EFFECT OF HOT WATER TREATMENT ON STORAGE PERFORMANCE OF PEACH FRUIT

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ABSTRACT

The research was conducted at Horticultural laboratory, Department of Horticulture, The University of Agriculture Peshawar during 2013. Fruits of Peach cv. 'Early Grand' were dipped in hot water at different temperatures (Control, 30, 40 and 50 °C) for a constant time period of 5 minutes. After drying, the fruits were stored at (5-8 °C) and then their chemical analysis and other quality parameters were studied at the end of each storage interval (0, 10, 20 and 30 days). The results indicated that there was a significant influence of the given treatments on quality of peach fruit. The fruits dipped in water having temperature of 50 °C showed the maximum TSS (11.49°Brix), total sugars (7.6%) and TSS: TA ratio (38.06) with minimum titratable acidity (0.3%). The alone effect of storage periods revealed that the fruits stored for 30 days gave the maximum TSS (9.86°Brix) and TSS: TA ratio (30.14) but also showed the minimum titratable acidity (0.34%), total sugars (6.11%). The interaction between hot water levels and storage durations proved that the peach fruits dipped in water having temperature of 40 °C and stored for 20 days showed the maximum TSS (12.24°Brix), but on the other hand it also gave minimum total sugars (5.53%). While increasing the hot water temperature (from 40 to 50 ^{0}C) and storage duration (from 20 to 30 days), most of the peach fruit quality attributes were declined with passage of time. From the results it was concluded that the hot water treatment at certain temperature i.e. 40 °C effectively sustained the quality traits of peach fruit such as TSS, titratable acidity and sugar acid ratio. Therefore it was recommended that peach fruits may be treated with water having temperature of 40 °C after harvest to sustain quality aspects for 10-20 days storage at 5-8 °C.

Keywords: Peach fruit, Hot water treatment, Storage durations

INTRODUCTION

Peach (*Prunus persica*) belongs to the family Rosaceae, it is the widely grown fruit in temperate regions throughout the world. Around 2000 B.C, peach was originated in China as in a wild form. At the time of Holy Christ, Romans were cultivating peach and later on it was disseminated in all over the world after The Romans spread it in their entire empire of Europe (Ferguson *et al*., 1987). In Pakistan, it is grown in Khyber Pakhtunkhwa Province and has got its importance. It is also grown in other areas of Pakistan like South Waziristan, Gilgit, Chitral and Hunza valley.

According to Pakistan Agricultural Statistics in 2010-2011, a total of 52600 tons of peach fruit were produced under the area of 15200 hectares. Peach cover on an area of 100 hectares in Punjab, 5600 in Khyber Pakhtunkhwa and 9500 hectares in Baluchistan with production of 500, 57800 and 25400 tons respectively. Due to various biotic and abiotic stresses like disease attack, insects and most importantly lack of proper preservation, the yield of peach in Khyber Pakhtunkhwa province is very low (Khattak, 2002). The fresh products play an important role in the market competition and its value is more in local and international market. Due to the nature of their perishability, diversity of horticulture, convenience and customer preferences, the conservation of product quality demands constant attention (Louis *et al*., 2001).

Heat treatment of the fruits for quality maintenance has been given in a wide range of international scientists work. Increase in protein levels and transcripts of heat shock proteins are caused due to this treatment (Lurie, 1998). Many other processes in fruit ripening are influenced by heat treatments, i.e. color, cell wall metabolism, respiration, ethylene production, fruit softening and volatile compounds production (Tian *et al*., 1996; Ketsa *et al*., 1999, Inaba and Chachin, 1988; Lurie and McDonald *et al.*, 1999). Heat application followed by cold storage can decrease chilling injuries, pathogen incidence and development in many fruits (McDonald *et al.*, 1999). It has been stated by Margosan *et al*. (1997) that peach fruits exposed to hot water of 46 ^{0}C up to 8 min showed significantly less disease incidence.

Shelf life of a fruit can be increased by giving proper post-harvest treatments. It also reduces packaging house losses. There are a very limited number of registered products in post-harvest regulations. Heat treatment given before storage is a very relevant strategy which provides fruits with less damage and better quality (Lurie, 1998). A high temperature application to the fruits is an example of physical treatments given in post-harvest in order to delay fruit ripening, control pest, reduce disease incidence, improve the fruits resistance against chilling injuries, and extent the shelf life (Wang, 1998). There are certain changes caused by the heat treatments, i.e. changes in ripening of fruits and inhibition in synthesis. Cell wall degrading enzymes are also triggered due to protein synthesis and alteration in gene expression (Paull and Chen, 2000).

MATERIALS AND METHODS

Two different factors were studied, i.e. hot water treatments and storage durations. The hot water treatments were given for a constant time period of 5 minutes. The distilled water was used in the whole experiment. After thoroughly washing, four lots of fruits were made

before the process of treatment. The fruits were treated with hot water for five minutes at different temperatures (30 ^{0}C, 40 ^{0}C and 50 ^{0}C). Some fruits were left without dipping as "control". After the treatment and cooling of the selected fruits they were kept for storage for different time of interval such as 0 day, 10 days, 20 days and 30 days respectively.

Proposed Plan of study for research

T_o = Peach fruit untreated.

T_1 = Peach fruit treated with hot water at 30 ^{0}C for 5 minute.

T_2 = Peach fruit treated with hot water at 40 ^{0}C for 5 minute.

T_3 = Peach fruit treated with hot water at 50 ^{0}C for 5 minute.

Statistical Procedure

To Analysis of Variance (ANOVA) all the data will be added and used the procedure suitable for RCBD with two factors arrangement. Least Significance Differences (LSD) test for these analyses used to compare the means. Statistix 8.1 is used as statistical package (Jan *et al*., 2009).

RESULTS AND DISCUSSION

Total Soluble Solids (˚Brix)

According to the mean table, the maximum total soluble solid content (11.49 ˚Brix) was observed in the fruits dipped in water having temperature of 50 ˚C, followed by the contents (10.08 and 8.89 ˚Brix) recorded in fruits dipped in water having temperature of 40 ˚C and 30 ˚C respectively, while the minimum (8.63 ˚Brix) was observed in control fruits (Table 1).

As regarding the storage durations, maximum total soluble content (9.86 ˚Brix) was found in fruits stored for 30 days, which was statistically the same as the mean values (9.86 ˚Brix) observed in the fruits stored for 20 days, followed by (9.70 ˚Brix) for fruits stored at 20 days while the minimum total soluble solid content (9.67) was recorded in fresh fruits. As referred to the mean values of interaction, maximum total soluble solid content (12.24 ˚Brix) was observed in the fruits dipped in water having temperature of 50 ^{0}C and stored for 30 days, while the minimum was recorded in control and fresh fruits.

These results are in harmony with Ozdemir and Dundar (2006). Who reported that an increased in total soluble solid contents of orange fruit had been found during storage.

Similarly, Kinh *et al*. (2001) observed rise in value of TSS of apple pulp and Shah *et al*. (1975) also cited that during storage period the increase in soluble content might be due to the solubilization of ingredients of fruit.

Titratable Acidity (%)

The mean table revealed that the maximum titratable acidity (0.45%) was observed in control fruits, followed by the values (0.40 and 0.33%) of the fruits dipped in water having temperature of 30 °C and 40 °C respectively, while the minimum titratable acidity (0.30) was observed in fruits dipped in water having temperature of 50 °C (Table 1).

As referred to storage intervals, the maximum titratable acidity (0.40%) was recorded in fresh fruits, followed by values (0.38% and 0.37%) which were observed in fruits stored for 10 and 20 days respectively, whereas the minimum titratable acidity (0.34%) was recorded in fresh fruits.

These results are in line with the results of Rapisarda *et al.* (2001) who determined a decrease in percent acidity of orange fruit with increasing storage duration. The decrease in titratable acidity indicated the maturity of the fruits. The decrease of titratable acidity might be due to the breakdown of pectin in to pectenic acid. This decrease in the percent acidity refers to the fruit ripening. Brar *et al.* (1997), Sarrwy *et al.* (2012) and Bhat *et al*. (2012) also recorded decrease in the titratable acidity of persimmon, peach, date palm and pear fruits respectively when calcium was applied as foliar spray at the pre-harvest stage. Workneh *et al*. (2012) observed that the maximum decrease in titratable acidity of tomatoes was due to the higher temperature in storage.

Sugar-Acid Ratio

According to the mean table, the maximum sugar-acid ratio (38.06) was observed in the fruits dipped in water having temperature of 50 °C, followed by the contents (30.44 and 38.06) recorded in fruits dipped in water having temperature of 40 °C and 30 °C respectively, while the minimum sugar-acid ratio (19.50) was observed in control fruits (Table 1). As regarding the storage durations, maximum sugar-acid ratio (30.14) was found in fruits stored for 30 days, followed by values (28.09 and 26.94) for fruits stored at 20 days and 10 days respectively, while the minimum sugar-acid ratio (25.52) was recorded in fruits left un-stored.

These results are in line with the results of Rapisarda *et al.* (2001), as well as with Ozdemir and Dundar (2006) who observed an increase in the proportion of TSS / acid of orange. This increase is due to lowering of percent acidity and an increase in the TSS which specifies the ripeness of the fruits. Comparable results were also observed by Khalil *et al.* (2002), i.e. an increase in the TSS/Acid ratio for peaches was recorded.

Table 1: Total soluble solids (ºBrix), Titratable Acidity (%), Sugar-Acid ratio of peach fruit as affected by hot water treatment during storage.

Hot water treatment	Parameters		
	Total soluble solids (ºBrix)	Titratable Acidity (%)	Sugar-Acid ratio
Control	8.63 d	0.45 a	19.50 d
30 ^{0}C	8.89 c	0.40 b	22.69 c
40 ^{0}C	10.08 b	0.33 c	30.44 b
50 ^{0}C	11.49 a	0.30 d	38.06 a
LSD (P≤0.05)	0.15	0.27	1.70
Storage durations (days)			
Fresh (0)	9.67 b	0.40 a	25.52 c
10	9.70 b	0.38 ab	26.94 bc
20	9.86 a	0.37 bc	28.09 b
30	9.86 a	0.34 c	30.14 a
LSD (P≤0.05)	0.31	0.05	1.3
Interaction at LSD (P≤0.05)			
Hot water × Storage	---	---	---
Significance	NS	NS	NS

Means followed by same letters are statistically different using LSD test at 5% Significance levels.

Fruit Firmness (kg cm^{-2})

The mean table revealed that the maximum fruit firmness (1.73 kg cm^{-2}) was observed in the fruits dipped in water having temperature of 40 ˚C, trailed by the values (1.57 and 1.30 kg cm^{-2}) of the fruits dipped in water having temperature of 30 ˚C and control fruits

respectively, while the minimum fruit firmness value (1.29) was observed in in fruits dipped in water having 50 ˚C of temperature (Table 2).

As referred to storage intervals, the maximum fruit firmness (2.43 kg cm^{-2}) was noted in fresh fruits, trailed by values (1.89 and 1.16 kg cm^{-2}) found in fruits that were kept in storage for 10 days and 20 days respectively, while the minimum value of fruit firmness (0.41 kg cm^{-2}) was recorded in un-stored fruits.

The similar results were also observed by Lurie *et al.* (1998), that peach fruits, when treated at 38 ^{0}C or 40 ^{0}C softened slower than control. Similar results were also observed by Zhou *et al.* (2002), that the firmness of fruit decreases as the storage duration of fruit increases.

Total Sugars

According to the mean table, maximum total sugars value (7.60 %) was observed in the control fruits, followed by the values (6.17 and 5.88 %) recorded in fruits dipped in water having temperature of 30 ^{0}C and 40 ^{0}C respectively, while the minimum total sugar (5.60 %) was noted in the fruits dipped in water having temperature of 50 ˚C (Table 2).

As regarding the storage durations, maximum total sugar value (6.53 %) was found in un-stored fruits, followed by values (6.39 and 6.23 %) for fruits stored at 10 days and 20 days respectively, while the minimum total sugar value (6.11 %) was recorded in fruits stored at 30 days interval. As referred to the mean values of interaction, maximum total sugar value (8.06 %) was observed in control and fresh fruits, however the lowest value was noted in fruits that were dipped in water having temperature of 50 ˚C and stored at 30 days interval.

These results are in correspondence with Aung *et al*. (1998), who observed that in heat treatments total sugars were significantly higher in control in citrus fruit, Similarly, a decreased in total sugar was noted in sweet oranges fruit with increasing the duration of storage (Moazong *et al.,* 1998), Similar results were also observed by Khan *et al.* (2007). Who reported that the total sugars were higher in zero time and decreased with increasing duration of storage in sweet orange. This decrease in sugars percentage might be because boron has a key role in various process like transportation of sugars and metabolism of carbohydrates. Our findings are in according with the study of Sarrwy *et al*. (2012), who noted decrease in sugar percentage as a results of boric acid application either alone or in combination with calcium nitrate. Also noted the highest reducing sugar percentage as a results of boric acid foliar application as compared to control. The study is also in line with

the results of Kumar *et al.* (2015), who observed the significant decrease in the sugar percentage because of hot water treatment. Reducing sugars vary with different peach cultivars. Ahmad *et al.*, (2013).

Table 2: Fruit firmness (kg cm^2) and Total Sugars of peach fruit as affected by hot water treatment during storage.

	Parameters	
Hot water treatment	**Fruit firmness (kg cm^2)**	**Total Sugars**
Control	1.30 bc	7.60 a
30 ^{0}C	1.57 ab	6.17 b
40 ^{0}C	1.73 a	5.88 c
50 ^{0}C	1.29 c	5.60 d
LSD (P≤0.05)	0.27	0.07
Storage durations (days)		
Fresh (0)	2.43 a	6.53 a
10	1.89 b	6.39 b
20	1.16 c	6.23 c
30	0.41 d	6.11 d
LSD (P≤0.05)	0.36	0.15
Interaction at LSD (P≤0.05)		
Hot water × Storage	---	---
Significance	NS	NS

Means followed by same letters are statistically different using LSD test at 5% Significance levels.

Conclusion

Hot water treatment significantly affected all the qualitative parameters. Among the hot water treatments hot water at 40^{o}C showed best results to retained the firmness of fruit. Storage duration up to 10 days was found to be the most effective for titratable acidity and total sugars and a gradual decline was also noted with increasing the storage duration.

References

Agricultural Statistics of Pakistan. 2010–2011. Peach production and area. Table 51, page 95. Retrieved from: http://www.pbs.gov.pk/content/agricultural-statistics-pakistan-2010-11.

Ahmed. M. J., S. G. M. Gillani and F. A. Kiani. 2013. Response of apple (Malus Domistica Borkh) cultivars grafted on two rootstocks under sub-humid temperate climate of Azad Jammu And Kashmir. Pak. J. Agri. Sci. 50(3): 379-386.

Aung, L.H., D.M. Obenland and L.G. Houk. 1998. Conditioning and heat treatments influence flavedo soluble sugars of lemon. J. Hort. Sci. Biotech. 73 (3): 399-402.

Brar, S.S., S.A. Simnani and G.S. Kaundal. 1997. Effect of pre-harvest sprays of calcium nitrate on the storage life of Shan-I-Punjab peach. J. Res. Punjab Agri. Uni., 34(2): 174-180.

Ferguson, B. R. Hldelorand and G. Hespendheild. 1987. All about growing fruits, berries and nuts. Ortho books San Francisco, CA: 287.

Ketsa. S., S. Chidtragool, J.D. Klein, and S. Lurie. 1998. Effect of heat treatment on changes in softening pectic substances and activities of polygalacturonase, pectin esterase and beta-galactosidase of ripening mango. J. Plant Physiology, 153 (3–4): 457–461.

Khalil, S.A., A. Muhammad, Z. Roshan, S. Muhammad, M. Ali, W. Fazali and F. Muhammad.2012. Influence of postharvest hot water dip treatment on quality of peach fruit (Prunus persica L.). J. Med. Plants Res. 6(1): 108-113

Khan. G.A., A. Rab, M. Sajid and Salimullah. 2007. Effect of heat and cold treatments on post-harvest quality of sweet orange cv. Blood red. Sarhad J. Agric. Vol. 23(1) 39-46.

Khattak, M.S., M.N. Malik and M.A. Khan. 2002. Guava propagation Via in Vitro Technique. Sarhad J. Agric. 18(2): 199-202.

Kinh, A.E.H. Shearer, C.P. Dunne and D.G. Hoover. 2001. Preparation and preservation of apple pulp with chemical preservatives and mild heat. J. Food Prot. 28(6): 111-114.

Kumar, J., R. Kumar., R. Rai., And D. S. Mishra. 2015. Response Of 'Pant Prabhat' Guava Trees To Foliar Sprays Of Zinc, Boron, Calcium And Potassium At Different Plant Growth Stages. Int. Quarterly. J. Life. Sci. 10(2): 495-498.

Louis, H. Aung, J.F. Jenner, J.G. Leesch, and F.J. Ryan. 2001. Postharvest quality/phytotoxicity of fresh commodities subjected to Mb Alternative Treatments USDA, ARS, Hort. Crops Research Lab.

Lurie, S. 1998. Review Postharvest heat treatments. Postharvest Biol. and Technol. 14: 257–269.

Lurie, S. and A. Nussinovich. 1996. Compression characteristics firmness and texture perception of heat treated and unheated apples. Int. J. Food Sci. Tech. 31:1-5.

Lurie, S. Fallik, E. Klein, J.D. Kozar, F. Kovacs, K. 1998: Postharvest heat treatment of apples to control San Jose scale Quadraspidiotus perniciosus Comstock and blue mold Penicillium expansum Link and maintain fruit firmness. J. Amer. Soc. Horti. Sci. 123(1):110-114

Margosan. D.A., J.L. Smilanick, G.F. Simmons, D.J. Henson. 1997. Combination of hot water and ethanol to control postharvest decay of peaches and nectarines. Plant Dis. 81:1405–1409.

McDonald, R.E., T.G. McCollum and E.A. Baldwin. 1999. Temperature of water treatments influences tomato fruit quality following low temperature storage. Postharvest Bio. Tech. 16: 14-155.

Moazong, Y., Y. Dingchi, X. Wenrong and M.Z. Ye. 1998. Some physiological changes in tangerines during storage. Plant Physiol. Communic. 33(2): 115-117.

Ozdemir. A.E. and O. Dundar. 2006. The Effects of Fungicide and Hot Water Treatments on the Internal Quality Parameters of Valencia Oranges. Asian J. of Plant Sci. 5 (1): 142-146.

Ozdemir. A.E., E.E. Candir, M. Kaplankiran, E.M. Soylu, N. Sahinler and A. Gul. 2010. The effects of ethanol-dissolved propolis on the storage of grapefruit cv. Star Ruby. Turk J. Agric. 34: 155-162.

Paull. R.E., and N.S. Chen. 2000. Heat treatment and fruit ripening. Postharvest Biol. and Technol. 21: 21–37.

Rapisarda, P., S.E. Bellomo and S. Intelisano. 2001. Storage temperature effects on blood orange fruit quality. Agri. Food Chem. Washington D.C. American Chem. Soci. 49(7): 3230-3235.

Sarrwy, S.M.A., E.G. Gadalla and E.A.M. Mostafa. 2012. Effect of Calcium Nitrate and Boric Acid Sprays on Fruit Set, Yield and Fruit Quality of cv. Amhat Date Palm. World. J. Agri. Sci. 8 (5): 506-515.

Shah, W.H., N.A. Sufi and S.I. Zafar. 1975. Studies on the storage stability of guava fruit juice. Pak. J. Sci. Ind. Res. 18(3-4): 179-183.

Tian, M.S., A.B. Woolf, J.H. Bowen and I.B. Ferguson. 1996. Changes in color and chlorophyll fluorescence of broccoli florets following hot water treatment. J. Amer. Soc. Sci. 121(2): 310-313.

Wang, K., S. Cao, P. Jin, H. Rui and Y. Zheng. 2010. Effect of hot air treatment on postharvest mould decay in Chinese bayberry fruit and the possible mechanisms. Intern. J. Food Micro biol. 141(1): 11-16.

Workneh. T.S., G. Osthoff and M. Steyn. 2012. Effects of preharvest treatment, disinfections, packaging and storage environment on quality of tomato. J. Food sci. Technol. 49(6): 685-694.

Zhou, T., S. Xu, D.W. Sun and Z. Wang. 2002. Effects of heat treatment on postharvest quality of peaches. J. Food Eng. 54: 17–22.