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TARGETING POSTHARVEST TREATMENTS AND STORAGE PRACTICES FOR EXTENDED MARKETING OF FRESH MUSCADINES

Final Report

Penelope Perkins-Veazie
Professor, North Carolina State University, Department of Horticulture, Plants for Human Health Institute, NC Research Campus, 600 Laureate Way, Kannapolis, NC, 28081 704.250.5419
penelope_perkins@ncsu.edu

Objectives: The objectives of these experiments were to 1) determine relative shelf life and acceptable SSC and firmness for consumers of commercially available muscadine cultivars, 2) establish tolerance of muscadines to long term and low temperature storage, 3) determine if muscadine firmness benefits from modified atmosphere (high carbon dioxide and low oxygen) without detrimental effects on aroma, and 4) follow changes in total anthocyanins and phenolic compounds in muscadine berries with treatments.

Justification

Interest in using muscadines for fresh market has grown to the point where new varieties and selections need to be evaluated for short and long term (2 to 8 week) shelf life. To aid selection, an evaluation protocol needs to be developed. To aid marketing, temperatures, packaging and modified atmosphere treatments need to be evaluated. Additionally, the issue of chilling injury in grapes needs to be addressed. Does chill injury happen, at what storage temperatures, and what are symptoms among colors and cultivars?

Methodologies

Fruit collection and cultivars: Muscadine grapes were obtained from plantings at the Horticultural Crops Research Station in Castle Hayne, NC. Connie Fisk left in July of 2011 to take a new position in Wyoming. Bill Cline at Castle Hayne stepped in with varieties from their plots. Unfortunately, Hurricane Irene removed a good portion of fruit a week before fruit were ripe. Despite this event, fruit were harvested August 13, August 30, and September 20. Experiments were scaled back to evaluate remaining material, 'Scarlett', 'Summitt', 'Triumph', 'Nesbitt', 'Southern Home', 'Ison', 'Granny Val' and 'Supreme'. Fruit were hand picked, transported and held at Kannapolis at 4C or at 1C.

Postharvest treatments: Firm fruit free of obvious injury (stem scar tears) or decay were placed in pint polyethylene clamshells. Since the volume of fruit needed for a modified atmosphere was not obtained, vented clamshell pints of fruit were placed in masters then covered with a regular food grade bag, loosely fastened, to minimize weight

loss, blue Fresh N Smart bags (purported to help keep fruit quiescent), and a clear Ziploc bag fastened securely to simulate a passive system for build up of carbon dioxide. Three pints were used for each cultivar, treatment and harvest date. Pints in one master with a food grade bag ('control') were weighed weekly and checked for visible decay, browning, or shrivel. Once decay or browning was determined to make fruit unmarketable, all berries were warmed to room temperature (20 C) then subjectively rated for presence or absence of decay, shrivel, and firmness determined subjectively as a measure of chill injury (more leakage indicates chill injury). All berries free of decay or not excessively soft/brown/shriveled were frozen and held at -20 C before and after storage treatments, for compositional analysis.

Compositional analysis: Subsamples of partially thawed fruit, consisting of 10 to 20 grapes per sample, were cut in half, seeds removed, and remaining berry tissue homogenized. The soluble solids content was measured by placing about 1 ml of puree on a digital refractometer. Five ml of puree will be extracted with methanol:water:acid for anthocyanin and phenolic determination. Methods of Giusti and Wrolstad (1999) will be used to determine total anthocyanins, and those of Singleton et al. (1999) will be used for total phenolics.

Results

Muscadines from the first two harvests held at either 1 or 4C were determined to be unmarketable after 33 days storage. Berries were weighed weekly from the control boxes and evaluated for appearance. Brown lesions appeared after about 3 weeks (21 days) on bronze berries and fruit became completely discolored and started to have visible decay by 33 days.

In the third harvest, fruit did not develop brown lesions until about 6 weeks of storage. Lesions appeared first at 1C and were present at 4C about a week after this. Fruit were determined unmarketable at 53 days from harvest. Bronze grapes ('Granny Val') had brown lesions, and 'Nesbitt' (purple) developed brownish areas that resembled scarring). A good number of 'Nesbitt' grapes were fermented. Below is a summary table of the ratings (Table 1).

Compositional analysis of the muscadines for SSC, acidity, total phenolic and anthocyanin content, and antioxidant tests (FRAP, DPPH) are under way.

Chilling injury has been indicated to occur in bronze muscadine grapes by various researchers. Symptoms that appear to indicate chill injury were seen in the present study. These included the slow appearance of water soaked lesions (apparently under the peel) that turned brown with time, the sudden appearance of leaking juice from stem ends of berries, and development of molds. Another type of browning, that appeared more black and on the top of the peel, usually occurred first, and often discolored the stem end of berries, especially if a small tear was present. In 'Granny Val' fruit, the brown lesions began splitting when berries were handled, indicating damaged peel.

A difference in chill injury between 1 and 4C was not evident in final ratings and was not clear in the first two harvests. In the third harvest, fruit at 1C clearly developed chill injury before those at 4C (about 1 week earlier) (Fig 1). The difference between early and late harvested fruit may be that early fruit simply deteriorate at a faster rate, masking differences in chill injury due to temperature. A logical future experiment would be to use intermittent warming after 2-3 weeks to see if chill injury can be delayed or alleviated.

Of the treatments (control, blue bag, or clear bag) tried, the clear sealed bags had marginally better overall ratings than the other bags (2.2 vs 2.3). The carbon dioxide in these bags was not above 3%, well below the 10-15% needed for benefit, but humidity inside the bags was at 100%, which helped alleviate water stress and probably chill injury development (which seems to develop first in stressed areas on the fruit). Temperature and treatment effects were not statistically different for the other variables measured.

'Supreme' had the best fruit quality after storage of the cultivars tested. A decent number of berries were still marketable even after 53 days in storage, and these berries remained firm to slightly soft, with acceptable flavor. 'Granny Val' berries also were edible, with a good sugar acid flavor. 'Nesbitt' berries were not appealing after storage and were not sampled for flavor.

One of the useful outcomes from this project was development of a protocol and a rating system that can be used by breeders to evaluate selections for fresh market use. The rating system is extensive and will have to be simplified if used for large numbers of evaluations.

Protocol for postharvest evaluation of fresh market life in muscadine:

1. Select berries that are firm and have an SSC of at least 10% but less than 18% (3/4 to full purple color, or green-bronze to pinkish bronze). A minimum berry size of 10 g should be used.
2. Place berries into vented pint (250 g) or quart clamshells. Weigh.
3. Place clamshells into masters and cover with a food grade plastic bag, closed loosely at the end of the master
4. Hold berries at 4-5C for 3 weeks (if plots are not sprayed with fungicide, 2 weeks may be the maximum)
5. Weigh clamshells
6. Before removing fruit from clamshells, evaluate overall appearance (1-3) and overall color (are berries green, bronze, brown, purple or purple-brown?)
7. Remove each berry and determine if hard (like a green muscadine), firm (very slight give similar to fresh), slightly soft, or soft. *Soft berries are indicators of problems such as fermented berries or decays*

(This part of rating could be simplified into 2 categories of hard/firm/sltly soft and soft only)

8. Determine number of leaky berries. We found that leak in stored berries was either from juice from the stem scar (especially if there was a tear going into storage) or from splits arising from brown lesions on other parts of the berry
9. Count number of berries with visible mold/decay, or with shrivel
10. Browning. This part of the rating is the most tedious as there are two parts-the blackish discoloration and the lesions that are often translucent. Best way to simplify would be to decide what is acceptable for either category-is none or slight good enough or should it be none only, then count number of fruit in each.
11. Determine percent in categories by dividing numbers by total number of berries, x 100%
12. Overall score: 100-sum(%brown, %leak, % mold, % soft). A good overall score would need to be determined based on several seasons, using standard varieties such as Fry, Supreme, Summitt, Triumph. Using browning in the overall score system biases in favor of purple varieties, which don't brown as readily as bronze types.

Conclusions

Supreme, Scarlett, and possibly Granny Val could be used for extended storage. However, chill injury is definitely present and poses problems for Scarlett and bronze type muscadines. Options for preventing or delaying chill injury will be increasing carbon dioxide levels to 10-15% and/or intermittent warming treatments. Little difference in weight loss or soft berries was seen between berries stored at 1 or 4C, but using packaging to keep humidity near 100% helped with overall appearance after storage. The rating protocol for fresh market muscadines should help breeders evaluate new selections.

Impact Statement

Muscadine grapes can develop chilling injury when stored over 3 weeks at either 1 or 4 C. 'Supreme' (purple) muscadine grapes had excellent long term storage life and offer a means to extend fresh market shelf life.

Publications

None to date; abstract for SR ASHS presentation to be done by February 1, 2012

Figure 1. ‘Granny Val’ muscadine grapes after 56 days storage at 1C (left) or 4C (right). Note brown lesions and overall browning of berries.