International Journal of Horticultural Science 2009, 15 (1–2): 81–85
Agroinform Publishing House, Budapest, Printed in Hungary
ISSN 1585-0404

Response of sour cherry cultivar 'Érdi jubileum' fruits to modified atmosphere packaging after ethephon spraying

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Summary: Sour cherries are not adapted to long storage. The largest percentage of sour cherries reaches the consumer either directly or indirectly through the tin can or the frozen pack. Different concentrations of ethephon usually are used commercially to facilitate harvesting sour cherry fruits that this hormone influences on fruit quality. The objective of this study was effect of ethephon preharvest application on sour cherry fruits quality during storage period at modified atmosphere packaging was investigated. Modified atmosphere packaging used with 10, 15 and 75 percent for O_2, CO_2 and N_2 respectively that those held at 0 °C. This gas compounds synchronous to 0 °C temperature caused to increase shelf life postharvest of fruits. Fruit samples were evaluated at harvest date and after 6 weeks in storage. Skin fruit colour, pH, total soluble solids, titrateable acidity, sugar/acid ratio, firmness were monitored. Ethephon concentration influenced on total soluble solid, titrateable acidity, sugar/acid ratio and L* value. In more case, 225 ppm ethephon's concentration has no observable different to control samples. Thus, the best ethephon's concentration was 225 ppm ethephon's concentration.

Key words: sour cherry, Erdi jubileum, shelf life, Modified atmosphere packaging (MAP), ethephon, concentration.

Introduction

Cherry has an important place in human nutrition, and can be used as fresh, dried or processed fruit. Sour cherries are fruits with a short shelf life, so postharvest deterioration occurs very quickly if adequate precautions are not taken to prevent it (*Childers*, 1983). More injuries are found in the early-picked and less ripened fruits stored at 4–5°C than in the more ripened fruits stored at 0–1 °C (*Kajiura*, 1972, 1973). *Sekse* (1996) found that the storage temperature greatly influenced the fruit respiration rate decreasing that low temperature caused decreased respiration during storage that due to protect fruits quality.

The used of ethephon (2-chloroethylphosphonic acid) for reducing the attachment force of olive fruits to the tree branch has been widely studied by many workers (*Hartmann* et al., 1968, *Lavee* et al., 1973).

Strawberries exposed to ethylene can have more intense red colour than those stored in ethylene-free air (*Curd*, 1988). Exogenous ethylene can also enhance the growth of Botrytis on strawberry and decrease fruit firmness (*El-Kazzaz* et al., 1983). *Wills & Kim* (1995) found that use of the ethylene absorbent, such as potassium permanganate, extended the storage life of strawberry fruit. Ku et al. (1999) found that treatment with 1-MCP (1-Methylcycloprppene) extended the postharvest life of strawberry fruit through a delay in rotting. *Alique* et al. (2005) recommended temperature about 0 °C and 95% RH as storage suitable conditions for both sweet and sour cherries that have extremely short shelf lives.

Allende et al. (2007) have been suggested modified atmosphere packaging (MAP) as postharvest treatment to control decay of strawberries. In general, overall quality was good in all samples throughout the shelf-life except for flavour scores of MAP strawberries, which were clearly lower than air-stored samples after 9 and 12 days of storage. No additional effect was observed when combining the postharvest treatments compared with the effect of individual treatments.

Controlled and modified atmospheres have also been recommended as ways of improving cherry marketability (*Meheriuk* et al., 1995; *Desai & Salunkhe*, 1995; *Rem´on* et al., 2000; *Petracek* et al., 2002; *Holb & Schnabel*, 2005).

Girardi et al. (2005) reported under CA storage on peach fruits, the firmness of the pulp was better preserved and the incidence of decay and woolliness decreased. The overall quality of the peaches was better preserved under CA storage alone.

Cordenunsi et al. (2003) found several parameters related to strawberry quality, such as texture, anthocyanin content, titrateable acidity, pH, total ascorbic acid, and total soluble sugars, were evaluated over a week of cool storage. That low temperature used to increase strawberry shelf-life could also induce small changes in some of the quality parameters studied. They study indicated that the cultivar is the most important factor for determining post-harvest quality and extended shelf-life.

The aim of the present study was to investigate the change in the quality of sour cherries cv. Erdi jubileum occurring from harvest to processing. Thus, the harvested fruits are in a perishable condition and are susceptible to changes in sensory properties especially if storage conditions favour enzyme activity or microbiological growth. Previous studies on the storage of cherries have included modified atmosphere packaging and the use of temperature 0°C. The quality of cherry products was determined by their appearance and sensory properties.

Despite, various investigations did about MAP, but little information is access about MAP fruits that spray with ethephon.

Materials and methods

Plant material

Sour cherry (*Prunus cerasus* cv. Erdi jubileum) fruits were harvested ripe stage and commercial maturity were obtained during the month of June 2007 from commercial orchard in Mashhad (Shahdiran in Iran) in early morning. The following product was used in our study: ethephon (Ethrel, produced by Hockley Company in UK). The chemical were applied as sprays at 0, 150, 225 and 300 ppm at 7 days before anticipated optimum maturity for harvest, using 1250 liters of spray per hectare (about 5 liters/tree). Uniform 13-years-old sour cherry cv. "Erdi jubileum" trees were used. The effects of the treatments on fruit quality were observed on two occasions 0 and 6 weeks after harvest and held of storage respectively, by evaluating weight loss, flesh firmness, total soluble solids (TSS), pH, titrateable acidity (TA), TSS/TA and skin colour (L*, a*, b*). Freshly harvested fruit were utilized here. Sour cherries intended for processing are shaken from trees when ripe.

Preparation of samples

A mass of 300g of fresh fruit, having the same quality, was packed in once consumption containers by vacuum henkelman 200A (Henkelman, Netherlands). Polyethylene (plastic) covers thickness (coarseness) was 70 µm and included 3 layers PE/PA/PE (polyethylene/polyamide/ polyethylene).

Chemical analyses

Total soluble solids (TSS) were measured as Brix using a digital refractometer (Palette, PR-101). The total titrateable acidity (TA) was assessed by titration with sodium hydroxide (NaOH) (0.1N) and expressed as a percent from malic acid. TSS/TA ratio calculated and the pH value was measured on using a digital pH-meter (Knick, Porttamess). Skin colour was measured on the cheek area of 30 fruit with a Minolta CR-200 chromameter having an aperture size of 10mm for reading of small samples without cut-off (Minolta, Japan).

Machine firmness

In the experiments, fruit firmness was measured as mm displaced in 30 fruits under a 150g constant load (after Macnish et al., 1997).

Statistical analysis

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). Differences at $p < 0.05$ were considered to be significant.

Results and discussion

Weight loss

In all cases, in modified atmosphere packaging and all concentrations of ethephon, found no effect significant on weight loss. Yaman and Bayoindirli (2002), found that fruits held in 0 °C decrease weight loss than fruits that held in environment condition. Thus, results the modified atmosphere packaging and 0 °C temperature caused to prevent from weight loss and increased shelf life. In spite of the fact that held in storage caused weight loss, but MAP and 0 °C temperature inhibited humidity loss and due to prevented weight loss. This resulted that ethephon with per concentration weren't caused fruits weight loss at this conditions (*Table 1*). Storage conditions greatly influenced

Table 1. Effect of ethephon treatments (0 [control], 150, 225, 300 ppm) in some quality parameters of sour cherry fruits in modified atmosphere packaging and 0 °C conditions

Ethephon concentration (ppm)	Weight loss (gr)	pH	°Brix (TSS)	Titratable Acidity(mg/100cc)	Sugar/Acid	Flesh firmness (mm)
0	5.27a	3.68a	21.17b	1.33ab	18.09b	5.41a
150	6.22a	3.73a	25.13a	1.49a	19.37ab	5.75a
225	7.16a	3.63a	25.25a	1.60a	15.94b	6.24a
300	5.09a	3.78a	25.35a	1.11b	23.25a	5.61a

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

Table 2. Changes in some quality parameters evaluated before storage and after storage on sour cherry fruit in modified atmosphere packaging and 0 °C conditions

Storage time (days)	pH	°Brix (TSS)	Titratable Acidity(mg/100cc)	Sugar/Acid	Flesh firmness (mm)
Before storage (Day 0)	3.51b	24.78a	1.64a	15.78b	5.86a
After 42 days storage (Day 42)	3.86a	23.68a	1.13b	22.54a	5.65a

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

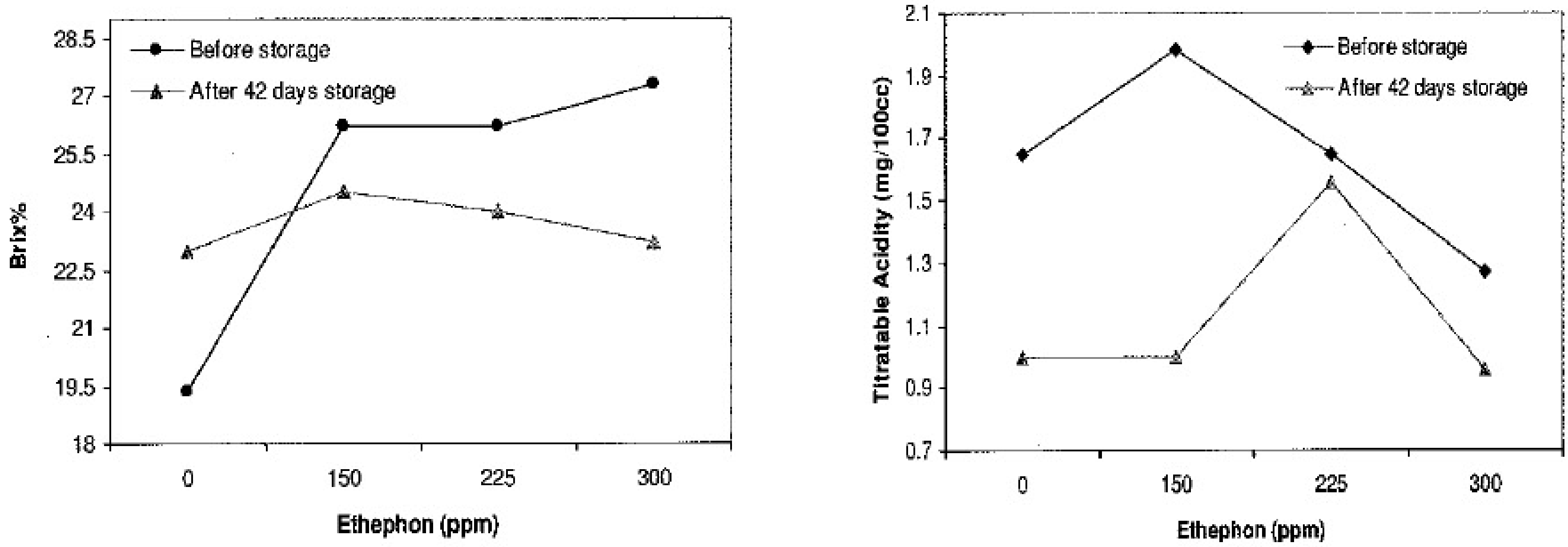

Figure 1. Effect of ethephon treatments (0 [control], 150, 225, 300 ppm) before storage and after storage on chemical attribute of sour cherry fruits in modified atmosphere packaging and 0 °C conditions

the quality loss of the fruits, the time of preservation quality fruits increased with decreasing storage temperature and MAP and weight loss decreasing during this term and have no significant.

Chemical properties

Some chemical properties of sour cherry cv. Erdi jubileum were investigated and given in *Table 2* both at harvest date and 6 week after storage.

Samples pH has not any significant different at various ethephon's concentrations (*Table 1*), but little increased after 6 weeks storage than at harvest date (*Table 2*). According to results of *Nunes* et al. (1995), cultivars 'Chandler', 'Oso Grande' and 'Sweet Charlie', stored at 1 °C, showed no differences in pH, but TA was slightly lower after 1 week.

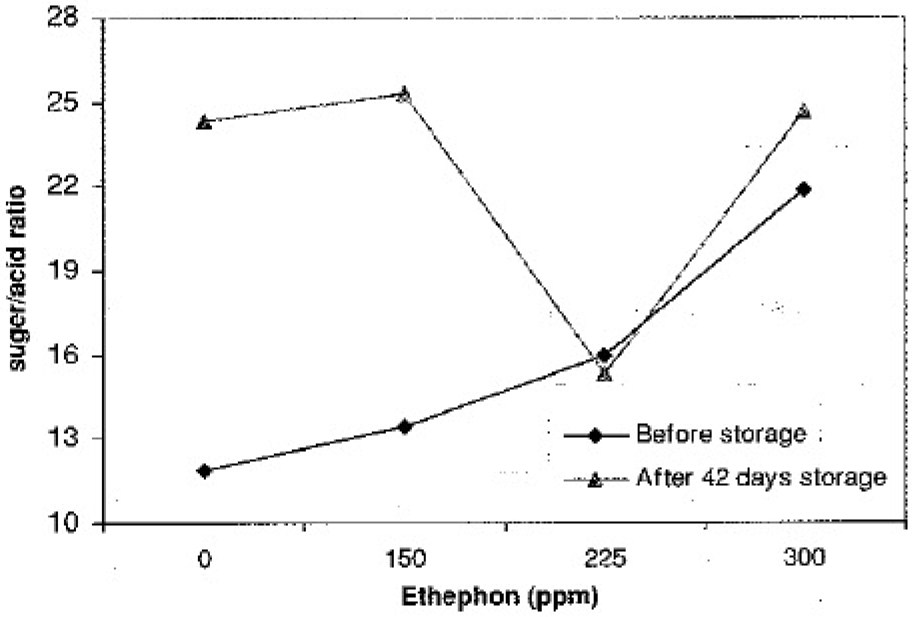

Figure 2. Effect of ethephon treatments (0 [control], 150, 225, 300 ppm) before storage and after storage on sugar:acid ratio of sour cherry fruits under modified atmosphere packaging and 0 °C conditions

When comparing total soluble solids (TSS) at various dates (at harvest date and after 42 days held in storage) haven't changes and were similar (*Table 2*) while concentrations of ethephon increased its than control samples (*Table 1*). As seen in *Figure 1*, TSS before storage decreased than after 6 weeks (42 days) storage at control samples, but other concentrations of ethephon after storage decreased TSS. *Yaman & Bayoindirli* (2002), found that cherries stored at 0 °C about 32 days after storage have no change in TSS and sugar and also *Alique* et al. (2005), resulted in MAP conditions its.

The titratable acidity (TA) of Erdi jubileum fruits was decrease after storage term (*Table 2*). Kupferman and Sanderson (2001), found sweet cherry fruits in 1°c temperature after 34 days packaging MAP decreased TA. *Mangarise* et al. (2007), found that was influenced storage time of peach fruits on decrease TA. With extend ethephon's concentration decreased TA, but 300ppm concentration compared with control samples have no significant different (*Table 1*). As seen in *Figure 1*, 225ppm closely before and after storage were similar.

The sugar/acid ratio after held 6 weeks increase from 15.78 to 22.54 (*Table 2*). The most amount sugar/acid ratio related to 300ppm ethephon's concentration, but other concentration have no effect significant different together. As seen in *Figure 2*, 225ppm ethephon's concentration before and after storage did not observable different.

Various ethephon's concentrations caused to decreased flesh firmness of fruits, but have no effect on its (*Table 1*). Also the flesh firmness before storage and after held 6 weeks at storage did not significant different (*Table 2*). *Simcic* et al. (1998), reported to decrease of flesh firmness during ripening. *Kupferman & Sanderson* (2001), found sweet cherry fruits stored at in 1°c temperature after 34 days MAP, no differences were detected in firmness those. *Mangarise* et al. (2007) found that was influenced storage time of peach fruits on firmness. These results confirm that the analysis of cherry firmness does not correlate with storage (*Lurie & Aharoni*, 1997).

The chromatic characteristics of the fruits studied are shown in *Tables 3* and *4* and *Figure 3*. Skin colour is considered to be the most important index of cherry quality and maturity. As seen in *Table 3*, the apparent colour (particularly L* value) of the sour cherry fruits was found to be statistically significant at the 0.05% probability levels. Fruits after held 6 weeks in storage had dark red colour of the skin (lower L* values) and less red (lower a* value) and less yellow (lower b* value) than harvest date but a* and b* weren't significant. Chroma and hue angle of fruits weren't found to have significantly different at the 0.05% probability levels, and resulted in different means varying from 4.20 to 3.84 and from 7.69 to 6.64, respectively. Various ethephon's concentrations did not significant effect on skin colour, except L* value that ethephon's hormone caused to increase it and fruits had lighter red colour than control samples. *Goncalves* et al. (2007), found cherries stored at 15 ± 5 °C showed higher reduction of L*, chroma and hue angle than fruits stored at 1.5 ± 0.5 °C. *Esti* et al. (2002), by held several sweet cherry cultivars at cool storage observed no change on colour correlations, except for L* value (decreasing in Ferrovia cultivar).

The results indicated that low temperature and MAP, used to increase sour cherry shelf-life that they treated by

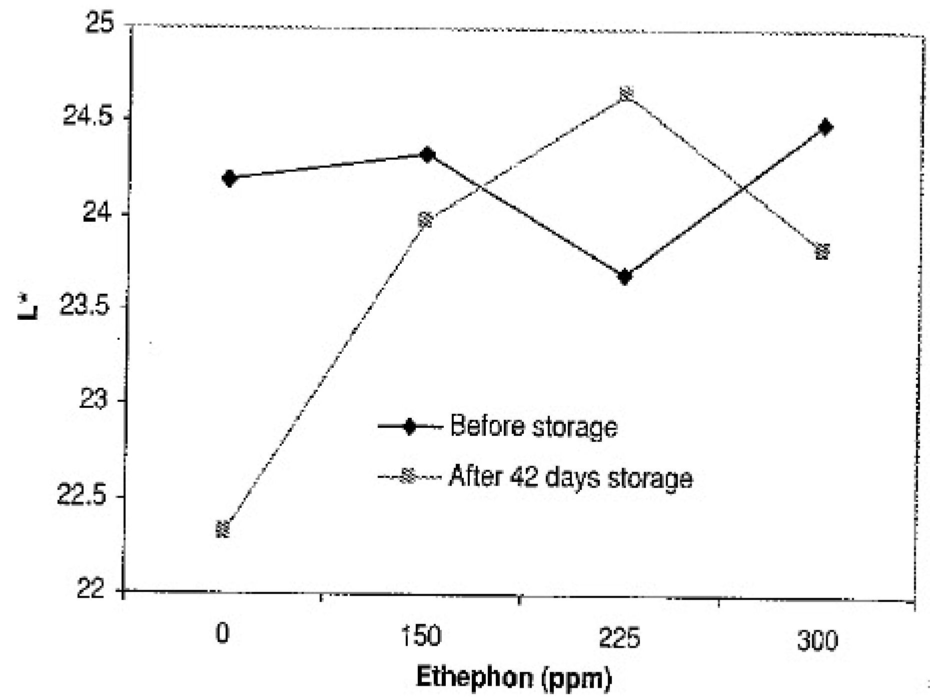

Figure 3. Effect of ethephon treatments (0 [control], 150, 225, 300 ppm) before storage and after storage on colour of sour cherry fruits in modified atmosphere packaging and 0 °C conditions

ethephon's hormone, could also induce small changes in some of the quality parameters studied. The best ethephon's concentration was 225ppm ethephon's concentration than other concentrations that mostly was similar to control samples.

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Table 3. Color development of non-treated and treated sour cherry under different modified atmospheres and 0 °C conditions

Storage time (days)	L*	a*	b*	Hue angle	Chroma value
Before storage (Day0)	24.17a	7.47a	1.81a	4.20a	7.69a
After 42 days storage (Day42)	23.70b	6.42a	1.67a	3.84a	6.64a

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

Table 4. Effect of ethephon treatments (0 [control], 150, 225, 300 ppm) on colour of sour cherry fruits under modified atmosphere packaging and 0 °C conditions

Ethephon concentration (ppm)	L*	a*	b*	Hue angle	Chroma value
0	23.26b	7.50a	1.84a	4.25a	7.72a
150	24.16a	7.22a	1.86a	3.80a	7.46a
225	24.18a	6.40a	1.65a	3.93a	6.61a
300	24.18a	6.66a	1.65a	4.11a	6.86a

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

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