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Astringency removal in persimmon fruits (*Diospyros kak*i L.) cv. "Hachiya" treated with CO_2 and ethanol

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Abstract
The study was carried out during the year 2016 season on "Hachiya" persimmon fruits as an astringent variety. The fruits were treated with CO_2 gas and ethanol vapour treatment and stored under normal atmospheres for 9 days. Fruits were analysed for firmness, total tannins, total soluble solids, titratable acidity and rate of respiration after treating and stored at ambient conditions. CO_2 deastringency treatment carried out with a high CO_2 concentration (>80 %) in a HDPE bags containing fruits for 8, 16 and 24 h at ambient temperature whereas, ethanol vapour treatment was applied as treating the fruits with ethanol solution @ 10, 20 and 30 per cent in desiccator for 24 hours and after the treatment fruits were packed in brown paper bags and stored at ambient conditions. Ethanol dip treatment was also tried as a dipping the fruits in 10, 20 and 30 per cent solution of ethanol solution for 15 minutes. Astringency removal treatment caused an immediate increase of acetaldehyde and ethanol, nearly to the same extent as in conventionally ripened or stored fruit. The amount of soluble tannins, the main cause of an astringent taste, decreased during storage, and it did much faster with CO_2 (> 80 %) treatment for 24 h. The physico-chemical test revealed that fruit treated with high CO_2 was preferred to conventionally ripened fruit.

Keywords: persimmon, astringency removal, CO_2, ethanol and total tannins

Introduction

Blending of fruit and vegetable juices is a recognized process in fruit and vegetable technology for improving the beverage qualities such as to impart body to the blend and to render it more attractive besides to regulate the brix to acid ratio to Persimmon (*Diospyros kaki* L.) belongs to family Ebenaceae and is a popular commercial fruit in China, Korea and Japan. The genus *Diospyros* has approximately 200 species including *D. virginiana* and *D. lotus* which are used as rootstocks for raising commercial persimmon varieties (Garcia-Carbonell *et al*., 2002) [5]. It was originally cultivated in China and Japan, and is also known as the Chinese Date Palm and is the national fruit in Japan (George *et al*., 1994) [6]. An important feature of the some persimmon cultivars is the high soluble tannin content responsible for astringency. Astringency is the sensation that results when tannins bind salivary proteins and cause them to precipitate or aggregate, which leaves a rough "sandpapery" or dry sensation in the mouth. According to the level of astringency upon harvest, persimmon cultivars can be classified into two general categories: astringent and non-astringent persimmons (also called 'sweet' persimmons) (Yonemori *et al*., 2003) [16]. Accordingly, persimmon fruits can be classified into four groups: 1) the Pollination Constant Non-Astringent (PCNA) group. The persimmon cultivars that belong to the PCNA group have a low content of the soluble tannins responsible for astringency. Therefore, these cultivars can be consumed with high firmness after harvest. Nevertheless, the rest of the cultivars show a high soluble tannins content at harvest time thus they must be subjected to postharvest deastringency treatments prior to their marketing, or otherwise they must be left on trees until they over-ripen, and can consequently be consumed as soft persimmons.

An alternative is to grow astringent cultivars and to remove astringency by exposing fruit to high concentrations of CO_2 gas and ethanol (Eaks 1967; Kitagawa 1970; Matsuo *et al*. 1976) [4, 11, 13]. Both treatments were used routinely in Japan to commercially treat astringent persimmons. These treatments are thought to induce soluble tannins in the flesh to coagulate and form insoluble complexes, resulting in loss of astringency. Fruit of astringent cultivars can be consumed firm or semi-firm only after the astringency has been removed, whereas non-astringent persimmons are normally edible at harvest, although they attain optimum flavour when fruit just start to soften. An important consideration in the development of astringent persimmons as an export crop is removal of astringency. Few reported studies have been conducted in Japan to examine the storage characteristics of astringent persimmons, although some work has been carried out in Israel with the cultivar 'Triumph' (Guelfat-Reich *et al.* 1975) [7] and in California with 'Hachiya' (Eaks, 1967) [4]. These preliminary trials provide guidelines for astringency removal and identify potential problems related to postharvest treatments and storage.

Materials and methods

Fruit procurement: For this study uniform, uninjured and healthy fruits of the astringent cv. Hachiya were harvested at RHRS Seobagh, Kullu, (H.P) and brought to the laboratory for the application of the following post-harvest deastringent treatments. After the application of treatments the fruits were stored under ambient conditions and fruit quality was evaluated periodically for 9 days.

CO_2 application: Carbon dioxide CO_2 treatment was applied as a gaseous application of fruits in HDPE packets. CO_2 treatment was applied by flushing the gas @ 99 per cent for 8, 16, and 24 hours. After the treatment fruits were packed in brown paper bags and stored at ambient temperature.

Ethanol applications: Ethanol dip treatment was applied as a dipping the fruits in 10, 20 and 30 per cent solution of ethanol solution for 15 minute. After the application fruits were removed from the solution and packed in brown paper bags whereas, ethanol vapour treatment was applied as treating the fruits with ethanol solution @ 10, 20 and 30 per cent in desiccator for 24 hours. After the application fruits were removed from the desiccator and packed in brown paper bags and stored at ambient conditions.

Fruit assessment: Fruit firmness was measured with a portable Effigi penetrometer (FT-327) which recorded the pressure required to force a plunger of 8 millimetres (mm) diameter into the flesh of the fruit samples. Soluble solid content were measured with hand refractometer. Titrable acidity was measured by titration method (0.1N NaOH) (Hortwitz, 1980) [9]. Total tannin content was measured by spectrophotometric method by extracted in 80 per cent ethanol and estimated on the basis of their reaction with an oxidizing agent phosphomolybdate in Folin-Ciocalteau reagent under alkaline conditions (Bray and Thorpe, 1954) [2]. The rate of respiration was measured as carbon-dioxide evolved per unit weight of fruit per unit time. Known weight of fruit was enclosed in an airtight container of known volume for a known time and the carbon dioxide evolved due to respiration was measured with the help of Gas data analyser (GFM series 301/2/3, Gas Data Ltd. Coventry UK) and was expressed as ml CO_2 kg hr^{-1}.

Statistical analysis: Data were subjected to analysis of variance (ANOVA) and analysed by Completely Randomized Design (CRD) with three replications (Mahony, 1985) [12].

Results and discussion

Data pertaining to the changes in TSS and titratable acidity of persimmon fruits cv. Hachiya as affected by different post-harvest treatment during ambient storage is presented in the Table 1. From the data it is evident that there was an increase in TSS content under all treatments as the storage period progressed. Among various treatments tried treatment T_9 (>80% CO_2 gas treatment 20 hrs) had the highest TSS value with maximum mean value (15.80 ºB) which was at par with treatment T_6 (Ethanol vapour 30 %). On the other hand minimum fruit TSS (14.15 ºB) was recorded in control fruits (T_{10}) which was significantly lowest as compared to other treatments. However, a decrease in titratable acidity content under all treatments as the storage period progressed. Among various treatments tried treatment T_9 (>80% CO_2 gas treatment 20 hrs) had the minimum titratble acidity value with minimum mean value (0.55%) which was followed by treatment T_8 and T_6. On the other hand maximum titratable acidity (0.66 %) was recorded in control fruits (T_{10}) which was significantly highest as compared to other treatments. The interaction between treatments (T) and storage intervals (S) was found to be significant. The possible reason in increasing TSS was the effect of CO_2 gas on accelerating the ripening process which leads to breakdown of complex carbohydrates into simple sugar molecules (Arnal and Del Rio, 2004) [1]. With respect to TA a rapid decline was observed in fruits treated with CO_2 gas which could probably be due to its ability to raise the rate of respiration and ripening process, thereby rapid changes was observed in titratable acidity. Similar results in persimmon fruits treated with different concentrations of CO_2 have been reported by earlier by Arnal and Del Rio, (2004) [1] and Salvador *et al.* (2007) [15].

Data pertaining to the changes in firmness and rate of respiration of persimmon fruits cv. Hachiya as affected by different post-harvest treatment during ambient storage is presented in the Table 2. From the data it is evident that there was a decrease in fruit firmness under all treatments as the storage period progressed. Among various treatments tried T_9 was most effective in increasing the fruit firmness by enhancing the ripening of the fruits and hence, resulted in significantly lowest mean firmness (5.1 kg/cm^2) and it was followed by the treatments T_8, respectively. On the other hand maximum fruit firmness (7.6 kg/$cm^{2)}$ was recorded in control fruits (T_{13}) which was significantly higher as compared to other treatments. With respect to rate of respiration, there was a progressive increase in rate of respiration under all treatments as the storage period progressed. Among various treatments tried treatment T_9 (>80% CO_2 gas treatment 20 hrs) had the highest respiration rate with maximum mean value (10.10 mL/CO_2/Kg/h) which was followed by treatment T_6 and T_8. On the other hand minimum respiration rate (8.98 mL/CO_2/Kg/h) was recorded in control fruits (T_{10}) which was significantly lowest as compared to other treatments. The interaction between treatments (T) and storage intervals (S) was found to be significant. The loss of fruit firmness is mainly attributed to change in the turgor pressure of cells walls due to fruit softening caused by the breakdown of insoluble protopectin into soluble pectin and its further breakdown by a series of pectic enzymes (Mattoo *et al.*, 1975) [14]. Itamura *et al.* (1997) [10] reported that enhancement on ethylene production in 'Saijo' persimmon treated with CO_2 to remove astringency. Harima *et al*., (2003) [8] stated that, high CO_2 concentrations could act as a stress that induces the production of ethylene and rate of respiration.

Changes in total tannin of persimmon fruits cv. Hachiya as affected by different post-harvest treatment for removal of astringency during ambient storage is presented in the Table 3. From the data it is evident that there was a decrease in soluble tannin content under all treatments as the storage period progressed. Among various treatments tried treatment T_9 (>80% CO_2 gas treatment 20 hrs) had the lowest tannin value with minimum mean value (2.13%) which was followed by treatment T_6 and T_8. On the other hand maximum tannin (3.06 %) was recorded in control fruits (T_{10}) which was significantly highest as compared to other treatments. The interaction between treatments (T) and storage intervals (S) was found to be significant. In this study CO_2 gas treatment was found most effective in reducing the tannin content which is due to the carbon dioxide nature that helps in acetaldehyde formation, which, in turn, causes the tannins to move into storage cells. (Del Bubba *et al*., 2009) [3].

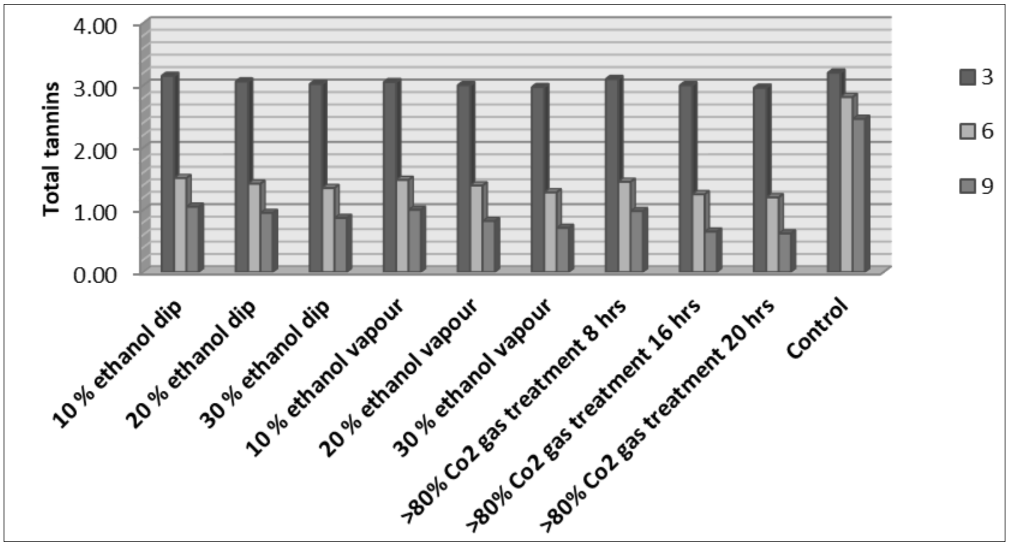

Fig 1: Graphical representation of changes in tannin content with respect to post-harvest treatments and storage intervals.

Table 1: Effect of various post-harvest treatments on change in total soluble solids (^{O}B) and titratable acidity (%) of persimmon fruit during 9 days of storage period

Treatment details	Total soluble solids (^{O}B)				Titratable acidity (%)			
	3	6	9	Mean	3	6	9	Mean
T_1: Ethanol dip @ 10 %	14.25	17.50	16.00	15.92	0.66	0.60	0.54	0.60
T_2: Ethanol dip @ 20 %	14.85	17.10	16.20	16.05	0.63	0.58	0.51	0.57
T_3: Ethanol dip @ 30 %	15.00	17.00	16.50	16.17	0.60	0.55	0.50	0.55
T_4: Ethanol vapour @ 10 %	14.10	17.35	16.10	15.85	0.64	0.58	0.52	0.58
T_5: Ethanol vapour @ 20 %	14.80	17.50	16.30	16.20	0.61	0.55	0.45	0.54
T_6: Ethanol vapour @ 30 %	15.41	17.85	16.65	16.64	0.59	0.51	0.43	0.51
T_7:>80% CO_2 @ 8 hrs	14.75	17.40	16.20	16.12	0.65	0.60	0.48	0.58
T_8:>80% CO_2 @ 16 hrs	15.41	17.83	16.72	16.65	0.60	0.55	0.36	0.50
T_9:>80% CO_2 @20 hrs	15.50	17.85	16.75	16.70	0.58	0.53	0.35	0.49
T_{10}: Control	14.00	14.50	15.00	14.50	0.69	0.65	0.60	0.65
Mean	14.81	17.19	16.24		0.63	0.57	0.47	
CD $_{0.05}$ T=0.08, S=0.04, T×S=0.14 T= 0.04, S=0.02, T×S=NA								

Table 2: Effect of various post-harvest treatments on change in firmness (kg/cm^2) and rate of respiration (mg/ CO_2/kg//h) of persimmon fruit during 9 days of storage period

Treatment details	Fruit firmness (Kg/cm^2)				Respiration rate (mg/ CO_2/kg//h)			
	3	6	9	Mean	3	6	9	Mean
T_1: Ethanol dip @ 10 %	7.20	4.32	3.10	4.87	8.70	10.50	11.00	10.07
T_2: Ethanol dip @ 20 %	7.02	4.05	2.94	4.67	8.75	10.70	11.20	10.22
T_3: Ethanol dip @ 30 %	6.84	3.55	2.52	4.30	8.90	10.80	11.30	10.33
T_4: Ethanol vapour @ 10 %	7.05	4.03	3.05	4.71	8.70	10.70	11.20	10.20
T_5: Ethanol vapour @ 20 %	6.75	3.61	2.45	4.27	8.90	10.90	11.50	10.43
T_6: Ethanol vapour @ 30 %	6.54	3.25	2.04	3.94	9.00	10.90	11.65	10.52
T_7:>80% CO_2 @ 8 hrs	6.75	3.31	2.82	4.29	8.90	10.90	11.30	10.37
T_8:>80% CO_2 @ 16 hrs	6.24	3.05	2.06	3.78	9.00	11.00	11.61	10.54
T_9:>80% CO_2 @20 hrs	6.05	2.90	1.83	3.59	9.20	11.00	11.70	10.63
T_{10}: Control	8.09	6.82	5.90	6.94	8.60	9.00	9.80	9.13
Mean	6.85	3.89	2.87		8.87	10.64	11.23	
CD $_{0.05}$ T= 0.05, S= 0.03, T×S=0.09 T= 0.06, S=0.03, T×S=0.10								

Table 3: Effect of various post-harvest treatments on change in total tannins (mg/100g) of persimmon fruit during 9 days of storage period

Treatment details	Total tannins (mg/100g)			
	3	6	9	Mean
T_1: Ethanol dip @ 10 %	3.15	1.51	1.05	1.90
T_2: Ethanol dip @ 20 %	3.06	1.42	0.95	1.81
T_3: Ethanol dip @ 30 %	3.02	1.35	0.87	1.75
T_4: Ethanol vapour @ 10 %	3.05	1.48	1.00	1.84

T_5: Ethanol vapour @ 20 %	3.00	1.39	0.82	1.74
T_6: Ethanol vapour @ 30 %	2.97	1.28	0.71	1.65
T_7:>80% CO_2 @ 8 hrs	3.10	1.45	0.98	1.84
T_8:>80% CO_2 @ 16 hrs	3.00	1.25	0.65	1.63
T_9:>80% CO_2 @20 hrs	2.96	1.20	0.62	1.59
T_{10}: Control	3.20	2.81	2.46	2.82
Mean	3.05	1.51	1.01	
CD $_{0.05}$ T= 0.04, S= 0.02, T×S=0.08				

Conclusion

A decline in fruit firmness, titratable acidity and total tannins content was observed under all the treatments during storage under ambient conditions. However, the use of different deastringent treatments resulted in decreasing the firmness, titratable acidity and total tannins content in fruits as comparison to control fruits which exhibited the highest fruit values under ambient condition. The minimum mean firmness, titratable acidity and total tannins content was recorded in fruits treated with treatment T_9 (80% CO_2 @ 24 hrs) under ambient storage condition.

An increase in the total soluble solids and rate of respiration content of persimmon fruits was observed during storage under ambient condition. The minimum mean TSS and rate of respiration was recorded in control fruits, whereas the maximum mean TSS and rate of respiration was observed in fruits treated with treatment T_9 (80% CO_2 @ 24 hrs) during 9 days of ambient storage.

References

1. Arnal L, Del Rio MA. Effect of cold storage and removal astringency on quality of persimmon fruit (*Diospyros kaki*, L.) cv. Rojo Brillante. Food Science and Technology International. 2004; 10(3):179-185.
2. Bray HC, Thorpe W. Analysis of phenolic compounds of interest in metabolism. Methods Biochemistry Analysis. 1954; 1:27-52.
3. Del Bubba M, Giordani E, Pippucci L, Cincinelli A, Checchini L, Galvan P. Changes in tannins, ascorbic acid and sugar content in astringent persimmons during on-tree growth and ripening and in response to different postharvest treatments. J Food Compos. Anal. 2009; 22:668-677.
4. Eaks IL. Ripening and astringency removal in persimmon fruits. Journal of the American Society for Horticultural Science. 1967; 91:868-875.
5. Garcia-Carbonell S, Yague B, Bleiholder H, Hack H, Meier U and Agusti M. Phenological growth stages of the persimmon tree (*Dispyros kaki*). Annal of Applied Biology. 2002; 141:73-76.
6. George AP, Nissen RJ, Collins RJ. Effects of temperature and pollination on growth, flowering and fruit set on the non-astringent persimmon cultivar ‘Fuyu’ under controlled temperature. Hort Science, 1994, 225-230.
7. Guelfat-Reich S, Ben-Arie R, Metal N. Effects of C02 during and following storage on removal of astringency and keeping quality of 'Triumph' persimmons. Journal of American Society of Horticultural Science. 1975; 100:95-98.
8. Harima S, Nakano R, Yamauchi S, Kitano Y, Yamamoto Y, Inaba A, *et al*. Postharvest Biology and Technology. 2003; 29(3):319-324.
9. Hortwitz W. Official Methods of Analysis, 13th ed. Association of Annual Chemistry, Washington, D.C, 1980.
10. Itamura H, Leng P, Yamamura H. Effects of some chemicals on break-ing bud dormancy in Japanese persimmons. Environment Control in Biology. 1997; 32:171-176.
11. Kitagawa H. Kaki culture and its utilization. Yokendo, Tokyo: 219 p. (Japanese).
12. Mahony MO. Sensory Evaluation of Food: Statistical Methods and Procedures. Marcel Dekker. Inc. New York, 1985.
13. Matsuo T, Shinohara J, Hoo S. An improvement on removing astringency in persimmon fruits by carbon dioxide gas. Agricultural biological chemistry. 1976; 40(1):215 -217.
14. Mattoo AK, Modi VV, Reddy VVR. Oxidation and carotenogenesis regulating factors in mangoes. Indian Journal of Biochemistry. 1975; 5:111-114.
15. Salvador A, Anarl L, Besada C, Larrea V, Quiles A, Pérezmunuera I. Physiological and structural changes during ripening and deastrigency treatment of persimmon fruit cv. ‘Rojo Brillante’. Postharvest Biology and Technology. 2007; 46:181-188.
16. Yonemori K, Ikegami A, Kanzaki S, Sugiura A. Unique features of tannin cells in fruit of pollination constant non-astringent persimmons. Acta Horticulturae. 2003; 601(1):31-35.