Storage Temperature and Time Impacts the Quality of East Coast Broccoli

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Introduction

Broccoli is a highly nutritious vegetable crop that is rich in antioxidants and anti-carcinogenic compounds. California is currently the leading producer of broccoli, which requires East Coast consumers to purchase broccoli that must travel thousands of miles postharvest. Moving production to the East Coast could cut down on transportation time and decrease the time between harvest and consumption, when decreases in flavor and nutrition can occur. Measuring glucosinolates and flavor volatiles in broccoli grown on the East Coast can help determine the appropriate postharvest storage conditions in order to optimize flavor and quality.

Objectives

- **To evaluate the impact of storage temperature and duration on broccoli grown on the east coast.**

Materials and Methods

- **Growing System:** Small-scale East Coast broccoli producer standard recommended production practices.
- **Harvest:** Arcadia and Pacman broccoli heads approximately 10 to 15 cm were harvested (Figure 1).
- **Temperature Treatments:** Broccoli harvested from field was separated into two treatments: iced and non-iced. Iced treatments were iced in the field using a slurry icing technique in coolers for transport and were placed in a cooler held at 0°C for Arcadia and Pacman. Non-iced treatments were stored in waxed corrugated cardboard boxes for transport and then held in a cooler at 5°C for Arcadia and 3°C for Pacman.
- **Postharvest Analysis:** Broccoli was removed from storage at 0, 7, 14, 21, 28, and 35 days post-harvest. Two heads were sampled per day/treatment combination.
- **Glucosinolate Analysis:** Tissue was freeze-dried, ground with liquid nitrogen to <20 mesh, and extracted (Figure 2) and analyzed for glucosinolates according to Charron et al. (2004) and Raney and McGregor (1990) using an Agilent 1100 Series HPLC with a Photodiode Array Detector (Figure 3).
- **Volatile Analysis:** Fresh tissue was added to headspace vials and analyzed loosely based on Junior et al. (2011) and Charles and Simon (1990) with an Agilent 6890N GC with an Agilent 5973 MS (Figure 4).

Figure 1. Small scale East Coast broccoli at harvest.

Figure 2. Extraction of glucosinolates using sephadex columns.

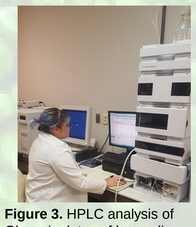

Figure 3. HPLC analysis of Glucosinolates of broccoli performed by Agilent 1100 HPLC.

Figure 4. Analysis of flavor volatiles of broccoli performed by Agilent 6890N GC-MS.

Results

- Arcadia broccoli total glucosinolate content was greatest when stored at 0.5°C (Figure 5)
- Glucobrassicin and glucoraphanin were found in significantly greater quantities for both cultivars when stored at the coolest temperature of 0°C (Figure 5)
- Glucobrassicin was greater at 35 days post-harvest for the Pacman cultivar than at harvest, and Pacman broccoli had significantly greater total glucosinolate content at 35 days post-harvest than at harvest (Figure 6).
- Glucoprogoitrin was not affected by storage time or temperature for either cultivar (Figures 5&6)
- For Pacman broccoli, dimethyl sulfide was greater when stored at 0°C, while dimethyl disulfide was greater when stored at 3°C (Figure 7).
- For Arcadia broccoli, 3-carene and dimethyl sulfide were greater stored at 0°C, while dimethyl disulfide was greater when stored at 5°C (Figure 7).
- For both cultivars, hexanal was greater on the day of harvest, while dimethyl sulfide increased with increase of post-harvest storage time (Figure 8).
- For Arcadia broccoli, 3-carene was greatest the first week after harvest and then greatly decreased (Figure 8).

Conclusion

Neither storage temperature nor time greatly affected nutritionally harmful glucosinolates, such as glucoprogiotrin. However, both cultivars of broccoli stored at the lower temperature had a higher concentration of anti-carcinogenic glucosinolates, such as glucobrassicin and glucoraphanin. Undesirable flavor volatiles, such as dimethyl disulfide, were increased by the increase in temperature and time. Desirable volatiles, such as hexanal and 3-carene, were reduced by the increase of storage time. This study indicates that storing broccoli at 0°C for no longer than 14 days is optimum to maintain the quality parameters evaluated. Future experiments will further examine other flavor and nutritional components, including expand glucosinolate and flavor volatile analysis, carbohydrates, organic acids, and carotenoids.

Literature Cited

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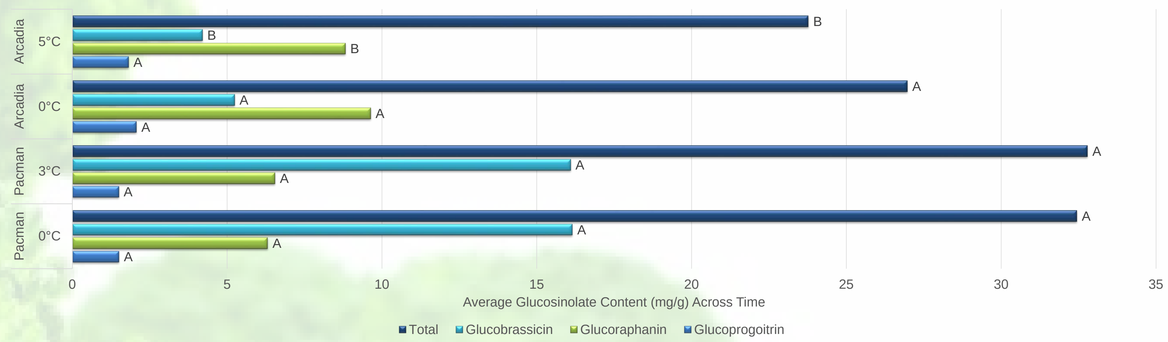
3. Junior, S. B., de Melo, A., Zini, C. A., and Gordoy, H. T. (2011). Journal of Chromatography A 1218 (2011): 3345-3350.
4. Raney, J. P., McGregor, D. I. (1990). Determination of glucosinolate content by gas liquid chromatography of trimethylsilyl derivatives of desulfated Glucosinolates. Proc. Oil Crops Network: 21-23.

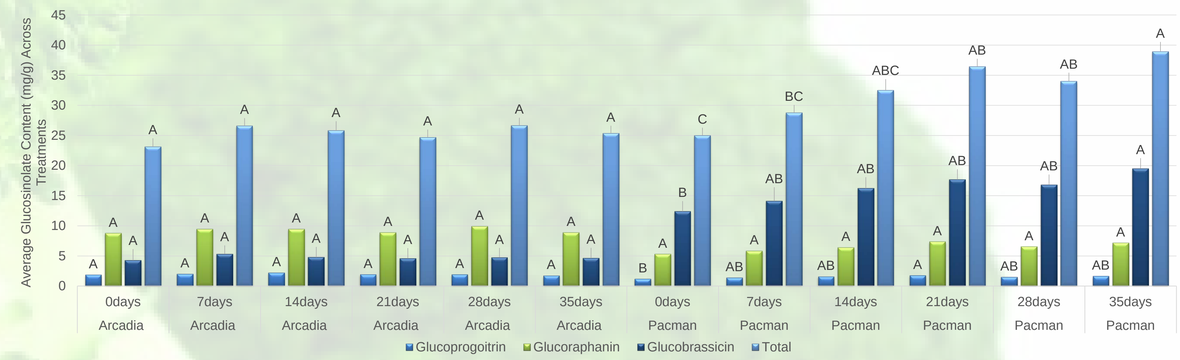
This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2016-51181-25402

Data Figures



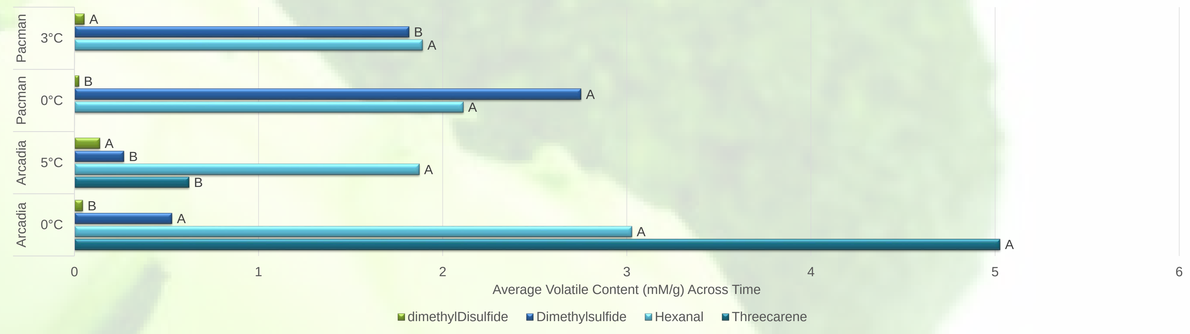
[z]Analysis separated by cultivar. Separate cultivars are not analyzed together due to difference in temperature holdings.
[y]Means separation by Least Squares means test. Means followed by the same letter are not statistically different, α=0.05
[x]Values are combined means from four replications taken over 35days.

Figure 5. Impact of Storage Temperature on Average Glucosinolate content[z][y][x] across time on a dry mass basis of Arcadia Broccoli stored at 5°C as opposed to 0°C and Pacman Broccoli stored at 3°C as opposed to 0°C.



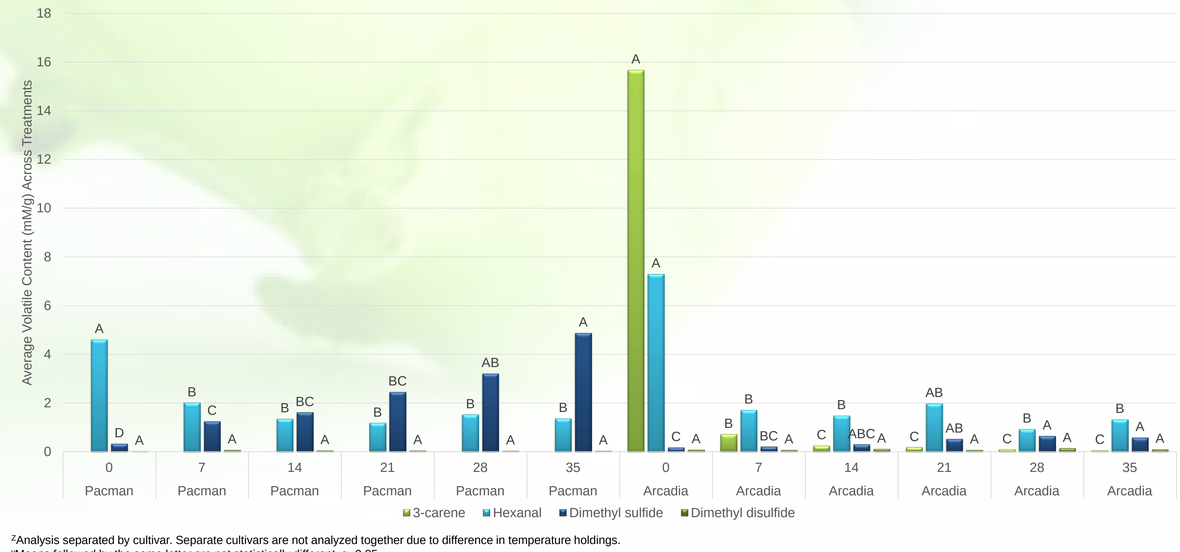
[z]Analysis separated by cultivar. Separate cultivars are not analyzed together due to difference in temperature holdings.
[y]Means followed by the same letter are not statistically different, α=0.05.
[x]Values are combined means from 2 plants per replication and four replications per treatment.

Figure 6. Impact of Storage time on average Glucosinolate content[z][y][x] across temperatures on a dry mass basis of two broccoli cultivars stored over 35 days post-harvest.



[z]Analysis separated by cultivar. Separate cultivars are not analyzed together due to difference in temperature holdings.
[y]Means separation by Least Squares means test. Means followed by the same letter are not statistically different, α=0.05
[x]Values are combined means from four replications taken over 35days.

Figure 7. Impact of Storage temperature on Flavor volatile content[z][y][x] across storage time on a fresh mass basis of Arcadia Broccoli stored at 5°C as opposed to 0 °C and Pacman Broccoli stored at 3°C as opposed to 0°C.



[z]Analysis separated by cultivar. Separate cultivars are not analyzed together due to difference in temperature holdings.
[y]Means followed by the same letter are not statistically different, α=0.05.
[x]Values are combined means from 2 plants per replication and four replications per treatment.

Figure 8. Impact of storage time on Flavor volatile content[z][y][x] across storage temperatures on a dry mass basis of two broccoli cultivars stored over 35 days post-harvest.