Short Report

Effects of Storage Temperatures and Oxygen Supplementation on Reducing Titratable Acid in ‘Ruby Star’ Passionfruit

(Passiflora edulis × P. edulis f. flavicarpa)

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Introduction

Purple passionfruit (Passiflora edulis Sims) have an aromatic juice with high sugar and acid contents (HIU and SCHEUER, 1961). The fruit is consumed as a juice or jelly. Fresh purple passionfruit are highly marketable because the juice contains many vitamins (PRUTHI, 1963).

Cultivation of purple passionfruit is most suited to the subtropical regions (MORTON, 1987). However, this fruit can be grown in the frost-free areas of Tokyo, Kagoshima and Okinawa Prefectures. In 1995, the domestic production of purple passionfruit was 320 t from 56 ha (ISHIHATA, 2000a).

The ‘Ruby Star’ passionfruit, a hybrid between purple passionfruit and yellow passionfruit (P. edulis f. flavicarpa Degener), produced in southern Japan is shipped as a fresh fruit since the fruit skin has an attractive purple color. The main post-harvest problems in maintaining high quality fresh ‘Ruby Star’ passionfruit are their shrinkage and high acidity. The acid levels in the fresh fruits affect their flavor and acceptability. High acid contents in the fruit reduce the commercial value. The shrinkage of fruit can be prevented by sealing the stem end (ISHIHATA, 2000b), but there has been no report on how to reduce the acidity of this juice. The object of this study was to investigate the effects of temperature and oxygen supplementation during storage on reducing the acidity of ‘Ruby Star’ passionfruit before shipping.

Materials and Methods

‘Ruby Star’ fruits were obtained from the vines grown in a plastic house at Ibusuki, Kagoshima Prefecture. The harvested fruits were promptly packed in a corrugated cardboard box and transferred to the Department of Citrus Research, National Institute of Fruit Tree Science (Kuchinotsu) in Nagasaki Prefecture via a shipping agency truck. The temperature during the transportation was kept at 5°C. It took 2 or 3 days to arrive. The surfaces of the fruits were wiped with a clean, damp towel before storage. Three storage rooms (1.65 m × 0.75 m × 2.0 m, Tokyo Reinetsu Co., Ltd. FHL series), originally designed for low temperature storage of citrus fruit, were temperature controlled at 1°C (95 ± 3% RH). A 7 m³ oxygen-gas cylinder supplied oxygen to each storage room. The oxygen supply was controlled by adjusting a valve, and the oxygen level was monitored by a pocket oxygen alarm (Model OX51, Yokogawa Electric Co., Ltd). The relative humidity was monitored by a Humidity and Temperature Indicator (HMI41, Vaisala). Each storage room had a ventilation hole that was 4 cm in diameter and 20 cm from the ground. Both oxygen level and relative humidity were measured via the ventilation hole.

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Effect of temperature

Experiment 1: Forty mature reddish purple fruits were harvested on July 5, 2003, and transferred to the Department of Citrus Research. The fruits arrived on July 7, and each fruit was weighed immediately. The juice was obtained by squeezing pulps from each of ten fruits selected randomly. These were measured for soluble solids concentration (SSC) with a refractometer and for titratable acidity (TA) by titrating a 2ml sample of juice with 0.156N NaOH to a phenolphthalein end point. The acidity was expressed as percentage of citric acid. The remaining 30 fruits were divided into three groups of 10 fruits which were transferred to a 20, 25 or 30°C storage room. The percentage weight loss, SSC and TA of the juice were determined after 7 days at every storage temperature.

Experiment 2: Eighty mature fruits were harvested on August 11, 2003 and each of them was weighed after 2 days. Twenty fruits were used to determine SSC and TA of juice with the same method as in experiment 1. The remaining fruits were divided into three groups of 20 fruits and each group was kept at a 15, 20 or 25°C storage room. After 5 and 10 days in storage, 10 fruits from each storage room were individually assessed for percentage weight loss, SSC and TA.

Effect of oxygen supplementation

Seventy mature fruits harvested on July 14 and 70 mature fruits harvested on July 25 were served for this experiment. Both these fruits were individually weighed after 3 days from harvest, and then 10 fruits of them were used for determining SCC and TA in juice. The remaining fruits were divided into three groups of 20 fruits and each group was stored at three different oxygen levels, 20.9% (control), 23.0%, 29.0%. The temperature during storage was kept at 20°C for the fruits harvested on July 14 and 15°C for those on July 25. After 5 and 10 days in storage, ten fruits were randomly selected and used for determining the percentage weight loss, SCC and TA at each oxygen level.

Results and Discussion

Effect of temperature

SSC of the juice was not affected by storage temperature in experiment 1. The value was a 16.5% at each storage temperature (data not shown). Fruit weight loss was significantly (Tukey’s test p<0.01) greater at the higher temperatures (Fig. 1). TA before storage was 3.1% and it decreased to 2.3%, 2.1% and 2.4% after 7 days storage at 20, 25 and 30°C, respectively (Fig. 1). Fruit shrinkage was not observed at any temperature level (data not shown) but some decay was observed at 30°C storage (data not shown).

In experiment 2, the TA of the juice after 5 days storage was significantly (Tukey’s test p<0.05) lower at 25°C than at 15 or 20°C, but after 10 days storage the content at 20 and 25°C was significantly lower than that at 15°C (Fig. 2).

HASINAGA et al. (1978) reported that the acid content of purple passionfruit is 4.12% for unripe fruit and 1.52% for ripe one, and PRUTHI (1963) reported that the average acid content of purple passionfruit was 3.4%. In the present study, the

![Fig. 1. Effect of storage temperatures in titratable acid content and percentage of fruit weight loss in 'Ruby Star' passionfruit after 7 days storage. Values are averages of 10 fruits. Vertical bars indicate SE (n=10).](image)
TA of the fruit before storage was similar to PRUTHI’s report, but it was too high for freshfruit marketing. The suitable acid content is about 2% for marketing. In this experiment, the suitable acid content was obtained by keeping fruits at 20, 25, 30°C for 7 days or 10 days.

Since there was some decay observed at 30°C storage (data not shown), and reduction of the TA was smaller at 15 and 30°C than at 20 or 25°C, a pre-shipping conditioning treatment at 20-25°C with high humidity is recommended for decreasing the TA in ‘Ruby Star’ passionfruit.

**Effect of oxygen supplementation**

Of the fruit kept at 20°C, SSC was not affected by oxygen supplementation and the value was a 16.0% at each oxygen level (data not shown). The ratio of fruit weight loss tended to be greater with increase in oxygen level but no significant difference was found among the levels (data not shown). TA before storage was 2.9% and it decreased to 2.4%, 2.1% and 2.0% after 10 days storage at oxygen levels, 20.9%, 23.0%, 29.0%, respectively (Fig. 3). TA was significantly (Tukey’s test p<0.05) lower in fruit supplemented with oxygen than that of the control after 10 days storage, but increasing the oxygen level did not affect the reduction in TA. Fruit shrinkage was not observed at any oxygen level (data not shown).

Of the fruit kept at 15°C, TA after 5 days storage was not significantly different between the oxygen levels, but it was significantly (Tukey’s test p<0.05) lower in fruit supplemented with oxygen than that of the control at 10 days storage. Fruit shrinkage was not observed at any oxygen level (data not shown).

![Fig. 2. Effect of storage temperatures in titratable acid content and percentage of fruit weight loss in ‘Ruby Star’ passionfruit after 5 and 10 days storage. Values are averages of 10 fruits. Vertical bars indicate SE (n=10).](image)

![Fig. 3. Effect of oxygen supplementation on reducing titratable acid contents of ‘Ruby Star’ passionfruit during 10 days storage at 15 and 20°C. Values are averages of 10 fruits. Vertical bars indicate SE (n=10).](image)
p<0.05) lower in the fruit with oxygen supplementation after 10 days storage (Fig. 3). Increasing the oxygen level did not affect the reduction in the TA (Fig. 3). The SSC in the juice was not affected by oxygen supplementation at 15 °C and the value was 16.9% at each oxygen level (data not shown). Fruit shrinkage was not observed at any oxygen level (data not shown).

In conclusion, Temperatures over 20°C are effective for reducing TA but fruit weight loss is much greater at a temperature over 25. Furthermore, fruit decay occurs at 30°C. Therefore, 10 days of pre-shipping conditioning treatment at 20 °C (95% RH) with oxygen supplementation (23% oxygen level) is recommended for reducing the TA of ‘Ruby Star’ passionfruit with high TA at harvest.

References


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