Quality Effects of Carbonation and Ethyl Maltol on Venus and Concord Grape Juices and Their Grape-Apple Blends

ANDREA SILER1 and JUSTIN R. MORRIS2*

Abstract. This study investigated the effects of ethyl maltol and carbonation on cold-pressed Venus (new Arkansas seedless grape release, 60% Vitis vinifera L. x 40% Vitis labrusca L.) and Concord (Vitis labrusca L.) grape juices and their grape-apple blends. Sensory analysis indicated Venus juice rated higher than Concord in flavor and aroma after two months of storage at 37°C. Sensory and laboratory analyses indicated that acceptable grape and grape-apple juice blends could be created from the Venus cultivar. Carbonation increased the acid taste and titratable acidity in all juice treatments. Ethyl maltol increased sweetness of noncarbonated, nonblended juices when added at 200 mg/L but generally had no significant effect on percentage of soluble solids compared to that with 100 mg/L of ethyl maltol. Grape juices blended with 50% apple juice had a higher degree of browning, a lower percentage of soluble solids, and a higher pH before and after storage when compared to nonblended grape juice.

American consumers are drinking greater quantities of juice and juice drinks (3,11,12), and the juice beverage industry is expanding at a rapid rate. New juice products are being introduced into the market. This growing market may provide a potential use for the Arkansas Venus fresh table grapes which do not meet fresh market shipping standards. Venus, a blue seedless grape released in 1977, (1,8,9) makes up the majority of table grapes recently planted in Arkansas. Under Arkansas growing conditions, as much as 30% to 40% of the table grape crop may not meet shipping standards (C. Price, University of Arkansas, personal communication, 1991). Little research is available as to the quality of juice that can be made from Venus (14). Alternative value-added juices and juice blends could be created from these grapes, which would meet consumer demand and provide an economical benefit for Arkansas table grape growers. Concord is the cultivar used most often in the production of grape juice, and it is the most widely grown grape cultivar in Arkansas. Arkansas wineries have expressed interest in producing a juice from the Venus grape. All Arkansas wineries press grapes without using traditional hotpressing techniques utilized by the juice industry. This cold-press method (7) produces a light-colored juice even from grapes with highly pigmented skins. An enzyme added prior to pressing the grapes has been shown to increase juice yield and the extraction of color grape-apple blends and flavor (16). The cold-press method has a distinct advantage over the hot-press method because it produces a juice with a more acceptable fresh grape flavor (4).

Blending and carbonating juices can affect color and flavor. Sistrunk and Morris (16) reported that blends of grape and apple juices were highly acceptable in quality and retained acceptable flavor and color during storage at 24°C for 12 months. Carbonation can enhance lightly flavored juices and can be used to make an acceptable and unique juice (5,15). The flavor and aroma of grape juice and grape juice blends can also be enhanced by adding ethyl maltol, a compound first isolated from the bark of larch trees (6). It intensifies fruit flavors and aromas without imparting a flavor or aroma of its own (2,6,13). The actual chemical mechanism producing this enhancement is not known. Maltol is typically used at levels of 50 to 200 mg/L in beverages (13). Research is needed to determine whether ethyl maltol will enhance and intensify lightly flavored, cold-pressed Venus and Concord juices and their blends with apple juice.

The purpose of this study was to (1) compare Venus with Concord juices relative to color, flavor, and storage stability and (2) to determine the influence of carbonation and ethyl maltol on the juice quality parameters.

Materials and Methods

Juices were produced from Concord and Venus grape cultivars that were hand-harvested at optimum maturity in August 1990. The Concord grapes used were grown in the University of Arkansas research vineyards at Fayetteville and were harvested at a fruit chemistry of 15.9% soluble solids (SS), pH 3.43, and 0.69% titratable acidity (TA), as tartaric acid, which is close to ideal for Concord juice grapes (10). Since differences exist between cold-pressed and hot-pressed juices (15), commercial Concord juice (hot-pressed) would not compare favorably with cold-pressed Venus. The Venus grapes used were cosmetically unsuitable for the fresh market and were grown by the Ozark Table Grape Growers Association in Searcy, Arkansas. The initial fruit chemistry for Venus had 18.1% SS, a pH of 3.29, and a TA of 0.64%. All grapes were delivered to the Department of Food Science experimental winery.

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Juice processing involved destemming and crushing grapes after a holding period of 24 hours at 21°C. During crushing, potassium metabisulfide was added at a level of 100 mg/L to reduce microbial growth, oxidation, and fermentation. Grapes were collected after crushing and destemming in a food-grade polypropylene container. A pectinolytic enzyme (Clarex L) was added to the grapes at a concentration of 200 mL/1000 kg of fruit, and the fruit was held for four hours at 30°C. Grapes were then pressed in a bladder-type press, and juice was collected in 22.8-L carboys and placed in a 2°C cold room for 24 hours. Juice was racked into 18.9-L carboys. Sulfur dioxide was added to maintain a free SO2 level of at least 30 mg/L in the juice. Titrets (based on the Ripper chemistry method) (CHEMetrics, Calverton, VA), were used to determine SO2 levels.

After the additions were made, the juice was placed in a freezer at -23°C for 10 hours to speed tartrate precipitation. When the freezing was complete, juices were placed in a 2°C cold room to thaw. The thawed juice was siphoned off the precipitates into a polypropylene container, and all the press fractions of the juice were combined into a uniform blend of juice. Potassium sorbate was added at 244 mg/L and sodium benzoate at 500 mg/L to inhibit microbial growth in all the juice treatments. The sugar:acid balance was determined for each juice by measuring the ratio of SS to TA. Citric acid was added to the Venus juice to obtain a sugar:acid ratio of 25 (15).

Further processing of juice involved filtering, blending, flavor enhancement, carbonation, and bottling. Juice was filtered with a peristaltic pump through land 0.45-µm pore size filters. A trained panel of seven people screened three commercially available apple juices. From these juices, 56.7 L of the apple juice preferred by the panel was purchased from the same commercial lot. This apple juice had a SS of 10.5%, a TA of 0.30% as citric acid, and a pH of 3.80. Concord and Venus grape juices were each blended at a level of 50% with the selected commercial bottled apple juice. Ethyl maltol was added at 100 mg/L and 200 mg/L to each juice and juice blend (manufacturer’s suggested rates). Half of the juices produced were carbonated to 3.0 atmospheres carbon dioxide with a Zahm pilot plant carbonator.

The juice was then bottled in sterilized 375-mL green glass wine cooler bottles and crown-capped for storage. Bottles were stored at 37°C for two months to simulate 10 months of storage at 21°C (a reasonable shelf life for fresh juice); a procedure used by Woodroof and Phillips (17). Treatments consisted of carbonated and noncarbonated grape juice and grape-apple blends from both cultivars, and carbonated and noncarbonated grape and grape-apple blends containing 100 mg/L or 200 mg/L ethyl maltol. A total of 24 juice treatments were produced.

**Objective analysis:**  
Titratable acidity, pH, carbonation, and SS were determined for each sample of carbonated juice prior and subsequent to degassing. Samples were degassed by placing bottles in a sonicator for 30 minutes. A Zahm Model-D-T piercing device was used to measure carbonation levels prior to degassing. Any sample that did not maintain a CO2 atmosphere was discarded. All remaining samples were analyzed.

Percent SS was measured with an Abbe Refractometer, and pH was measured with a Orion Expandable Ion Analyzer EA-920 combination electrode meter. Titratable acidity was determined by diluting 5 mL of juice in 126 mL of deionized water and titrating to a pH of 8.2 with a 0.1 N sodium hydroxide solution. Tristimulus color of juice was analyzed with a Gardner Color Difference Meter (CDM) standardized to a dark red plate (L =23.4, a = 24.8, b = 6.8). A white plate (L = 92.4, a = -1.0, b = 1.0) was placed on an optical glass cup containing 50 mL of the juice, and values were recorded. A Bausch and Lomb Spectronic 20 spectrophotometer was used to measure transmittance at wavelength settings of 430 nm and 520 nm for each juice sample. Transmittance readings were then translated into absorbance values.

All instruments used in the experiment were standardized prior to use, and samples were analyzed in triplicate. Objective analyses were conducted on all treatments of each juice and juice blend before and after storage.

**Subjective evaluation:**  
Thirteen trained panelists participated in the sensory analysis of the juice. The panel members attended a training session prior to the actual juice evaluations. Members were given juice samples to taste, smell, and examine which had attributes that were to be rated in the evaluations. Each person was trained to recognize the addition of ethyl maltol to grape juice at 100 mg/L and 200 mg/L, sweetness, sourness, balance, color, fruit aroma, and browning of grape juice. Immediately prior to evaluating the juices, the panelists were presented standard samples representing a balanced juice of that day’s variety and the same juice with an enhancer added. These standard sensory guides were used throughout the panel evaluations. One and a half ounces of each juice was poured into opaque 3.5-oz. plastic cold drink cups and placed on a white surface with a white folding board dividing panelists. The lights used in the sensory room were GE chroma 50 fluorescent lamps (giving the bluish-white color qualities of a noonday summer sun). Ten-milliliter clear glass vials were filled with juice and viewed under the same conditions. Panelists were asked to arrange and rank the juices in descending order of browning.

Sensory qualities evaluated were fruit aroma, flavor intensity, sugar:acid balance, sweetness, sourness, and visual browning. Each quality other than visual browning was charted on a 10-cm continuous vertical line with anchor words on each end (e.g., not sweet, very sweet). Panelists were asked to place a mark and the
sample number on the line for each juice to indicate the intensity rating. Six juices, one from each treatment, were presented to the panelists. A set of six samples of the nonblended grape juice was evaluated; one hour later a set of six grape-apple blends was evaluated. Panelists rinsed their mouths with water between samples. The distance of each mark from the anchor words on the lines was measured in centimeters. The highest rating for all qualities except balance was 10 and the lowest zero. The most favorable score for balance was five, with 10 being unbalanced toward sour and one being unbalanced toward sweet.

The sensory and laboratory data were analyzed in a split plot factorial design with storage time as the whole plot factor. Split plot factors were variety, blend, enhancement, carbonation, and for sensory data only, panelist. Analyses were conducted using PC-SAS version 6.04 (SAS Institute Inc., Cary, NC 27512). All statistical differences are expressed at the 5% level of significance using the least significant difference (LSD) test method.

Since there were no replications of storage time, the whole plot main effects could not be tested. This also prevented the direct comparison of storage time effects.

### Results and Discussion

**Sensory analysis:** Sensory analysis rated Venus juice higher in flavor intensity than Concord juice before and after storage (data not shown). Aroma ratings for Venus and Concord juice before storage were not significantly different. However, after two months of storage, panelists rated Venus higher in fruity aroma than Concord juice (data not shown). Carbonated Venus juice was rated highest in sourness and lowest in sweetness, and noncarbonated Venus was rated highest in sweetness and low in sourness (Table 1). This difference indicates that carbonation of Venus increased the sour taste. In the presence of carbonation, sugar:acid balance ratings increased. Panelists rated noncarbonated juice containing 200 mg/L ethyl maltol highest in sweetness (Fig. 1). This rating was expected since ethyl maltol has a sweetening effect in fruit beverages (6). Venus-apple blend rated highest in the amount of visual browning when compared to all other juices (Fig. 2), due to the higher pH of the apple juice blends. Concord juice and the Concord-apple blend were not significantly different in visual browning, and the Venus juice received the lowest visual browning ratings.

**Laboratory analysis:** Carbonated and noncarbonated Concord juice had the highest absorbance readings at both 520 and 430 nm before and after storage (Table 2). Noncarbonated and carbonated Venus juice had the highest browning index values both before and after storage, indicating a lower degree of browning when compared to other juices.
Table 2. Effects of blending, carbonation, and two months of storage at 37°C on color change of Venus and Concord juice and their grape-apple blends.

<table>
<thead>
<tr>
<th>Juice</th>
<th>Carbonation</th>
<th>Absorbance at 520nm</th>
<th>Absorbance at 430nm</th>
<th>Browning index (A_{520nm})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venus</td>
<td>None</td>
<td>0.40c</td>
<td>0.20g</td>
<td>2.06b</td>
</tr>
<tr>
<td></td>
<td>Removed</td>
<td>0.50b</td>
<td>0.17h</td>
<td>3.11a</td>
</tr>
<tr>
<td>Venus-Apple</td>
<td>None</td>
<td>0.32c</td>
<td>0.28f</td>
<td>1.14c</td>
</tr>
<tr>
<td></td>
<td>Removed</td>
<td>0.33c</td>
<td>0.36e</td>
<td>0.92d</td>
</tr>
<tr>
<td>Concord</td>
<td>None</td>
<td>0.86a</td>
<td>0.89a</td>
<td>1.02cd</td>
</tr>
<tr>
<td></td>
<td>Removed</td>
<td>0.89a</td>
<td>0.86b</td>
<td>1.03cd</td>
</tr>
<tr>
<td>Concord-Apple</td>
<td>None</td>
<td>0.50b</td>
<td>0.51c</td>
<td>1.01cd</td>
</tr>
<tr>
<td></td>
<td>Removed</td>
<td>0.50b</td>
<td>0.48d</td>
<td>1.03cd</td>
</tr>
</tbody>
</table>

Means within the same column followed by the same letter are not significantly different at the 5% level, n = 3. xCalculated as arc tangent of b/a • 57.296.

Venus at all levels of carbonation had significantly higher SS when compared to Concord and Concord apple juice, before and after storage (Table 3). The interactive effects of blending, carbonation, and storage on Venus and Concord juice and the juice blend sweetness ratings by panel members were not significantly different at the 5% level (data not shown). All carbonated juice treatments prior to decarbonation a higher TA before and after storage when compared to their noncarbonated and decarbonated juice treatments (Table 3). This result was due to the dissociation of carbonic acid during titration. The presence of this acid was detected by panel members who rated carbonated juice as more sour than noncarbonated juice for both Concord and Venus (Table 1). Concord-apple juice at all levels of carbonation had the highest pH of all juice treatments before and after storage. Noncarbonated Concord-apple juice had the highest pH of all juice treatments before and after storage. Concord-apple juice had the highest pH of all juice treatments before and after storage. Concord-apple juice had the highest pH of all juice treatments before and after storage.

Table 3. Effects of blending, carbonation, and two months of storage at 37°C on Venus and Concord grape juice and grape-apple blend quality.

<table>
<thead>
<tr>
<th>Juice</th>
<th>Carbonation</th>
<th>Soluble solids (%)</th>
<th>Titratable acidity (%)</th>
<th>SS/acid</th>
<th>pH</th>
<th>Soluble solids (%)</th>
<th>Titratable acidity (%)</th>
<th>SS/acid</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venus</td>
<td>Present</td>
<td>19.3a</td>
<td>0.93a</td>
<td>20.8g</td>
<td>3.18h</td>
<td>19.1a</td>
<td>1.08b</td>
<td>17.8f</td>
<td>3.15g</td>
</tr>
<tr>
<td></td>
<td>Removed</td>
<td>19.0b</td>
<td>0.80b</td>
<td>23.8bc</td>
<td>3.20g</td>
<td>19.0ab</td>
<td>0.87d</td>
<td>21.8d</td>
<td>3.11h</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>18.9b</td>
<td>0.81b</td>
<td>23.4bcd</td>
<td>3.18h</td>
<td>18.9b</td>
<td>0.76e</td>
<td>25.4a</td>
<td>3.16g</td>
</tr>
<tr>
<td>Venus-Apple</td>
<td>Present</td>
<td>15.4c</td>
<td>0.80b</td>
<td>19.5h</td>
<td>3.37f</td>
<td>15.1d</td>
<td>1.04c</td>
<td>14.7g</td>
<td>3.29e</td>
</tr>
<tr>
<td></td>
<td>Removed</td>
<td>15.4c</td>
<td>0.69c</td>
<td>22.5ef</td>
<td>3.45d</td>
<td>15.2cd</td>
<td>0.77e</td>
<td>19.9e</td>
<td>3.26f</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>15.0e</td>
<td>0.70c</td>
<td>21.9f</td>
<td>3.39e</td>
<td>15.3c</td>
<td>0.70f</td>
<td>22.1d</td>
<td>3.34d</td>
</tr>
<tr>
<td>Concord</td>
<td>Present</td>
<td>15.0e</td>
<td>0.92a</td>
<td>16.5i</td>
<td>148b</td>
<td>14.7e</td>
<td>1.13a</td>
<td>13.8h</td>
<td>3.41c</td>
</tr>
<tr>
<td></td>
<td>Removed</td>
<td>15.0e</td>
<td>0.66d</td>
<td>22.8de</td>
<td>3.46cd</td>
<td>15.1d</td>
<td>0.63g</td>
<td>24.1b</td>
<td>3.40c</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>15.2d</td>
<td>0.63d</td>
<td>24.1b</td>
<td>3.47bc</td>
<td>14.8e</td>
<td>0.64g</td>
<td>23.2c</td>
<td>3.47b</td>
</tr>
<tr>
<td>Concord-Apple</td>
<td>Present</td>
<td>12.8f</td>
<td>0.93a</td>
<td>14.0j</td>
<td>3.52a</td>
<td>12.9g</td>
<td>1.02c</td>
<td>12.7h</td>
<td>3.52a</td>
</tr>
<tr>
<td></td>
<td>Removed</td>
<td>12.8f</td>
<td>0.56e</td>
<td>23.1cde</td>
<td>3.52a</td>
<td>12.8g</td>
<td>0.62g</td>
<td>20.6e</td>
<td>3.48b</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>12.9f</td>
<td>0.51f</td>
<td>25.5a</td>
<td>3.53a</td>
<td>13.4f</td>
<td>0.52h</td>
<td>25.8a</td>
<td>3.53a</td>
</tr>
</tbody>
</table>

*Soluble solids (%)/*titratable acid (%Tartaric). Means within the same column followed by the same letter are not significantly different at the 5% level, n = 3.
Table 4. Effects of blending, ethyl maltol, and two months storage at 37°C on color quality parameters of Venus and Concord grape juice and grape-apple blends.

<table>
<thead>
<tr>
<th>Juice</th>
<th>Ethyl maltol (mg/L)</th>
<th>Before storage</th>
<th>After storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hue angle(°)</td>
<td>Absorbance at 520 nm</td>
<td>Absorbance at 430 nm</td>
</tr>
<tr>
<td>Venus</td>
<td>0</td>
<td>23.7a 0.47d 0.20g 2.37b</td>
<td>28.1a 0.58d 0.53e 1.15a</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>23.0b 0.44e 0.15gh 2.41b</td>
<td>28.7a 0.61c 0.55cd 1.15a</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>23.2ab 0.44e 0.16h 2.97a</td>
<td>28.0b 0.51a 0.46g 1.13ab</td>
</tr>
<tr>
<td>Venus-Apple</td>
<td>0</td>
<td>10.4f 0.31g 0.30f 1.04d</td>
<td>20.9f 0.44f 0.53de 0.84c</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>10.0f 0.32f 0.31ef 1.04d</td>
<td>22.0e 0.43f 0.49f 0.86c</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>10.3f 0.32f 0.33e 1.00d</td>
<td>21.4f 0.50e 0.57c 0.86c</td>
</tr>
<tr>
<td>Concord</td>
<td>0</td>
<td>19.0d 0.87b 0.85a 1.02d</td>
<td>20.0g 0.88b 0.90a 0.98abc</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>17.5e 0.91a 0.86a 1.05d</td>
<td>18.3h 0.90a 0.91a 0.98abc</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>18.8d 0.86b 0.85a 1.00d</td>
<td>19.8g 0.88b 0.90a 0.98abc</td>
</tr>
<tr>
<td>Concord-Apple</td>
<td>0</td>
<td>23.1ab 0.46d 0.45d 1.00d</td>
<td>25.2c 0.58d 0.64b 0.91be</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>21.2c 0.57c 0.49c 1.13c</td>
<td>22.4e 0.61c 0.66b 0.93c</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>23.3ab 0.48d 0.54b 0.90d</td>
<td>24.5d 0.59d 0.66b 0.89c</td>
</tr>
</tbody>
</table>

*Calculated as arc tangent of b/a • 57.296. Means within the same column followed by the same letter are not significantly different at the 5% level, n = 3.

Effects of ethyl maltol and blending on juice quality: Venus apple juice at all levels of ethyl maltol had a color that was redder than other treatments prior to storage as indicated by the low hue angle values (Table 4). The interactive effects of blending, ethyl maltol, and storage on quality parameters of Venus and Concord juice and juice blends were not significantly different at the 5% level (data not shown).

Effects of ethyl maltol on juice quality: Nonblended juice at all levels of ethyl maltol addition had higher absorbance values at 520 and 430 nm prior to storage when compared to juice blended with 50% apple juice (Table 5). The apple blend at all levels of ethyl maltol addition had the lowest browning index prior to storage, which indicates a higher degree of browning when compared to nonblended juices. Concord juice at all levels of ethyl maltol addition had high absorbance values at 520 and 430 nm before and after storage (Table 4). Venus juice containing 200 mg/L of ethyl maltol had the greatest browning index value prior to storage, indicating less browning when compared to all other treatments. Concord juice containing 100 mg/L of ethyl maltol had the highest absorbance value at 520 nm before and after storage, indicating that it was more green when compared to other juice treatments. Concord and Concord-apple juices at all levels of ethyl maltol addition had the highest absorbance values at 430 nm before and after storage, indicating that it was more violet than other treatments.

Sensory analysis indicated that noncarbonated juice containing 200 mg/L ethyl maltol was sweeter than any other treatment (Fig. 1). No significant differences were found in the percentages of SS in noncarbonated juice when levels of 200 mg/L ethyl maltol were compared to additions of 100 mg/L (Table 6). This confirms that ethyl maltol is a sweetness
enhancer. Nonblended juice had a significantly higher percentage of SS than did the apple blend before and after storage. The noncarbonated apple blend containing no ethyl maltol had the highest SS:acid ratio prior to storage. The apple blend at all levels of carbonation and ethyl maltol addition was significantly higher in pH than nonblended juice before storage. These results support Workman’s (18) findings in which grape juice pH increased in the presence of apple juice.

### Table 6: Main effects of blending, ethyl maltol, carbonation, and two months of storage at 37°C on juice quality parameters of nonblended and blended juice.

<table>
<thead>
<tr>
<th>Blend</th>
<th>Ethyl maltol (mg/L)</th>
<th>Carbonation</th>
<th>Soluble solids (%)</th>
<th>Titratable acidity (% tartaric acid)</th>
<th>SS/acid</th>
<th>pH</th>
<th>Soluble solids (%)</th>
<th>Titratable acidity (% tartaric acid)</th>
<th>SS/acid</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonblended</td>
<td>Present</td>
<td>17.3a</td>
<td>0.94a</td>
<td>19.4f</td>
<td>3.31h</td>
<td>17.0b</td>
<td>1.06b</td>
<td>16.0f</td>
<td>3.30h</td>
<td>1.06b</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>17.1ab</td>
<td>0.92b</td>
<td>18.7f</td>
<td>3.28g</td>
<td>16.6d</td>
<td>1.11g</td>
<td>15.1f</td>
<td>3.21i</td>
<td>1.11g</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>17.1ab</td>
<td>0.91a</td>
<td>18.7f</td>
<td>3.40g</td>
<td>17.1b</td>
<td>1.14b</td>
<td>15.0g</td>
<td>3.34g</td>
<td>1.14b</td>
</tr>
<tr>
<td>Apple blend</td>
<td>Present</td>
<td>14.1d</td>
<td>0.81b</td>
<td>23.7g</td>
<td>3.47d</td>
<td>14.0j</td>
<td>1.00c</td>
<td>14.0h</td>
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<td>1.00c</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>14.1d</td>
<td>0.91a</td>
<td>15.7e</td>
<td>3.43f</td>
<td>14.1f</td>
<td>1.04b</td>
<td>15.7e</td>
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<td>1.04b</td>
</tr>
<tr>
<td></td>
<td>200</td>
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Means within the same column followed by the same letter are not significantly different at the 5% level, n=3.

### Conclusions

Sensory and laboratory analysis indicated that carbonation increased the sour taste and the titratable acidity in all juice treatments. Ethyl maltol at 200 mg/L increased the sweetness of noncarbonated juice but generally had no significant effect on juice SS when compared to effects from 100 mg/L. In general, Concord and Venus juice blended with 50% apple juice had a higher degree of browning, a lower SS, and a higher pH before and after storage when compared to nonblended juice of both Concord and Venus cultivars. Sensory analysis indicated apple blends had a color that was more brown than nonblended juices.

Sensory analysis indicated that Venus grape juice was rated higher in flavor intensity and fruity aromawhen compared to Concord grape juice after two months of storage at 37°C. Laboratory analysis showed that Venus juice had a lower degree of browning than Concord juice after two months of storage at 37°C. These analyses indicate that the Venus table grape can produce quality juice and grape-apple juice blend comparable to the standards set with Concord (10).

### Literature Cited