Postharvest Quality of Sour Cherry Fruits Sprayed by Ethephon

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Abstract

Ethephon (2-chloroethylphosphonic acid) was used to reduce the fruit removal force and facilitate the harvest process for sour cherries. The effect of preharvest Ethephon application on the quality of sour cherry during the storage period in modified atmosphere packaging (MAP) at 0°C was investigated. Modified atmosphere packaging was used with 10, 15 and 75 % O_2, CO_2 and N_2, respectively. This composition of gas at 0°C increased the postharvest shelf life of fruits. Fruit samples were evaluated at harvest date and after 6 weeks of storage. Weight loss, skin colour, pH, total soluble solids (TSS), titratable acidity (TA), TSS/TA ratio and firmness of fruits were monitored. Ethephon effects on TSS, TSS/TA ratio, L* value, and TA at harvest date were concentration-dependent. Fruit colour became darker after 6 weeks of storage.

INTRODUCTION

Many products are stored for periods before consuming. During the last few years, there have been activities in sweet cherry (*Prunus avium*) research and development aimed at the application of new postharvest storage technologies to extend fruit storage life, extending the original quality of the freshly harvested fruits. Cherries are the most appreciated fruit by consumers since they are early season fruits and have excellent quality. The main quality indices are skin colour, which is related to fruit ripening and is affected by anthocyanin concentration (Serrano et al., 2005), and total soluble solids-total acidity ratio (TSS/TA) at harvest. Sour cherry (*Prunus cerasus*) fruits deteriorate rapidly after harvest and in some cases do not reach consumers at optimum quality after transport and marketing. The main causes of cherry fruit deterioration are weight loss, colour changes, softening, surface pitting and loss of acidity, while low variations occur in TSS (Bernalte et al., 2003).

The technology of harvest has a beneficial effect on maintaining cherry fruit quality during the postharvest storage. Years ago, sour cherry fruits were hand-harvested, but today, they are harvested mechanically by shaker machines so the fruit can be harvested more efficiently. Cherry has an important place in human nutrition, and can be used as fresh, dried or processed fruit. Sour cherries destined for processing are shaken from trees when ripe. Ethephon (2-chloroethylphosphonic acid) is used before harvesting to facilitate mechanical harvest. Likewise, fruits such as strawberry (*Fragaria* × spp.) (Curd, 1988) and cherry exposed to ethylene can have more intense red colour than those stored in ethylene-free air. Alique et al. (2005) recommended a temperature about 0°C and 95% relative humidity as suitable storage conditions for sour cherries, which have extremely short shelf lives. Allende et al. (2007) suggested modified atmosphere packaging (MAP) to control postharvest decay of fruits. Controlled and modified atmospheres have also been recommended to improve cherry marketability (Meheriuk et al., 1995; Desai and Salunkhe, 1995; Remón et al., 2000).

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The object of the present study was to investigate the change in quality of 'Érdi jubileum' sour cherries from harvest to processing. Harvested fruits are in a perishable condition and are susceptible to changes in sensory properties, especially if storage conditions favor enzyme activities or microbiological growth. The quality of cherry products was determined by their appearance and sensory properties. Although various investigations have been conducted about MAP, little information is available concerning MAP fruits that have been treated with Ethephon.

MATERIALS AND METHODS

'Érdi jubileum' sour cherry fruits were harvested at the ripe stage and at commercial maturity that was determined by both fruit colour and total soluble solids from a commercial orchard that was grafted on *Prunus mahaleb* rootstocks, near Mashhad, Iran. Ethephon (produced by Khorasan Science and Technology Park in Iran) was sprayed at concentrations of 0, 150, 225 and 300 ppm at 7 days before anticipated optimum maturity for harvest.

About 250 g of fresh fruit were packed in containers by vacuum (Henkelman 200A, Henkelman, Netherlands). Modified atmosphere packaging was created using polyethylene covers for the containers, with a thickness of 70 µm and which included three layers PE/PA/PE (polyethylene/polyamide/polyethylene). The atmosphere that was established was comprised of 10% O_2, 15% CO_2, and 75% N_2. The trays of fruit were located in a cold-storage room at 0°C. The effects of treatments on postharvest fruit quality were evaluated by measuring weight loss, flesh firmness, total soluble solids (TSS), pH, titratable acidity (TA), sugar/acid ratio and skin colour (L*, a*, b*) before and after being stored up to 6 weeks.

The TSS was measured as °Brix using a digital refractometer (Palette, PR-101, Japan). The TA was assessed by titration with sodium hydroxide (0.1N) and expressed as percent from malic acid. The TSS/TA ratio was calculated and the pH was measured by using a digital pH-meter (Knick, Portamess, Germany). Skin colour was measured on the cheek area of 30 fruits with a Minolta colorimeter CR-200™ model (Minolta camera Co., Osaka, Japan). Estimates of cherry firmness, based on deformation (as mm/60 second) were obtained with a pressure tester (Atago, Japan).

Three replications were evaluated in a randomized experiment. Statistical analysis was carried out using data analysis functions in Microsoft Excel and significant differences between the results were calculated by analysis of variance (ANOVA) and LSD test. Differences at $p < 0.05$ were considered to be significant.

RESULTS AND DISCUSSION

In the modified atmosphere packaging and at all concentrations of Ethephon, no significant effect was found on weight loss (data not shown). Yaman and Bayoindirli (2002) found that fruits kept at 0°C lost less weight than fruits held in environment conditions. Similarly, the modified atmosphere packaging and 0°C temperature prevented weight loss and increased shelf life.

Ethephon did not affect fruit pH (data not shown); however, pH increased after 6 weeks of storage (Table 1). According to Nunes et al. (1995), 'Chandler', 'Oso Grande' and 'Sweet Charlie' strawberries, stored at 1°C, showed no differences in pH, but TA was slightly lower after 1 week.

Ethephon increased TSS at harvest (Fig. 1A). The TSS of control samples increased during storage, but the TSS of Ethephon-treated fruit decreased during storage. Yaman and Bayoindirli (2002) found that cherries that were stored at 0°C after 32 days had no change in TSS or sugar, and Alique et al. (2005) got this result in MAP conditions**.** The TA of 'Érdi jubileum' fruits was increased at harvest by Ethephon, and TA decreased during storage (Table 1 and Fig. 1B). After 6 weeks storage, TA was higher in control fruits and those treated with 150 ppm of Ethephon than in fruits treated with 225 and 300 ppm of Ethephon. Kupferman and Sanderson (2001) found that TA in sweet cherry fruits kept in MAP at 1°C decreased after 34 days. Manganaris et al. (2007) found that storage time decreased TA in peach (*Prunus persica*) fruit.

The TSS/TA ratio increased with Ethephon application (Fig. 2A), which indicates that the fruit treated with Ethephon presented a more pronounced ripening development than that of control fruits. Likewise, the ratio increased during the 6 weeks of storage, from 15.5 to 20.9 (Table 1). The increase could be related to the higher respiration rate of fruits during storage. As would be expected from the TSS and TA data analyses, there were no considerable differences in the ratio for the 225 ppm and 300 ppm of Ethephon after storage, while there were significant differences for the control samples and fruits treated with 150 ppm.

The deformation of fruits at harvest, an inverse measure of fruit firmness, increased with increasing Ethephon concentrations (Fig. 2B), indicating that the Ethephon caused softer fruit at harvest. Storage did not significantly affect fruit firmness for any of the treatments (Table 1, Fig. 2B). Kupferman and Sanderson (2001) found no differences in fruit firmness of sweet cherry fruits stored in MAP at 1°C for 34 days. Manganaris et al. (2007) found that storage time of peach fruits influenced firmness. These results confirm that cherry firmness does not correlate with storage (Lurie and Aharoni, 1997).

The main quality indices are skin colour, which is related to fruit ripening. Although Ethephon causes fruits to ripen sooner, it had no significant effect on fruit colour (Fig. 3), and storage had only a slight effect, primarily on the L* value (Table 2, Fig. 3). Fruits after 6 weeks of storage had a dark red skin colour (lower L* values), but red (a* value) and yellow (b* value) values, as well as hue angle and chroma values, were not significantly different. The results determined that fruits on the MAP at 0°C would have appropriate storability, shelf life and colour after 6 weeks. Gonçalves et al. (2007) found that cherries stored at 15 ± 5°C showed higher reduction of L*, chroma and hue angle in comparison with fruits stored at 1.5 ± 0.5°C. Esti et al. (2002) reported no change in colour coordinates, except for L* value (decreasing in 'Ferrovia') in several sweet cherry cultivars during cold storage.

CONCLUSION

The results indicated that low temperature (0°C) and MAP conditions can be used to increase shelf life of sour cherries that have been treated with Ethephon, although they caused a minor change in some of the quality parameters. Increasing Ethephon concentration did not change the quality parameters of sour cherry fruits more before storage than after 42 days of storage, although some quality parameters (such as TA, sugar/acid ratio and colour coordinates) were better than those of control samples. In spite of that, TSS decreased in Ethephon-treated fruits, but it was still acceptable and was comparable to that of control fruits before storage. Therefore, this research showed the beneficial effects of modified atmosphere packaging for 'Érdi jubileum' sour cherry fruit quality.

Literature Cited

Alique, R., Zamorano, P.J., Martínez, M.A. and Alonso, J. 2005. Effect of heat and cold treatments on respiratory metabolism and shelf-life of sweet cherry, type Picota cv. 'Ambrunés'. Postharvest Biology and Technology 35:153-165.

Allende, A., Marín, A., Buendía, B., Tomás-Barberán, F. and Gil, M.I. 2007. Impact of combined postharvest treatments (UV-C light, gaseous O_3, superatmospheric O_2 and high CO_2) on health promoting compounds and shelf-life of strawberries. Postharvest Biology and Technology 46:201-211.

Bernalte, M.J., Sabio, E., Hernández, M.T. and Gervasini, C. 2003. Influence of storage delay on quality of 'Van' sweet cherry. Postharvest Biol. Technol. 28:303-312.

Curd, L. 1988. The design and testing (using strawberry fruits) of an ethylene dilution system. M.Sc. thesis, Silsoe College, Cranfield Institute of Technology, UK.

Desai, B.B. and Salunkhe, D.K. 1995. Cherry, production, composition, storage and processing. p.397-405. In: D.K. Salunkhe and S.S. Kadam (eds.), Handbook of Fruit Science and Technology. Marcel Dekker, New York.

Esti, M., Cinquanta, L., Sinesio, F., Moneta, E. and Di Mateo, M. 2002. Physicochemical and sensory fruit characteristics of two sweet cherry cultivars after cool storage. Food Chemistry 76:399-405.
Gonçalves, B., Silva, A.P., Moutinho-Pereira, J. and Bacelar, E. 2007. Effect of ripeness and postharvest storage on the evolution of colour and anthocyanins in cherries (*Prunus avium* L.). Food Chemistry 103:976-984.
Kupferman, E. and Sanderson, P. 2001. Temperature management and modified atmosphere packaging to preserve sweet cherry quality, Washington State University – Tree Fruit Research and Extension Center. Postharvest Information Network.
Lurie, S. and Aharoni, N. 1997. Modified atmosphere storage of cherries. Post-Harvest Horticulture Series, Department of Pomology, University of California, Davis, USA. No. 17, p.149-152.
Manganaris, G.A., Vasilakakis, M., Diamantidis, G. and Mignani, I. 2007. The effect of postharvest calcium application on tissue calcium concentration, quality attributes incidence of flesh browning and cell wall physicochemical aspects of peach fruits. Food Chemistry 100:1385-1392.
Meheriuk, M., Girard, B., Moyls, L., Beveridge, H.J.T., McKenzie, D.L., Harrison, J., Weintraub, S. and Hocking, R. 1995. Modified atmosphere packaging of Lapins sweet cherry. Food Res. Int. 28:239-244.
Nunes, M.C.N., Brecht, J.K., Morais, A.M.M.B. and Sargent, S.A. 1995. Physical and chemical-quality characteristics of strawberry after storage are reduced by a short delay to cooling. Postharvest Biology and Technology 6:17-28.
Remón, S., Ferrer, A., Marquina, P., Burgos, J. and Oria, R. 2000. Use of modified atmospheres to prolong the postharvest life of Burlat cherries at two different degrees of ripeness. J. Sci. Food Agric. 80:1545-1552.
Serrano, M., Guillén, F., Martínez-Romero, D., Castillo, S. and Valero, D. 2005. Chemical constituents and antioxidant activity of sweet cherry at different ripening stages. J. Agric. Food Chem. 53:2741-2745.
Yaman, Ö. and Bayoindirli, L. 2002. Effect of edible coating and cold storage on shelf life and quality of cherries. Lebensm. Wiss. Technol. Food Sci. Technol. 35:146-150.

Tables

Table 1. Changes in some quality parameters of 'Érdi jubileum' sour cherry fruit evaluated before and after storage in modified atmosphere packaging at 0°C.

Storage time (days)	pH	°Brix (TSS)	Titratable acidity (mg/100 ml)	TSS/TA ratio	Flesh firmness (mm)
Before storage	3.6b	23.8a	1.6a	15.5b	5.8a
After 42 days storage	3.8a	22.9a	1.2b	20.9a	5.6a

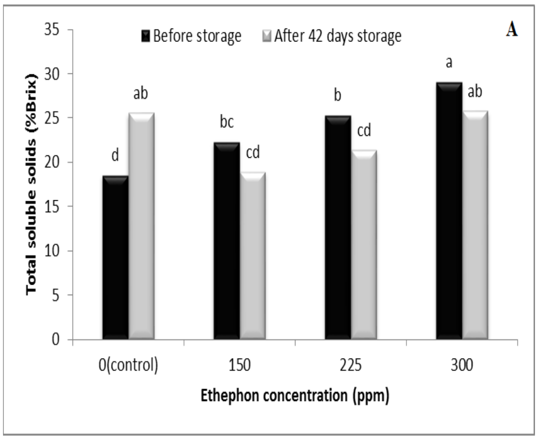
In each column, means with the same letters are not significantly different at 5% level of probability using DMRT.

Table 2. Changes in some colour properties of 'Érdi jubileum' sour cherry fruit evaluated before and after storage in modified atmosphere packaging at 0°C.

Storage time (days)	L*	a*	b*	Hue angle	Chroma value
Before storage	24.0a	9.2a	2.0a	4.7a	9.5a
After 42 days storage	23.1b	7.4a	1.9a	4.0a	7.6a

In each column, means with the same letters are not significantly different at 5% Level of probability using DMRT.

Figures



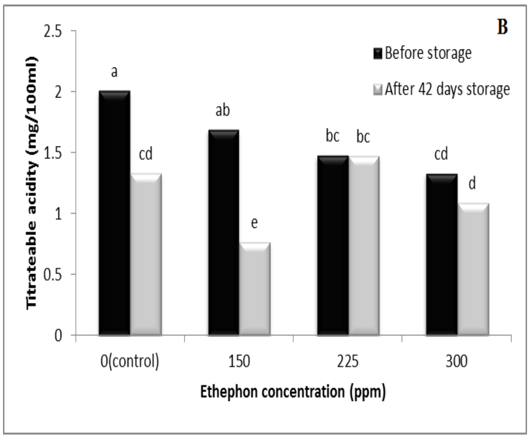


Fig. 1. Effect of Ethephon treatments (0 [control], 150, 225, 300 ppm) on A) total soluble solids and B) titratable acidity of 'Érdi jubileum' sour cherry fruit evaluated before and after storage in modified atmosphere packaging at 0°C.

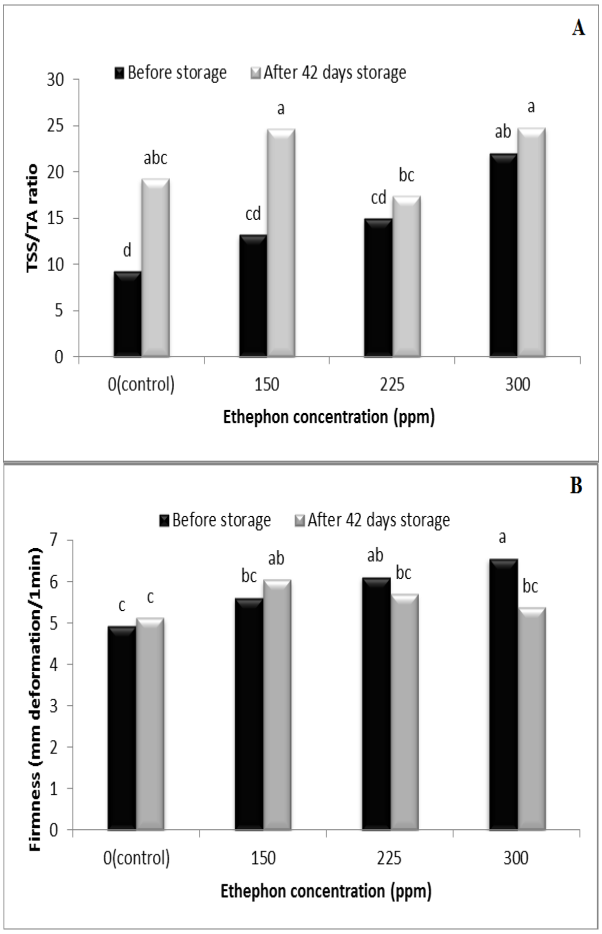


Fig. 2. Effect of Ethephon treatments (0 [control], 150, 225, 300 ppm) on A) sugar/acid ratio and B) firmness of 'Érdi jubileum' sour cherry fruit evaluated before and after storage in modified atmosphere packaging at 0°C.

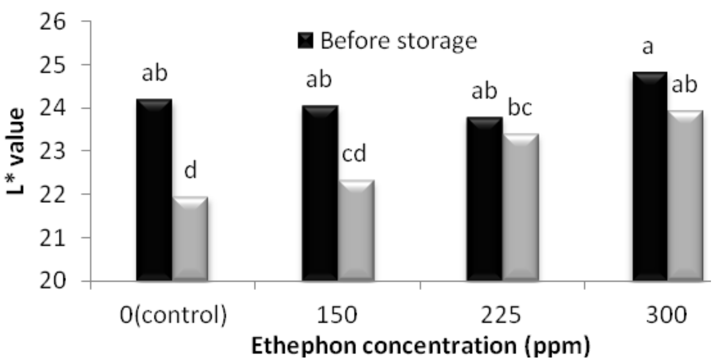


Fig. 3. Effect of Ethephon treatments (0 [control], 150, 225, 300 ppm) on L* value of 'Érdi jubileum' sour cherry fruit evaluated before and after storage in modified atmosphere packaging at 0°C.