

การประเมินคุณภาพหลังเก็บเกี่ยวของผลเสาวรสที่ปลูกในนิงาตะ
Postharvest quality evaluation of passion fruit produced in Niigata

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Abstract

The changes of postharvest quality during passion fruit (*Passiflora edulis* Sims) senescence were studied. Commercially mature (natural drop) passion fruit were harvested from a greenhouse in Murakami city, Niigata prefecture and then stored at 25°C, 85%RH in a controlled chamber. Passion fruit were determined for their chemical properties depending on the degree of wrinkle on fruit surface; normal fruit (no wrinkle), less than 40 percent, at 50 percent and 100 percent (wrinkle). The results showed that titratable acidity (TA), potassium content (K) and fruit weight decreased upon the increasing of fruit wrinkle. Passion fruit at 100 percent wrinkle on the whole surface had lower titratable acidity, potassium content and fruit weight than those of normal fruit. In contrast, total soluble solids (TSS)/TA ratio notably increased with wrinkle incidence while unchanged notes were found in percentage of edible part, TSS and vitamin C content during fruit senescence.

Keywords: passion fruit, chemical properties, fruit wrinkle

บทคัดย่อ

การศึกษาการเปลี่ยนแปลงคุณภาพหลังเก็บเกี่ยวของผลเสาวรระหว่างการผลิต โดยนำผลเสาวรที่มีความแก่ทางการค้า (การร่วงตามธรรมชาติ) จากโรงเรือนในเมืองมูราคามิ จังหวัดนิงาตะมาเก็บรักษาที่อุณหภูมิ 25 องศาเซลเซียส ความชื้นสัมพัทธ์ 85 เปอร์เซ็นต์ วิเคราะห์การเปลี่ยนแปลงคุณภาพทางเคมีตามระดับความเหี่ยวของผล ได้แก่ ผลปกติ ผลเหี่ยว น้อยกว่า 40 เปอร์เซ็นต์ ผลเหี่ยว 50 เปอร์เซ็นต์ และผลเหี่ยว 100 เปอร์เซ็นต์ พบว่า ปริมาณกรดทั้งหมดที่ไทเทรตได้ ปริมาณโพแทสเซียมและน้ำหนักของผลเสาวรลดลงเมื่อผลเหี่ยวเพิ่มขึ้น โดยผลเสาวรที่เหี่ยว 100 เปอร์เซ็นต์ มีปริมาณกรดทั้งหมดที่ไทเทรตได้ ปริมาณโพแทสเซียมและน้ำหนักน้อยกว่าผลปกติ ในทางกลับกันอัตราส่วนของปริมาณของแข็งทั้งหมดที่ละลายน้ำได้ต่อปริมาณกรดทั้งหมดที่ไทเทรตได้ (TSS/TA ratio) มีค่าเพิ่มขึ้นตามการเหี่ยวของผล ในขณะที่ร้อยละส่วนที่บริโภคได้ ปริมาณของแข็งทั้งหมดที่ละลายน้ำได้และปริมาณวิตามินซีมีค่าไม่เปลี่ยนแปลงระหว่างการผลิตของผล

คำสำคัญ: เสาวร, คุณภาพทางเคมี, การเหี่ยวของผล

Introduction

Passion fruit or granadilla (*Passiflora edulis* Sims.), a woody perennial vine with spherical-shaped fruit filled the central cavity with numerous hard black seeds surrounded by yellowish aromatic soft pulp attached to small peg-like outgrowths on the fruit wall (Chavan and Kadam, 1995). Due to its respiration characteristic, ethylene production and ethylene respond, passion fruit is classified as a climacteric fruit (Shiomi *et al.*, 1996). Its juicy pulp is a good source of ascorbic acid (vitamin C), phenolic acids and carotenoids (pro-vitamin A) that literary known as antioxidants which exhibit high level of radical scavenging activity and inhibit oxidative damage (Zeraik *et al.*, 2011). A mixture of organic acids and other vitamins greatly distribute desirable aroma and flavor

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which attract to consumers as drinks and desserts. However, after harvest, passion fruit physico-chemical quality easily changes due to its high level of water losses and ethylene responses that induce exocarp shriveling and pulp fermentation (Casimir *et al*, 1981; Shiomi *et al*, 1996; Zeraik *et al.*, 2011). For postharvest practices, room cooling and forced-air cooling are recommended prior cold storage operation in order to extend storage life. Purple passion fruit is a chilling tolerant and can be stored at 3 to 5°C for 21 to 35 days (Wills *et al*, 1982; Arjona and Matta, 1992).

The place of origin of passion fruit is the southern part of Brazil. Thus, this tropical fruit can be well cultivated in warm weather regions. In Japan, recently, passion fruit is grown in Kagoshima and Okinawa prefectures where the weather considered the warmest areas. However, the cultivating scale is not as large as other fruit due to its unrecognized commodity among consumers and considered high price per fruit unit. Nonetheless, Kaisei In-cooperation launched the agro-tourism in Murakami city, Niigata prefecture by building and expanding a number well-controlled greenhouses for tropical fruit production especially passion fruit and dragon fruit. The company tries to focus on fruits' advantages i.e. good productivity for whole year supplies, fruit price, high quality of fresh fruit and processed products, and future market shares. Therefore, the ultimate aim of this study was to evaluate passion fruit postharvest quality and study the changes of physico-chemical properties during fruit senescence.

Materials and methods

Purple passion fruit at commercial maturity (natural drop) were harvested from a greenhouse in Murakami city, Niigata prefecture (January, 2011). The fruit were produced under imitated-tropical weather model with heat pump and shading systems. Then they were transported to Agricultural Systems Engineering Laboratory, Niigata University. Passion fruit were then stored at 25°C, 85%RH in a controlled chamber. And sampled fruit were at every 4 stages of senescence which was determined by the degree of wrinkles on fruit surface; no wrinkle (normal fruit), 1 - 40%, 41 - 50% (half wrinkle) and 51 - 100% (full wrinkle). The sampled fruit at different degrees of wrinkle were determined for the total soluble solids (TSS) by refractometer (ATAGO model PR-1010 α), titratable acidity (TA) and vitamin C content by refractometer (MERCK model RQflex plus10), TSS/TA ratio, potassium content by atomic absorption spectrophotometer (Hitachi model Z-2000), fruit weight and edible part.

Results

The changes of chemical property studies showed the decreasing trend in titratable acidity of passion fruit juice. Normal fruit and fruit with fewer wrinkles had higher titratable acidity than fruit with half and full wrinkle. Besides, potassium content was also found higher amount in normal fruit than those of fruit with wrinkle incidences. However, unchanged contents were found in total soluble solids and vitamin C during passion fruit senescence. On the other hand, TSS/TA ratio showed significant increase during the wrinkle development and reached the highest ratio in fruit with full wrinkle (Table 1).

In case of physical evaluation, fruit fresh weight decreased upon the degree of wrinkle. Passion fruit had about 40% moisture loss during senescence process. The rapid decrease was found when fruit developed wrinkle from 50% up to full wrinkle. Nonetheless, percentage of edible part had no significant difference among the degrees of wrinkles (Figure 1).

Table 1 Comparative study on chemical properties of passion fruit during fruit senescence

Degree of wrinkle	Titrateable Acidity (TA) (%)	Total Soluble Solids (TSS) (%)	TSS/TA ratio	Vitamin C content (mg/100 gFW)	Potassium content (K) (mg/100 gFW)
0% (normal fruit)	3.73±0.23 ^a	17.73±0.12	4.83±0.34 ^b	23.63±0.70	591.10±24.38 ^a
1 - 40%	3.30±0.20 ^a	17.47±0.18	5.33±0.32 ^b	27.50±0.92	507.77±9.09 ^b
41 - 50%	2.00±0.25 ^b	18.30±0.25	9.57±1.52 ^{ab}	27.00±1.55	503.33±5.11 ^b
51 - 100%	1.50±0.35 ^b	17.85±0.38	13.85±2.71 ^a	26.63±1.60	499.18±5.51 ^b
C.V. (%)	20.5	2.9	28.4	9.3	4.3
LSD _{0.05}	0.93	0.92	6.06	4.35	40.36

Means with different letters within columns differ significantly (P<0.05)

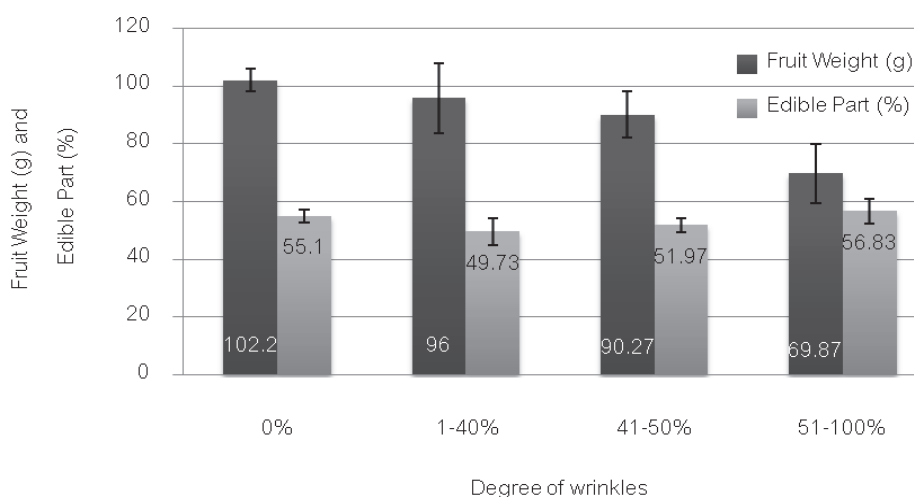


Figure 1 Fruit weight and percentage of edible part of passion fruit at 4 degrees of wrinkle incidences

Discussion

Passion fruit juice contained high titrateable acidity which had over 3.73% when fruit reached their fully ripe. The total acids steadily decreased until fruit reached 100% shriveling. At last, passion fruit juice contained total acids less than half of the initial amount (Table 1). Organic acids found in purple passion fruit normally distributed among citric acid, malic acid and lactic acid. These acids appeared increased during ripening stage and gradually decreased after postharvest ripening (off-vine) that caused by the inactivation of citrate synthase and aconitase together with the acid metabolism themselves (Chan, 1980; Shiomi *et al.*, 1996; Saradhuldhath and Paull, 2007). In case of potassium content, purple passion fruit had high amount of potassium and calcium especially at the end of ripening stage (Vanderplank, 1991). In this study, the content slightly decreased and remained constant until passion fruit reached their full wrinkle. Potassium is an important nutrient which accumulated during fruit development and maturity in order to prevent premature falls and shrivels (Chan, 1980; Vanderplank, 1991). Thus, the higher potassium content was reasonably found in normal fruit than in senescing one.

During fruit senescence, total soluble solids and vitamin C content tended to be stable until fruit had full wrinkle. The similar trends of these changes were reported during storage of purple passion fruit (Shiomi *et al.*,

1996) and Japanese apricot (Inaba and Nakamura, 1981). The decline in titratable acidity and the stable in total soluble solids effected TSS/TA ratio. The ratio dramatically increased upon the degree of wrinkle. Commercially, the ratio is regarded as the most reliable measure of fruit flavor (Saradhulhat and Paull, 2007). Shiomi *et al.* (1996) reported that eating quality improves mainly due to a decrease in organic acids with the insignificant change in total soluble solids.

At all degrees of wrinkle, fruit fresh weight gradually decreased in weight loss, however, the rapid decrease was found when fruit developed wrinkle symptom from 50% to full wrinkle. Still, percentage of edible part had no significant difference among the degrees of wrinkle (Figure 1). Purple passion fruit lost weight fast and became shrivel under ordinary storage condition. Nonetheless, higher moisture loss was usually found in fruit peels rather than in pulps, hence fruit peels appeared wrinkled and became unacceptable (Pruthi, 1963; Shiomi *et al.*, 1996).

Summary

Purple passion fruit lost titratable acids, potassium content and fruit fresh weight during senescence while TSS/TA ratio increased. However, total soluble solids and vitamin C content were not affected by the process.

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