Shelf-life Extension of Sweet Cherries by Field Management, Post-harvest Treatments and Modified Atmosphere Packaging

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Sweet cherries have a short shelf life of 7-14 days in conventional cold storage, but with modified atmosphere packaging in cold storage cherry storage life can be as long as 30-40 days. This technology will provide NY cherry growers with an expanded marketing season for sweet cherries. Our research has shown that the best cherry quality after storage is achieved by application of gibberellic acid in the field, harvest at optimum maturity, rapid cooling of cherries after harvest by hydrocooling with proper fungicide application, modified atmosphere packaging of quality healthy fruit, and refrigerated storage at 38°F or lower.

Sweet cherries (*Prunus avium* L.) are a very perishable commodity with a short shelf life of 7-14 days in conventional cold storage. In many cases, cherries must be sold at low prices to expedite movement and prevent complete losses that can occur once the fruit quality declines below market standards. Factors such as field conditions, harvest time, rapid cooling, proper refrigeration and packaging, greatly influence the shelf-life and consumer acceptability of the fruit. Proper handling and cooling practices such as hydrocooling are essential in maintaining sweet cherry quality after harvest. Fruit quality is determined by visual appearance, stem color, firmness and flavor.

Sweet cherries and tart cherries (*Prunus cerasus* L.) also contain significant amounts of phytochemical components such as phenolic compounds, which are known to have positive health effects (Kim et al., 2005). Sweet cherries have approximately 1500 mg total phenols per kg of fresh weight, in which 60-74% of the phenols by weight consist mainly of hydroxycinnamates, anthocyanins, flavan-3-ols (catechins) and flavanols (Goncalves et al., 2004). Furthermore, the anthocyanins in cherries have been associated with alleviating arthritis and gout-related pain (Wang, 1999).

In recent years, the use of Modified Atmosphere Packaging (MAP), especially in the large production areas in the Western U.S. has become more prevalent to extend the life of fresh cherries (Shelton, 1994). Properly designed MA bags have been shown to lower respiration rates and ripening of fruits by altering the oxygen and carbon dioxide concentration in the bags to close to ideal MA conditions for cherries: 3-10% oxygen and 10-15% carbon dioxide at 32°F (Mitcham et al., 2002). MA bags can also prevent water loss and fruit shriveling by maintaining a high humidity environment of 90-95% relative humidity. Other research has also shown that MAP maintained green stems and fruit firmness, both of which are critical for marketing cherries in retail stores (Padilla-Zakour et al., 2004; Kappel et al., 2002; Remón et al., 2000). Incorrect use of MAP or not matching the product to the appropriate MA film could result in anaerobic conditions leading to product spoilage (Rai et al., 2002).

We have conducted MAP studies for the last three years on NY sweet cherries with positive results. We continue to investigate the best practices needed to optimize the postharvest treatment of sweet cherries grown in NY in order to maintain quality and prolong shelf life.

Results from 2005 harvest

From previous studies, we had observed a beneficial effect of hydrocooling and MAP in Lapins and Hedelfingen with up to four weeks shelf life compared to no more than two weeks for control fruit stored at 38°F and 90% relative humidity. Some problems encountered were cracking and detachment of green stems in MAP cherries, which seemed to be variety dependant.

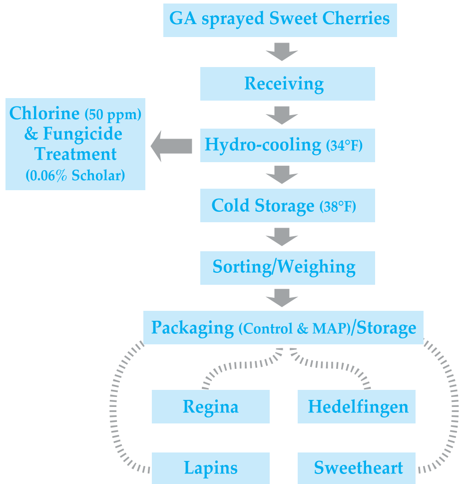

Figure 1. Post-harvest handling of sweet cherries to evaluate their shelf-life under modified atmosphere packaging at 38°F.

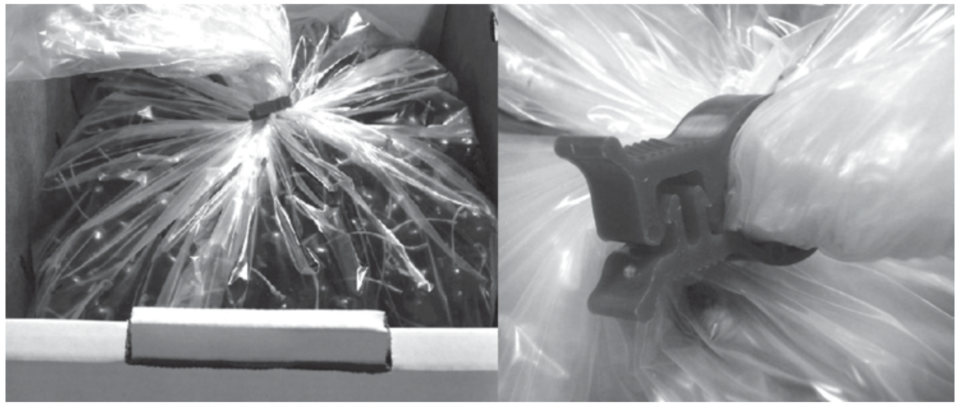

Figure 2. Typical 10-pound Modified Atmosphere (MA) bag for prolonged refrigerated storage of sweet (Regina) cherries.

In 2005, we evaluated the use of gibberellic acid (GA) in the field, harvest date, hydrocooling and MAP on cherry quality and shelf-life. GA is applied to the trees as a spray (20 ppm) 3-5 weeks before harvest when fruit is light green to straw color. GA is expected to delay the ripening process, extend the harvest season, increase fruit size and firmness, and decrease surface pitting. The varieties studied were Lapins, Hedelfingen, Sweetheart and Regina (small trial).

Cherries were manually harvested, hydrocooled in 50-100 ppm chlorinated water at 33-34°F for 15 min, drained and left to dry overnight in a cold room at 35°F. Blowers were used to eliminate excess moisture on the fruit surface (which promotes cracking due to excessively high moisture in bagged fruit). Cherries were packed in perforated poly bags (control) and in MA LifeSpan L212 10-pound bags designed for sweet cherry storage (courtesy of Chris King, Amcor Flexibles, Australia). Samples were stored in controlled rooms set at 90% relative humidity and 38°F or 45°F. Sampling was done every 10 days, up to 40 days for evaluation of quality attributes: moisture loss, % cracked and decay, color, stem color/loss, firmness, pH, acidity, soluble solids (°Brix) and eating quality.

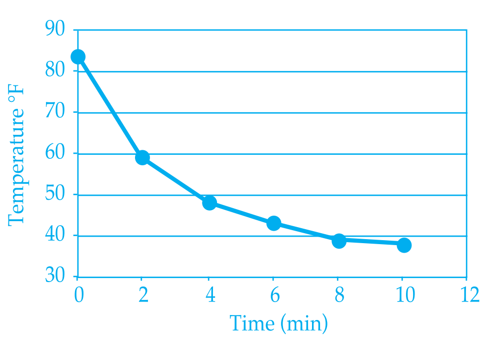

Figure 3. Cooling of freshly harvested sweet cherries by hydrocooling with chlorinated water at 34°F.

Effect of gibberellic acid application and MAP. For the four sweet varieties studied, the use of GA combined with MAP resulted in extended shelf-life with better overall quality. MAP cherries had 20 to 30 day shelf-life at 38°F compared to about 10 days for control samples. In 2005, we observed a high incidence of mold and decay in the packaged cherries, which shortened the length of the study even though healthy cherries were in very good condition.

Effect of harvest date and storage temperature. A significant decrease in quality of the fruit was observed when the cherries were harvested a week later and when the storage temperature increased from 38 to 45°F. The use of MAP to decrease the respiration rate, and therefore the ripening of the fruit, was only marginal for fruit harvested late and stored at 45°F.

Effect of variety. There were some differences in changes in quality over time depending on the variety studied. Lapins, Sweetheart and Regina seem to respond well to MAP while Hedelfingen presented higher incidence of cracking. Overall, the use of MAP combined with GA application yielded positive results if the harvested fruit was of good quality and in healthy condition.

Results From 2006 Harvest

The same four sweet cherry varieties were studied to evaluate year-to-year variation: Lapins, Hedelfingen, Regina, and Sweetheart (Figure 1). GA was applied in the field to all varieties and fruit was harvested at optimum maturity between July 10 and 24. All samples were stored at 38°F, 90% relative humidity, with and without MAP (Figure 2). Due to the high incidence of mold in 2005, we tested a post-harvest fungicide application, Scholar (fludioxonil, Syngenta Crop Protection Inc., Greensboro, NC), at 0.06% concentration during the hydrocooling of Sweetheart cherries (Figure 1). This fungicide is intended to control common post-harvest diseases of kiwi, pome fruit, stone fruit and yam.

Samples were evaluated as described before with the addition of anthocyanin and total phenolic content, which are becoming important parameters for marketing purposes.

The efficacy of hydrocooling. Hydrocooling is considered the fastest and the most homogenous effective way to cool cherries compared to other methods such as room cooling and forced-air tunnel cooling. By rapidly eradicating field heat, hydrocooling helps maintain color and quality, reduce glucose and fructose metabolism, control respiration rate, and lower percentage of decay (Alique et al., 2006). Our hydrocooling unit was very effective (Figure 3) as cherries were cooled from 84°F to 39°F within 10 min.

Effect of MAP on respiration rate of cherries. The optimal concentration of gases for prolonged storage of cherries is 3-10% O_2 and 10-12% CO_2. Each variety responded differently to the MAP conditions as shown in Figure 4, where the final concentrations were close to the ideal conditions but it took longer to achieve for Lapins and Sweetheart.

Efficacy of MAP as compared to conventional poly bags. Much lower percent decay for all varieties was documented in MAP samples as compared to perfo-

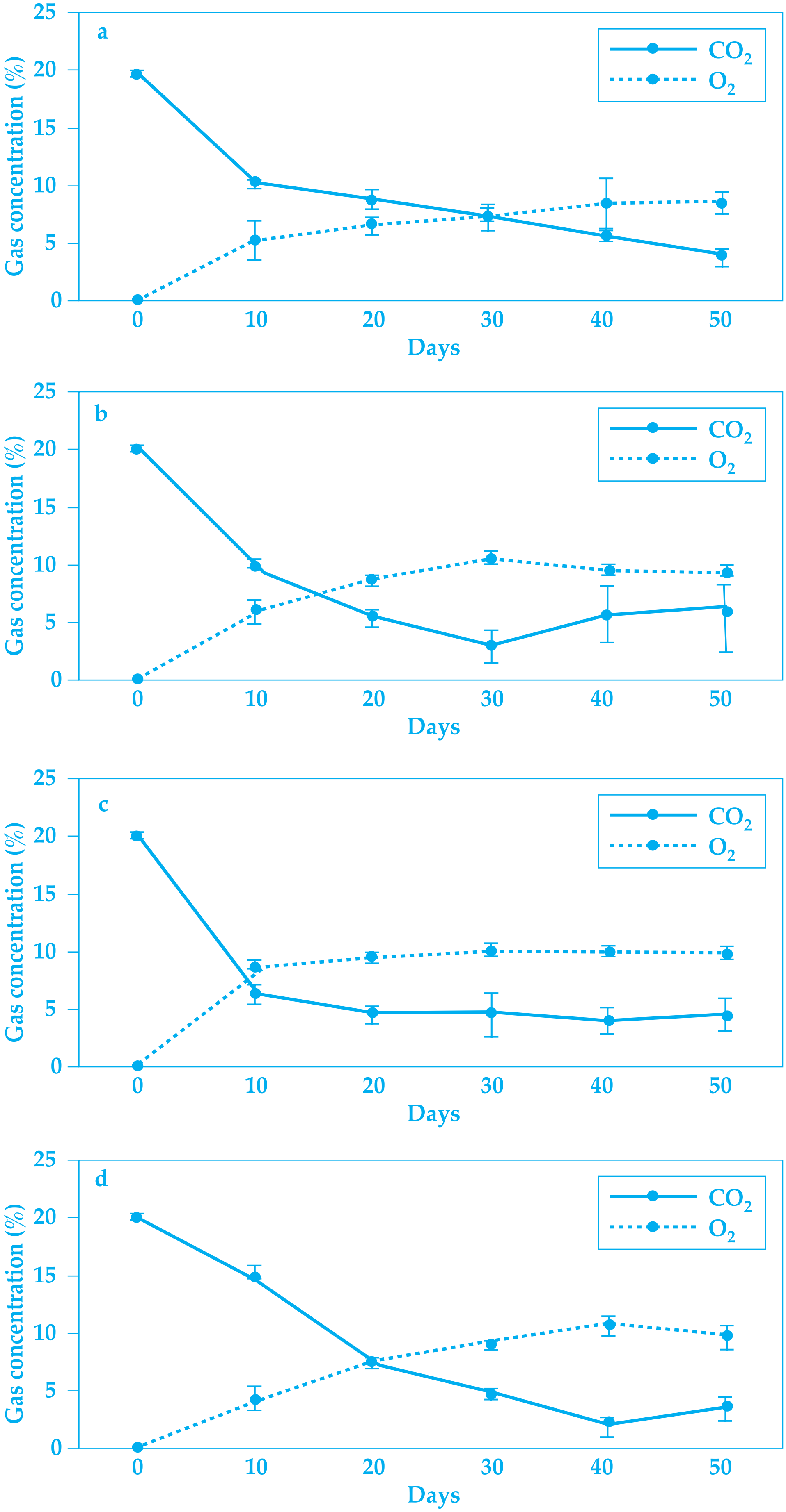

Figure 4. Changes in gas composition within MAP packages of a) Lapins, b) Regina, c) Hedelfiingen, d) Sweetheart stored at 38°F.

Figure 5. Hedelfingen shown cracking at day 20 of MAP storage at 38°F, and significant decay at day 40.

rated poly bags (control), prolonging the shelf-life of fresh sweet cherries. Table 1 shows the values obtained at 40 days, the time considered to be the end of the storage time for most varieties. The application of MAP also showed significant improvement on weight loss and texture on all cherries.

Significance of fruit-maturity at harvest. Notably, fruit-maturity at harvest impacts storage quality of sweet cherries. Hedelfingen was tasted and visually inspected to be at over-matured stage at the point of harvest compared to the other cultivars. Technical measurements (color, total soluble solid, acidity level, and texture analysis) also showed over-maturity. This resulted in the highest percentage of decay (34.6%) in MAP packaged Hedelfingen cherries stored up to 40 days as compared to the other three varieties. In addition, Hedelfingen showed significant fruit-cracking at 20 days that most likely accelerated the high level of decay observed (Figure 5).

Effect of MAP on phenolic and anthocyanin content. Kalt and others (2001) reported that anthocyanin content in fruit vary among cultivars. Within the same cultivar, the anthocyanin content also differed due to factors such as stage of maturity, geographic location, light, temperature, and various stresses (Chaovanalikit and Wrolstad, 2004). Notably, anthocyanin content in each variety can vary up to 4-5 fold among cultivars (Goncalves et al., 2004). Phenolic content measured for the four varieties was not affected by MAP, ranging from 315 for Regina to 535 mg/kg for Lapins, and anthocyanins from 88 for Regina to 148 mg/kg for Hedelfingen. The phenolic and anthocyanin content decreased over the storage time at the same rate in control and MAP samples.

Efficacy of fungicide (Scholar) treatment. Sweetheart was the only variety treated with fungicide. There was no significant difference for any quality measurements, except for percent decay. Statistical analysis showed no significant difference in the gas composition measured in MAP samples with and without fungicide, suggesting that the additional treatment had no significant effect on respiration rate of cherries. However, the treatment clearly inhibited the growth of molds and reduced percent decay significantly as shown in Table 2. The application of fungicide accounted for 76% reduction in decay for both conventional and MAP storage.

Conclusion

A much extended shelf-life of fresh sweet cherries can be accomplished by proper field management and post-harvest treatments. Results vary by cultivar and therefore our conclusions are based on our trials with Lapins, Hedelfingen, Regina and Sweetheart cherries. The best quality is achieved by application of gibberellic acid in the field, harvest at optimum maturity for storage, rapid cooling of cherries after harvest by hydrocooling with proper fungicide application, modified atmosphere packaging of quality healthy fruit, and refrigerated storage at 38°F or lower. Under these conditions, the fresh shelf-life can be extended up to 30-40 days with minimal changes in quality.

TABLE 1

Decay at 40 days of sweet cherries packaged in MA bags and stored at 38°F

	% Decay	
Variety	**Control (poly bag)**	**MAP**
Lapins	8.6 %	3.6 %
Regina	12.9 %	3.8 %
Hedelfingen	75.2 %	34.6 %
Sweetheart	8.4 %	5.5 %

TABLE 2

Decay at 50 days of Sweetheart cherries packaged in MA bags with applied Scholar and stored at 38°F

	% Decay	
Treatment	**Without fungicide**	**With fungicide**
Control	29.0 %	7.0 %
MAP bag	13.0 %	3.0 %

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