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Quality Characteristics of Selected Muscadine Grape Cultivars Grown in North Florida

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Muscadine grapes are a popular fruit, but choosing cultivars that perform well and have good eating quality can be a challenge for homeowners. This study evaluated quality characteristics and eating quality of 11 muscadine grape cultivars grown in northern Florida. Fully ripe fruits were evaluated for quality characteristics, including pH, titratable acidity, soluble solids (°Brix), and water activity (Aw). Sensory evaluation using a consumer panel (n = 75) was conducted on five cultivars, four of which are currently recommended cultivars for fresh market and one of which is a cultivar recommended for trial for fresh market. Consumers evaluated the cultivars based on color, taste (sweetness and sourness), muscadine flavor, firmness, and overall preference on a line scale (0–9 cm, where 0 represents the lowest rating and 9 represents the highest rating). The pH (3.0–3.5), titratable acidity (0.16%–0.59%), °Brix (12.6–21.45), and °Brix/acid ratio (21.35–100.00) were significantly different among different cultivars ($P < 0.0001$). Among the cultivars used in the sensory evaluation study, the consumer panel consistently rated 'Fry', 'Ison', and 'Nesbitt' higher than 'Tara' and 'Southern Home', but all of them were rated as more than acceptable by a consumer panel. This study revealed that quality characteristics were different among the 11 cultivars.

Muscadine grape is a popular crop in the southeastern United States. Improved cultivars have been released and evaluated for commercial production of wine, juice, fresh market, or pick-your-own operations (Andersen, 2006; Basiouny and Himelrick, 2001; Mortensen and Harris, 1989).

Cultivar recommendations for muscadine in Florida are currently based on the designations such as pick-your-own, fresh market, juice or jelly, or home gardens (Crocker and Mortensen, 2001). These cultivar designations were based on vine and berry characteristics (Mortensen and Harris, 1989) such as soluble solids (Andersen, 2006) and yield. While data on yield and soluble solids are highly crucial for commercial muscadine production, homeowners are requesting different types of information. For example, shipping qualities are not important cultivar characteristics for home use.

Typical requests for information from homeowners in northern Florida have been for muscadine cultivars with good eating quality, and currently, these requests overwhelm commercial requests. Homeowners typically like to know which cultivars have good eating quality or sensory properties. Sensory qualities, such as color, aroma, acidity (sourness), sweetness, and flavor of muscadine juice blends (Baek et al., 1997) and color, flavor, and aroma for 'Carlos' juice (Lanier and Morris, 1977), have been evaluated using taste-test panels.

Information on sensory properties of fresh eating of muscadine cultivars was not widely available in the literature. Thus, the objectives of this study were to 1) evaluate sensory property information of the muscadine cultivars that are adapted to the Suwannee Valley area of northern Florida for extension professionals, who would be able to utilize this information in making cultivar recommendations for homeowner fresh eating use; and 2) correlate the sensory property with some basic chemical properties for future predictive use for cultivar evaluation. The information will be used by extension professionals for making muscadine cultivar recommendations for homeowners and fresh consumption use.

Materials and Methods

Muscadine grape production. Muscadine grape vines were grown at the University of Florida North Florida Agricultural Research and Education Center–Suwannee Valley (N 30°18.051', W 082°54.006') on moderately well drained soils (USDA Natural Resources Conservation Service, 2007). Vine management was single wire trellis. Cultivars were planted continuously in single rows, with pollinator cultivars in adjacent rows to minimize berry size variability due to pollination effects (NeSmith, 1999). Plant spacing was 3.6 m (2 ft) within rows and 4.9 m (16 ft) between

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Table 1. General characteristics of muscadine grape cultivars used in the study.

Cultivar	Skin color	Avg berry wt (g)
Black Beauty	black	13.9
Early Fry	bronze	12.8
Fry	bronze	11.5
Ison	black	11.3
Nesbitt	black	10.9
Summitt	bronze	10.8
Tara	bronze	7.7
Southern Home	black	6.5
Granny Val	bronze	5.0
Carlos	bronze	4.6
Noble	black	3.6

rows. Vines were pruned to 2- to 4-node spurs during the dormant season. Drip irrigation was applied as needed. Fertilizer was applied during the dormant season. Each plant received N at 90 g (0.2 lb), P at 20 g (0.043 lb), and K at 80 g (0.116 lb) rate per season. Weed management consisted of a 1-m- (3.3 ft) wide in-row strip maintained with glyphosate herbicide and by mowing between rows as needed.

Muscadine grape harvest. Eleven cultivars of fully ripe muscadine grapes (Table 1) were harvested from established vines on 17 Aug. 2006. The grapes were stored under current recommendation for storage until use for sensory evaluation and chemical analyses. Because flavor at harvest is dependent on berry chemical composition (Lanier and Morris, 1978), only uniform ripe berries were used in sensory ratings and chemical quality characteristic evaluation. The cultivars in the trial included 'Black Beauty', 'Carlos', 'Tara', 'Early Fry', 'Fry', 'Granny Val', 'Ison', 'Nesbitt', 'Noble', 'Southern Home', and 'Summitt'.

Grape quality evaluation. Harvested grapes were evaluated for physical quality (average fruit weight, sensory quality, and chemical characteristics) the day after harvest. Average berry weights for each variety were determined by randomly weighing 15–25 berries and calculating average weight per fruit, in four replications.

Sensory evaluation. Sensory evaluation was conducted on only five cultivars ('Fry', 'Tara', 'Ison', 'Nesbitt', and 'Southern Home)' following the recommendations from the American Society of Testing Materials (1981). The five cultivars, four of which ('Fry', 'Tara', 'Nesbitt', and 'Southern Home') are currently recommended cultivars for fresh market, and one of which ('Ison') is recommended for trial for fresh market. Volunteer consumer panel ($n = 75$) ages ranged from 18 to 80+ years of age. Volunteers were asked to evaluate the cultivars based on color, sweetness, sourness, muscadine flavor, firmness, and overall preference on a line scale (0–9 cm) where 0 represents the lowest and 9 represents the highest rating.

Chemical characteristics. Titratable acidity (expressed as percent tartaric acid), pH, °Brix (soluble solids content), °Brix/acid ratio, and water activity (Aw) were determined or calculated. For each variety, 15 to 20 grapes were blended, skin and seeds included. The blended sample was filtered using vacuum and #1 Whatman paper to obtain juice. The juice was then used for analysis. Each analysis was done in duplicate. The pH of the sample was measured with an MP320 pH meter (Mettler, Toledo, OH). Tartaric acid and malic acids typically account for >90% of acids in grapes (Lamikanra et al., 1995). Tartaric acid is the main acid used to express titratable acidity as grams per liter. To determine titratable acidity, a 2-mL aliquot was taken and analysis was done according to AOAC method 942.15 (2000). Total soluble solid (°Brix) was measured using a refractometer (Abbe Mark II Refractometer, Reichert, Cambridge, MA) with the juice while water activity was measured by using blended material prior to filtration. Since the moisture content of the muscadine grape was not determined in this study, water activity (Decagon Devices Aqua Lab water activity meter, Pullman, WA) was determined as an indicator of moisture or available water in the sample.

Chemical analyses and sensory data were analyzed using analyses of variance, with means separated by Duncan's multiple range test (SAS, 2000).

Results and Discussion

Table 1 provides basic characteristics, including skin color as well as average fruit size of muscadine grape cultivar used in this study. The size of muscadine grapes used in this study varied greatly from 3.6 to 13.9 g/fruit. Although it is not known if consumer panels prefer smaller fruit sizes or bigger ones, it appeared that the overall preference for muscadine grapes for smaller fruit size ('Tara' and 'Southern Home') seem to be lower than for bigger fruits. Overall preference may be influenced by other factors other than fruit size. Additional information on fruit size and consumer preference should be included in the next study.

Sensory evaluation results of the five selected muscadine cultivars are presented in Table 2. Color, sweetness, and muscadine flavor tended to rank cultivars similarly to overall cultivar preference. Age and gender of the consumer panel ($n = 75$, 50:50 male/female ratio) were not significantly different for rating of sweetness, firmness, and overall preference. However, for color attribute, a slight difference ($P < 0.0001$) were found between the 80+ and the younger group (20–29); the elder group tended to rate color attribute lower than the younger group. Among the cultivars used in the sensory evaluation study, the consumer panel consistently rated 'Fry', 'Ison', and 'Nesbitt' higher than 'Tara' and 'Southern Home' in terms of overall preference, sweetness, and muscadine flavor. Color was rated the highest in 'Ison' (6.56), and lowest in 'Southern Home' (4.80); the midpoint scale was 4.5. Any rating of 4.5 (midpoint) or higher would be consider

Table 2. Sensory evaluation results of selected muscadine grape cultivars.

Cultivar	Fruit color	Color	Sweetness	Sourness	Flavor	Firmness	Overall preference
Ison	Black	6.6 a[z]	5.7 a	4.8 a	5.9 a	5.7 b	6.3 a
Nesbitt	Black	6.4 ab	6.2 a	4.8 a	5.8 a	5.2 bc	5.9 a
Fry	Bronze	5.9 b	5.8 a	5.0 a	5.8 a	5.6 b	5.8 a
Tara	Bronze	5.1 c	4.5 b	4.3 a	4.8 b	4.7 c	4.9 b
Southern Home	Black	4.8 c	4.8 b	4.3 a	4.8 b	6.3 a	4.9 b

[z]Means represent the measurements on the line scale (0–9 cm, where 0 = lowest and 9 = highest rating. Means separation in columns by Duncan's multiple range test, 5% level.

Table 3. Chemical characteristics of muscadine grape cultivars.

Cultivar	pH	Titratable acidity (% Tartaric acid)	ºBrix	Acid water activity (Aw)	°Brix/acid ratio[z]
Early Fry	3.56 a[z]	0.16 c	16.05 cde	0.981 d	100.31
Southern Home	3.44 b	0.26 bc	15.75 de	0.985 abc	60.57
Summitt	3.39 b	0.32 b	21.45 a	0.982 cd	67.03
Black Beauty	3.33 c	0.23 bc	17.75 b	0.983 cd	77.17
Tara	3.31 c	0.30 bc	16.3 c	0.9830 cd	54.33
Nesbitt	3.32 c	0.27 bc	15.55 e	0.988 a	57.59
Ison	3.30 c	0.33 b	16.15 cd	0.9850 abc	48.93
Fry	3.24 d	0.27 bc	14.15 f	0.9825 cd	52.40
Noble	3.24 d	0.29 bc	13.10 g	0.9865 ab	45.17
Granny Val	3.09 e	0.29 bc	13.50 g	0.9850 abc	46.55
Carlos	3.00 f	0.59 a	12.60 h	0.9845 bc	21.35

[z]Means separation in columns by Duncan's multiple range test, 5% level.

acceptable for consumers. There was no significant difference in sourness rating among cultivars used in the taste test. Overall, 'Fry', 'Ison', and 'Nesbitt' were rated higher than 4.5 for every attribute. Degrees Brix to acid ratio and overall preference of sample appeared to have an inverse relation (r = –0.66) while the rating of sweetness (r = 0.86) and sourness (r = 0.86) tended to increase with the overall preference. Since the sourness was not significantly different among cultivars, it appears that sweetness is an important factor for determining overall preference for muscadine grapes. Fruit firmness did not appear to follow the overall preference scale, although differences between cultivars were significant.

Chemical characteristics of cultivars, including those selected for sensory evaluation, are presented in Table 3. Fruit pH appeared to have an inverse trend for overall cultivar preference (r = –0.59); the lower the pH, the higher the consumer preference for the cultivar. Titratable acidity (expressed as percent tartaric acid) was not significantly different among the five cultivars. Degrees Brix, a measure of total solids (including sugars) did not appear to be an indicator of the overall preference by consumers, whereas in Table 2, sweetness ratings by consumers did. These results are different from grape tomatoes, where the higher ºBrix to acid ratio represented sweeter tomatoes and tended to receive higher preference scores by consumers (Simonne et al., 2005). In our muscadine grape study, ºBrix/acid ratio showed a ranking similar to consumer overall preference. Other chemical characteristics of muscadine, such as the presence of aromatic compounds, may also influence consumer preference. Thirty- three aroma-active compounds were detected in the juice of 'Carlos' muscadine (Baek et al., 1997). These compounds included alcohols, esters, aldehydes, ketones, acids, and a phenol. Consumer preference for a muscadine cultivar may be due to the unique complex of aromatic compounds, which are rated in the flavor category in Table 2.

Six additional cultivars were evaluated for chemical characteristics, which are presented in Table 3. It is intended to conduct additional consumer ratings of these cultivars, in order to identify those characteristics that might be associated with consumer preference. 'Early Fry' had the highest pH (3.56) and third highest °Brix (16.05). 'Summit' had a moderate pH (3.33) and the highest °Brix (21.45). There is a need to test these cultivars for fresh eating purposes with consumer sensory tests. From this preliminary study, it can be expected that those cultivars with higher soluble solids or higher °Brix will receive higher ratings.

This study revealed that quality characteristics (titratable acidity, pH, °Brix) were different among the 11 cultivars. This study showed that there were differences in consumer sensory tests of muscadine cultivars. 'Fry', 'Ison', and 'Nesbitt' were rated higher than 'Tara' and 'Southern Home'. Extension professionals could use this information to make recommendations to homeowners as they select cultivars for their home muscadine orchard for fresh eating use.

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