Effects of forced-air precooling, 0℃transportation and different retailing methods on the quality of peach

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Abstract: The objective of this experiment was to evaluate the effects of different retailing methods on the maintenance of peach quality after pre-cooled to 5℃and transportation at 0℃. 'Okubao' peaches were film wrapped using 35 μm anti-fogging cast polypropylene (CPP) and stored for 3 days at 0℃or 4℃to simulate refrigerated display cabinet condition. Some other peached directly stored at 20℃unwrapped after transportation. Results revealed that softening and deterioration occurred quickly in 20℃. Peach stored in 20℃lost significantly more weight, 3.7%. 0℃and 4℃resulted in less weight loss of the packaged peach, 0.7% and 1.7%, respectively. After shelf life, 0℃retailed peach wrapped in CPP showed the highest sensory quality, lost less weight, was firmest, and retained color better than either 4℃or 20℃retailed peach. Additionally, soluble solids content, titratable acidity, soluble sugar and ascorbic acid concentration significantly remained when retailed at 0℃.
Keyword: 'Okubao' peach; Retailing; Shelf life; refrigerated display cabinet; CPP package; Quality

1. Introduction

Fresh fruits and vegetables probably receive the greatest temperature abuse at the retail level [1]. The majority (90%) of fruits and vegetables that should have been stored at less than or equal to 4℃were above the recommended temperature range, resulting in poor quality and shorter shelf life, and increased waste at the retail and consumer levels [1], [2]. Our preliminary researches suggested that peach should be hold at 0℃ideally to reduce the quality loss and deterioration, which coincided with Crisosto C H, et al. [3], who stated that the proper postharvest temperature condition (near 0℃) during storage, shipping, and retail marketing can extend peach, nectarine, and plum postharvest storage and shipping potential. Crisosto C H, et al. [4] also suggested that peach fruit should be cooled and held near or below 0℃ according to their freezing point.

Although 0℃was found to be the ideal storage temperature for peach, 4℃is the temperature generally used in supply chain, due to technical and commercial requirements [5]. The temperature of refrigerated display cases was generally setup between 2℃and 4℃[6] and the temperature in dry retail display varies between 15 and 20℃, resulting excessive firmness loss after 2-3 days [4].

Since there seems to be a lack of information on the effects of retail displays on the produce quality, the objective of this study was to evaluate the simulated retail display treatments on the physical and chemical characteristics of peaches.

2. Materials and methods

2.1. Fruit harvest, treatment and storage conditions

Peaches (Prunus persica L. Batsch cv.Okubao) were harvested at commercial maturity from a commercial fruit grower in Beijing, China, and transported by ventilated car to laboratory, where they were sorted for uniform size and appearance. After forced-air cooled to the core temperature of 5℃, the peaches were transported at 0℃packed in 35 μm anti-fogging cast polypropylene (CPP) for 3 days. The fruits, after transportation, were subjected to the following treatments: T1 = storage in air at 20℃; T2 = 0℃refrigerated retail in CPP package (0℃+ CPP); T3 = 4℃refrigerated retail in CPP package (4℃+ CPP). Samples were evaluated after removal from transportation and after each shelf life period.

2.2. Physical measurements and sensory evaluation

Weight loss was determined as the percentage of the loss of weight with respect to the initial weight.

Color was measured using a hand-held CR-400 colorimeter. Numerical values of L*, a* and b* were recorded and converted to hue angle (h° = arctan (b*/a*)) and chroma (C* = (a*2+b*2)1/2).

Flesh firmness of the fruit was measured using a penetrometer (TR-FT327, Italy) with a 5-mm diameter plunger tip. Opposite sites on the equatorial part of the fruit were peeled at the site of probe insertion. The results were expressed as Newton (N).

The sensory analysis was performed by a well-trained panel of five members. All fruits were evaluated for quality on a 1-9 scale, where excellent, freshly = 9; very good = 7; good, limit of marketability = 5; fair, limit of usability = 3 and poor, unusable = 1, where 6 is considered the minimum for salability [7].

2.3. Chemical analyses.

Soluble solid content (SSC) was determined with a hand-held refractometer (Atago Co.Ltd., Tokyo, Japan), and results were expressed as %. Titratable acidity (TA) was determined by diluting 10 grams of flesh to a final volume of 100 ml with distilled water and then titrating 20 ml diluted juice to pH 8.1with 0.1 mol·L-1 NaOH; results were given as percent malic acid.

Ascorbic acid content was determined by molybdenum blue colorimetric method according to the method of Li (2000) [8].

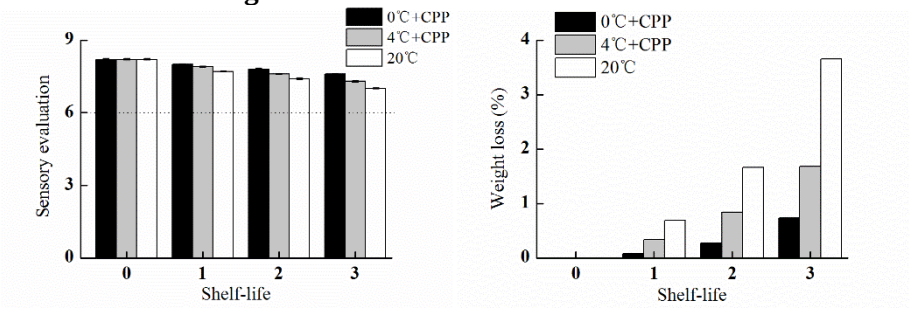
Soluble sugar content was determined according to the method of Cao JK et al, (2013) using anthrone reagent and sucrose glucose as the standard [9].

2.4. Statistical analysis

All statistical analyses were performed with SPSS 19.0. Data were analysed by one-way analysis of variance (ANOVA). Means were compared using least significant difference (LSD) test. Differences at $P < 0.05$ were considered to be significant.

3. Results

3.1. Sensory evaluation and weight loss



a b

Fig. 1. Sensory evaluation and weight loss of 'Okubao' peaches during retail display at 0℃+CPP, 4℃+CPP or 20℃following simulated transportation at 0℃. Vertical bars represent ±SE.

Fruit from the 0℃packed in CPP obtained the highest sensory quality score (Fig. 1a), being statistically different from the scores obtained for 4℃with CPP, and 20℃stored fruit. Under 20℃for 3 days peach received the lowest sensory quality score, but sailing under 0℃with CPP significantly improved sensory acceptance of fruit followed by treatment of 4℃with CPP. Fruit sailed at 20℃appeared especially less attractive (7 points), due to the slight symptoms of decay and soft texture.

The increase in weight loss continued in relation to the prolonging shelf life period while the lowest weight loss in peach was obtained from 0℃with CPP application (Fig. 1b). Fruit incurred quite a rapid weight loss during shelf life at ambient temperature (20℃), which was retarded markedly when the packed fruit was stored at low temperature. The high relative humidity generated inside the CPP package might be responsible for the delay in fruit weight losses. At the end of shelf life, weight loss of peaches stored in the 0℃with CPP was found to be 0.7% compared with 1.7% and 3.7% of the 4℃with CPP and the 20℃, respectively. Fruits at 20℃showed an approximate 5-fold increase in weight loss after 3 days.

3.2. Color

Table. 1 Chromaticity values (lightness, hue angle and chroma) of 'Okubao' peaches during retail display at 0℃ +CPP, 4℃+CPP or 20℃following simulated transportation at 0℃.

Color parameter	Treatment	Retail display		
		1	2	3
L*	0℃+CPP	47.1±2.9	46.5±1.2	46.4±1.6
	4℃+CPP	46.5±2.3	45.6±1.5	42.2±2.1
	20℃	45.4±2.9	43.5±12	41.8±2.3
H°	0℃+CPP	34.5±1.2	34.2±0.9	34.1±2.2
	4℃+CPP	33.2±1.9	32.1±1.7	30.8±1.6
	20℃	31.5±2.6	30.6±0.9	28.2±1.9
C*	0℃+CPP	37.3±2.9	36.6±1.5	35.8±1.8
	4℃+CPP	37.3±1.9	34.6±2.2	32.2±2.2
	20℃	36.8±3.2	33.9±1.3	31.2±2.7

The L*, h° and C* values during ripening of fruit at 20℃ decreased by day 1 (Table. 1), and remained at lower levels than the initial ones. Stored fruit at 0℃or 4℃with CPP package showed significantly higher L*, h° and C* values than fruit at 20℃($P<0.05$).

3.3. Firmness, SSC, TA and soluble sugar content

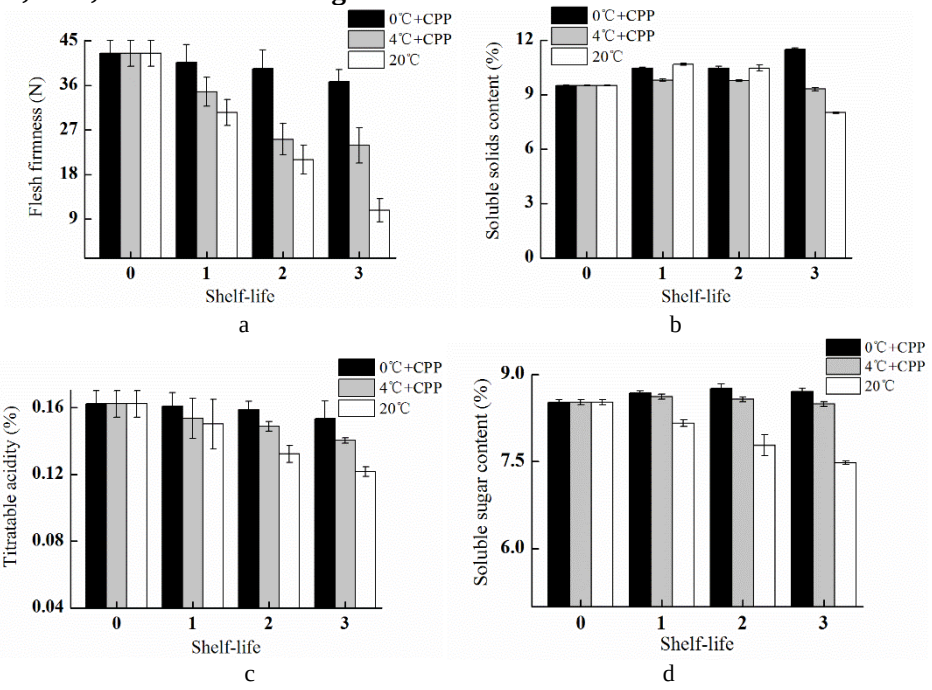


Fig. 2. Firmness (a), SSC (b), TA (c) and soluble sugar content (d) of 'Okubao' peaches during retail display at 0℃+CPP, 4℃+CPP or 20℃following simulated transportation at 0℃. Vertical bars represent ±SE.

Fruit marketed at 0℃with CPP did not soften significantly throughout the marketing period, while fruit marketed at 20℃softened significantly faster. Fruit firmness decreased rapidly from 42.5N after delivery to 30.5N after 1 day of selling at 20℃, and then further declined to 10.8N after 3 days. Fruit sailed at 0℃with CPP were all about 3.5 time firmer than the 20℃sailed fruit at the end of shelf life.

When SSC values of fruits of peach cv. 'Okubao' were considered, it can be seen a generally increase occurred from the initial values of 9.5% before the decrease at the end of shelf life. Figure. 2b showed the fruits treated with 0℃+CPP retained higher SSC (11.5%) than those at 4℃+CPP (9.3%), and 20℃(8.0%) at the end of shelf life. Moreover, the situation of TA during retail display was similar. The highest TA content in the trials was determined in 0℃with CPP at the end of shelf life (0.15%), while the lowest TA value wAS determined at 20℃(0.12% at the end of shelf life). Figure. 2d showed the fruits displayed at 0℃combined with CPP retained higher soluble sugar content (8.7%) than the fruits selling at 20℃ (7.5%) throughout the marketing period.

3.4. Ascorbic acid concentration

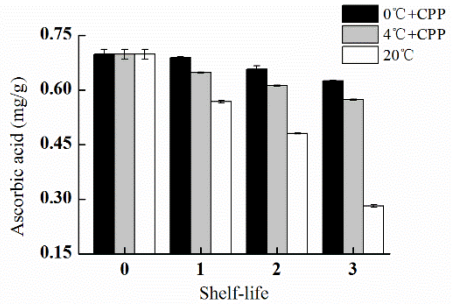


Fig. 3. Ascorbic acid concentration of 'Okubao' peaches during retail display at 0℃+CPP, 4℃+CPP or 20℃ following simulated transportation at 0℃. Vertical bars represent ±SE.

Treatments with 0℃+CPP significantly remained the ascorbic acid concentrations ($P<0.05$) (Fig. 3). At the end of 3 days shelf life, the ascorbic acid concentrations of peaches at 0℃with CPP reduced to 0.624 mg/g, while those of the treatments with 4℃packed in CPP and 20℃showed 0.573 mg/g and 0.281 mg/g, respectively. The ascorbic acid concentrations of packed fruits at 0℃was significantly higher.

4. Conclusion

Throughout 3 days shelf life, the fruit held at 0℃combined with CPP package effectively alleviated the softening and weight loss, providing a satisfactory and good retention of quality attributes by peaches and an extended shelf-life.

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