Another quality attribute that can be used to judge ripeness within certain cultivars is berry weight. As the berries became more dense, berry weight increased to a maximum in density grade 4, then decreased in density grade 5 (Table 2). When the berries from these density grades were observed, it was apparent that density grade 5 berries were over-ripe to the point that they were starting to dehydrate and shrivel, as opposed to grapes from density grade 4 that were still turgid (Table 2). For all sensory attributes, there was a significant increase in acceptance with each increase in density grade.

In studies designed to further evaluate the effectiveness of density separation, Walker et al. (2001) found that this method successfully sorted Fry muscadines into maturity levels (Table 3). Sensory analysis revealed that grapes from maturity level 1 were more firm, less sweet, and more sour than those from level 5. Panelists had difficulty ranking sweetness and sourness for levels 2 – 4.

Table 3. Quality factors of Fry muscadine grapes from 5 density/maturity grades (Walker et al., 2001).

Maturity Level	Soluble Solids[1] (%)	Tartaric Acid (%)	pH	Firmness (Newtons)	Sensory Ratings[1] (Rank sums[2]) Firmness	Sweetness	Sourness
1	14.2e	0.65	3.33	10.01a	56b	123a	68bc
2	15.2d	0.59	3.39	9.51ab	90a	92ab	98ab
3	15.8c	0.57	3.41	9.16b	103a	63b	114a
4	17.0b	0.59	3.42	8.88b	91a	102a	66c
5	19.5a	0.58	3.46	7.97c	114a	70b	104a

[1] Means within a column not followed by the same letter are significantly different $P \leq 0.05$

[2] Low rank sum values indicate the most firm, sweet, and sour fruit

Density separation is a rapid and inexpensive method of removing fruit of undesirable maturity. The spherical shape of the muscadine berry and the relatively small variation in its fruit size make it ideal for mass density sorting.

Good management of temperature and humidity is the single most important factor in determining the ultimate quality of fresh muscadines (Morris and Brady, 2004). For optimum quality, product deterioration must be slowed as much as possible. This is best achieved by slowing respiration (Mitchell, 1991). One way to do this is to lower the temperature. As a general rule, each 18°F (10°C) reduction in temperature lowers respiration rate by a factor of two to four. This can have a significant effect on maintaining quality of muscadines. For optimum quality, pre-cooling with forced air to 36°F or lower within twelve hours of harvest is recommended (Perkins-Veazie, 2002).

Direct Markets

According to market research, harvested muscadine grapes must have a minimum storage life of eight weeks to be competitive with other grape varieties for fresh market sales (Morris, 1980). However, muscadines generally have a much shorter storage life since they are highly perishable and have a very short harvest season.

Many factors affect the commercial acceptability of fresh market muscadines. These include fruit maturity, size, skin thickness, and berry integrity. Grapes with a wet stem scar have a much shorter market life since this is an ideal entry point for microorganisms (Ballenger and Nesbitt, 1982).

In research at the University of Arkansas, it was found that, without refrigeration, the shelf life of muscadines is only a few days. This could be lengthened to one to two weeks by refrigerating at 34°F and to almost four weeks by placing the fruit in polyethylene (plastic) storage bags in the refrigerator (Main et al., 1995). These findings were confirmed by Ballenger and Nesbitt (1998), who found that Carlos muscadines decay twice as fast at 68°F as at 50°F and three times as fast at 50°F as at 32°F. They also observed that muscadines with wet stem scars stored for one week at 50°F or three weeks at 32°F have six to ten times more decay than grapes with dry stem scars.

Research has shown that muscadines can be stored for at least six weeks under proper controlled atmosphere (CA) conditions (Himelrick, 2003). Storage conditions that result in maximum storage life are: temperature 34° to 36°F; relative humidity 90 to 95%; oxygen (O_2) 5%; carbon dioxide (CO_2) 15%; nitrogen (N_2) 80%; and air circulation of 25 cfm/ton.

Walker et al. (2001) looked at changes that occurred in Fry muscadines during a six week storage period (Table 4). As storage time increased, soluble solids and firmness decreased. Percent decay increased with increasing time in storage.

Table 4. Effect of storage time on Fry muscadine grapes stored at 35.6°F (Walker et al., 2001).

Storage (weeks)	Soluble Solids (SS) (%)	pH	Titratable Acidity (tartaric %)	Ripeness Index (SS x pH)	Decay (%)	Firmness (Newtons)
0	17.09a[1]	3.41	0.57	199.7a	0	10.35a
2	16.35b	3.41	0.57	191.0b	19.2	9.04b
4	15.97c	3.41	0.63	186.2c	25.7	8.55b
6	15.83c	3.38	0.61	181.7d	42.4	8.47b

[1] Means within a column followed by a different letter are different $p \leq 0.05$.

Value Added Products

Value-added food products are commodities whose value has been increased through the addition of ingredients or processes that make them more attractive to the buyer and/or more readily usable by the consumer. More income may be obtained from a crop if a farmer can identify innovative ways to add value to it so that the farmer is able to receive a bigger share of the consumer dollar.

It should be noted, however, that value-added agricultural activities do not increase commodity prices; rather, they add value to products by performing activities usually done by others (Ellerman et al., 2001). The added value is reflected in higher market prices. The benefit to the farmer comes if the value is added at the farm level so that the added value of the product is received at the farm level, not by someone else.

Adding value to muscadines may be as simple as creatively packaging the grapes. This might be washing and packaging the fruit for a ready-to-eat snack or placing the fruit in a decorative container either alone or with other fresh fruit as a "farm fresh gift basket."

Production of some value-added products goes beyond the simple steps of washing or creative packaging and may require processing the muscadines into new, very different forms. There are a number of value-added processed products that can be produced from muscadines. Figure 6 presents, in a decision-tree format, some of the options for processed muscadine products. Details of the technology of the actual preparation procedures for products identified with an asterisk on the decision tree are presented in Appendix A.

Juice

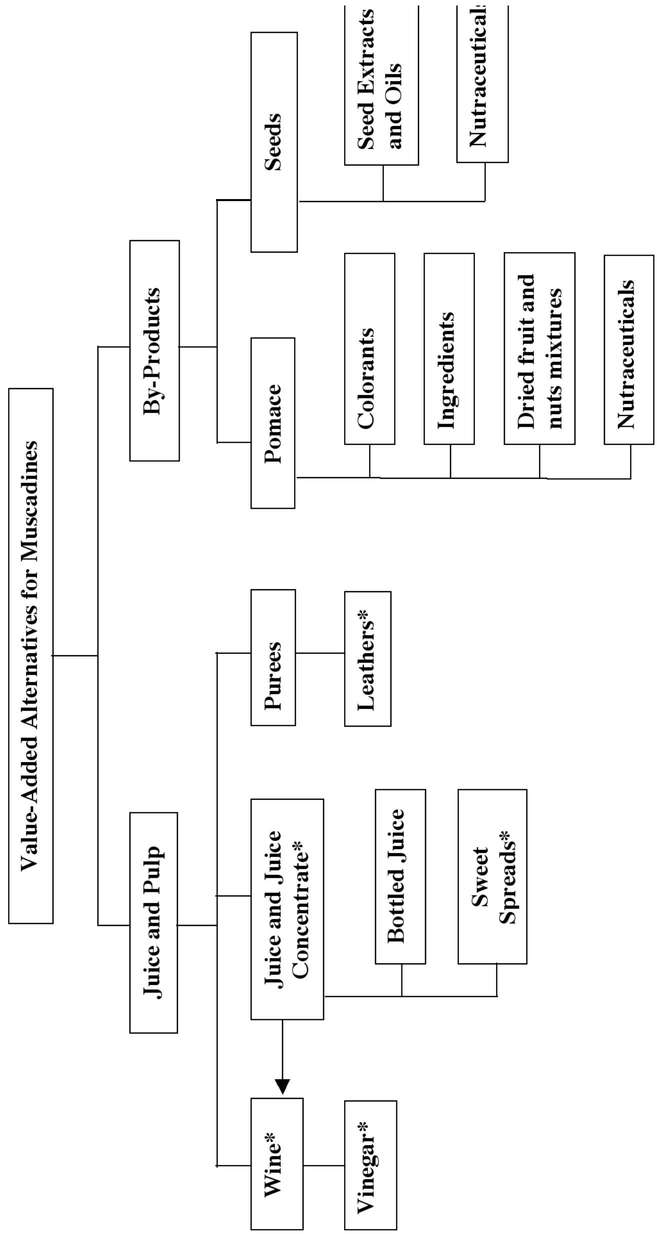
Muscadine juice has a unique flavor and bouquet. Scuppernong, a white muscadine grape, and Hunt, a red cultivar, were two of the original varieties used for processing juice for local consumption. High quality juices have also been produced from Creek, Dulcet, Yuga (Murphy et al., 1938), Noble, and Carlos (Sistrunk and Morris, 1982) cultivars.

Changes that occur in muscadine grapes during growth and maturation determine the quality of the juice (Bates, et al., 2001). Flavor and aroma develop during the ripening process. In general, as the fruit matures, sugars and color increase and pH and titratable acidity decrease.

The composition of muscadine grape juice is similar to that of the whole grapes except that the fiber (predominantly in the skins) and oils (predominantly in the seeds) are removed (Bates et al., 2001). The quality of grape juice depends to a great extent on the sugar level, acid content and flavor constituents. Glucose and fructose are the major sugars in grape juice. Other flavor components are acids, volatile esters, and aldehydes.

The specific composition of the juice from any cultivar varies from year to year and changes continually during ripening. The composition of a specific cultivar will also vary from one area of growth to another and from one vine-

Figure 6. Decision tree for some of the choices for processed muscadine products.



* Information on the technology of producing this product is provided in Appendix A.

yard to another since composition is affected by soil, climatic conditions, and vineyard management practices.

Color of muscadine juice is largely the result of anthocyanin pigments located in or near the skin. Different cultivars have different types and amounts of these pigments. This affects suitability of the cultivar for processing since it determines the color stability in processed products.

Carlos and Noble are representative of the muscadine grapes grown commercially in Arkansas (Sistrunk and Morris, 1982). Both have a good flavor and ripen evenly, making them adaptable for mechanical harvest. Carlos is bronze-skinned, and juice made from this cultivar has lower soluble solids, pH, and total phenols but higher titratable acidity than that from the black-skinned Noble variety (Table 5). No significant differences in the sensory quality characteristics of juices from these two cultivars were found except in color.

Table 5. Effect of cultivar on quality attributes of muscadine juice (Sistrunk and Morris, 1982).

Cultivar[1]	Soluble Solids (%)	Titratable Acidity (%)	pH	Total Phenols (%)	Sensory Attributes[2] Color	Flavor	Lack of Browning	Overall Acceptance
Noble	14.1a	.688a	2.92a	.219a	7.12a	5.19a	7.36a	6.48a
Carlos	13.0b	.763b	2.89b	.105b	6.40b	5.19a	7.38a	6.34a

[1] Means within a column not followed by the same letter are significantly different by Duncan's Multiple Range test, 5% level
[2] Sensory rating conducted by a 12- to 15-member panel on a scale of 10 (best) to 1 (poorest)

Juice Production

The process for preparing juice from muscadine grapes is outlined in Appendix A. One limitation of producing juice from muscadines is poor yield. Muscadines yield about 130 gallons of juice per ton while other grapes average 180 gal/ton (Ahmedullah and Himelrick, 1989).

Muscadine juice can be extracted using either a hot-press or a cold-press technique. Threlfall et al. (2004) compared the juice yields of Black Beauty muscadines with those of Sunbelt (*Vitis labrusca* L.) grapes. Sunbelt is a large blue-colored grape that was developed by the University of Arkansas. It is similar to Concord in most plant and fruit characteristics, but it ripens more evenly (Moore et al., 1993). Sunbelt juice quality has been shown to be equal to or better than Concord. Juice was pressed from the grapes using either a hot-press method or by cold pressing (Table 6). Juice yields were greater from Sunbelt grapes than from the Black Beauty, and within cultivars, yields were greater with hot pressing than with cold.

Table 6. Juice yields from different processing treatments of Black Beauty and Sunbelt grapes (Threlfall et al., 2004).

Cultivar	Press Treatment	Juice Yield (gal/ton)
Black Beauty	Cold	127.5
	Hot	169.5
Sunbelt	Cold	152.1
	Hot	188.3

A comparison of juices extracted from three muscadine cultivars by either hot or cold pressing showed that extraction temperature has a significant effect on all quality characteristics for each of the cultivars tested (Threlfall, 2002). As shown in Figure 7, hot-pressed juice had better color than cold-pressed samples. The hot-press method also yielded more juice (See Table 7) than cold pressing. Within a cultivar, pressing method had no effect on soluble solids but did cause significant differences in pH and color density.

Table 7. Effect of pressing method on juice yields and quality attributes (Threlfall, 2002).

Variety	Press Method	Yield (gal/ton)	°Brix	pH	Color Density
Black Beauty	Hot	145	16.8b	3.19c	5.42c
	Cold	125	16.8b	3.29a	0.40ef
Carlos	Hot	144	14.6d	2.81h	0.78e
	Cold	120	14.7d	3.01g	0.15f
Nesbitt	Hot	139	16.9e	3.08f	7.08b
	Cold	125	15.6e	3.12e	0.43ef

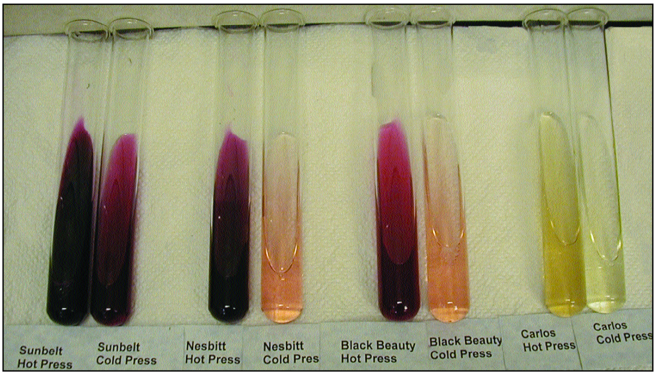


Figure 7. A comparison of the effect of extraction method on the color of juice from Sunbelt and three cultivars of muscadine (L to R. Sunbelt, Nesbitt, Black Beauty, and Carlos). Tubes on the left in each pair contain hot-pressed juice; tubes on the right were cold pressed (Threlfall, 2002).

In a study looking at juices from Carlos and Noble muscadines, extraction temperature had a significant effect on all quality parameters (Sistrunk and Morris, 1982). The lots extracted at higher temperatures were higher in acidity and total phenols, but lower in pH. Soluble solids were lowest when grapes were extracted at 140°F (Table 8). Color was darkest in juice from the 176°F extraction. Browning increased with increased extraction temperature. Crushing the grapes and adding polygalacturonase and SO_2, followed by holding the grapes for 24 hr at room temperature prior to low temperature extraction, resulted in juice with good color and flavor.

A sensory panel rated the juice extracted at 140°F highest for color (Table 8), although flavor and overall acceptance scores were not significantly different from juice extracted at 75°F (Sistrunk and Morris, 1982). Apparently, the more intense flavor and greater browning of juice extracted at 176°F were disliked by the panelists.

Table 8. Effect of extraction temperature on quality attributes of muscadine juice (Sistrunk and Morris, 1982).

Extraction Temperature[1] (°F)	Soluble Solids (%)	Titratable Acidity (%)	pH	Total Phenols (%)	Sensory Attributes[2]			
					Color	Flavor	Lack of Browning	Overall Acceptance
75°	13.8a	.699b	2.93a	.144c	6.66b	6.40a	7.77a	6.61a
140°	13.2b	.734a	2.90b	.156b	6.90a	6.24a	7.39b	6.48a
176°	13.6a	.743a	2.87c	.176a	6.71b	5.92b	6.95c	6.15b

[1] Means within a column not followed by the same letter are significantly different by Duncan's Multiple Range test, 5% level
[2] Sensory rating conducted by a 12- to 15-member panel on a scale of 10 (best) to 1 (poor)

Pressing muscadine grapes without heating creates several problems: 1) enzymes that promote browning are not inactivated; 2) juice yield from the grapes is poor because of the thick skins; 3) color extraction of dark-skinned cultivars is low; and 4) a high percentage of the flavor remains in the skins (Sistrunk and Morris, 1985). Some of these problems could be lessened by treating the grapes with enzymes prior to pressing.

Factors That Influence Juice Quality

The juice of muscadines is perceived by some consumers as being too strongly flavored and high in acidity and astringency (Flora, 1979). However, flavor characteristics of the juices vary depending on cultivar. Juice from Carlos grapes has natural acidity that is too high for the taste of many consumers, while Noble is naturally astringent, leading to a harsh flavor. Flora determined that storing muscadine juice at 36°F for seven days (cold stabilization) before bottling and pasteurizing aids in reducing acidity levels without affecting overall quality. He also found that the addition of up to 40% water improves the quality of Carlos juice by diluting the phenols and acids; however, this dilution level is too great for Noble juice. The addition of 3% sugar also serves to improve quality. Flora observed that during 12 months of storage, the light-colored Carlos juice became darker due to browning while the dark Noble juice became lighter because of pigment loss.

In order to determine optimum storage conditions for muscadine juice and to characterize the changes in quality attributes which occur during processing and storage, Sistrunk and Morris (1982) evaluated the effects of three storage temperatures (36°, 75°, and 90°F), and three storage times (0, 7, and 12 months) on the juice from two muscadine cultivars (Carlos and Noble). The researchers observed that all quality parameters except soluble solids decreased as storage time increased (Table 9). Juice stored at 75° and 90°F had rapid loss of color at seven months because of browning. Panel scores decreased as storage time was increased reflecting the changes that were occurring during storage. Color was especially affected by storage temperature. All color parameters changed more in juices stored at 90°F than in those stored at 36° or 75°F. Juice stored at 75°F was rated acceptable by the panel after 12 months of storage; however, juice stored at 90°F was deemed unacceptable after seven months.

Table 9. Effect of storage temperature and storage time on quality attributes of muscadine juice (Sistrunk and Morris, 1982).

Main Effect	Soluble Solids (%)	Titratable Acidity (%)	pH	Total Phenols (%)	Sensory Attributes Color	Flavor	Lack of Browning	Overall Acceptance
Storage Temperature								
36°F (2°C)	13.6a	.716c	2.92a	.161a	7.18a	6.76a	8.18a	7.03a
75°F (24°C)	13.5a	.725b	2.90b	.157a	6.89b	6.20b	7.55b	6.45b
90°F (32°C)	13.4a	.735a	2.90b	.158a	6.21c	5.60c	6.38c	5.57c
Storage time								
0 mo	13.4ab	.726a	2.99a	.189a	7.25a	6.43a	9.39a	6.61a
7 mo	13.2b	.720a	2.91b	.154b	6.56b	6.21b	6.42b	6.54a
12 mo	14.0a	.676b	2.81c	.133c	6.47c	5.92c	6.31b	6.08b

[1] Means within a main effect not followed by the same letter are significantly different by Duncan's Multiple Range test, 5% level
[2] Sensory rating conducted by a 12- to 15-member panel on a scale of 10 (best) to 1 (poor)

Juice from two cultivars (Carlos and Noble) was cold stabilized for 0, 7, and 60 days at 36°F then stored at 36° or 75°F for 0, 4, 8, and 12 months (Sistrunk and Morris, 1984). The two cultivars reacted differently to cold stabilization (Table 10). The color of Noble juice decreased significantly between 0 and 60 days at 36°F as shown by lower a, b, chroma, and total anthocyanin values. Subsequently, the browning increased. The color of Carlos juice became darker during cold stabilization as indicated by lower L values and higher b and chroma values.

Table 10. Influence of cultivar and cold stabilization on color quality of muscadine grape juice [a] (Sistrunk and Morris, 1984).

Cold Stabilization (days)	Color Difference L	a	b	Chroma $(a^2 + b^2)^{1/2}$	Total anthocyanins (OD/gfw)	Browning index (OD520/430nm)
Noble						
0	11.7b[b]	6.8a	0.6a	6.93a	100.4b	5.49a
7	12.0a	6.2b	0.5b	6.28b	104.6a	5.52a
60	11.2c	5.1c	0.5b	5.17c	88.1c	4.83b
Carlos						
0	50.1b	-2.2b	13.8b	14.0b	0.9b	0.64b
7	50.8a	-2.3c	12.2c	12.5c	1.3a	0.68b
60	48.8c	-1.9a	14.5a	14.6a	0.9b	1.99a

[a] Means represented by data – Cold stabilization n = 112

[b] Means in columns within a cultivar followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

Table 11. Influence of storage time and cultivar on quality attributes of muscadine grape juice [a] (Sistrunk and Morris, 1984).

Cultivar and Storage Time (months)	pH	Soluble solids (%)	Total (mg/100ml)	Acidity as tartaric (%)
Noble				
0	3.63b[b]	19.6a	587a	0.553a
4	3.67a	19.3b	553b	0.429b
8	3.63b	19.5b	552b	0.422b
12	3.42c	18.8c	536c	0.406c
Carlos				
0	3.28a	18.1a	291a	0.622ab
4	3.27a	17.8ab	289a	0.610b
8	3.25b	18.0a	293a	0.632a
12	3.08c	17.5b	275b	0.618b

[a] Means represented by data are: storage time n = 84

[b] Means in columns within a cultivar followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

After cold stabilization, juices were treated by filtration or the addition of sugar (3%), water (20% or 40% plus sugar to equalize to original solids level), or $CaCO_3$ (0.1% or 0.2%), bottled, pasteurized, and stored for periods of 0, 4, 8 or 12 months.

The effect of storage time on quality changes in bottled juice from both cultivars was similar (Sistrunk and Morris, 1994). In general there was a decrease in pH, soluble solids, total phenols, and acidity during the 12 months of storage (Table 11). However, Carlos changed very little in total phenols and acidity while the changes in Noble were much greater.

Table 12. Influence of cultivar and storage time on sensory attributes of muscadine grape juice[ab] (Sistrunk and Morris, 1984).

Cultivar and Storage Time (mo)	Color intensity	Color acceptance	Flavor	Acid balance	Overall acceptance
Noble					
0	8.9a[c]	8.6a	7.2a	6.9a	7.3a
4	8.6b	8.4a	6.8b	6.8a	7.2ab
8	8.5b	8.0b	6.8b	6.9a	7.0b
12	8.4b	7.3c	6.0c	6.1b	6.3c
Carlos					
0	7.6a	6.9a	7.5a	7.4a	7.4a
4	7.7a	7.1a	7.2a	7.1b	7.2b
8	7.4b	6.1b	7.1a	7.0b	7.0c
12	6.9c	5.8c	6.4b	6.4c	6.1d

[a] Means represented by data are: storage time n = 84

[b] Rated on a 9-point Hedonic scale: 9 = like extremely to 1 = dislike extremely

[c] Means in columns within a cultivar followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

Because of the obvious differences in color between the two cultivars, sensory panelists were instructed to rate each on its own merits and not to make comparisons between the cultivars. The change in color intensity in the Noble juice was barely detectable because of the browning of the sample (Table 12). There were significant changes in the color intensity of the Carlos juice during storage with the color becoming less intense as storage time increased. Sensory ratings for color acceptance, flavor, and overall acceptance decreased with increasing length of storage for both cultivars.

Table 13. Effects of cultivar and treatment on quality attributes of muscadine grape juice (Sistrunk and Morris, 1984).

Treatments by cultivar	pH	Soluble solids (%)	Total Phenolics (mg/100ml)	Acidity as tartrate (%)
Noble				
Control	3.48c[1]	19.3b	603a	0.541a
Control, filtered	3.48c	18.8bc	597a	0.526a
20% H_2O*	3.49c	18.9bc	488b	0.451b
40% H_2O*	3.49c	18.8bc	420c	0.367d
3% added sugar	3.49c	21.9a	588a	0.527a
0.1% $CaCo_3$	3.70b	19.1bc	602a	0.427c
0.2% $CaCo_3$	3.96a	18.6c	600a	0.326e
Carlos				
Control	3.18c	17.5b	329a	0.740a
Control, filtered	3.17dc	17.5b	313b	0.711b
20% H_2O*	3.17dc	17.4bc	255d	0.596c
40% H_2O*	3.18c	17.0c	209e	0.477e
3% added sugar	3.15d	20.6a	299bc	0.700b
0.1% $CaCo_3$	3.27b	17.5bc	297c	0.605c
0.2% $CaCo_3$	3.42a	17.3bc	307bc	0.511d
Means by cultivar				
Noble	3.58a	19.3a	557a	0.452b
Carlos	3.22b	17.8b	287b	0.620a

* 20% or 40% water dilutions had sugar added to equalize samples to original solids level
[1] Means in columns within a cultivar followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

The pH was higher and the acidity lower in Noble juice than in Carlos juice (Table 13). The addition of water did not change the pH significantly with either cultivar but did decrease the titratable acidity. With both cultivars, the $CaCO_3$ treatments increased pH and lowered acidity. Sensory ratings for color intensity were decreased by the addition of water for both cultivars (Table 14). With Carlos juice, the unfiltered control was judged lighter than the filtered juice. Color acceptance of the Noble juice was lowered significantly in samples diluted with 40% water or treated with 0.2% $CaCO_3$. Carlos samples diluted with water were the most acceptable in color while those treated with $CaCO_3$ were the least acceptable. Ratings for flavor and sugar/acid balance were the highest for the diluted samples and those with added sugar.

Table 14. Effects of cultivar and treatment on sensory attributes of muscadine grape juice (Sistrunk and Morris, 1984).

Treatments by cultivar	Color Intensity	Color Acceptance	Flavor	Acid/Sugar Balance	Overall Acceptance
Noble					
Control	8.86a	8.23a	6.58cd	6.35cd	6.81b
Control, filtered	8.84a	8.42a	6.78bc	6.63b	7.10a
20% H_2O*	8.29b	8.14a	7.11a	7.10a	7.26a
40% H_2O*	7.56c	7.51b	7.02ab	7.13a	7.15a
3% added sugar	8.88a	8.45a	7.00ab	6.94a	7.28a
0.1% $CaCo_3$	8.89a	8.17a	6.41d	6.60bc	6.77b
0.2% $CaCo_3$	8.68a	7.63b	6.03e	6.11d	6.33c
Carlos					
Control	7.40b	6.65b	6.62b	6.39d	6.64bc
Control, filtered	7.89a	6.70b	6.72b	6.71c	6.80b
20% H_2O*	6.98c	6.99ab	7.50a	7.38a	7.12a
40% H_2O*	6.17d	7.30a	7.52a	7.43a	7.20a
3% added sugar	7.75a	6.66b	7.33ab	7.07b	7.10a
0.1% $CaCo_3$	7.71a	6.21c	6.83b	6.88bc	6.79b
0.2% $CaCo_3$	7.85a	5.79d	6.82b	6.89bc	6.57c
Means by cultivar					
Noble	8.57a	8.80a	6.70b	6.69b	6.96a
Carlos	7.39b	6.62b	7.05a	6.96a	6.89a

*20% or 40% water dilutions had sugar added to equalize samples to original solids level

[1] Means in columns within a cultivar followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

The conclusions from this study (Sistrunk and Morris, 1984) were that cold stabilization for seven days was sufficient to remove much of the acidity from muscadine juice without significantly changing the quality. In this study the addition of up to 40% water improved the juice quality. This was probably because the water reduced the phenols and acidity but the sugar that was added to equalize the samples to their original solids levels prevented a dilution effect on flavor. The addition of 3% sugar also improved juice quality. Reduction of acidity with $CaCO_3$ was not beneficial, mainly because of the adverse effect on flavor and color after storage. The highest quality juice was obtained by adding water and/or sugar.

The quality of juice made from a number of muscadine cultivars commonly produced in Arkansas was evaluated by Main et al. (1995). Sugar levels for Fry, Sterling, and Tara cultivars were below the optimum 16% level (Table 15). The authors suggested that sugars might have been increased in Fry and Sterling by allowing longer ripening on the vine. However, the Tara grapes were at full maturity. Very few of the cultivars in this study had sugar to acid ratios in the optimum range, however, it would have been possible to adjust this ratio in the juices by adding juice concentrate or acid. While it is fairly easy to increase acidity using citric or tartaric acid, it is very difficult to reduce the natural acid levels of fruit.

Table 15. Objective measures of juice quality for muscadines grown in Arkansas (Main et al., 1995).

Cultivar	Soluble Solids (%)	pH	Tartaric Acid (%)	SS:Acid Ratio
Bronze				
Fry	14.8	3.25	0.72	20.6
Sterling	14.4	2.88	0.80	17.9
Summit	16.1	3.25	0.54	29.8
Tara	14.7	3.12	0.56	26.2
Purple				
Jumbo	15.2	3.19	0.61	24.9
Sugargate	16.4	3.24	0.61	28.5

Sensory panelists evaluating the juices detected the flavor attributes of sweetness and sourness (Table 16). They found very little difference among the samples when assessing bitterness, muscadine flavor intensity, or astringency.

Table 16. Mean sensory scores for juice made from muscadine grapes grown in Arkansas.[1]

Cultivar	Sweetness	Sourness	Bitterness	Flavor Intensity	Astringency
Bronze					
Fry	8.0	9.9	0.5	7.3	4.9
Sterling	7.3	10.5	0.7	6.9	5.7
Summit	8.0	7.7	0.4	7.7	4.9
Tara	7.7	7.9	0.3	7.5	5.4
Purple					
Jumbo	7.5	8.7	0.7	7.0	5.7
Sugargate	8.3	6.8	0.4	7.1	4.9

[1] Scored on a 15-point hedonic scale with 1 = lowest score, 15 = highest.

Juice Blends

Consumer acceptance of muscadine juice has been limited to some extent by its strong flavor. Consumers are more accustomed to Concord (*Vitis labrusca* L.) grape juice which makes up the majority of grape juice produced commercially in the United States and is considered the standard in the industry (Morris, 1985). Another juice that is widely accepted commercially is Niagara, also a *Vitis labrusca*, a white juice grape.

Flora (1979) showed that muscadine juice could be successfully blended with commercial fruit juices without sacrificing quality and, in some cases, improving acceptability. Blends of Concord and Niagara juices with muscadine juice can have good color and a refreshing taste. In addition, blending muscadine juice with juices from different varieties of grapes can improve the acceptability of the strong-flavored muscadine and therefore increase the market potential for muscadines.

Sistrunk and Morris (1985) looked at the acceptability and storage stability of muscadine juice blends. Two varieties of muscadine grapes, Noble (black skinned) and Carlos (bronze skinned) were each blended at three levels with apple juice, cranberry juice, Concord and Niagara grape juice, and with each other. The Noble/Concord blends were found to be the most acceptable of the dark blends (data not shown). They also retained the most flavor during a 12-month storage period. Carlos juice blended with light-colored apple juice or with the light-colored Niagara grape juice was rated higher than blends with darker juices. The light amber color of the Carlos-light juice blends was stable during a 12-month storage period, and the flavor and overall acceptability ratings were the highest of all of the blends.

Another approach which needs to be investigated for increasing the acceptability of muscadine juice would be to blend it with Thompson Seedless grape concentrate. This white juice is used extensively commercially for blending with other juices since it provides the light color preferred by consumers, but is inexpensive compared to other juices used in blending. Concentrate from Thompson Seedless has been successfully used commercially for many years to stretch the flavor of the Niagara (white) cultivar.

Muscadine Wine

Most of the commercial muscadine grape crop is used to produce wine. Wine made from suitable cultivars of muscadine grapes has a fruity flavor that appeals to an increasing number of people. Procedures for making muscadine wine are described in Appendix A.

Muscadine grape wines are very susceptible to browning and overall loss of color quality during processing and storage (Sims and Morris, 1985). This color instability severely limits shelf-life and hinders marketing of muscadine wines. In a comparison of the color stability of Noble muscadine wine and Cabernet, Noble browned to a much greater extent during twelve months of storage. This browning was revealed by greater increases in CDM ‘b’ and absorbance (Abs.) at 420 nm in Noble than in Cabernet (Table 17). Apparently, chemical changes in the pigments of the Cabernet wine, measured as chemical