Effects of different transportation methods on quality maintenance of peach 'Okubao' after forced-air cooling

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Abstract: The goal of this research was to evaluate the efficiency of various simulated transport treatments on maintaining the quality of 'Okubao' peach. Peaches were pre-cooled to 5℃for 140 minutes and afterwards treated with three simulated transport treatments, consisting of cold transportation with or without 35 μm anti-fogging cast polypropylene (CPP) plastic package, and detachable incubator. Parameters evaluated included sensory quality, weight loss, color, flesh firmness, soluble solids content, titratable acidity, soluble sugar and ascorbic acid concentration. Weight loss of fruits was reduced tremendously, lower than 1%.The appearance, soluble solids content, titratable acidity, soluble sugar and overall sensory quality of the wrapped peaches transported at 0℃were found to be better than those unwrapped and transported by incubator. Transportation at 0℃in CPP was shown most useful to prevent weight losses and maintain fruit color, freshness and nutritional values.
Keywords: 'Okubao' peach; Transport; Refrigeration; Package; Quality

1. Introduction

Peach is of great commercial importance for its good taste, size and aromatic, but rapid rate of softening, over-ripeness and high perishability at room temperature during the post-harvest period lead to drastically limited market life potential throughout the marketing chain[1], [2].Peach after harvested in the orchard normally transported at the ambient temperature, ranged from about 25.8℃to 27.7℃[3]. Thus, shipping of peaches to distant markets before selling requires low temperature to prevent postharvest quality losses by decreasing the rate of deterioration[4]. Commercial transportation conditions (0-5℃and 80–95% relative humidity) delay the deterioration and reduce weight loss and decay incidence, retard the aging, softening and changes in texture and color. It also slows undesirable metabolic changes and loss of edibility[5].

However, undesirable holding temperatures (around 4-6℃), even short periods of abuse during distribution, can exaggerate deterioration and cause a considerable amount of quality loss by the time the product reaches its destination[6]. Packaged product deteriorate dramatically due to increase in metabolism and spoilage because of temperature abuse during transportation[7].

It is of vital importance to make sure that perishables can be maintained in the best condition throughout the distribution to preserve fruit quality and reduce postharvest losses[8]. The use of cooling after harvest and during transportation forms the basis of the postharvest handling procedures and will continue as the primary technology for minimizing deterioration after harvest[9]. Adequate refrigeration during transport can eliminate quality loss due to maintain low temperatures, also other strategies are required to reduce water loss and prevent wilting. The main aim of this work was to apply different treatments to inhibit weight loss and to improve the quality of peach fruit.

2. Materials and methods

2.1 Fruit harvest and transport treatments

Fruits were purchased at commercial maturity and transported by ventilated car to the laboratory, where they were selected for uniform size, appearance and freedom from defects. After immediately forced-air precooled to reach 5℃(core temperature) 140 minutes later, peaches were randomly divided into batches of 60 fruits each, putting in clean plastic boxes with the fruit touching and used for subsequent transportation. The peaches were stored at [1] 0℃, [2] 0℃with 35 μm anti-fogging cast polypropylene (CPP) (0℃+CPP), [3] detachable incubator with 0℃cold storage agents until the temperature rose by 3℃,respectively, simulating 3-day transportation conditions. Three replicates of eighteen fruits were used for physicochemical measurements and sensory evaluation.

2.2 Weight loss, overall quality

Weight loss (%) was as the percentage of the original weight lost by the samples.

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[10].

2.3 Color, firmness, soluble solid content (SSC) and total titratable acidity (TA)

Color was measured around the equatorial region of each fruit with a CR-400 colorimeter and the results were expressed as lightness (L*) value, hue angle (h°) and chroma (C*). Hue values were obtained as h° = arctan (b*/a*) when a*> 0 and b*> 0. Chroma was expressed as $C^* = (a^{*2}+b^{*2})^{1/2}$.

Flesh firmness was determined using a penetrometer (TR-FT327, Italy) equipped with a 5-mm diameter plunger tip in two opposite sides of the fruit after the peel removal. The firmness was expressed as Newton (N).

Soluble solids content (SSC) was measured with a digital refractometer (Atago Co.Ltd., Tokyo, Japan) and reported as percentage (%).

Titratable acidity (TA) was characterized 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 8.1 with 0.1 $mol \cdot L^{-1}$ NaOH. Volume of NaOH was recorded and calculation convert to a percent malic acid basis.

The remaining was picked, cut into small cubes, immediately frozen in liquid nitrogen and stored at -80℃until used for extraction and measurement of ascorbic acid concentrations, and soluble sugar content.

2.4 Extraction and measurement of ascorbic acid concentration and soluble sugar content

Ascorbic acid content was determined by molybdenum blue colorimetric method according to the method of Li (2000)[11].

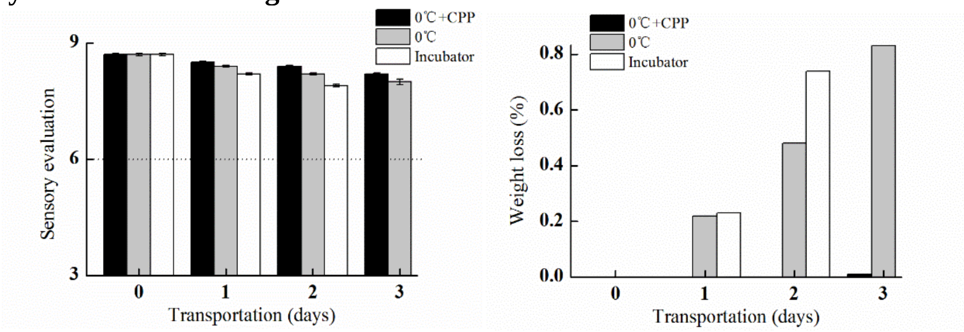
Soluble sugar content was determined according to the method of Cao JK et al, (2013) [12] using anthrone reagent and sucrose glucose as the standard.

2.5 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 Effects of 0℃, 0℃+ CPP and incubator treatments on sensory evaluation (a) and weight loss(b) of ‘Okubao’ peach. Each value is presented as the mean ± SE (n = 3).

Fruit samples transported by incubator in 2 days until the fruit temperature rose by 3℃(data not shown). As observed in the Figure. 1a, fruit transported at 0℃with CPP received significantly higher sensory quality score than those at 0℃and incubator (P<0.05). Otherwise, it is important to point out that all the simulated transport treatments obtained sensory quality scores higher than 7.5 at the end transportation, therefore meaning that all the fruits were well accepted with excellent eating quality.

The weight loss of the three simulated transport treatments all increased slightly, lower than 1%, with a final value of 0.8% over 3 days transportation at 0℃, and 0.7% over 2 day transportation at incubator. In contrast, the fruits packaged in CPP at 0℃almost did not lose weight by the end of the transportation period. The high relative humidity generated inside the CPP packages might be responsible for the delay in fruit weight loss compared with peach stored in air.

3.2 Color

Table.1 Lightness(L*),hue angle(h°)and chroma(C*) values of 'Okubao'peaches kept at simulated transportation conditions.

Color parameter	Treatments	Transportation		
		1	2	3
L*	0℃+CPP	48.6±1.9	47.6±1.4	47.5±1.0
	0℃	47.3±1.1	46.3±1.2	44.5±1.3
	Incubator	47.7±1.1	46.0±1.5	
h°	0℃+CPP	35.8±2.1	35.1±0.5	34.8±0.9
	0℃	34.1±0.7	33.9±1.4	33.5±0.5
	Incubator	34.3±1.9	29.3±0.9	
C*	0℃+CPP	40.1±1.3	39.2±1.8	37.7±1.7
	0℃	39.5±1.2	38.5±1.5	37.1±1.7
	Incubator	40.1±1.6	37.1±1.7	

When color was evaluated by the end of transportation, fruit stored in incubator had lower L*, h° and C*values than those stored at 0℃(Table. 1). Moreover, fruit stored at 0℃with CPP had a color brighter and redder than those unwrapped.

3.3 Firmness, SSC, TA and soluble sugar content

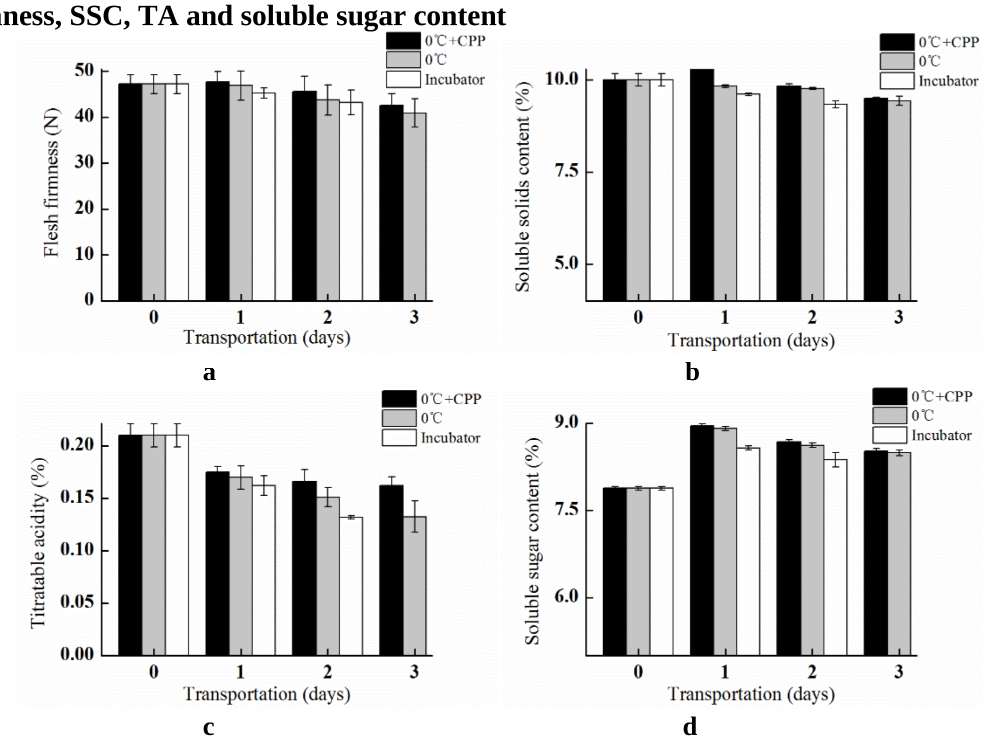


Fig.2 Effects of 0℃, 0℃+ CPP and incubator treatments on firmness (a), SSC (b), TA (c)and soluble sugar content (d) of 'Okubao' peach. Each value is presented as the mean ± SE (n = 3).

Figure2a showed the statistical firmness difference ($P<0.05$) of 'Okubao' peaches among different delivery conditions. Fruit firmness decreased continuously but softening was greatly inhibited by low temperature, being higher than 40N during the 3 days delivery period. Compared with the value at 0℃, firmness was lower in incubator fruits. The flesh firmness of fruit conventionally delivery at incubator was observed about 43.2N until the fruit temperature rose 3℃. The firmness of 47.2N after precooling decreased to 42.5N and 40.9N after 3d delivery under 0℃+CPP and 0℃, respectively. It must be emphasized that the application of cold storage, when combined with CPP, effectively inhibited softening during delivery.

Figure 2 showed that the cold transportation with CPP treatment was the most effective in maintaining SSC, TA and soluble sugar contents during delivery. The initial SSC value which was10% became 9.5% in 0℃ with CPP treatment; 9.4% in 0℃; and 9.3% in incubator treatment at the end of delivery period. During transportation, TA decreased over time from the initial value of 0.21% to 0.16% and 0.13% respectively in 0℃with CPP and in air, and to 0.13% in incubator treatment when the fruit temperature rose 3℃. Among all the delivery conditions minimum soluble sugars were shown in fruits treated with incubator (8.4%) and the maximum contents were recorded in 0℃+CPP treated fruits (8.5%).

3.4 Ascorbic acid concentration

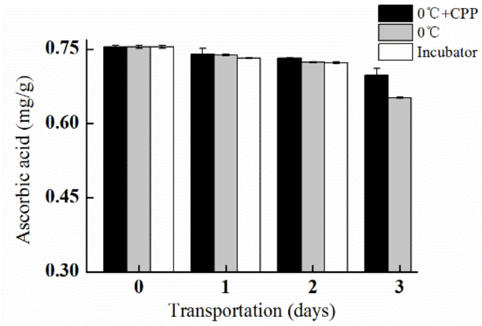


Fig.3 Effects of 0℃, 0℃+ CPP and incubator treatments on ascorbic acid concentration of 'Okubao' peach. Each value is presented as the mean ± SE (n = 3).

The ascorbic acid concentration at harvest (0.76 $mg \cdot g^{-1}$) decreased gradually over transportation, the diminution being significantly higher in incubator (0.72 $mg \cdot g^{-1}$, after 2 days) than in those under 0℃ constantly (Fig. 3). Ascorbic acid retention at the end of the delivery period was higher in CPP at 0℃ than in air. The total ascorbic acid content of peach ranged from 0.7 to 0.65 $mg \cdot g^{-1}$.

4. Conclusion

In summary, transportation of fruit at 0℃with CPP had profound effects on preventing weight loss, maintaining fruit color, firmness and nutritional values at acceptable levels. Thus, the right packaging coupled with the right storage temperature can contribute to create conditions in the package which will delay quality loss and ageing of fruit.

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