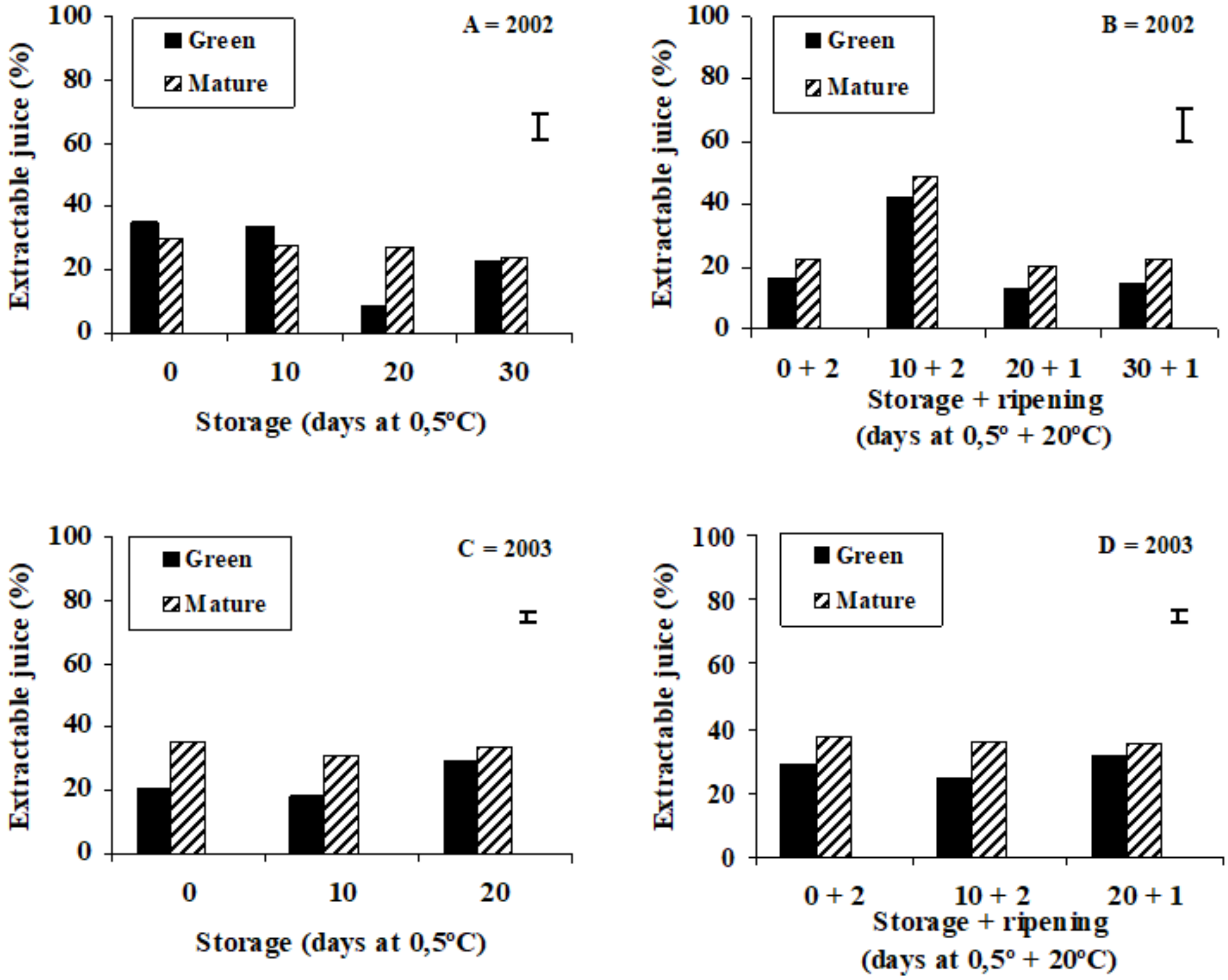

Figure 3

Extractable juice contents of cv. Chimarrita peaches after up to 30 days of cold storage at 0.5ºC (A and C) and plus up to two more days of ripening at 20ºC (B and D) in two years of evaluation: first trial year (A and B - 2002) and second trial year (C and D - 2003). Vertical bars (I) indicate Least Significant Difference (p<0,05).

In the second trial year, juice contents of tree-ripe peaches was significantly higher compared to mature-green peaches (Figure 3C and 3D). Tree-ripe peaches maintained high juice contents, about 35%. In mature-green peaches juiciness increased from 21% at harvest up to 29% after 20 days of storage. During the ripening period at 20°C, tree-ripe peaches had about 36% of juice and mature-green peaches ranged from 24% to 30% (Figure 3D). Luchsinger (2000b) concluded that peaches might have low juice contents attributable to high firmness, because of woolliness or because of both, firmness and woolliness.

Juice viscosity increased during ripening. In the second trial year, 73% of tree-ripe peaches and only 20% of mature-green peaches had viscous juice during ripening at 20°C after 20 days of storage at 0.5°C. In the previous season, viscous juice was determined from harvest on and always after the transfer period to 20°C when the peaches had less than 32% of juice contents. After 20 days of refrigerated storage, 80% of the tree-ripe and all the mature-green peaches had viscous juice. Viscous juice is a characteristic of woolly peaches. Von Mollendorff and De Villiers (1988) concluded that soluble pectin viscosity reaches its maximum values during woolliness development and in fruits without woolliness, less juice viscosity increases are observed. According to Von Mollendorff et al. (1993), the increase in juice viscosity could result from high pectinmethylesterase activity. Ben-Arie e Lavee (1971) determined low concentrations of methoxy moyeties and an increase in the ability of gel formation of soluble pectins in stored fruits.

Woolliness and firmness retention are the symptoms of chilling injuries observed in cv. Chimarrita peaches. Flesh browning was not observed in any of both years of evaluations, however, the cultivar is susceptible to flesh browning according to previous observations (Seibert, 2004). Chimarrita peaches showed high susceptibility to woolliness in the first trial year. Despite of a good external appearence of the peaches, already after 10 days of cold storage at 0.5°C, 30% of the tree-ripe fruits were wooly (Table 4). Mature-green peaches showed woolliness symptoms after 20 days of cold storage. Chilling injuries are normally visualized after one or two days of retrieval to ambient temperatures (Ben-Arie and Lavee, 1971; Luchsinger, 2000b). Brackmann et al. (2003) did not determine woolliness of Chimarrita peaches at retrieval from storage, but did observe symptoms after 2 days at 20ºC, what corroborates our conclusion of high susceptibility of fruits harvested for the first trial year.

Table 4

Percentages of woolly and leathery mature-green and tree-ripe cv. Chimarrita peaches determined subjectively after up to 30 days of cold storage at 0.5ºC and two more days of ripening at 20ºC along two trial years.

Storage periods	Woolly peaches in the first trial year				Woolly fruit in the second trial year		Leathery fruit in the second trial year	
	Cold storage at 0.5 °C		Ripening at 20°C		Ripening at 20°C		Ripening at 20°C	
	Mature -green	Tree-ripe	Mature-green	Tree-ripe	Mature-green	Tree-ripe	Mature-green	Tree-ripe
10	0 a [a]	30 a	0 a	0 a	0 a	20 a	40 a	0 a
20	70 a	40 a	100 a	60 b	0 b	33 a	73 a	27 a
30	30 a	60 a	100 a	100 a	--- [b]	---	---	---
Average	30 a	43 a	67 a	53 b	0 b	27 a	57 a	14 b

[a] Averages followed by the same letter in lines inside each year and variable are not significantly different (Tukey test; $p<0.05$)

[b] --- Indicates that there was no evaluation on this day.

In view of objective woolliness evaluations, no symptoms were observed after 10 days of cold storage in the first trial year. Symptoms were observed after 20 days of cold storage in mature-green peaches as well as in tree-ripe fruit (Figure 4A). After 20 days of storage 58% of the mature-green fruit and 9.6% of tree-ripe fruit had woolliness symptoms. With regards to the transfer periods to 20°C, objectively determined woolliness was observed only after 20 days of cold storage. At this point, 57% and 54% of the mature-green peaches compared to 35% and 33% of tree-ripe peaches were woolly (Figure 4B). The differences, though, were not significantly different.

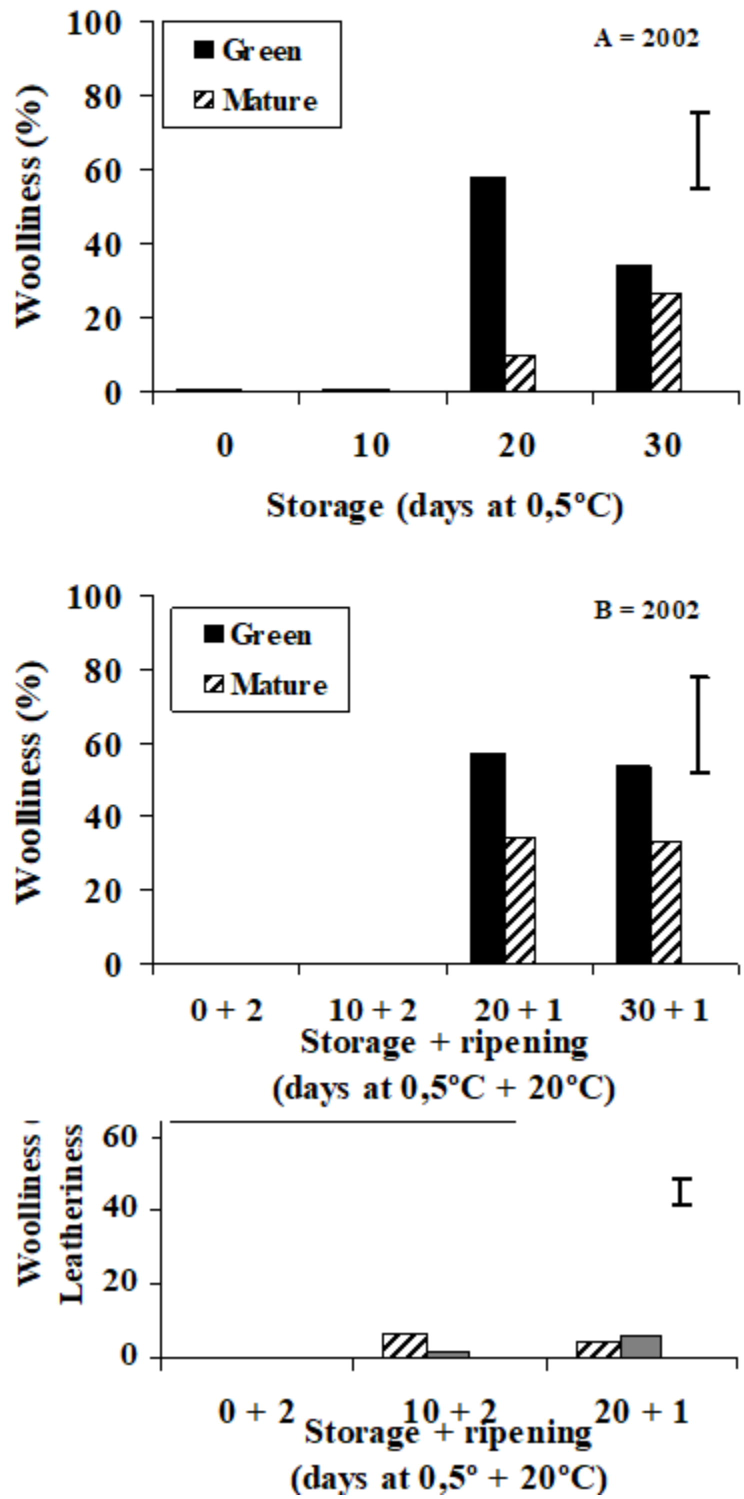

Figure 4

Woolliness occurence in ‘Chimarrita' peaches after up to 30 days of cold storage at 0,5°C in 2002 (A and B) and woolliness and leatheriness in 2003 (C) and after up to two more days of a ripening period at 20ºC (B and C). Vertical bars (I) indicate Least Significant Difference (p<0,05).

High percentages of woolliness in the first season correspond to low extractable juice determinations. 57% of woolly peaches released only 10% of extractable juice after 20 days at 0.5ºC (Figure 3A). High woolliness indices are followed by low juice contents (Figure 3B and 4B). Von Mollendorff et al. (1989; 1993) observed that 'Independence' and 'Flavortop' nectarines with at least 35% juice contents after a ripening period at 20°C had no symptoms of woolliness. Likewise, mature-green and tree-ripe cv. Chimarrita peaches with woolliness symptoms had less than 32% juice contents while, on the other hand, none of the peaches with more than 35% juice contents showed symptoms.

In the second trial season no woolliness symptoms were determined at retrieval from storage. Through visual analyses, symptoms were observed in 20% of the peaches at ripening following 10 days of storage (Table 5). The woolliness index determined objectively was low in the second trial season with averages of 6.3% and 4.5% during ripening following 10 or 20 days of cold storage, respectively (Figure 4C). Looking at intensity data of woolliness in peaches in which symptoms had been observed, the averages increase up to 15.6% and 13.4%.

Firmness retention was observed in mature-green fruit during ripening at 20°C after 10 days of cold storage of mature-green peaches with high firmness and corky flesh in the second year of trial. Following 20 days of storage, firmness retention was detected in peaches of both ripening stages, though in higher intensity in mature-green fruit. High occurrence of firmness retention is, possibly, influenced by high dehydration percentages, beyond 10% after 20 days of cold storage (Table 1).

Fruk et al. (2014) indicate that woolliness as well as other stone fruit flesh disorders result from low storage temperatures. Since firmness retention was high, mainly in peaches harvested at the mature-green ripeness stage, data of juice contents were compared with the relation juice *versus* firmness (Figure 4C). After 20 days of storage, there is an average of 5.9% of firmness retention in mature-green fruit.

To estimate the market life of cv. Chimarrita peaches after cold storage, fruit were considered as marketable when without visual symptoms of chilling injuries (Table 5). Chilling injuries reduced the percentages of salable fruit after 10 days of cold storage. After 30 days of storage no peaches of either ripeness stage were marketable. In the second year all the peaches were in good quality after 20 days of storage, though after retrieval to ambient temperatures the fruit turned unsaleable. Therefore, 10 to maximum 20 days is the maximum storage period possible for cv. Chimarrita peaches. Storage periods longer than 20 days increase the risk of occurence of chilling injuries. According to Bruhn et al. (1991) one of the major causes of consumer fruit rejection are the incidence of chilling injuries.

Table 5

Percentages of healthy cv. Chimarrita peaches after cold storage at 0.5ºC and ripening period at 20ºC harvested at the mature-green and tree-ripe ripeness stage in two years of trials.

Storage periods	Healthy fruits in the first trial year				Healthy fruits in the second trial year			
	Cold storage		Ripening		Cold storage		Ripening	
	Mature -green	Tree-ripe	Mature -green	Tree-ripe	Mature -green	Tree-ripe	Mature -green	Tree-ripe
10	100 a[a]	70 a	100 a	100 a	100 a	100 a	60 a	80 a
20	30 a	60 a	0 b	40 a	100 a	100 a	27 a	40 a
30	70 a	40 a	0 a	0 a	---	---	---	---
Average	67 a	57 a	33 b	47 a	100 a	100 a	43 a	60 a

[a] Same letter in lines, inside each year and parameter do not differ statistically (Tukey test; $p<0,05$).

Conclusions

Cultivar Chimarrita peaches are very susceptible to chilling injuries. Wooliness is the major symptom of the cultivar harvested at the mature-green or tree-ripen ripeness stage. Because of that and because of excessive flesh firmness losses cv. Chimarrita peaches should not be cold stored at 0°C for more than 20 days.

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Información adicional

redalyc-journal-id: 813

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Injúrias por frio e qualidade dos frutos de pêssegos 'Chimarrita' colhidos em dois estádios de maturação

Revista Iberoamericana de Tecnología Postcosecha
vol. 25, núm. 2, p. 108 - 123, 2024
Asociación Iberoamericana de Tecnología Postcosecha, S.C., México
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ISSN: 1665-0204