Effects of Household Preservation Methods on Maintaining Quality of Peach After Forced-air Cooling, Low Temperature Transportation and Retailing

Lijun Sun\textsuperscript{1,2}, Sheng Liu\textsuperscript{1,2*}, Zhongyang Fan\textsuperscript{1}, Yan Li\textsuperscript{1,2}, Junyan Wang\textsuperscript{1}, Xiaoming Duan\textsuperscript{1}

1. Vegetable Research Center, Beijing Academy of Agriculture and Forestry Sciences, National Engineering Research Center for Vegetables, Beijing Key Laboratory of Fruits and Vegetables Storage and Processing, Key Laboratory of Urban Agriculture (North), Ministry of Agriculture, Key Laboratory of Vegetable Postharvest Processing, Ministry of Agriculture. Beijing, 100097, P.R.China
E-mail: liusheng@nercv.org

2. Shanghai Ocean University, Shanghai, 201306, P.R.China
E-mail: 15921386021@163.com

Abstract: In order to evaluate the effects of different household preservation methods on maintaining the fruit quality of the ‘Okubao’ peaches, fruits were either stored in domestic refrigerator at 4℃ or room temperature (20℃) wrapped or unwrapped using 35 μm anti-fogging cast polypropylene (CPP). Physical and chemical changes were recorded each day during household preservation. The results demonstrated that wrapped peach placed in domestic refrigerator scored highest in sensory quality with retardation of discoloration and softening. Soluble solid and soluble sugar content decreased over time as did the amount of titratable acidity. Weight loss of fruit was reduced tremendously by refrigerator combined with CPP. Fruits almost developed soft flesh on first day at 20℃, by this time, fruits at refrigerator successfully overcame the problem and extended the period before the fruits became over-soft.

Keyword: ‘Okubao’ peach; Household preservation; Refrigerator; Room temperature; Package

1. Introduction

Melting flesh peaches undergo rapid ripening and senescence after harvest, therefore perishable peach fruits need proper temperature-controlled environments from the point of supply to the point of consumption to ensure fruit quality and maximize their postharvest life \cite{1}, \cite{2}. Correct temperature management is important for the consumer as well. Laguerre O, et al. \cite{3} found the normal distribution of air temperature in domestic refrigerators is 6.62±2.56℃. Previous studies also reported that the temperature in domestic refrigerators was often too high, which leads to quality loss at home \cite{3}-\cite{6}.

CO2 concentrations were very high and O2 concentrations very low in packages after keeping them for more than 9.5 h at 22℃ probably due to the very high respiration rate with the danger of causing anaerobic respiration, as 0℃, 90% relative moisture, 1-2% O2, 3-5% CO2 is recommended as the optimum storage condition for peach \cite{7}. Thus, consumers should keep the packages in refrigerated shelves if it is kept for more than 10 h at room temperature \cite{8}, in agreement with results in loquat fruit, which indicated that the high temperature (20℃) sustained severe decay, and 20 μm thickness PE package hastened the decay. Bagging loquats at 5℃ resulted in the highest scores for appearance and chemical compounds \cite{9}. Therefore, the beneficial effects of package have to be combined with low-temperature storage. It has been reported that poor temperature control can lead to the deterioration of the packaged product due to increase in product metabolism and growth of spoilage organisms \cite{1}.

In summary, consumers need to realize the importance of maintaining cold chain fruits at the recommended temperature in the home to reduce the quality loss. The objectives of this investigation were to indicate possible benefits and limitations for package based on domestic refrigerator and room kitchen. Second, evaluate the general physiological and biochemical responses of peaches to the different simulated household conditions.

2. Materials and methods
2.1. Fruit harvest, treatment and storage conditions

‘Okubao’ peaches were harvested from a commercial orchard in Beijing, China, and transported by ventilated car to the laboratory, where they were sorted for uniform size, appearance and without any damage. The fruits, after selection, were immediately forced-air cooled to 5°C followed by 3 days transportation at 0°C in 35 μm anti-fogging cast polypropylene (CPP) package, and subsequently refrigerated retail display at 0°C for 3 days prior to household preservation.

In order to simulate household conditions, after postharvest transport and sailing, the samples were subjected to the following treatments: T1= fruits were placed at 20°C to simulate kitchen countertop condition (control); T2= fruits were placed at 20°C packaged in CPP (20°C+CPP); T3= fruits were placed in a standard home refrigerator at 4.0°C; T3= fruits were placed in a standard home refrigerator at 4°C with CPP package (4°C+CPP).

2.2. Weight loss and sensory quality

Weight loss was expressed as percentage of fresh weight against initial weight.

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 and firmness

A CR-400 colorimeter was used to measure the ground color, recording the data in L*, a* and b* parameters. Hue values were calculated as $h^\circ = \arctan (b^*/a^*)$ when $a^* > 0$ and $b^* > 0$. Chroma was expressed also as $C^* = (a^*2 + b^*2)^{1/2}$.

Firmness of the mid center of one peeled cheek per fruit was measured with a penetrometer (TR-FT327, Italy) equipped with a 5-mm diameter plunger tip. The results were expressed as Newton (N).

2.4. Soluble solids content (SSC), total titratable acidity (TA) and Soluble sugar content

Soluble solids content (SSC) and titratable acidity (TA) were measured with a hand-held refractometer (Atago Co.Ltd., Tokyo, Japan) and 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·L⁻¹ NaOH, respectively. The latter was expressed as percent malic acid basis.

Soluble sugar content was determined according to the method of Cao JK et al., (2013) [11] using anthrone reagent and sucrose glucose as the standard.

2.5. Extraction and measurement of ascorbic acid concentrations

Ascorbic acid content was determined by molybdenum blue colorimetric method according to the method of Li (2000) [12].

2.6. Statistical analysis

All statistical analyses were performed with SPSS 19.0. Data were analyzed 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 and discussion

3.1. Sensory evaluation and weight loss

![Sensory evaluation and weight loss](image)

Fig. 1. Sensory evaluation (a) and weight loss (b) of ‘Okubao’ peaches during household preservation at 4°C+CPP, 4°C, 20°C+CPP, 20°C following transportation and retailing at 0°C. Vertical bars represent ±SE.
The sensory evaluations of peach in the different household conditions were shown in Fig. 1a. The appearance of wrapped fruits remained more acceptable at refrigerated domestic storage, while those packaged in CPP bags at 20°C had high incidence of decay during 3 days preservation (data not shown). The fruits at refrigerated domestic storage scored a value higher than 7.5 and maintained a higher quality and minimal risk of decay development. The flavor and taste after the third day was poor and unacceptable for peaches at 20°C, especially in CPP bags probably due to the anaerobic respiration at high temperature.

Differences in the weight loss between fruit stored at different household conditions were also observed, with higher values in fruit stored at 20°C, which lost above 3% at day 3 (Fig. 1a). The packaging material contributed to significant decrease in weight loss compared with the unpackaged samples, regardless of temperature (P<0.01). The same trend was that weight loss of fruit stored in refrigerator was significantly less (P<0.01) than those at room temperature. The combination of packaging material and low temperature contributed to the wholesomeness of the fruit, with no sign of wrinkles at all.

3.2. Color

![Chromaticity values of 'Okubao' peaches during household preservation at 4°C+CPP, 4°C, 20°C+CPP, 20°C following transportation and retailing at 0°C. Vertical bars represent ±SE. As can be seen, the wrapped peach at refrigerator of 4°C had the highest L*, h° and C* values of 45.9, 32.8 and 31.8 respectively, after 3 days preservation. High storage temperatures significantly reduced L*, h° and C* values, the skin of unwrapped peaches at 20°C being dark red, as would be expected from faster ripening at warm temperature.

3.3. Firmness, SSC, TA and soluble sugar contents

In simulated kitchen countertop condition, peaches rapidly softened and the firmness decreased quickly. After the third day of preservation, firmness decreased to 7.9 N and was only 21.5% of the initial value. Treatments with domestic refrigerator preserved significantly higher firmness than did kitchen countertop conditions (P<0.05), showing the values of 29.5 N and 28.0 N respectively in wrapped or unwrapped fruits on day 3. Packaged fruits preserved significantly higher firmness than did unpackaged peaches (P<0.05).

The SSC value, which was initially 11.5%, was found to be 9.1% and 9.3% respectively in wrapped and unwrapped fruits at 20°C, 10.4% and 9.7% respectively in wrapped and unwrapped fruits at refrigerator conditions. Total acidity at the beginning of preservation was 0.153%, which decreased to 0.138% to 0.140% under domestic refrigerated conditions after 3 days. The lowest TA value was observed from kitchen countertop condition without package (0.117%).

Domestic refrigerator significantly kept the soluble sugar content values as compared to high room temperature. A more pronounced effect in packaged fruits than conventionally stored fruit was found. After 3 days period, the maximum (7.4%) was recorded in packaged fruits at refrigerator, followed by unpackaged fruits.
at the same condition (7.1%). The minimum soluble sugar content (6.5%) was observed in control fruits, followed by packaged fruits.

![Graphs](image)

Fig. 3. Firmness (a), SSC (b), TA (c) and soluble sugar contents (d) of ‘Okubao’ peaches during household preservation at 4°C+CPP, 4°C, 20°C+CPP, 20°C following transportation and retailing at 0°C. Vertical bars represent ±SE.

3.4. Ascorbic acid concentration

![Graph](image)

Fig. 4. Ascorbic acid concentration of ‘Okubao’ peaches during household preservation at 4°C+CPP, 4°C, 20°C+CPP, 20°C following transportation and retailing at 0°C. Vertical bars represent ±SE.

Ascorbic acid concentrations decreased over time and were higher at domestic refrigerator (0.43 to 0.46 mg·g⁻¹) than at kitchen conditions (0.31 to 0.33 mg·g⁻¹) (P<0.005). After the third day of preservation, ascorbic acid concentrations of peach fruits declined extensively at kitchen conditions and reached 48.9% and 52.5% of initial value (0.62 mg·g⁻¹), respectively, while only 26.5% and 31.5% reduction under domestic refrigerated conditions.

4. Conclusion

The results demonstrated the importance of storage temperature and package. All domestic refrigerated treatments had minimal weight loss, delayed the postharvest deterioration and significantly retained SSC, TA, soluble sugar content and ascorbic acid concentration, with low temperature combined with CPP being most effective. Fruits stored at high temperature (20°C) sustained severe decay. In summary, packaging with CPP (35μm thick) is a simple and effective method for maintaining the visual quality, and storage temperature was very important for peach fruit in package.
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Corresponding author: Sheng LIU

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