Quality Changes of Yellow Summer Squash Blossoms (*Cucurbita pepo*) During Storage

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Abstract

Male and female summer squash (*Cucurbita pepo* 'Dixie') blossoms were stored in vented, polystyrene clamshells (3 blossoms per container) for two weeks at 2.5 and 5.0 °C ± 1.0 °C (36 and 41 °F). Blossom appearance was visually evaluated every three days and rated as marketable or unmarketable. Acceptable appearance was retained for 7 days at both 2.5 and 5.0 °C, however microbial rot, petal necrosis, and collapsed tissue were evident by 14 days at both storage temperatures, at which point the blossoms were considered unmarketable. Weight loss after 7 days in storage averaged 2.3 % at both 2.5 °C and 5.0 °C and it increased to 5.1% and 7.3 % after 14 days at these respective temperatures. In a separate test, average respiration rate of female flowers varied according to the storage temperature. During 7 days storage, the respiration rate of female flowers held at 5.0 °C was relatively constant, ranging from 70 to 90 ml-kg^{-1} h^{-1}, however those held at 10.0 °C (50 °F) decreased from 190 to 130 ml-kg^{-1} h^{-1}.

INTRODUCTION

Edible flowers have gained in popularity as an elegant way to garnish dishes, desserts and salads or for use as simple ingredients. Marketing of commercially-grown edible flowers is typically directed to clientele at upscale restaurants who can afford the relatively expensive blossoms, although they can also be found at specialty spice stores, gourmet markets, farmers markets, and picked fresh from home gardens. Squash blossoms are marketed as individually-wrapped male or female flowers, the latter sold either with or without the immature fruit attached. Blossoms may also be sold as clusters in tray packs or other types of packaging. The quality of the flowers at these locations varies greatly due to the high perishability of flowers and the lack of published information concerning postharvest handling.

Squash plants are monoecious, bearing both male and female flowers on the same plant. Female squash flowers are borne on a short stem, and can be easily identified by the small fruit or ovary attached below the fused corolla (Lerner, 2000); male flowers are borne on a longer, slender peduncle. Cucurbit flowers open early in the morning and are receptive (open) for only one day (Johnson, undated). This is an important aspect of flower biology to consider when harvesting squash blossoms for the edible flower market, since some recipes require the use of open blossoms. Popular media publications recommend that flowers be harvested the same day that they will be consumed, although this advice is geared towards home gardeners and definitely limits marketing possibilities for commercial growers. Storage temperature usually is the most important factor limiting the shelf life of fruits, vegetables and herbs (Kelley et al., 2002). Therefore, a proper assessment of the impact of storage temperature on the quality of squash blossoms could help marketers extend the shelf-life through proper temperature management and increase sales by allowing shipment of the produce to further locations.

MATERIALS AND METHODS

Squash blossoms (male and female) were harvested from plants grown in soil-less

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media under protected culture in the spring of 2003 at the University of Florida/IFAS Horticultural Research Unit in Gainesville (Lat: 29.65 N, Long: 82.35W) as part of the UF-Israeli Protected Agriculture Project. Summer squash plants were grown in a variety trial and not specifically for flower production for the commercial market. Flowers were clipped from the stem using sharp scissors; for male flowers approximately 2.5 cm (approximately 1 inch) of peduncle was left, while female flowers were detached from the immature fruit by a gentle twist. Flowers were both male and female and were closed at the time of harvest and were placed directly into hinged, rigid, 2-liter polystyrene containers (Ultra Pac, Minnesota), with three blossoms per container. The containers were immediately transported to the Postharvest Horticulture Laboratory at the Horticultural Sciences Department, University of Florida. Blossoms were visually rated for appearance and weighed before transfer to storage at 2.5 or 5.0 °C (36 and 41 °C). Postharvest treatments typical for other fresh produce, such as sanitizing with chlorinated water, were not applied to the blossoms prior to cold storage. Female blossoms weighed 8 to10 g, while diameter (at widest girth) was 17 to 25 mm and average length was 55 to 60 mm. Due to the limited number of flowers available, both male and female blossoms were stored in the same container and data for the storage tests were not segregated by sex. Flowers were visually evaluated and weighed every three days for two weeks with digital images taken at each evaluation. In a separate test, respiration was determined on female blossoms ('Dixie') stored at 5.0 and 10.0 °C (41 and 50 °F, respectively). Individual containers (3 blossoms per container) were sealed for approximately 1 hr and 0.5 ml headspace was sampled for CO_2 (GowMac® series 580 gas chromatograph with Thermal Conductivity Detector and a CTR-1 column).

RESULTS AND DISCUSSION

Appearance

Blossoms were rated as marketable or unmarketable. Blossoms were considered marketable when appearance was near field fresh and they remained relatively turgid. Flowers were rated unmarketable when they showed petal necrosis, water-soaking, and mycelial growth or wilting. Acceptable visual quality was retained for 7 days at both temperatures, after which time it deteriorated to unmarketable status (data not shown) due to microbial rot, petal necrosis, and collapsed tissue. Different species of edible flowers subjected to low temperature storage respond differently. Kelley et al., (2002) reported that blossoms of viola (*Viola tricolor* L. 'Helen Mount'), pansy (*V.* x wittrockiana L. 'Accord Banner Clear Mixture') and nasturtium (*Tropaeolum majus* L 'Jewel Mix') were still marketable after two weeks storage at -2.5 to 2.5 °C, but only after one week when stored above 2.5 °C while scarlet runner bean blossoms (*Phaseolus coccineus* L. 'Dwarf Bees') retained marketability only for one week when stored at 0 to 10 °C.

Weight Loss

After 7 days in storage, squash blossoms lost less than 3% of fresh weight without a significant difference between temperatures. After 14 days storage, at which point the blossoms were unmarketable, total weight loss was significantly higher in blossoms stored at 5.0 °C than those stored at 2.5 °C. Total weight loss was 7.32% at 5.0 °C and 5.12% at 2.5 °C.

Respiration

The perishability of horticultural commodities is generally proportional to their respiration rates, and crops can be classified based on the respiration rate. Commodities with respiration rates higher than 60 ml-kg^{-1} h^{-1} at 5 °C are classified as having extremely high respiration rates (Kader, 2002) and represent the upper limit in this scale. Carbon dioxide production is influenced by many factors including storage temperature, atmospheric composition as well as the physiology of the commodity itself.

Respiration rates measured in this study showed that 'Dixie' squash blossoms

have an extremely high respiration rate, averaging 76 mg-kg^{-1}-hr^{-1} at 5 °C. After 24 hr, blossoms stored at 10 °C produced 195 mg-kg^{-1}-hr^{-1}, 138% more than those blossoms stored at 5 °C (Fig. 1). However, after 4 days of storage, respiration at 10 °C decreased to 130 mg-kg^{-1}-hr^{-1} and remained fairly constant for 2 more days. These blossoms became unmarketable after 2 days in storage at this temperature. The respiration rate of blossoms at 5 °C was essentially unchanged during the 8-day storage period.

CONCLUSION AND RECOMMENDATIONS

Squash blossoms retained acceptable visual appearance for 7 days at either 2.5 or 5.0 °C. Storage in vented, PETE containers maintained high relative humidity and protected the flowers from crushing. Postharvest senescence is a major limitation to the marketing of many species of cut flowers (Bowyer, 2003). Given the economic importance of the ornamental cut-flower industry, large amounts of resources have been and are being devoted to develop technologies that would extend the postharvest life of cut flowers. This is in contrast to the near-absence of scientific research being conducted to develop treatments and postharvest recommendations for the commercial handling of edible flowers. It must be noted that, due to their toxicity, certain technologies that are standard in the cut-flower industry are not adaptable to the edible flower market. However, other treatments have been approved and proven effective as postharvest treatments, such as controlled atmosphere storage or 1-methylcyclopropene (1-MCP) for fruits, vegetables (Huber et al., 2003), cut flowers and potted plants (Çelikel, 2002). These treatments could one day prove valuable in extending the postharvest life of edible blossoms.

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Literature Cited

Bowyer, M.C., Wills, R.B.H., Badiyan, D. and Ku, V.V.V. 2003. Extending the Postharvest Life of Carnations with Nitric Oxide - Comparison of Fumigation and in Vivo Delivery. Postharvest Biol. and Technol. 30:281-286.

Çelikel, F.G., Dodge, L.L. and Reid, M.S. 2001. Efficacy of 1-MCP (1-methylcyclopropene) and Promalin for the Extending of Post-harvest Life of Oriental Lilies (*Lilium* x 'Mona Lisa' and 'Stargazer'). Scientia Horticulturae 93:149-155.

Huber, D.J., Jeong, J. and Mao, L.C. 2003. Softening During Ripening of Ethylene-Treated Fruits in Response to 1-Methylcyclopropene Application. Acta Hort. 628:193-202.

Johnson, H., Jr. Undated. Fruit Set Problems in Squash, Melons, and Cucumbers in Home Gardens. Leaflet 21242. Cooperative Extension Division of Agricultural Sciences. University of California, Riverside, California, USA.

Kader, A. 2002. Postharvest Technology of Horticultural Crops. University of California Agricultural and Natural Resources Publication 3311. Oakland, Cal., pp. 40.

Kelley, M.K., Cameron, C.A., Biernbaum, A.J., and Poff, L. 2003. Effects of Storage Temperature on the Quality of Edible Flowers. Postharvest Biol. and Technol. 27:341-344.

Lerner, R. 2000. Senior Study Vegetables - Squash Flower. Purdue University. http://www.hort.purdue.edu/ext/senior/vegetabl/squash6.htm.

Tables

Table 1. Average squash blossom weight loss (%) during storage.

Storage Temperature (°C)	Storage Time	
	7 Days	14 Days
2.5	2.17% (0.16)* a	5.12% (0.41) a
5.0	2.58% (0.26) a	7.32% (0.55) b

*Value in parenthesis is standard deviation. Columns with different letters are significantly different at $P < 0.05$ ($n = 3$).

Figures

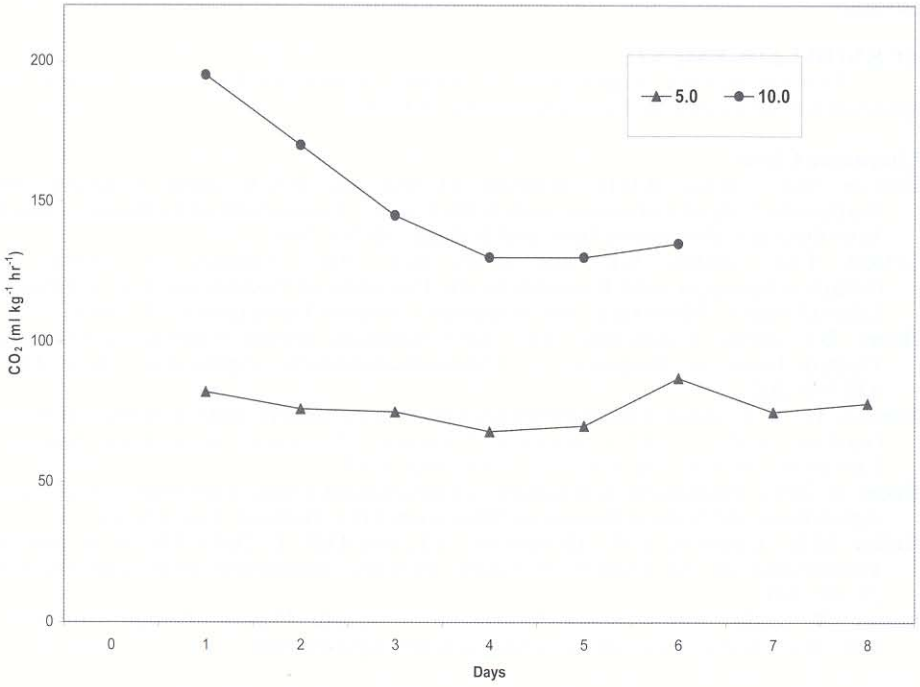

Fig. 1. Respiration rate of female squash blossoms during storage at 5 and 10 °C.