2025 SR SFC Grants Program Report

Title: **Assessing the Effect of Postharvest Storage on Fruit Quality Attributes of Recently Released Perfect-flowered Muscadine Grape Cultivars and Advanced Selections**

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Public Abstract:

The interest in grape cultivation is steadily growing in Alabama. According to the 2022 Census survey, there are 622 acres of grapes currently planted in Alabama which represents an impressive 6.9 folds increase within the last 20 years. Muscadine grapes and wines are noted for their health benefits due to high phenolic contents and other nutritive values. The interest in nutraceutical products derived from muscadine grapes has been growing, particularly due to their rich content of phenolic phytochemicals like ellagic acid and resveratrol found in waste products such as skin, seeds, and pulp**.** Muscadine grapes have a short shelf life and about 50% of the berries can suffer from decay within 7–10 days at ambient temperature. Notable reduction in decay incidence of muscadines was achieved when the berries were stored at 0 or 4.5°C in comparison to 20°C. At refrigerated or low-temperature storage, muscadines can be stored up to 2–3 weeks, but they are susceptible to postharvest softening, shriveling, weight loss, and

decay when stored longer. Muscadine breeding programs in the SE currently released perfect flowered genotypes with large berry size, good vine productivity, excellent flavor, thinner skin, and disease resistance, but information about cultivars' storage potential is limited. This research aimed to evaluate the effect of postharvest storage on fruit quality attributes of select recently released perfect-flowered muscadine grape cultivars grown in Alabama conditions. Our results indicate Hall berries had below 10% weight loss after 4 weeks of cold storage exposure, demonstrating a better storage potential with less berry weight loss. After four weeks of cold storage exposure RubyCrisp and Paulk berries had high berry firmness, similar to the standard Supreme. With the exception of Southern Home, all tested cultivars had a TSS:TA ratio withing the acceptable muscadine grape ranges of 25-35 after three weeks of cold storage. Berries of Paulk , Ruby Crisp, Eudora and Supreme also had an acceptable TSS:TA ratio after 4 weeks of cold storage exposure. The newly generated knowledge can directly impact muscadine grape production, availability, and marketing. Generated knowledge on best postharvest management practices can increase growers' profitability, contribute to food security and enhance the competitiveness of small fruits in the southeastern region.

Introduction:

The interest in grape cultivation is steadily growing in Alabama. According to the 2022 Census survey, there are 622 acres of grapes (USDA-NASS, 2022) currently planted in Alabama which represents an impressive 6.9 folds increase within the last 20 years. The warm, humid climate of the southeast favors muscadine cultivation, primarily in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and parts of Texas and Virginia (Hickey et al., 2019; Conner and Worthington, 2023).

Muscadine grapes and wines are noted for their health benefits due to high phenolic contents and other nutritive values (Xu et al., 2017). The fruit has a distinct fruity, or 'musky' aroma, and the juice is sweet with a light taste, lacking the 'sticky' aftertaste of some fruit juices (Olein and Hegwood, 1990). The interest in nutraceutical products derived from muscadine grapes has been growing, particularly due to their rich content of phenolic phytochemicals like ellagic acid and resveratrol found in waste products such as skin, seeds, and pulp (Greenspan et al., 2005; Conner, 2009). Muscadine grapes are particularly noted for their high levels of ellagic acid, resveratrol, and flavanols including myricetin, quercetin, and kaempferol, which exhibit significant antioxidant and anti-inflammatory properties. Ellagic acid, abundant in grape skins, is associated with potential anti-cancer effects, while resveratrol in the pulp is linked to cardiovascular health benefits, positioning muscadine grapes as a 'super fruit' with substantial nutraceutical value (Marshall et al., 2012).

Research has demonstrated that muscadine grape skin powder has high anti-inflammatory properties both in vitro and in vivo. Among the flavonoids in muscadine grapes, anthocyanins are the most prevalent, followed by flavanols. Key antioxidants found in muscadine such as vitamins, phenols, carotenoids, and flavonoids can help prevent cardiovascular diseases (Pastrana-Bonilla et al., 2003). The health benefits of muscadine grapes are extensive, including cancer prevention, improved cardiovascular health, mitigation of obesity-related metabolic complications, enhancement of type-2 diabetes

management, and anti-inflammatory effects. Regular consumption of muscadine grapes or their extracts and by-products can offer protection against these health issues.

Muscadine grapes have a short shelf life and about 50% of the berries can suffer from decay within 7–10 days at ambient temperature (Walker et al., 2001). Notable reduction in decay incidence of muscadines was achieved when the berries were stored at 0 or 4.5°C in comparison to 20°C (Takeda et al., 1983). At refrigerated or low-temperature storage, muscadines can be stored up to 2–3 weeks (Perkins-Veazie et al., 2012), but they are susceptible to postharvest softening, shriveling, weight loss, and decay when stored longer (Walker et al., 2001).

Muscadine vines exhibit three distinct floret types: staminate (male), pistillate (female), and hermaphrodite (perfect flowered). Currently, commercial production primarily utilizes pistillate and perfect flowered vines. Pistillate cultivars require pollination from either staminate or perfect flowered cultivars, whereas perfect flowered cultivars are self-pollinating and do not require external pollination (Hickey et al., 2019; Huang and Lu, 2000).

Currently, several institutions are actively involved in muscadine breeding, including the University of Georgia, the University of Arkansas System Division of Agriculture (UA), Florida A&M University, the USDA-ARS Southern Horticultural Research Station in Poplarville, MS, and ’Gardens Alive!’ LLC (Buck and Worthington, 2022). The primary focus at the UGA is to select perfect flowered genotypes with large berry size, good vine productivity, excellent flavor, thinner skin, and disease resistance (Conner, 2019). Recently released cultivars such as ‘Hall’, ‘Paulk’, Lane’ and ‘Ruby Crisp’ are perfect flowered, thus do not require cross pollination or planting along with pistillate cultivar for successful pollination (Conner and Worthington, 2023).

‘Hall’ is a self-fertile cultivar with bronze color developed at the University of Georgia. It is a cross between ‘Fry’ and ‘Tara’ which is suitable for fresh market with medium to large sized berries. It possesses low pedicel scar and ripens early in the season (Conner, 2014).

‘Paulk’ is another cultivar from a cross between ‘Supreme’ and ‘Tara’ released by the UGA breeding program. It is also perfect flowered and considered excellent for fresh market. It is known for producing large sized berries which can be comparable to the size of berries of pistillate cultivars (Conner, 2017).

‘Lane’ is a cross between ‘Supreme’ and ‘Tara’ released in 2005. 'Lane' features self-fertile flowers and produces large black berries that ripen early in the harvest season. Its high soluble solids and excellent berry firmness make it well-suited for fresh market sales. Due to its medium yields, it is recommended to limit 'Lane' plantings to what is necessary for early-season sales (Conner, 2013).

‘RubyCrisp’ originated from a cross between ‘Supreme’ and ‘Tara’ in 2008. 'RubyCrisp' berries are dark red, standing out from the usual bronze and dark purple muscadine varieties. With hermaphroditic flowers, 'RubyCrisp' produces berries comparable in size to the largest female cultivars with individual berry weight of 15 grams. It has a midseason harvest. Due to a low percentage of dry pedicel scars, it is not recommended for commercial packing. As a result, its excellent texture, attractive and unique color, and overall eating quality make 'RubyCrisp' ideal for home gardens and pick-your-own operations (Conner, 2020).

Muscadine grapes are native to southeastern U.S. and considered as a southern favorite fruit. New perfect flowered cultivars with improved fruit quality attributes have been developed and released, but information is lacking on postharvest storage conditions of the Alabama-grown newly released perfect flowered muscadine cultivars. Due to this gap in knowledge, the objective of the present study is focused on evaluating the effect of postharvest storage on fruit quality attributes of newly developed perfect flowered cultivars and advanced selections grown under central Alabama conditions. Newly gained knowledge can assist in the development of postharvest management recommendations for commercial producers and home gardeners.

The outcomes from this project can lead to improved sustainability in muscadine grape postharvest management practices ensuring improved fruit quality and increased economic benefits to the grower. We also envision a project impact on improved food security and increased consumption of muscadine grapes which are a favorite local fruit. Outcomes from the proposed research can: 1) aid in expansion of muscadine grape production in both Alabama and the Southeast: and 2) determine postharvest quality and storage requirements of recently released muscadine cultivars to extend their shelf-life.

Materials and Methods:

An experimental vineyard established at the Chilton Research and Extension Center in Clanton, AL, was used to study the postharvest qualities of select muscadine grape cultivars. Muscadine grape vineyard is arranged as a RCBD with four single vine replications per cultivar. Muscadine cultivars included in this study were 'Paulk', 'Lane', 'Hall', 'Ruby Crisp', 'Southern Home' (perfect flowered), and 'Eudora', and 'Supreme' (female standards).

After harvest, berries from each experimental vine were graded and 20 berries were packed into clamshells then stored at 1^0C for 0, 1, 2, or 4 weeks. The samples were rated for storage disorders such as: shriveled berries, bruises, skin cracks, molds and chill injury. Color ratings were recorded including L*, a*, b* c* and hue angle with a Konica Minolta Colorimeter, but due to the late harvest/storage period color data analyses will be available later. After each storage period clamshells were removed from cold storage and allowed to warm up for 1 hour before running texture analysis on the fruit. Fresh weight (g) and berry weight loss were recorded for each storage period. After visual ratings were completed, a 50 mL falcon test tubes were filled with berries. The labelled samples were placed in -20 ^{0}C until all time points were collected. General composition was done to assess soluble sugars, titratable acids and pH. The TSS:TA ratio was calculated.

Results and discussion:

Our results suggest that both cultivar ($P < 0.0001$) and storage duration ($P < 0.0001$) affected the berry weight (Table 1). RubyCrisp had the highest 20-berry weight of 308.9 g, followed by Paulk and Supreme (276.9 and 273.9 g respectively), while Southern Home had the smallest 20-berry weight of 127.0 g. After 4 weeks in cold storage, Paulk had the greatest percent berry weight loss (17.3%), followed by Southern Home (12.6%) and Lane (11.7%). Berries of Supreme lost 6% of their weight after 4 weeks

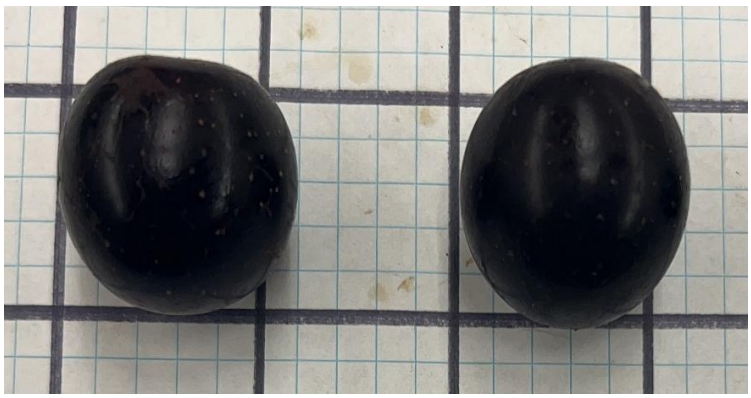
in storage which was the least amount of weight loss. Eudora and Hall berries also had below 10% weight loss as their berries were 7 and 8% respectively lighter after 4 weeks of cold storage exposure, demonstrating a better storage potential with less berry weight loss.

Table 1. Effect of cultivar and storage period on berry weight, firmness, and damage loss of select perfect flowered muscdaine cultivars, 2025.

Cultivar	20 berry weight, (g)				No. shriveled out of 20 berries				Berry Firmness, (Newton)			
	Week 0	Week 1	Week 3	Week 4	Week 0	Week 1	Week 3	Week 4	Week 0	Week 1	Week 3	Week 4
Southern Home	127.0 klm	121.2 lm	114.5 m	110.9 m	0 e	0 e	7 a		16.5 a-d	16.8 abc	15.4 a-e	
Paulk	276.9 abc	266.2 abc	246.3 cd	229.2 de	0 e	0 e	2 cde	7 a	16.5 a-d	13.5 b-f	13.5 b-f	10.7 efg
Hall	185.2 fgh	181.3 f-i	174.0 f-j	170.2 f-j	0 e	0 e	3 bcd		15.8 a-e	11.6 d-g	11.0 efg	
Lane	156.9 g-k	151.5 h-l	143.6 i-m	138.7 j-m	0 e	0 e	4 bc		17.9 ab	14.9 a-f	12.2 c-g	
Rubycrisp	308.9 a	301.5 ab	294.7 ab	289.9 abc	0 e	0 e	3 bcde	6 ab	19.6 a	16.2 a-e	15.2 a-f	12.6 b-g
Eudora	201.3 ef	196.4 f	190.7 fg	187.3 fg	0 e	0 e	2 cde	6 ab	9.6 fgh	7.7 gh	7.5 gh	5.6 h
Supreme	273.9 abc	268.1 abc	261.3 bcd	257.4 bcd	0 e	0 e	1 de	5 ab	18.9 a	19.3 a	16.2 a-e	15.7 a-e
Cultivar	<.0001				0.0001				<.0001			
Week	<.0001				<.0001				<.0001			
Cultivar*Week	0.7507				<.0001				0.1443			

A cultivar x storage duration interaction was accountable for the amount of damaged berries after 3 and 4 weeks in cold storage (Table 1). No berries with any type of damage were found after one week of storage (Fig. 1A), while after the third week of cold storage exposure Southern Home had the highest amount of damaged berries (35%), while Supreme had the least damage of 5%. Berries of Southern Home, Hall and Lane (Fig. 1B) showed over 50% damage after four weeks of cold storage exposure and were not included in the analysis, while only 25% of Supreme berries were damaged at this storage period.

Berry firmness was affected by both – cultivar and storage duration in our test (Table 1). Supreme berries had the highest fruit firmness at harvest (Week 0) and were similar to Southern Home, Paulk, Hall, Lane, and RubyCrisp, while after four weeks of exposure only RubyCrisp and Paulk berries had fruit firmness similar to Supreme. Berries of Southern Home, Hall and Lane were too soft after the Week 4 storage treatment and were discarded without data collection.


A


B

Figure 1. A,B. Healthy berries of Lane muscadine grape at harvest (A) and shriveled/damaged berries (B) at Week 3 exposure to cold storage, 2025.

Table 2. Effect of cultivar and storage period on berry pH, TA, and TSS:TA decline of select perfect flowered muscdaine cultivars, 2025.

Cultivar	pH				Titrable acidity				TSS:TA			
	Week 0	Week 1	Week 3	Week 4	Week 0	Week 1	Week 3	Week 4	Week 0	Week 1	Week 3	Week 4
Southern Home	3.4 a-e	3.4 b-f	3.4 a-f		0.8 a	0.6 bcd	0.7 ab		21.6 c	24.1 c	21.7 c	
Paulk	3.7 a	3.7 ab	3.6 abc	3.5 a-e	0.5 de	0.5 e	0.4 e	0.5 de	32.2 abc	33.0 abc	34.0 a	31.2 abc
Hall	3.5 a-d	3.6 abc	3.4 a-f		0.6 bcd	0.5 de	0.6 bcde		29.6 abc	32.6 abc	27.7 abc	
Lane	3.7 a	3.7 ab	3.6 abc		0.5 cde	0.5 de	0.5 cde		32.6 abc	33.5 ab	31.9 abc	
RubyCrisp	3.7 a	3.6 abc	3.7 a	3.7 ab	0.5 de	0.5 cde	0.5 de	0.5 de	33.0 abc	30.7 abc	33.4 abc	32.9 abc
Eudora	3.3 c-f	3.2 f	3.3 ef	3.3 def	0.6 abc	0.6 bcd	0.6 abcd	0.6 cde	24.9 c	25.2 bc	23.2 c	27.4 abc
Supreme	3.5 a-e	3.4 b-f	3.4 a-f	3.4 b-f	0.5 de	0.4 e	0.5 de	0.5 cde	29.1 abc	31.3 abc	29.3 abc	27.3 abc
Cultivar	<.0001				<.0001				<.0001			
Week	0.0603				0.0009				0.5542			
Cultivar*Week	0.3099				0.1973				0.7638			

The results for muscadine juice pH (Table 2) indicate a significant cultivar effect with Paulk, Lane and RubyCrisp having the highest pH of 3.7 at harvest (Week 0). After 4 weeks of storage, berries of Paulk and RubyCrisp had a similar pH ranging between 3.5 for Paulk to 3.7 for RubyCrisp.

Muscadine grape titratable acidity (TA) was influenced by both – the cultivar ($P < 0.0001$) and the cold storage treatment duration ($P < 0.0009$) and was similar for most cultivars during the storage period except for Southern Home where there was a significant difference in berry TA between Week 0 and Week 1 storage treatments (Table 2).

Cultivar had a significant effect on the total soluble solids (TSS) to titratable acidity (TA) ratio which ranged from 21.6 for Southern Home at harvest (Week 0) to 34.0 for Paulk at Week 4 of storage

(Table 2). All tested cultivars had a TSS:TA ratio withing the acceptable ranges of 25-35 except Southern Home with a range between 21.6 at harvest to 24.1 at W eek 1 of cold storage exposure.

Study outcomes were used to prepare presentations for local, state and regional professional and growers' meetings, including the ASHS and the SR ASHS Annual Conferences and the Alabama Fruit and Vegetable Growers Association (AFVGA) Annual Conference. An Extension leaflet on the best postharvest management practices for the newly released perfect flowered muscadine grape cultivars is also being developed.

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