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Research Article

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Effects of hot water and chemical treatments on quality attributes of grapefruit during cold storage

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ABSTRACT

Limitations on the use of postharvest chemicals have led the use of physical treatments such as hot water treatments or its use with low doses of synthetic fungicides recently. In this study, the effects of 56 ^{o}C hot water dip for 60 seconds, determined by pre-experiments, Imazalil (500 ppm) widely used in packaging houses against fungal diseases and the combination of hot water+Imazalil on the quality parameters of Star Ruby grapefruit stored at 8 ^{o}C and 85-90% relative humidity for 5 months were determined. As a result of the experiments, hot water+Imazalil treatments and Imazalil treatments better maintained the number of deteriorated fruits without changes in other quality parameters compared to control and hot water treatments hence have been determined as suitable treatments for practical use.

Key words: Star Ruby, hot water, fungicide, quality, storage.

INTRODUCTION

Fruits and vegetables contain carbohydrates, proteins, organic acids, vitamins and minerals that are basic elements for human nutrition. citrus fruits are important for human health since they are rich in vitamin C, antioxidants, flavonoids[1].

Total citrus fruit production in Turkey is 2.912.000 tones [2]. In terms of production, orange is the first among other citrus fruits with a production quantity of 1.250.000 tones followed by mandarin with 715.000 tones, lemon with a quantity of 600.000 tones and grapefruit with 347.000 tones. When the export of citrus fruits are considered, lemon is in the first place with 359.000 tones followed by mandarin in the second place with 249.000 tones, orange in the third place with 179.000 tones and grapefruit with a quantity of 100.000 tones. It can be estimated that 35.90% of grapefruit production and 34.82% of mandarin production is exported by comparing the ratio of export quantity to production. Fruit losses are 20-25% on average while exporting these two important fruit species [3]. These losses can be reduced by postharvest fungicide and different preparations.

As a consequence of the increases in use of synthetic chemicals against physiological, pathogen and insect damage that are harmful for human health, the urge for other physical or synthetic treatments to prevent these losses have arisen [4, 5, 6]. Efforts on the generation and release of a fungicide effective at low doses and harmless to human health is quite time consuming and includes several steps that require big investments. Therefore, studies for the development of an effective method against physiological deteriorations and pathogen hazards by reducing the use of chemicals have been initiated extensively resulting in big advances. Among these advances, the most important ones are hot water treatments, combined with different biological treatments, combination of hot water and chemical treatments that gained importance and widespread due to their practical value [7,8].

Citrus fruits have a big potential in the Mediterranean region. Particularly for the production of grapefruit that have an important place in the export of citrus fruits Çukurova basin is an important grapefruit producer. In this study, the effects of fungicide widely used in packaging houses, hot water treatments, combination of hot water and low dose and normal dose fungicides on the quality parameters of Star Ruby grapefruit cultivar grown extensively in the region during storage were determined.

EXPERIMENTAL SECTION

As experimental material, Star Ruby grapefruit cultivar grafted on citrus rootstock was obtained from the fruit orchards of Çukurova University Faculty of Agriculture Research and Training Station. Hot water treatment and its duration were determined by pre-experiments and the optimum combination for Star Ruby grapefruit was found as 56 ^{o}C hot water dip for 60 seconds. In this experiment, 1) Control, 2) 500 ppm Imazalil dip, 3) Hot water dip (56^{o}C, 60 seconds), 4) Hot water (56^{o}C, 60 seconds)+Imazalil (500 ppm) treatments were used. 500 ppm İmzalil dip was applied in a tank of 50 l capacity. Hot water dip and hot water+Imazalil combination was applied in a water bath of which its temperature was adjusted automatically with a thermometer. After treatments, fruits were dried and placed in plastic fruit cases and were taken to storage rooms. Star Ruby grapefruit cultivar was stored at 8 ^{o}C and 85-90% relative humidity for 5 months. The experiments were conducted as 3 replicates and 10 fruits per replicate and quality parameters were investigated periodically in fruit samples once every month during storage.

At the beginning of storage period, fruits were numbered individually, initial fruit weight were determined. Weight loss was calculated as the percentage of initial fruit weight on numbered fruits weighed during analysis. During storage period, fruit juice was extracted from fruit samples taken once every month using an electrical fruit juicer and each time after quantifying the residual weight, by extracting the residual weight from the initial weight, juice yield ratio was calculated as the percentage of entire fruit weight.

Titratable acidity of fruit samples were calculated as citric acid with a pH metre using 0.1 N NaOH solutions. In fruit juice samples extracted using a fruit juicer, total soluble solids were determined by a hand refractometer (Atago, Japan). Vitamin C content (L-Ascorbic Acid) content was calculated with spectrophotometer [9]. In the experiments, Shimadzu UV-1208 spectrophotometer was used. Amount of decayed fruits was calculated as percentage by taking the proportion of the number of decayed fruits to the total number of fruits in each replicate.

The experiment was conducted according to factorial design, the statistical analysis of data were performed using COSTAT statistical programme. Average values of the sources of variation that found significant according to F test were compared by Tukey test.

RESULTS AND DISCUSSION

Investigations on the effects of different treatments on fruit weight loss in Star Ruby grapefruit cultivar revealed that, fruit weight loss increased at longer storage. Weight loss calculated as 1.77 % at the beginning of storage was found as 6.69% on average towards the end of storage period. The highest mean weight loss was identified in control fruits as 4.53% and the least mean weight loss in Imazalil (fungicide) as 4.10% (Table 1). Weight loss is dependent on fruit maturity, fruit size, fruit skin structure, storage conditions during storage resulting in different amounts of weight loss [10]. It is reported that, fractures on thin wax layer covering fruit surface formed during harvest or postharvest are restored as a result of hot water treatments [11]. In relation with this, it is reported that after hot water treatments and its combination with fungicides, fruit weight loss was less compared to control fruits during storage [12, 13].

Table 1. Mean Weight Loss (%) in Star Ruby Grapefruit During Storage Upon Different Treatments

Treatments	Storage Period (Months)					Mean of treatment
	1	2	3	4	5	
Control	1.90	3.40	4.71	5.58	7.04	4.53 a
Hot water	1.72	3.21	4.38	5.29	6.74	4.27 b
Imazalil	1.75	3.06	4.23	5.09	6.36	4.10 b
Hot water+Imazalil	1.72	3.05	4.26	5.62	6.64	4.25 b
Mean of Storage Period.	1.77 e	3.17 d	4.39 c	5.39 b	6.69 a	

Storage Period $D_{\%5}$: 0.24 Treatment $D_{\%5}$: 0.21

Changes in fruit juice yield of Star Ruby grapefruit cultivar stored after different treatments are presented in Table 2. Fruit juice yield calculated as 50.04 % at the beginning of storage period was found as 51.88% at the end of storage period. Comparing the treatments, the highest mean juice yield was 52.47% in control, while the lowest mean juice yield was 48.92% in hot water treatments. Imazalil and Hot water+Imazalil combination was in the middle. Similar results were obtained in several other studies in different citrus species [8, 13, 14, 15]. Several factors such as climate, growing conditions, cultivar, the orchard conditions etc are reported to have an influence on differences in juice yield [13].

Table 2. Fruit Juice Yield (%) in Star Ruby Grapefruit During Storage Upon Different Treatments

Treatment	Storage Period (Months)						Mean of treatment
	0	1	2	3	4	5	
Control	50.04	52.76	51.98	52.36	54.21	53.50	52.47 a
Hot water	50.04	49.29	48.31	48.08	48.71	49.09	48.92 c
Imazalil	50.04	52.35	48.81	52.87	52.56	52.91	51.59 ab
Hot water+Imazalil	50.04	46.27	50.18	52.04	51.17	52.05	50.29 bc
Mean of Storage Period	50.04	50.16	49.82	51.34	51.66	51.88	

Storage Period $D_{\%5}$: N.S. Treatment $D_{\%5}$: 1.71

In terms of changes in titratable acidity, the initial mean value calculated as 2.39 g citric acid/100 ml fruit juice decreased during storage and calculated as 1.67 g citric acid/100 ml fruit juice at the end of 5th month. While the highest mean titratable acidity was obtained from hot water treatment, the lowest mean value was obtained from Imazalil treatment (Table 3). Metabolic activity continues in fruits after harvest. In particular, in fresh fruits and vegetables, sugar and organic acids are used during respiration to maintain continuity of physiological functions [16, 17].

Investigation on changes in total soluble solids content in Star Ruby grapefruit cultivar during storage showed that total soluble solids content decreased at longer storage (Table 4). While mean total soluble solids content was found as 11.26% at the beginning of storage period, was found as 9.96% at the end of storage period. Differences among treatments revealed that the lowest mean total soluble solids content was in control calculated as 10.22% whereas the highest mean total soluble solids content was calculated as 11.01% in hot water treatments. Studies report that, hot water treatments do not have an impact on total soluble solids content however, some decreases may occur in total soluble solids content due to the extended storage period [18, 19]. It is believed that slight differences among treatments do not have an important influence for practical use and such differences may occur when average values related with fruit maturity are considered.

Table 3. Changes in Mean Titratable Acidity (%)in Star Ruby Grapefruit During Storage Upon Different Treatments

Treatment	Storage Period (Months)						Mean of treatment
	0	1	2	3	4	5	
Control	2.39	2.08	1.92	1.80	1.79	1.71	1.95 b
Hot water	2.39	2.24	2.15	1.94	1.90	1.83	2.07 a
Imazalil	2.39	1.97	2.01	1.79	1.74	1.58	1.91 b
Hot water+Imazalil	2.39	2.15	1.94	1.76	1.76	1.58	1.93 b
Mean of Storage Period	2.39 a	2.11 b	2.00 c	1.82 d	1.80 d	1.67 e	

Storage Period $D_{\%5}$: 0.05 Treatment $D_{\%5}$: 0.04

Table 4. Changes in Mean Total Soluble Solids Content (%) in Star Ruby Grapefruit During Storage Upon Different Treatments

Treatment	Storage Period (Months)						Mean of Treatment
	0	1	2	3	4	5	
Control	11.26	10.33	10.13	10.00	10.13	9.66	10.22 b
Hot water	11.26	11.20	11.06	11.33	10.93	10.26	11.01 a
Imazalil	11.26	10.00	10.73	9.86	10.20	9.73	10.30 b
Hot water+Imazalil	11.26	11.60	10.86	10.80	10.86	10.20	10.93 a
Mean of Storage Period	11.26 a	10.73 b	10.70 b	10.50 b	10.53 b	9.96 c	

Storage Period $D_{\%5}$: 0.30 Treatment $D_{\%5}$: 0.24

Citrus fruits have health promoting properties due to high levels of vitamin C content (L-Ascorbic acid). Particularly in winter, they are preferred for their antioxidant properties and ability to promote human defense system. Therefore, it is very important to assess changes in vitamin C content among other fruit quality parameters during storage. In Star Ruby grapefruit cultivar, although slight changes were observed upon extended storage, it was found that vitamin C content was well maintained at the end of storage period (Table 5). Considering the effects of different treatments on vitamin C content, the lowest mean vitamin C content was 53.96 mg Ascorbic acid/100 ml fruit juice in Hot water+Imazalil treatments and the highest mean vitamin C content was found as 55.25 mg Ascorbic acid/100 ml fruit juice in Imazalil treatment at the end of storage period. It is known that vitamin C content (L-Ascorbic acid) decreases or maintains the initial value during extended storage period in postharvest storage of citrus fruits [20]. Several factors pre harvest or postharvest are reported to be effective on both vitamin C and the other components and owing to this fact, these changes may be influenced during storage [21, 22].

Table 5. Changes in Mean Vitamin C Content (L-Ascorbic acid) (mg Ascorbic acid/100 ml fruit juic) in Star Ruby Grapefruit During Storage Upon Different Treatments

Treatment	Storage Period (Months)						Mean of Treatment
	0	1	2	3	4	5	
Control	55.53	56.25	55.89	56.05	53.30	55.20	55.37
Hot water	55.53	52.83	54.26	52.74	52.13	56.67	54.01
Imazalil	55.53	57.30	54.54	55.46	55.26	53.40	55.25
Hot water+Imazalil	55.53	52.31	53.92	54.85	51.21	55.97	53.96
Mean of Storage Period	55.53 a	54.67 ab	54.65 ab	54.77 ab	52.97 b	55.28 a	

Storage Period $D_{\%5}$:1.97 Treatment $D_{\%5}$: N.S.

Although physiological or fungal decays were not observed at the first 4 months of storage, decayed fruits were observed in control and hot water groups at the end of storage. Comparing the treatments, the highest amount of losses was in control calculated as 2.66% followed by hot water treatment calculated as 2.00% and Imazalil treatment calculated as 0.66% (Table 6). It is speculated that decreases in the number of decayed fruits upon hot water treatment is associated with decreases in pathogen population by hot water treatments in pathogen-host relation [4, 12]. This effect is clearly observed in the present study.

Table 6. Changes in Mean Physiological and Fungal Deteriorations (%) in Star Ruby Grapefruit During Storage Upon Different Treatments

Treatment	Storage Period (Months)					Mean per Treatment
	1	2	3	4	5	
Control	0.00	0.00	0.00	0.00	13.33	2.66
Hot water	0.00	0.00	0.00	0.00	10.00	2.00
Imazalil	0.00	0.00	0.00	0.00	3.33	0.66
Hot water+Imazalil	0.00	0.00	0.00	0.00	0.00	0.00
Mean Storage Period	0.00 b	0.00 b	0.00 b	0.00 b	6.66 a	

Storage Period $D_{\%5}$:1.46 Treatment $D_{\%5}$: 1.31

CONCLUSION

The findings of the current research suggested that different treatments changed fruit quality parameters in Star Ruby grapefruit cultivar at the end of 5 months storage period, however, this change was not important for practical use and Imazalil and Hot water+Imazalil treatments were more effective than control and hot water treatments in terms of physiological and fungal originated fruit losses. In the light of these evidence, it was determined that, Hot water+Imazalil treatment can be effective for storage houses and at the end of this treatment, grapefruits can be stored for 5 months at 8 ^oC, 85-90% relative humidity successfully.

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REFERENCES

[1] MS Ladaniya, Citrus Fruits: Biology, Technology and Evaluation, Elsevier, **2008,** 1-4.
[2] ANONYMOUS, Akdeniz İhracatçılar Birliği Kayıtları, **2005**, http://www.akib.org.tr.
[3] F Şen, Ege Üniversitesi Fen Bilimleri Enstitüsü, **2004,** 34-36.
[4] R Porat; D Pavoncello; Z; Peretz; B; Weiss; A Daus; L Cohen; S Ben-Yehoshua; E Fallik; S Droby; and S Lurie, *Journal of Horticultural Science & Biotechnology*, **2000**, 75(4), 428-432.
[5] E Fallik; Y Aharoni; A Copel;V Rodov; S Tuvia-Alkalai; B Horev; O Yekutieli; A Wiseblum and R Regev, *Plant patology*, **2000**, 49, 333-338.
[6] M Bassal; M El-Hamahmy, *Postharvest Biology and Technology*, **2011**, 60, 186–191.
[7] M Schirra; P Cabras; A Angioni; G D'hallewin; M Pala, *J. Agric. Food Chem.*, **2002**, 50, 2293–2296.
[8] M Schirra; M Mulas; A Fadda; E Cauli, *Postharvest Biology and Technology*, **2004**, 31, 191–200.
[9] D Pearson; AA Churchill, The Chemical Analysis of Foods. Gloucester Place, London, **1970**, 104, 233.
[10] D Valero; D Martínez –Romero; JM Valverde; F Guillen; M Serrano, *Innovative Food Science and Emerging Technologies*, **2003**, 4, 339–348.
[11] E Fallik, *Postharvest Biology and Technology*, **2004**, 32, 125-134.
[12] M Schirra; G D'hallewin; P Cabras; A Angioni; S Ben-Yehoshua; S Lurie, *Postharvest Biology and Technology*, **2000**, 20, 91-98.
[13] AE Özdemir and Ö Dundar, *Proceedings of the Fourth International Conference on Postharvest Science*, **2001**, 2, 561-598.
[14] M Pekmezci; M Erkan; H Gübbük, *National Horticultural Conference of Turkey*, **1992**, 1, 403-408.
]15] AE Özdemir; Ö Dündar, *Asian Journal of Plant Science*, **2006**, 5 (1), 142-146.
[16] O Pailly; G Tison; A Amouroux, *Postharvest Biology and Technology*, **2004**, 34, 65-73.
[17] O Özkaya; Ö Dündar; H Demircioglu, *Journal of Food, Agriculture & Environment – JFAE*, **2010**, 8 (2), 284-291.
[18] S Lurie; T Jemric; A Weksler; R Akiva; Y Gazit, *Postharvest Biology and Technology*, **2004**, 34, 321-329.
[19] M Erkan; M Pekmezci; CY Wang, *International Journal of Food Science and Technology*, **2005**, 40, 91-96.
[20] A Biolatta; V Salitto; RJC Cantet; NA Pensel, *Lebensm-Wiss. U-Technolgy*, **2005**, 38, 131-134.
[21] SK Lee; A Kader, *Postharvest Biology and Technology*, **2000**, 208, 207-220.
[22] G Sathyaprabha; S Kumaravel and A Panneerselvam, *Journal of Chemical and Pharmaceutical Research*, 3(6), 1-6.