**Title:**

Evaluating the Wine Potential of High Acid Bunch Grapes When Blended with Other Grape Cultivars and Small Fruits

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**Public Abstract:**


As the U.S. grape and wine industry expands, there is growing interest in developing production in the Gulf South region. However, local production of high-quality wine grapes remains limited, with few region-specific cultivars available and currently grown bunch grapes exhibiting high acidity and low soluble solids for winemaking. Blending high-acid grape wines with other fruit wines presents a promising strategy to balance acidity and enhance phenolic composition while supporting local fruit growers. To improve the composition and consumer appeal of local wines, this study examined blending Mississippi-grown 'MidSouth' grapes, blueberries, and blackberries to include the wine blend treatments: 100% 'MidSouth', 75% 'MidSouth': 25% Blackberry, 50% 'MidSouth': 50% Blackberry, 75% 'MidSouth': 25% Blueberry, and 50% 'MidSouth': 50% Blueberry. Physicochemical analysis revealed blending influenced acidity, pH, ethanol, phenolics, and color. Wines made entirely from 'MidSouth' grapes had the highest monomeric anthocyanin and ethanol content, while blends with blackberries

exhibited the highest total phenolic content and produced lighter-colored wines with stronger red and yellow tones. Blueberry blends had the lowest pH, highest acidity, and the darkest color. Preliminary consumer evaluations ranked 100% 'MidSouth' wine highest overall, while the 100% 'MidSouth' and 50% blackberry blends both received the highest flavor ratings. The 25% blackberry blend was rated highest for sweetness and body, while the 50% blueberry blend was rated highest for appearance. While further refinement is needed to enhance appeal, as even the highest-rated blend received only moderate preference, blending offers a strategy to improve certain attributes of local wines.

**Introduction:**

With the expansion of the grape and wine industry throughout the United States and the economic and agronomic impact it can have on states, there is a significant need to find ways to bring more of that industry to the southeast region - more specifically, South Mississippi. The interest from growers and winemakers to use locally grown grapes and other small fruit is evident, but currently, high quality wine grape production is low, and few new cultivars have been released in recent years that would have potential in the area. Thus, the wine capacity potential of current southern wine grape cultivars needs to be improved.

Interspecific hybrid bunch grapes currently grown in South Mississippi tend to have higher levels of titratable acidity and lower levels of total soluble solids than what is recommended for wine production. The ideal range for grapes at harvest is a titratable acidity of 0.5-1.0% and soluble solids of 20-25%. While high acidity can change during maturation of wine and contribute herbaceous aromas to the final product, this quality in grapes is typically considered negative by winemakers. However, these grapes could be co-fermented with other grapes, or the finished wine could be blended with other wine, in the process known as coupage, to produce a final product that exhibits more desirable composition and sensory attributes, such as less tartness and more balanced acidity levels that allow more fruit-forward flavors to come through. Additional reasons to blend wines are to improve color and phenolic composition. Studies have shown that consumption of berries and moderate consumption of red wine made from dark berries (not only grapes) can have positive effects on human health due to the antioxidant ability of their phenolic composition of anthocyanins and tannins.

While they are non-traditional, non-grape wines have their benefits, as they can be made with almost any fruit, and they provide diversity to the wines that are commercially available. They also provide an opportunity for winemakers to source material from local non-grape, fruit growers for wine production rather than locating outside sources of grapes. Not only does this support the local economy, but it helps to eliminate the losses associated with shipping. Additionally, non-grape fruits could act as blending agents in the production of wine made from high acid, low yield grapes that needs additional body and flavor balance.

The overall objective of the project is to increase the quality of wine from high acid bunch grapes grown in Mississippi and surrounding areas. The goal is to select the best small fruit wine blends for an improved composition and palatability for consumers.

**Materials and Methods:**

Approximately 84 kg of crushed grapes, 19 kg of crushed blackberries, and 17 kg of crushed blueberries were used in this study. Cultivars consisted of 'MidSouth' bunch grapes, a mix of 'Prime-Ark Freedom', 'Prime-Ark Traveler', 'Prime-Ark 45', and 'Sweetie Pie' blackberries and a mix of breeding selections of rabbiteye blueberries. These fruits were harvested from plants grown in McNeill, Beaumont, and Poplarville, MS. Blackberries and blueberries were immediately frozen after harvest in 3.8 L freezer bags, while grapes were destemmed and crushed, treated with 30 mg/L $SO_2$ as potassium metabisulfite, and then frozen in sealed 18.9 L buckets lined with 4-mm food-grade plastic bags.

In early September, blackberries and blueberries were removed from the freezer and 30 mg/L $SO_2$ was added to each. Grapes were removed from the freezer 24 hr later, and all fruits thawed during transport to the University of Arkansas Food Science Department in Fayetteville, AR and stored at 2 °C for 24 hr. The fruits were then moved to 21 °C. The grapes were transferred into triplicate 26.5 L plastic containers lined with food-grade polyethylene liners, and the blackberries and blueberries were each transferred into triplicate 18.9 L polyethylene-lined plastic containers. Initial juice composition was analyzed and adjusted as needed, and then each must type was inoculated with D254 yeast, GoFerm yeast rehydration nutrient, and FermAid K yeast fermentation nutrient (Lallemand, Montreal, Canada). The bags were partially sealed with tape to allow $CO_2$ to escape during fermentation, and twice a day the must cap was punched down through the bag. Each fruit type was fermented with their skins for 72 hr before being pressed with a bladder press at 4 bar pressure into 18.9 L glass carboys. The partially fermented juice types were then transferred into duplicate 11.4 L carboy replications of each blend type, based on weight, and consisted of:

- 100% 'MidSouth'
- 75% 'MidSouth': 25% Blackberry
- 50% 'MidSouth': 50% Blackberry
- 75% 'MidSouth': 25% Blueberry
- 50% 'MidSouth': 50% Blueberry

These fruit blends were then allowed to co-ferment at 15 °C for 11 weeks. They were racked as needed, and free $SO_2$ was maintained at approximately 30 mg/L. Prior to bottling, up to 0.85 molecular $SO_2$ was added to each wine, depending on final total soluble solids. The wines were then sparged with nitrogen while bottling into 750 mL and 375 mL bottles, which are being stored at 2 °C.

Data compiled on the fruit and/or wine included:

- Total soluble solids (TSS) by digital hydrometer
- pH by automated titrimeter
- Titratable acidity (TA) by automated titrimeter
- Ethanol by ebulliometer
- Free $SO_2$ by aeration-oxidation method
- Monomeric anthocyanin pigment by spectrophotometer pH differential method
- Total phenolic content by spectrophotometer Folin-Ciocalteu method
- Color L*, a*, b* by ColorFlex system

Analysis of physicochemical and color attribute data was conducted using RStudio®. The must data were analyzed as a completely randomized design with 3 fruit types x 3 replications, and the wine data were analyzed as a completely randomized design with 5 blend treatments x 2 replications. Tukey's Honestly Significant Difference (HSD) was used for mean separation at a p-value $\leq 0.05$.

Preliminary consumer ratings (n=35) for sensory attributes and overall liking of each wine blend treatment were assessed through blind tastings held at the Specialty Crops Conference at the Lake Terrace Convention Center in Hattiesburg, MS on December 13th, 2024. The wines were presented as a balanced block design, and Tukey's Honestly Significant Difference (HSD) was used for mean separation at a p-value $\leq 0.05$.

Results of this work were presented at the annual meeting of the Southern Region American Society for Horticultural Science in February 2025.

**Results and Discussion:**

Analysis of fruit physicochemical attributes reveal the grapes to have the lowest adjusted TSS, and blueberries to have the lowest pH (Table 1). While the reported grape TSS is remarkably low, the TSS at harvest was approximately 15 °Brix, which suggests that some fermentation via wild microbes took place either prior to freezing or while thawing.

Physicochemical analysis of the completed wine blends revealed highest TSS in 75% 'MidSouth': 25% Blackberry and lowest in both blueberry blends. Highest pH was determined in 100% 'MidSouth' and 75% 'MidSouth': 25% Blackberry, while lowest was determined in both blueberry blends. Highest TA was in the 50% 'MidSouth': 50% Blueberry blend and lowest was in the 100% 'MidSouth'. Ethanol was highest in 100% 'MidSouth' and 75% 'MidSouth': 25% Blueberry and lowest in 50% 'MidSouth': 50% Blackberry. Free $SO_2$ was highest in 100% 'MidSouth' and 75% 'MidSouth': 25% Blackberry, while the lowest was in 75% 'MidSouth': 25% Blueberry. 100% 'MidSouth' had the highest monomeric anthocyanin pigment and 50% 'MidSouth': 50% Blackberry had the lowest. The highest total phenolic content was in 50% 'MidSouth': 50% Blackberry and the lowest was in both blueberry blends. The highest lightness (L*) values were found in both blackberry blends and lowest were found in 75% 'MidSouth': 25% Blueberry. 50% 'MidSouth': 50% Blackberry had the highest red (a*) values and 100% 'MidSouth' and 75% 'MidSouth': 25% Blueberry had the lowest. Both blackberry blends had the highest yellow (b*) values and 75% 'MidSouth': 25% Blueberry had the

lowest (Table 2). Additionally, all blend treatments underwent malolactic fermentation and were determined to have malic acid content of <0.1 g/L.

Preliminary consumer ratings of the completed wine blends revealed that 100% 'MidSouth' wine had the highest flavor preference and overall liking among the wine blends evaluated. The wine blend containing 50% blackberry was also rated highly for flavor, and the blend containing 25% blackberry had the most preferred sweetness and body. The blend containing 50% blueberry had the most preferred color; however, the blueberry blends were generally rated the lowest in other sensory attributes (Table 3).

This research provides valuable insights into optimizing regionally grown fruit for wine production to achieve desired sensory and physicochemical attributes. While preliminary consumer ratings indicate the need for further refinement to enhance appeal, as even the highest-rated blend received only moderate preference, blending 'MidSouth' grapes with other small fruits offers the ability to enhance certain wine attributes, offering the potential to improve marketability of these local fruits while promoting economic and environmental sustainability in the region.

Table 1. Average physicochemical properties of each fruit type prior to fermentation.

| Fruit | TSS[z] (°Brix) | Adjusted TSS (°Brix) | pH | TA[y] (g/L) |
|---|---|---|---|---|
| Grape | 11.0 a[x] | 21.7 b | 3.5 a | 9.2 a |
| Blackberry | 9.6 a | 25.6 a | 3.4 a | 10.7 a |
| Blueberry | 9.9 a | 25.4 a | 3.2 b | 9.7 a |
| Significance | ns[w] | *** | *** | ns |

[z]TSS, Total soluble solids.
[y]TA, Titratable acidity.
[x]Different lowercase letters following the means within columns indicate significant differences.
[w]*** means significantly different at $p \leq 0.001$ and ns means no significant difference.

Table 2. Average physicochemical properties and color attributes of each wine blend treatment at bottling.

| Blend Treatment | TSS[z] (°Brix) | pH | TA[y] (g/L) | Ethanol (% v/v) | Free $SO_2$ (mg/L) | Monomeric Anthocyanin Pigment (mg/L)[x] | Total Phenolic Content (mg/L)[w] | L* | a* | b* |
|---|---|---|---|---|---|---|---|---|---|---|
| 100% 'MidSouth' | -0.2 b[v] | 3.7 a | 6.8 e | 12.9 a | 52.0 a | 66.2 a | 799.6 bc | 12.5 ab | 35.1 c | 20.6 ab |
| 75% 'MidSouth': 25% Blackberry | 0.5 a | 3.7 a | 8.2 d | 12.0 b | 54.5 a | 35.7 d | 915.5 ab | 13.0 a | 36.9 b | 21.5 a |
| 50% 'MidSouth': 50% Blackberry | 0.2 ab | 3.5 b | 9.6 b | 11.5 c | 49.5 ab | 31.1 e | 993.7 a | 13.1 a | 38.4 a | 21.9 a |
| 75% 'MidSouth': 25% Blueberry | -0.8 c | 3.5 c | 8.5 c | 12.7 a | 29.5 b | 53.0 b | 729.6 c | 10.2 c | 35.1 c | 16.7 c |
| 50% 'MidSouth': 50% Blueberry | -1.1 c | 3.5 c | 9.9 a | 12.2 b | 35.5 ab | 40.9 c | 692.8 c | 11.5 b | 37.0 b | 19.0 b |
| Significance | ***[u] | *** | *** | *** | * | *** | *** | ** | *** | *** |

[z]TSS, Total soluble solids.
[y]TA, Titratable acidity.
[x]Expressed as cyanidin-3-O-glucoside.
[w]Expressed as gallic acid equivalent.
[v]Different lowercase letters following the means within columns indicate significant differences.
[u]*, **, *** mean significantly different at $p \leq 0.05$, $p \leq 0.01$, and $p \leq 0.001$, respectively.

Table 3. Average consumer ratings for sensory attributes and overall liking of each wine blend treatment, assessed using a 9-point verbal hedonic scale (n=35).

| Blend Treatment | Appearance | Aroma | Flavor | Sweetness | Tartness | Astringency | Body | Persistency | Overall Liking |
|---|---|---|---|---|---|---|---|---|---|
| 100% 'MidSouth' | 7.3 b[z] | 6.9 a | 6.5 a | 6.0 ab | 6.2 a | 6.2 a | 5.9 ab | 6.1 a | 6.5 a |
| 75% 'MidSouth': 25% Blackberry | 7.5 ab | 6.7 a | 6.1 ab | 6.1 a | 5.9 a | 6.2 a | 6.4 a | 5.8 a | 6.1 abc |
| 50% 'MidSouth': 50% Blackberry | 7.7 ab | 7.1 a | 6.4 a | 5.8 abc | 5.9 a | 6.1 a | 5.9 ab | 5.9 a | 6.2 ab |
| 75% 'MidSouth': 25% Blueberry | 7.9 ab | 6.8 a | 5.2 bc | 5.0 bc | 5.3 a | 5.7 a | 5.5 b | 5.2 a | 5.1 c |
| 50% 'MidSouth': 50% Blueberry | 7.9 a | 6.8 a | 5.1 c | 5.0 c | 5.6 a | 5.5 a | 5.5 b | 5.1 a | 5.3 bc |
| Significance | *[y] | ns | *** | ** | ns | ns | ** | ns | *** |

[z]Different lowercase letters following the means within columns indicate significant differences.

[y]*, **, *** mean significantly different at $p \leq 0.05$, $p \leq 0.01$, and $p \leq 0.001$, respectively, and ns means no significant difference.