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Examining the Effect of Dipping Period and Temperature of Hot Water and Packaging Type on Qualitative Traits of Orlando Tangelo Hybrid in Fasa Region

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Abstract

The present study aimed to evaluate the effect of dipping time and temperature of hot water and type of packaging on qualitative traits of Orlando tangelo variety of tangerine. This study was conducted as a factorial experiment in a completely randomized design with three repeats. The treatments consisted of dipping in hot water at seven water levels at 53°C and 58°C each for 1, 2 and 4 minutes. The control treatment consisted of dipping in 20°C water for 2 minutes. Packaging treatment included individual packaging in nylons plastic (LDPE) and group packaging in nylons plastic (LDPE) and not packing the fruits. Such traits as percentage of changes in pH level of fruit juice, total organic acid, total soluble solids (TSS) and vitamin C content were evaluated in this experiment. The results showed that such treatments as dipping in hot water and packaging had significant effects on all measured traits. Minimum increase in TSS was observed in the control group (20°C water for 2 minutes). Maximum increase in TSS was observed in dripping the fruit in 53°C water for 1 minute.

Keywords: Hot water, Packaging, Organic acid, Soluble solids, Vitamin C

Introduction

In recent years, heat treatment was increasingly used to prevent such post-harvest disorders as invasion of pests and insects, rottenness and other post-harvest damages. This was mostly due to decline in demand for using chemicals to prevent post-harvest diseases. Heat is a non-damaging physical treatment, which can be replaced with chemical treatments. Tangelo tangerines hybrids result from crosses between Dancy tangerine species (tangerine groups) and Duncan grapefruit (C. reticulate × C. paradise). Two well-known

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varieties of this group are Minneola and Orlando tangelo. The fruits are both similar to tangerines and grapefruits (1).

Lurie (1998) and Luo (2006) stated that heat treatment is used to control pests, fungal decay, increase resistance to frost and storage life of various fruits and vegetables (2 and 3). Schirra *et al.* (2000) and Palou *et al.* (2002) have shown that hot water treatment effectively control post-harvest decay in citrus fruit varieties (4 and 5). Fotoohi Qazvini and Fatahi Moghadam (2006) have stated that hot water treatment activates heat shock proteins and pathogenesis related-proteins. Chitinase and glucosidase enzymes hydrolyze polymers of fungi cell walls (1). Yuanselo *et al.* (2001) stated that hydrolysis of cell walls is a defense mechanism against fungi (6). Ben-Yehoshua *et al.* (2000) stated that hot water treatment at 55 ° C temperature for 20 seconds significantly decreased development of rots in citrus fruit during storage (7). Yildiz *et al.* (2005) also reported that hot water treatment effectively controlled decay and green mold on Tangerine (8). However, Palou *et al.* (2002) have shown that hot water treatment significantly control mold on tangerines less than on oranges and lemons (5). Schirra and D'hallewin (1997) reported various results in terms of proper hot water temperature for different products. A temperature range of 52°C to 60°C was suggested for tangerines (9).

Fotoohi Qazvini and Fatahi Moghadam (2006) have stated that placing physical coverage around the product decreases the speed of air passing through the product and cause an atmosphere saturated with moisture, which can effectively reduce water loss in the product. Ben-Yehoshua (1985) and Riss (1989) suggested individual packaging of fruits and vegetables in polyethylene coatings, films and other synthetic coatings to maintain fruit quality (10, 11). Shah Bik *et al.* (1381) reported that polyethylene coating of Thomson Navel oranges delayed fruit softening and increased TSS and TA (12).Shah Bik (1376) examined the effects of various heat therapy treatments and polyethylene coatings in reducing postharvest losses of Washington Navel and Valencia orange varieties. He reported that polyethylene coatings and heat therapy effectively control fungal diseases and prevent weight loss in fruits (13). So far, post-harvest heat and packaging treatments were not used to reduce post-harvest losses in tangelo fruit. The present study aimed to determine the best temperature for dipping the fruits in hot water and packaging type in order to reduce post-harvest losses in tangelo fruit.

Materials and Methods

Fresh Orlando tangelo varieties were harvested from a commercial orchard in Fasa City. Healthy, uniform and same-sized fruits without any decay were transferred to the desired location. The study was conducted as a factorial experiment in a completely randomized design with 3 repeats (each repeat included 20 fruits) for seven weeks. The treatments used in the experiment were as follows: dipping in hot water at 53°C for 1, 2 and 4 minutes and at 58°C water for 1, 2 and 4 minutes. The control treatment included dipping in 20°C water for 2 minutes. Packaging factor consisted of three levels of individual and group packaging in nylons plastic (LDPE) and no packaging. In group packaging, 3 fruit were packed together in nylons plastic. Water bath model (HWA) was used for hot water treatment. The fruits were dipped in water for 1, 2 and 4 minutes at 53°C and 58°C. Then, the fruits were packaged.

Then, pH level of the fruit juice was measured using AL 20 model of the waterproof portable pH meter. Titratable acidity was determined as pH=8.3 with 0.1 Normal NaOH. In addition, 10 ml of fruit juice was titrated with 0.1 Normal NaOH in presence of phenolphthalein reagent to determine acidity level, which was expressed in terms of percentage of citric acid (12). Total soluble solids were measured using Carl Zeiss Model of the manual digital refractometer. Vitamin C content was measured using iodometric titration method. The results were expressed in terms of ascorbic acid milligram content per 100 ml of the sample. The results were statistically analyzed using SASS. The means were compared using Duncan.

Discussion and Conclusion

The results showed that the effects of such treatments as dipping in hot water and packaging were significant on pH level of the fruit juice respectively at 5% and 1% levels. Interaction of dipping in water treatment and packaging was not significant on pH level of the fruit juice (Table 1).

Table 1. Mean squares of the effect of treatments on decrease in percentage of pH, total acidity, total soluble solids and vitamin c content

Source of variation	Degree of freedom	Mean squares			
		Fruit juice pH	Total Acidity (TA)	Total Soluble Solids (TSS)	Vitamin C content
Factor A (dipping in water)	6	0.005*	0.0001*	0.074^{ns}	237.273**
Factor B (packaging)	2	0.123**	0.004**	0..968**	103.408**
Interaction A x B	12	0.004^{ns}	0.0001	0.019^{ns}	2.071^{ns}
Error level	42	0.002	0.0005	0.057	2.318
CV%		1.07	1.42	2.52	3.00

ns: not significant; * and ** significant at 5% and 1%, respectively

Mean comparison results of fruit juice pH after 7 weeks of dipping in hot water showed a significant difference between the treatments. The results showed that fruit juice pH increases over time. Fruit juice pH was equal to three before the experiment. The highest pH level of fruit juice was observed in the control group (dipping at 20°C water for 2 minutes) while the lowest pH level of fruit juice was observed in the treatment of dipping at 58°C water for 2 minutes (pH=4.09). Moreover, pH level of fruit juice was averagely obtained as 4.16 in the control group. Therefore, minimum increase in the pH level of fruit juice was observed in treatment of dipping in 58°C water for 2 minutes while maximum increase in pH level of the fruit juice was observed in the control group before applying treatments. The results showed that treatments of dipping in 58°C water for 1 or 2 minutes were significantly different from the control group but other treatments did not significantly differ from the control group (Table 2).

The results relevant to pH level of fruit juice in terms of packaging showed that pH level of either non-packed fruits or group-packed fruits was significantly higher than pH level of individual-packed fruits. Therefore, group-packaging and non-packaging of the fruits increased pH level of the fruit juice.

Furthermore, pH level of the fruit juice in individual-packaging, group-packaging and non-packaging were respectively as 4.050, 4.167 and 4.194 (Table 3).

Table 2. Effect of dipping in hot water treatments on fruit qualitative characteristics

Traits	Before the experiment	At the end of experiment						
		Control	At 53°C water			At 58°C water		
			1 min	2 min	4 min	1 min	2 min	4 min
pH	3	4.16^{a*}	4.15^{ab}	4.14^{abc}	4.141^{bc}	4.11^{bc}	4.09^{c}	4.13^{abc}
TA%	0.92	0.63^{c}	0.64^{bc}	0.63^{bc}	0.64^{abc}	0.63^{bc}	0.65^{a}	0.65^{bc}
TSS%	10	9.2^{b}	9.52^{ab}	9.40^{ab}	9.41^{ab}	9.46^{ab}	9.49^{ab}	9.54^{a}
Vitamin C (mg/100ml)	60.62	39.74^{d}	55.26^{a}	53.67^{b}	52.60^{b}	52.87^{b}	51.02^{c}	50.22^{c}

* the figures with similar letters had no significant differences according to Duncan mean comparison test at 5% level

Table 3. The effect of packaging treatment on qualitative traits of the fruit

Traits	Before the experiment	Packaging		
		Individual	Group	No packaging
pH	3	4.05^{b*}	4.16^{a}	4.19*
TA%	0.92	0.62^{c}	0.64^{b}	0.65^{a}
TSS%	10	9.21^{b}	9.50^{a}	9.63^{a}
Vitamin C (mg/100ml)	60.62	50.77^{c}	52.99^{a}	48.55^{b}

* the figures with similar letters had no significant differences according to Duncan mean comparison test at 5% level

The results of analysis of variance showed that the effects of packaging and dipping in hot water treatments was significant on total organic acid of fruits at 5% and 1% levels respectively. Interaction of dipping in water and packaging on organic acid content of the fruits was significant at 5% level (Table 1). Acidity level of the fruits was affected by dipping in hot water. Mean comparison results showed that dipping fruit in hot water decreased organic acid level of the fruit. The minimum organic acid level of the fruits with an average of 0.63% was observed in the control group (dipping in water at 20°C for 2 minutes) and the maximum organic acids level with an average of 0.6489% was observed in treatment of dipping the fruits at 58°C water for 2 minutes. These treatment had a significant difference with the control group. Other treatments had no significant difference with the control group (Table 3).

The results relevant to organic acidity of the fruit in term of packaging showed that packaging type and non-packaging of the fruits resulted in significant difference in organic acidity level of the fruits. In addition, organic acid levels before the experiment, in individual packaging, group packaging and non-packaging were respectively as 0.92%, 0.6238%, 0.6414% and 0.6490% (Table 3). In this study, results of analysis of variance showed that the effect of dipping in hot water treatments was not significant on total soluble solids (TSS) but the interaction between dipping in water and packaging was significant on TSS at 1% probability level (Table 1).

Total soluble solids (TSS) of the fruit were affected by dipping the fruit in hot water. Mean comparison results showed that maximum reduction in TSS compared to pre-test was observed in the control group (dipping in 20°C water for 2 minutes) while minimum reduction in TTS was observed in treatment of dipping fruits in 58°C water for 4 minutes (TTS = 9.547%). Treatments of dipping in 53°C water and 58°C water was not significant on TTS (Table 2). Therefore, increase in water temperature increases TSS in the fruits. The minimum TTS with an average of 9.281% was observed in treatment of dipping in 20°C water while the maximum TTS with an average of 9.547% was observed in treatment of dipping in 58°C water for 4 minutes (Table 2).

The results relevant to the effect of packaging on TTS showed that no packaging and group packaging significantly increased TSS compared to individual packaging. TSS before the experiment, in individual packaging, group individual and no packaging were respectively as 10, 9.212, 9.503 and 9.631 (Table 3). Results of analysis of variance showed that the effects of dipping in water and packaging treatments on vitamin C content were respectively significant at 5% and 1% levels. Interaction of treatment of dipping in water and packaging was not significant on vitamin C content (Table 1). Vitamin C content was affected by dipping in hot water. Mean comparison results showed that maximum reduction in vitamin C content compared to before the experiment was observed in the control group (dipping in 20°C water for 2 minutes) while minimum reduction was observed in treatment of dipping in 53°C water for 1 minute (vitamin C content = 55.26 mg per 100 ml of fruit juice). Dipping in 58°C water reduced vitamin C content compared to treatment of dipping in 53°C water. Therefore, increased water temperature reduces vitamin C content. Dipping in 58°C water for 2 and 4 minutes caused no significant difference in vitamin C content (Table 2). Increase in water temperature reduced vitamin C content with an average of 39.7422 mg per 100 ml of fruit juice at minimum level in treatment of dipping in 20°C water for 2 minutes (Table 2). In this study, acidity level of fruit juice in singular packaging increased vitamin C content in fruit compared to lack of packaging and group-packaging. Vitamin C content in the fruit before the experiment, individual packaging, group packaging and lack of packaging were respectively as 60.62, 52.99, 50.77 and 48.55 mg per 100 ml of fruit juice (Table 3).

Long storage period of citrus fruit can change the amount of sugar and acidity level (14) (Echeveria and Valich, 1988). Organic acid level of fruits was reduced due to high conversion of citric acid to other materials in storage period (15). Organic acids is a source of energy savings in fruits, which are consumed during ripening as metabolism increases. Therefore, using the factors that reduce respiration and ethylene production due to reduced sugar consumption do not allow decrease in organic acids. Various reports have declared that placing the fruits at high temperature increase sugar to acid ratio (16). Reduced acidity level in citrus fruit is largely controlled by aconitase and isocitrate dehydrogenase enzymes (17). In this study, the effects of some treatments on activity of these two enzymes resulted in a significant difference in acidity level. Total dissolved solids increase in uncoated fruits mostly due to weight loss. In this study, total soluble solids of uncoated fruits treated with 20ºC water was relatively higher than other treatments at the end of experiment. Increase in TSS during storage is not only related to addition of sugar but also increase or decrease in other substances such as acids, soluble pectins and phenolic compounds (18). Less changes in TSS and TA in packed fruits could be due to less water loss in the fruits.

Acidity level of the fruits is influenced by type of packaging and pre-storage treatments but fruit lifetime gradually decline with increased storage period of the fruits. Probably, acidity level of the fruits decreases due to respiration or conversion of acids to other materials. Vitamin C is significantly preserved in the fruits by preventing ethylene production, reducing respiration and delaying fruit aging, which can prevent cell wall hydrolysis and consequently reduce production of free radicals. Low rate of free radicals decreases cellular need to ascorbic acid consumption. As a result, vitamin C is preserved in the fruit. Treatment with hot water is effective in accumulation of antioxidants in the products due to increased activity of catalase and other enzymes that eliminate free radicals (19). Group packaging further reduces the vitamin C content in the fruit compared to individual packaging because group packaging can increase ethylene production, respiration and production of free radicals. Vitamin C as an acid is consumed rapidly in respiration reaction with onset of aging process in the fruit. However, maximum vitamin content is preserved in these treatments due to prevention of fruit aging. This interpretation is in line with those results obtained by Larigodir *et al.* (2002) (20). Puris *et al.* (1983) also reported that vitamin C content in coated grapefruits is significantly higher than non-coated fruits. This may be due to the effect of polyethylene coatings in preventing fruit weight loss since vitamin C is strongly influenced by water loss in the fruit (21).

Conclusion

Treatments of dipping in hot water kept the fruit qualitative traits such as pH, total acidity level, soluble solids and vitamin C content. In addition, pH levels of non-packed fruits or group-packed fruits were significantly higher than individually packed fruits.

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