Effects of Hot Water, Submergence Time and Storage Duration on Quality of Dragon Fruit (*Hylocereus polyrhizus*)

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Abstract

This study was conducted to determine the effects of hot water temperature, time of submergence and storage duration on dragon fruit *(Hylocereus polyrhizus).* Fresh harvested dragon fruits were treated with hot water temperatures at 35, 45 and 60 °C and time of submergence for 15, 30 and 60 minutes for 0, 5, 10 and 15 days of storage. The result showed that the hot water temperature significantly affected ($p<0.05$) the percentage of weight loss, titratable acidity (TA) and firmness of dragon fruit. The highest percentage of weight loss (12.80 %) was the fruit treated with hot water at 60˚C and submergence for 60 minutes whereas the lowest percentage of weight loss (5.05 %) was the fruit treated with hot water at 35 ˚C for 60 minutes. Dragon fruit treated with hot water at 35 ˚C has high percentage of TA, 2.44 %. Fruit which was submergence in hot water at 35 ˚C showed the highest fruit firmness. The result also showed that the interaction between the three factors significantly affected ($p<0.05$) the percentage of weight loss, TA and pH of the fruits. TA decreased and pH increased for the fruit treated with hot water at 35 ˚C and submergence for 60 minutes. The interaction between hot water temperature at 35 ˚C and time of submergence for 60 minutes effectively reduced the weight loss and acidity of the dragon fruit ($p<0.05$). The shelf life and quality of dragon fruits can be extended using proper submergence time of hot water treatment.

Keywords: Dragon fruit, Hot water temperature, Submergence time, Postharvest produce

1. Introduction

Dragon fruit (*Hylocereus* spp.) has an attractive color and shape and is rich in fiber, vitamin C and minerals (Morton, 1987). It also has phytoalbumins which are highly valued for their antioxidant properties. It has less sugar content than most popular tropical fruits, and thus is more suitable to diabetics and high blood pressure patients. These attributes have led people to consider it as a health fruit and this is one of the reasons why it commands a premium price (Le *et al*., 2000).

Locally, fruits are sold mainly for fresh consumption. The deterioration of physical appearance and damages due to disease attacks on fruits after keeping for a few days under ambient conditions could render losses in value and spoilage. These losses are costly to retailers for such a high valued fruit. There is growing demand for dragon fruit in nearby countries such as China, Hong Kong and Singapore. It has good potential to be exported to European countries, as they like its taste.

Hot water treatments of fruit following harvest have been demonstrated to protect horticulture produces against post harvest decay (Wills *et al*., 1989, Lurie, 1998, Ferguson *et al*., 2000, Fallik *et al*., 2001, Vicente *et al*., 2002, Lana *at al*., 2005, Ho *et al.,* 2006). The mode of action of the hot water treatments may be through the impact of the heat to kill the pathogens directly or indirectly on horticulture produces (Lurie *et al*., 1996). Heat treatment technologies are currently a relatively simple, non-chemical alternative to methyl bromide that can kill quarantine pests in perishable commodities, as well as control some post harvest diseases. Unlike methyl bromide, heat treatments do not pose significant health risks from chemical residues and, as a result, are more appealing to consumers than methyl bromide fumigation (Irtwange, 2006).

This study was focused on the postharvest handling on the shelf life of dragon fruit using hot water treatment.

Increasing its shelf life not only reduce spoilage locally but also augers well for marketing it overseas. The objective of the present study was to determine the effects of hot water temperature, submergence time and storage duration on the physical and chemical quality of dragon fruit.

2. Materials and Methods

2.1 Plant materials

Dragon fruits with maturity index of 4, undamaged, free from apparent pathogen infection and were uniformed in shape; weight and color were selected and harvested from Luyang, Sabah, and carefully transported to Laboratory, Universiti Malaysia Sabah, Malaysia. When arrived, the fruits were washed with distilled water and dried.

2.2 Hot water treatment

The dragon fruits were submergenced in temperature-controlled water bath with different hot water temperatures and time of submergences. The hot water temperatures used in this study were 35 °C, 45 °C and 60 °C, and the time of submergences were 15, 30 and 60 minutes.

2.3 Storage duration

All treated and untreated dragon fruits were stored at 25 °C for 5, 10 and 15 days.

2.4 Quality assessments

The percentages of weight loss of dragon fruits were determined after the storage durations. Soluble solid concentrations of the fruits were determined using a refractometer. Titratable acidity of the fruit was determined through titration method. The pH of the fruit was measured by pH meter, and the firmness was determined using a penetrometer.

2.5 Data analysis

Each treatment was applied to three replicates of three fruits per each. Analysis of variance (ANOVA) of Statistics package for Science Social (SPSS) was conducted to determine the differences between each treatment.

3. Results and Discussion

3.1 Effect of hot water temperature, time of submergences and storage period on fruit weight loss

The percentage of weight loss in dragon fruit was increased significantly ($p<0.05$) as the hot water temperature (Figure 1) and storage period (Figure 2) increased (Table 1). This is the natural characteristic for horticulture commodity. When the fruit is harvest, it no longer depends on its root system. Therefore, water loss in fruit cannot be replaced from the root (Pantastico *et al*., 1995). Weight loss in guava fruit also increased when the storage period from day one to day eight (Renato *et al*., 2005).

Longer submerging time will cause the water to enter the fruit cells and results the cells will full with water. Thus, the fruit weight will increase and the fruit weight lost percentage will decrease. The interaction between hot water temperature and the period of submerging will also influence the weight loss of dragon fruit. Fruit that submergence for 60 minutes at 60 °C has the highest weight loss percentage (15.06 %). High temperature is the cause of the high weight loss (Smock *et al*., 1977).

3.2 Effect of hot water temperature, time of submergences and storage period on fruit soluble solid concentration

The soluble solid concentration of fruit was increased significantly ($p<0.05$) as the storage period increased (Table 1; Figure 3). SSC of dragon fruit has showed increment from day 0 to day 15, from 8.88 % °Brix to 12.75 % °Brix (Figure 3). Dragon fruit at ripeness index 4 is a fruit that has encountered ripeness ranking from 31 to 32 days. At 25 to 30 days after blooming, SSC will increase to approximately 14 % °Brix (Nerd *et al*., 1999; Le *et al*., 2000). SSC has decreased from day 15 to day 20. Decreasing of SSC in fruit is because of the absence of starch to convert into sugar (Dull, 1971). Sugar content in fruit is come from the whole fruit (Rohrbach *et al*., 2003).

There were relationship among soluble solid, titratable acid and fruit pH. For 5 days storage period, soluble solid content increased, percentage of titratable acid decreased and pH value increased. High soluble solid in fruit is because of there was plenty of starch in fruit to convert into sugar. High sugar content will cause fruit acid content decrease and the pH value will increase.

3.3 Effect of hot water temperature, time of submergences and storage period on fruit titratable acid

Titratable acid found in fruit is citric acid. Citric acid is produced and used during fruit maturity process. This study has showed titratable acid percentage will decrease when submergence at temperature 35 °C to 45 °C

(Figure 4). The percentage of titratable acid has decreased after treating with hot water and this result is similar to other fruits such as apple, grape and tomato studied by Vicente *et al*. (2002). Titratable acid in dragon fruit was also descending as the storage period increased (Figure 5). Long storage period will cause decrease in titratable acid in dragon fruit. Process of converting starch into sugar also may cause the decrease in titratable acid in fruit. Descending in titratable acid was caused by temperature that increase the respiration rate will therefore using the organic acid as substrate for respiration process (Vicente *et al*., 2002).

3.4 Effect of hot water temperature, time of submergences and storage period on fruit pH

The pH value decrease as the time of submergences increased (Figure 6). Even though the respiration rate is low inside the fruit, prolong submerging and storing period will also cause changes to the level of organic acid (Echeverria dan Valich, 1988). Vacuolar ATPase (V-ATPase) and vacuolar phyrophosphatase (V-PPase) catalyze translocation of electrogenic H^+ from cytosol to lumen vascular to produce acid pH inside fruit, and this activity is important in production of energy during acid descending inside fruit (Marsh *et al*., 2001). Dragon fruit soaked for 15 minutes at 60°C will have high pH value compare to those at 35 and 45 °C. Treatment at high temperature will cause severe damage on fruit respiration metabolism, thus descending in respiration rate (Lurie, 1998). When, the respiration rate descending, the H^+ ion become respiration energy source will be low. Low in H^+ ion will have high pH value. The fruit submergence in hot water at 35 and 45 °C has high pH value (Figure 6). High pH value is because of low H^+ ion inside the fruit. Free H^+ ion is an important source for respiration energy inside plant cells (Smock *et al*., 1977).

The pH value also showed increase as prolong the storage period (Figure 7). The pH value increased as the storage period prolongs (Wills *et al*., 1989). The pH value increased is because of the increase of microbial population inside the fruit (Zhou *et al*., 2006). Fruit submergence for 15 minutes has showed high pH value for 5 days storage. This is also because of low in H^+ ion inside the fruit. Even for that submergence for 30 minutes also showed increment in pH value for storage from zero days to day 10. Prolong submerging and storage period caused the respiration rate inside the fruit descending and increase in pH value. The pH value increase as the storage period prolongs (Wills *et al*., 1989).

3.5 Effect of hot water temperature, time of submergences and storage period on fruit firmness

Increasing of hot water temperature and storage period has showed decrease in dragon fruit firmness significantly (Table 1; Figure 8). Disturbance in cell structure and membrane damaged on fruit which soaked in high water temperature will be the source of decreasing in fruit firmness (Wills *et al*., 1989). Longer time of submergence and storage period also showed decreasing in fruit firmness (Figure 9). Fruit structure will decline when long storage period (Rohrbach *et al*., 2003). The results showed that fruit submergence for 15 and 30 minutes will decrease in firmness. However, when the fruit submergence for 60 minute, fruit firmness will increase as the storage period longer (Figure 9). Normally, long submerging time will cause the water to go into the fruit cells and the fruit become soft. But, reverse reaction occurred when submerging for 60 minutes. This may due to vary of factors such as surrounding environment before harvesting, physiology age of a commodity and plenty more (Luria, 1998). ‘Eldorado’ pir still maintain its firmness although has store for a long period (Wang *et al*., 1985). Fruit that submergence for 15 and 30 minutes, decrease in firmness during storage period may be caused by abnormal metabolism process. Fruit structure decline fast during storage period (Pantastico *et al*., 1995).

4. Conclusion

There is significance different between the treatments on the quality of dragon fruits. The interaction of hot water treatment, time of submergences and storage duration were affected the weight loss, titratable acidity and pH of the treated dragon fruits significantly ($p<0.05$).

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Table 1. The effects of hot water treatments (HW), time of submergences (TS), and storage durations (SD) on the percentage of weight loss (%), soluble solid concentration (%), titratable acidity (%), pH and firmness (N) of dragon fruits (*Hylocereus polyrhyzus*)

Treatment	Weight loss (%)	Soluble solid concentration (%)	Titratable acidity (%)	pH	Firmness (N)
HW (˚C)					
Control	10.52c	11.83b	1.39a	5.66b	149.10c
35	5.85a	11.01a	2.44c	5.53ab	145.20c
45	8.09b	10.32a	2.10b	5.47a	113.01b
60	13.75d	10.31a	2.33c	5.43a	83.11a
Significance	*	NS	*	NS	*
TS (min)					
0 (control)	11.01b	10.50a	2.28b	5.58b	124.01a
15	10.19b	10.47a	2.26b	5.56b	123.88a
30	8.71a	10.55a	2.19b	5.52b	113.08a
60	8.79a	10.62a	2.41b	5.35a	104.35a
Significance	*	NS	NS	*	NS
SD (days)					
0	4.63a	8.88a	3.90b	4.48a	134.38b
5	4.62a	12.75c	1.53a	5.88b	141.54b
10	10.62b	10.30b	1.63a	5.82b	96.54a
15	21.14c	10.86b	1.49a	5.94b	89.47a
Significance	*	*	*	*	*
Interaction					
HW X TS	*	NS	*	*	NS
HW X SD	*	NS	*	*	*
TS X SD	*	NS	*	*	*
HW X TS X SD	*	NS	*	*	NS

* = significance; NS = Not significance

Results are means of three replicates of three fruits each

Values with the same letter(s) are not significantly different (p>0.05)

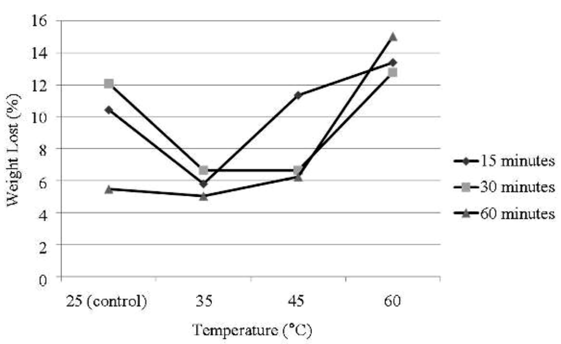

Figure 1. Effect of hot water temperature and time of submergence on fruit weight loss

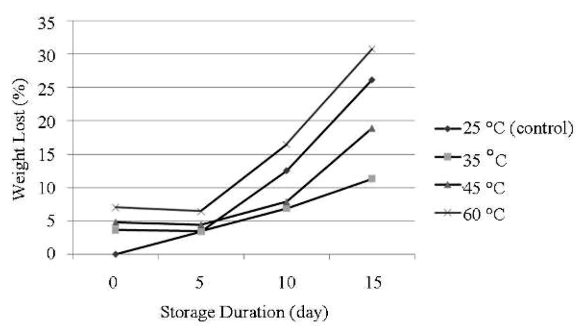

Figure 2. Effect of hot water temperature and storage period on fruit weight loss

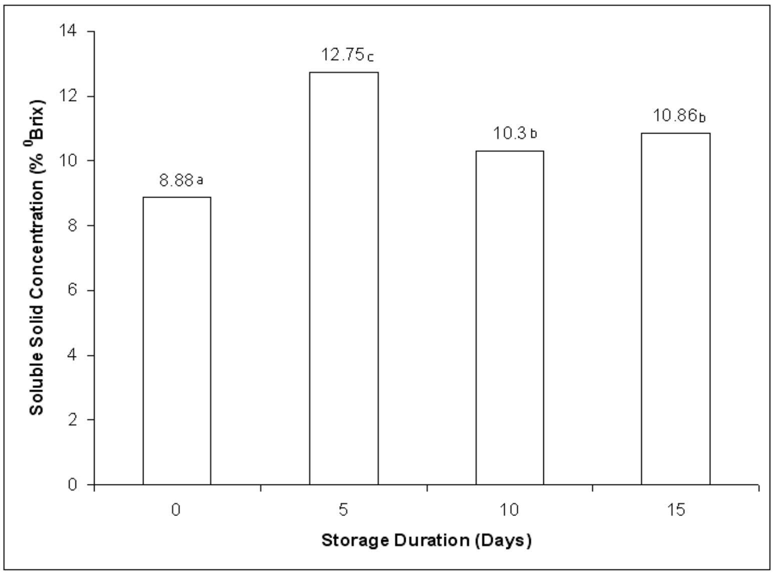

Figure 3. Effect of storage period on fruit soluble solid concentration

Values with the same letter(s) are not significantly different (p>0.05)

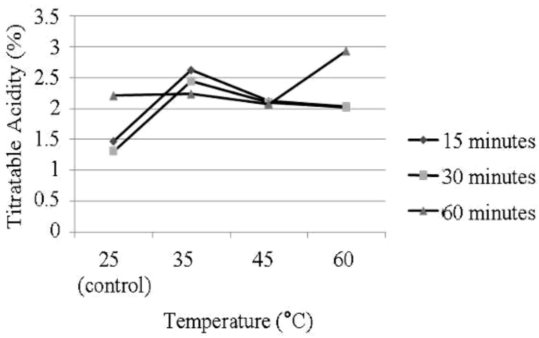

Figure 4. Effect of hot water temperature and time of submergences on fruit titratable acid

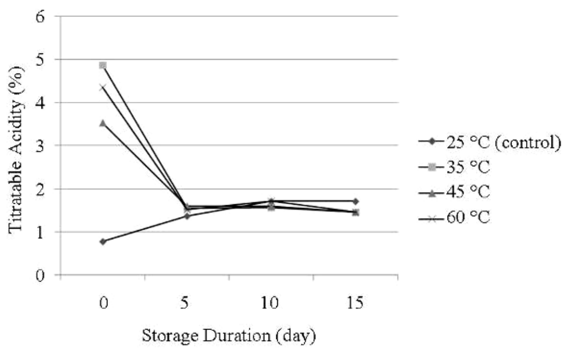

Figure 5. Effect of hot water temperature and storage period on fruit titratable acid

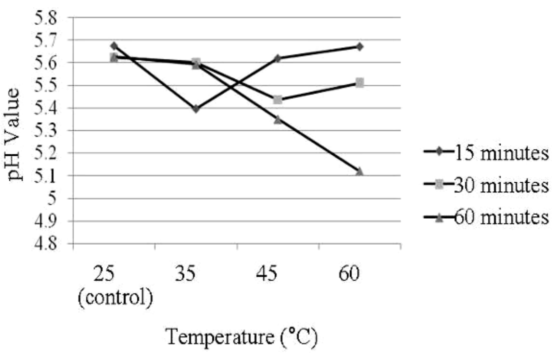

Figure 6. Effect of hot water temperature and time of submergences on fruit pH

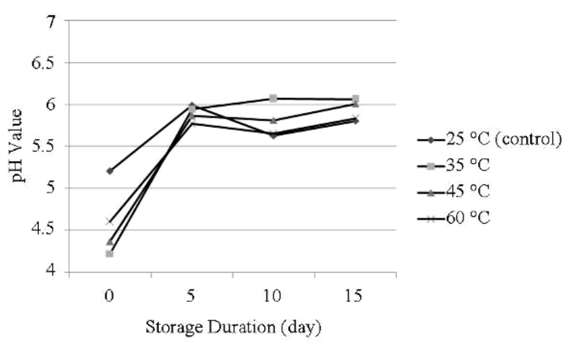

Figure 7. Effect of hot water temperature and storage period on fruit pH

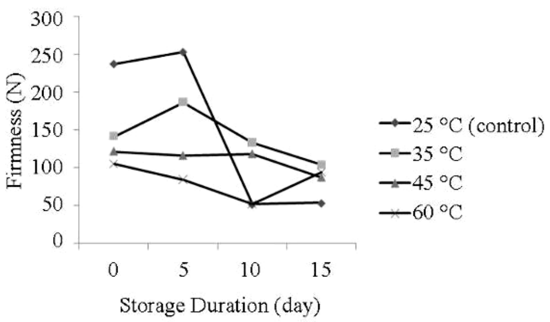

Figure 8. Effect of hot water temperature and storage period on fruit firmness

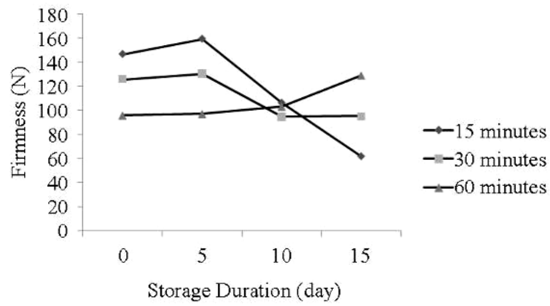

Figure 9. Effect of time of submergences and storage period on fruit firmness

Results are means of three replicates of three fruits each