

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

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**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 metabisulfite 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 SO<sub>2</sub> level of at least 30 mg/L in the juice. Titrats (based on the Ripper chemistry method) (CHEMetrics, Calverton, VA), were used to determine SO<sub>2</sub> 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 0.45- $\mu$ m 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 CO<sub>2</sub> 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

Table 1. Main effects of carbonation on Venus and Concord sensory ratings.

Treatment	Sourness	Sweetness	Sugar:Acid balance
Venus			
Noncarbonated	4.2c	5.4a	4.3b
Carbonated	6.0a	4.3c	6.0a
Concord			
Noncarbonated	4.1c	4.9b	4.3b
Carbonated	5.3b	4.7b	5.5a

Means within the same column followed by the same letter are not significantly different at the 5% level, n = 13.

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.

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

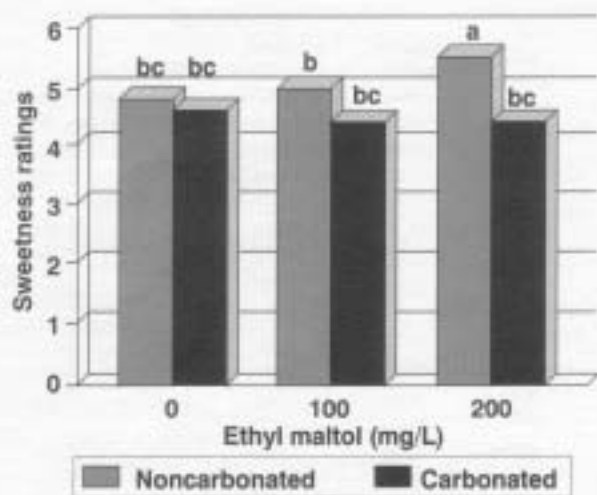


Fig. 1. Main effects of carbonation and ethyl maltol on noncarbonated and carbonated juice sweetness ratings.

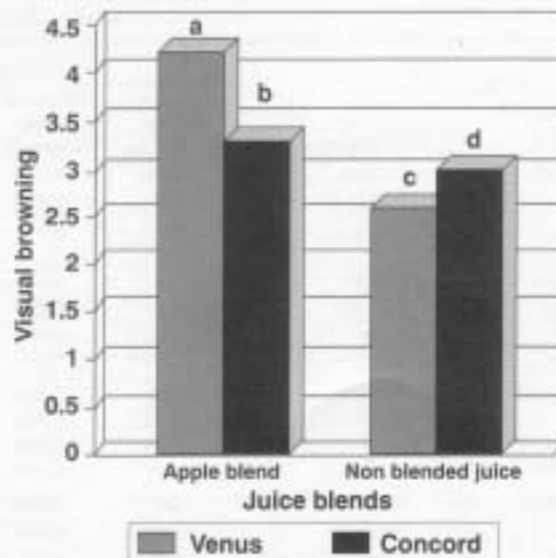


Fig. 2. Visual browning in Venus and Concord grape juices and grape-apple blends.

## 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.**

Juice	Carbonation	Hue angle(°) <sup>x</sup>	Absorbance at		Browning index (A <sub>520/430</sub> )
			520nm	430nm	
<b>Before storage</b>					
Venus	None	23.6a	0.40c	0.20g	2.06b
	Removed	23.1ab	0.50b	0.17h	3.11a
Venus-Apple	None	9.0f	0.32c	0.28f	1.14c
	Removed	11.5e	0.33c	0.36e	0.92d
Concord	None	18.6d	0.86a	0.89a	1.02cd
	Removed	18.2d	0.89a	0.86b	1.03cd
Concord-Apple	None	22.2c	0.50b	0.51c	1.01cd
	Removed	22.9b	0.50b	0.48d	1.03cd
<b>After storage</b>					
Venus	None	28.0a	0.47e	0.37h	1.27a
	Removed	28.5a	0.67b	0.65d	1.03b
Venus-Apple	None	20.6e	0.42f	0.49g	0.84c
	Removed	22.3d	0.50e	0.58f	0.86c
Concord	None	20.2e	0.87a	0.89b	0.98bc
	Removed	18.6f	0.98a	0.93a	0.98bc
Concord-Apple	None	24.8b	0.57d	0.62e	0.92bc
	Removed	23.3c	0.62c	0.68c	0.90bc

Means within the same column for each sampling time followed by the same letter are not significantly different at the 5% level, n = 3. <sup>x</sup>Calculated 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

**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.**

Juice	Carbonation	Before storage				After storage			
		Soluble solids (%)	Titratable acidity (% Tartaric)	SS/acid <sup>x</sup>	pH	Soluble solids (%)	Titratable acidity (% Tartaric)	SS/acid <sup>x</sup>	pH
Venus	Present	19.3a	0.93a	20.8g	3.18h	19.1a	1.08b	17.8f	3.15g
	Removed	19.0b	0.80b	23.8bc	3.20g	19.0ab	0.87d	21.8d	3.11h
	None	18.9b	0.81b	23.4bcd	3.18h	18.9b	0.76e	25.4a	3.16g
Venus/ Apple	Present	15.4c	0.80b	19.5h	3.37f	15.1d	1.04c	14.7g	3.29e
	Removed	15.4c	0.69c	22.5ef	3.45d	15.2cd	0.77e	19.9e	3.26f
	None	15.0e	0.70c	21.9f	3.39e	15.3c	0.70f	22.1d	3.34d
Concord	Present	15.0e	0.92a	16.5i	148b	14.7e	1.13a	13.h	3.41c
	Removed	15.0e	0.66d	22.8de	3.46cd	15.1d	0.63g	24.1b	3.40c
	None	15.2d	0.63d	24.1b	3.47bc	14.8e	0.64g	23.2c	3.47b
Concord/ Apple	Present	12.8f	0.93a	14.0j	3.52a	12.9g	1.02c	12.7h	3.52a
	Removed	12.8f	0.56e	23.1cde	3.52a	12.8g	0.62g	20.6e	3.48b
	None	12.9f	0.51f	25.5a	3.53a	13.4f	0.52h	25.8a	3.53a

<sup>x</sup>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.**

Juice	Ethyl maltol (mg/L)	Before storage				After storage			
		Hue angle(°) <sup>x</sup>	Absorbance at 520nm	Browning index 430nm (A <sub>520/430</sub> )		Hue angle(°) <sup>x</sup>	Absorbance at 520nm	Browning index 430nm (A <sub>520/430</sub> )	
Venus	0	23.7a	0.47d	0.20g	2.37b	28.1ab	0.58d	0.52e	1.15a
	100	23.0b	0.44e	0.18gh	2.41b	28.7a	0.61c	0.55cd	1.15a
	200	23.2ab	0.44e	0.16h	2.97a	28.0b	0.51a	0.46g	1.13ab
Venus-Apple	0	10.4f	0.31g	0.30f	1.04d	20.9f	0.44f	0.53de	0.84c
	100	10.0f	0.32f	0.31ef	1.04d	22.0e	0.43f	0.49f	0.86c
	200	10.3f	0.32f	0.33e	1.00d	21.4f	0.50e	0.57c	0.86c
Concord	0	19.0d	0.87b	0.85a	1.02d	20.0g	0.88b	0.90a	0.98abc
	100	17.5e	0.91a	0.86a	1.05d	18.3h	0.90a	0.91a	0.98abc
	200	18.8d	0.86b	0.85a	1.00d	19.8g	0.88b	0.90a	0.98ab
Concord-Apple	0	23.1ab	0.46d	0.45d	1.00d	25.2c	0.58d	0.64b	0.91be
	100	21.2c	0.57c	0.49c	1.13c	22.4e	0.61c	0.66b	0.93c
	200	23.3ab	0.48d	0.54b	0.90d	24.5d	0.59d	0.66b	0.89c

<sup>x</sup>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.

juice had the highest SS:acid ratio of all juice treatments prior to storage (Table 3). Noncarbonated Venus and noncarbonated Concord-apple juice had the highest SS:acid ratio of all juice treatments after storage. The most desirable SS:acid ratio range for grape juice has been shown to be 23 to 26 (15). The presence of carbonation reduced SS: acid balance values within variety and juice treatments. The presence of carbonation resulted in juice having a SS:acid balance ratio less than the optimum range in all treatments. Panelists rated carbonated juices higher in sugar:acid balance than noncarbonated juices, with ratings slightly greater than five (Table 1).

**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).

Table 5. Effects of blending, ethyl maltol, carbonation, and two months of storage at 37°C on nonblended and blended juice color quality parameters.

Ethyl maltol (mg/L)	Carbonation	Before storage			After storage		
		Absorbance at 520nm	Absorbance at 430nm	Browning index (A <sub>520</sub> /A <sub>430</sub> )	Absorbance at 520nm	Absorbance at 430nm	Browning index (A <sub>520</sub> /A <sub>430</sub> )
<b>Nonblended juice</b>							
0	Removed	0.70a	0.52a	1.84b	0.78b	0.79b	1.00ab
100	Removed	0.70a	0.52a	1.90b	0.84a	0.82a	1.02ab
200	Removed	0.68b	0.49b	2.48a	0.74c	0.75c	1.00ab
0	None	0.64c	0.53a	1.55c	0.68d	0.63d	1.13a
100	None	0.65c	0.52a	1.55c	0.68d	0.64d	1.13a
200	None	0.62d	0.52a	1.50c	0.65e	0.62de	1.11a
<b>Apple blend</b>							
0	Removed	0.39h	0.40d	0.99e	0.55f	0.64d	0.86b
100	Removed	0.44e	0.43c	1.01de	0.56f	0.62de	0.90b
200	Removed	0.40g	0.43c	0.91e	0.56f	0.62de	0.89b
0	None	0.38h	0.34f	1.06de	0.48h	0.54f	0.89b
100	None	0.45e	0.36e	1.17d	0.48h	0.53f	0.89b
200	None	0.41f	0.43c	0.99e	0.52g	0.60e	0.86b

Means within the same column followed by the same letter are not significantly different at the 5% level, n = 3.

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

**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

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.

Blend	Ethyl maltol (mg/L)	Carbonation	Before storage				After storage			
			Soluble solids (%)	Titrateable acidity (%tartaric)	SS/acid*	pH	Soluble solids (%)	Titrateable acidity (%tartaric)	SS/acid*	pH
Nonblended juice	0	Present	17.3a	0.94a	18.4f	3.31h	17.0b	1.06b	16.0f	3.30i
	100	Present	17.1ab	0.92a	18.7f	3.29j	16.6d	1.11a	15.1fg	3.21i
	200	Present	17.1ab	0.91a	18.7f	3.40g	17.1ab	1.14a	15.0g	3.34g
	0	Removed	17.1ab	0.73cd	23.3bcd	3.32h	17.1ab	0.75de	23.2bc	3.26k
	100	Removed	17.0bc	0.70d	24.2b	3.28j	16.8cd	0.76d	22.4cd	3.16m
	200	Removed	17.0bc	0.76c	22.3c	3.40g	17.3a	0.75de	23.2bc	3.35g
	0	None	17.3a	0.73cd	23.6bc	3.29i	16.9bc	0.64f	26.7a	3.32h
	100	None	16.8c	0.71d	23.7b	3.27j	16.7cd	0.73de	22.9bc	3.28j
	200	None	17.0bc	0.72d	23.9b	3.39g	16.9bc	0.72de	23.4b	3.34g
Apple blend	0	Present	14.1d	0.81b	17.8f	3.47cde	14.0gh	1.00c	14.0h	3.43c
	100	Present	14.1d	0.91a	15.8g	3.43f	14.1fgh	1.04bc	13.7h	3.38f
	200	Present	14.2d	0.91a	16.6g	3.45e	14.0gh	1.04bc	13.5h	3.41de
	0	Removed	14.1d	0.58fg	24.0b	3.51a	14.0gh	0.64f	21.9d	3.30i
	100	Removed	14.1d	0.65e	21.9e	3.47cde	13.9h	0.71e	19.7e	3.42cd
	200	Removed	14.2d	0.64e	22.4e	3.48bc	14.2fg	0.74de	19.3e	3.40e
	0	None	14.0d	0.55g	25.8a	3.49b	14.5e	0.56g	25.9a	3.48a
	100	None	14.0d	0.63ef	22.8cde	3.43f	14.3ef	0.63f	23.2bc	3.45b
	200	None	14.0d	0.63ef	22.7de	3.46de	14.3ef	0.64f	22.7bcd	3.37f

\*Soluble solids (%) / total acid (% tartaric).

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 titrateable 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

1. Bowden, H. L. Fresh market table grape industry. In: Proceedings of the Arkansas State Horticultural Society 110<sup>th</sup> Annual Meeting, Fort Smith, AR. pp 81-111 (1989).
2. Gaffield, I. L. Production of flavor and aroma compounds by biotechnology. *Food Tech.* 42:118 (1988).
3. Haring, P. E. St. Regis -the no-alcohol white wine. *Wines and Vines* 66:25 (1985).
4. Huckleberry, J. M., J. R. Morris, C. James, D. Marx, and I. M. Rathburn. Evaluation of wine grapes for suitability in juice production. *J. Food Qual.* 13:71-84 (1990).
5. King, R. C., C. A. Sims, L. F. Moore, and R. P. Bates. Effects of maturity, skin contact and carbonation on the quality of sterile-filtered white muscadine grape juice. *J. Food Sci.* 53:1474-6, 1485 (1988).
6. LeBlanc, D. T., and H. A. Akers. Maltol and ethyl maltol: From the larch tree to successful food additive. *Food Tech.* 43:78-84 (1989).
7. McLellan, M. R., and E. J. Race. Grape juice processing. In: *Production and Packaging of Noncarbonated Fruit Juices and Fruit Beverages*. D. Hicks (Ed.), pp 226-42. Blackie and Son Ltd, New York (1990).

8. Medders, H. Record table grape harvest expected. Progress Report. Arkansas Agricultural Experiment Station. Fayetteville, AR. July 5, 1990.
9. Moore, J. N., and E. Brown. 'Venus' grape. *J. Am. Soc. Hort. Sci.* 12:585 (1977).
10. Morris, J. R. Grape Juice: Influences of preharvest, harvest, and postharvest practices on quality. In: *Evaluation of Quality of Fruits and Vegetables*. Harold E. Pattee (Ed.). pp 129-76. AVI Publishing Co., Westport, CT (1985).
11. Norman, G. Three new marketing varietal grape juices. *California Grape Grower* 15:10-1 (1984).
12. Pehanich, M. The beverage business is bubblin'. *Prepared Foods* 153:42-6 (1984).
13. Pfizer. Data Sheet 660. Pfizer Chemicals Division, New York. (1977).
14. Price, C., and J. R. Morris. Juice processing as an alternative market for Arkansas' fresh table grape production. *Ark. Bus. and Econ. Rev.* 24:615 (1991).
15. Rathburn, I. M., and J. R. Morris. Evaluation of varietal grape juice; Influence of processing method, sugar and acid adjustment, and carbonation. *J. Food Quality.* 13(6):395-409 (1990).
16. Sistrunk, W. A., and J. R. Morris. Quality acceptance of juices of two cultivars of Muscadine grapes mixed with other juices. *J. Am. Soc. Hort. Sci.* 110:325-32 (1985).
17. Woodroof, J. G., and G. F. Phillips. *Beverages: Carbonated and Noncarbonated*. pp374-98, 169. AVI Publishing Co. Inc., Connecticut (1981).
18. Workman, D. S., and J. R. Morris. Storage stability of wine coolers as influenced by juice content and citric acid addition. *J. Food Quality.* 15:3952 (1992).