The Impact of Increased Ethanol Concentration through Chaptalization on the Chemical and Sensory Properties of Merlot (2019)

King Family Vineyards
Matthieu Finot

Summary

Even in good years in Virginia (such as 2019), some varieties, such as Merlot and Malbec, stall in Brix accumulation but still present other markers of maturity (varietal character, ripe seeds and tannins). The purpose of this study was to examine the effect of three chaptalization rates on the perception of ripeness in Merlot from a block with poor sugar accumulation. The study examined the effect of chaptalization rates of 30 g/L and 50 g/L with both white sugar and brown sugar. There was no difference in conversion rate or sensory impressions for white sugar vs. brown sugar. Wines made from chaptalization of must with rates of 30 g/L and 50 g/L had higher scores for positive sensory descriptors while unchaptalized wine was described as thin and acidic. This experiment was conducted in a warm, dry growing season (2019). The study will be repeated in 2020 to determine if these positive effects are still found in a less “ripe” vintage.

Introduction

The 2018 growing season was fraught with consistent and sometimes heavy rainfall throughout the state of Virginia. Some localities reported more than 80 inches of rain in 2018, leading to the wettest year on record for many cities and counties[1]. Through diligent work in the vineyard, many wineries were still able to harvest a crop, however these grapes came in with notably lower sugar accumulation. Winemakers in Virginia began to wonder how much a low Brix wine can be chaptalized before becoming unbalanced. Anecdotally, several winemakers had been trained that the limit for chaptalization was two degrees of alcohol while others had been trained 1.5 degrees was the limit (perhaps reflecting their region of training). The 2018 vintage forced sugar additions up to 3 degrees of alcohol with surprisingly acceptable results, challenging the assumptions of many local winemakers.

Increasing alcohol through chaptalization has several effects on the finished wine. The concentration of alcohol affects the chemical stability of the wine (acting as an antimicrobial agent). The viscosity of alcohol adds weight to the palate[2], it volatilizes fruit aromas[2], augments the production of glycerol, succinic acid, and esters[3]. Previous work by Sherman et al[4] tested the effects of ethanol concentration on chemical and sensory properties of wines harvested at three levels of ripeness in Washington State Merlot. In an elegant experimental design, they harvested the same block at three intervals: underripe, ripe, and overripe. For each harvest, they broke the grapes into three treatments and used either chaptalization (to raise the Brix) or saignée and watering back with acidulated water (to lower Brix) so that they could compare chemistry and sensory responses for wines of each harvest interval with each resulting alcohol concentration. They found that there were expected differences in chemistry between wines from different harvest dates, however, adjustments for ethanol “had a greater effect on wine sensory properties than fruit maturity” Specifically, “wines made from ripe (24° Brix) or overripe fruit adjusted to low ethanol concentrations were described similarly to wines made from unripe fruit” including green and sour, and “wines made from unripe or ripe fruit adjusted to high ethanol concentrations were described similarly to wines made from overripe fruit” including descriptors such as red fruit and flora. They conclude that “wine ethanol concentration is more important for the sensory profiles of wines than is fruit maturity at harvest.”

Even in good years in Virginia (such as 2019), some varieties, such as Merlot and Malbec, stall in Brix accumulation but still present other markers of maturity (varietal character, ripe seeds and tannins). At King Family, one block of Merlot often ceases sugar accumulation at or near 20°Brix, perhaps due to leaf roll virus. The management team is faced with the decision of whether to pull out the vines and replant this block, relegate the fruit to Rosé production, or augment the potential alcohol through chaptalization. The purpose of this study was to examine the effect of three chaptalization rates on the perception of ripeness in this low-Brix Merlot.

Methods

Fruit was hand harvested (on 9/20) and refrigerated overnight, then destemmed and lightly crushed into three TBins with the addition of 13 ppm SO_2. The same day, saignée was performed on each treatment bin with the removal of 50L of juice from each bin, roughly 10% of the juice volume. After saignée, each treatment bin was inoculated with D80 yeast. Two days into fermentation, 35 g/bin (6 g/hL) Lafasse HE Grand Cru was added to each treatment. There were no acid or nutrient additions during fermentation. On the third day of fermentation, chaptalization occurred according to the following:

Control: no sugar addition
S30: addition of 30 g/L white sugar, increase in potential alcohol of 1.6%
BS30: addition of 30 g/L brown sugar, increase in potential alcohol of 1.6%
S50: addition of 50 g/L white sugar, increase in potential alcohol of 2.7%
BS50: addition of 50 g/L brown sugar, increase in potential alcohol of 2.7%

Each treatment bin was punched down twice per day. Brix and temperature were checked daily. Wine was pressed on 10/7, after 20 days of maceration. Wine was settled overnight then racked to barrels for malolactic fermentation. The progress of malolactic fermentation was checked every week with paper chromatography and completion was confirmed with enzymatic analysis. KMBS (15 g) and 3 g/hL chitosan were added to each barrel at the completion of malolactic fermentation with no racking.

Sensory analysis was completed by a panel of 25 wine producers. Due to social distancing practices put in place during COVID-19, blind sensory analysis was completed remotely. Wines were presented in randomly numbered bottles with instructions for tasting. There were two flights for this experiment. In the first, three wines were presented (control, 30 g/L white sugar, 50 g/L white sugar) and tasters were asked to score each wine on a scale from 1 to 10 for color intensity, aromatic intensity, fruit intensity, fruit character (bright/red vs. dark/black), perception of ripeness, and herbaceous/green character. There were three tasting groups with the order of analysis balanced among groups. In the second flight, tasters were presented with three wines, two of one type and one of another (white sugar vs. brown sugar, each at 50 g/L), and asked to identify which wine was different (a triangle test). There were three tasting groups with the unique wine in the triangle test balanced between groups. Tasters were then asked to score each wine on a scale of 0 to 10 for color intensity, aromatic intensity, fruit intensity, fruit character, perception of ripeness and astringency. Open ended questions asking respondents to describe the wines were also used. Results for the triangle test were analyzed using a one-tailed Z test. Descriptive scores were analyzed using repeated measures ANOVA. In flight 1, if significant differences were found among descriptive score, Tukey's test was used to determine which categories were significantly different from one another.

Results

Fruit was harvested with 19.7°Brix, and all wines finished with <1.0 g/L glucose/fructose and <0.15 g/L malic acid. Potential alcohol was calculated using a conversion factor of 0.56 and a standard of 18 g/L sugar needed to raise the alcohol by 1%. The control wine showed lower alcohol conversion than expected (Table 1). The conversion rates of sugar to alcohol are dependent upon many factors including the strain of yeast and fermentation temperature. Also, initial Brix measurement may have overestimated sugar due to other suspended solids in the juice sample. The increase in alcohol due to chaptalization was consistent with predicted values. There was no difference in conversion rate due to the type of sugar used. Acid profile and volatile acidity of the wine was not affected by chaptalization rates nor type of sugar (Table 2). The control wine had lower color intensity than the other wines. Wines chaptalized with white sugar had higher color intensity than those chaptalized with brown sugar.

In sensory analysis comparing three levels of chaptalization (control, 30 g/L white sugar, 50 g/L white sugar), the chaptalized wines had significantly different scores for several descriptors (Figure 1, Table 3). Chaptalization to 30 g/L resulted in significantly higher fruit intensity, darker fruit character, and increased perception of ripeness. These gains were also seen when wine as chaptalized to 50 g/L. Aromatic intensity was significantly higher with the higher level of chaptalization but not the lower level. There was no significant difference in scores for herbaceous/green character; all wines had relatively low scores for this descriptor. Color intensity was significantly higher in wine made from 30 g/L chaptalization but not 50 g/L. This is consistent with spectrophotometer readings of color intensity (Figure 1). Color is a complex metric that also relies on pH and SO_2. Slightly lower pH and SO_2 in the wine chaptalized with 30 g/L of sugar may be contributing to this color difference. Several respondents also noted that the control wine had pronounced acid and was thin in the mouth while the wine chaptalized with 50 g/L of sugar was "super fragrant and lovely". Others noted that the two chaptalized wines were not very different.

In a triangle test comparing wines chaptalized with 50 g/L white sugar vs. 50 g/L brown sugar, 8 out of 25 respondents were able to distinguish which wine was different, indicating the wines were not significantly different (Z= -0.35, p= 1.00). There were no significant differences in scores for color intensity (F=0.496, p=0.493), aromatic intensity (F=0.172, p-0.685), fruit intensity (F=0.542, p=0.474), fruit character (F=0.233, p=0.637), perception of ripeness (F=0.017, p=0.898) nor astringency (F=0.333, p=0.573).

Conclusions

- Alcohol conversions rates were consistent with published values.
- There was not difference in conversion rate or sensory impressions for white sugar vs. brown sugar.
- Wines made from chaptalization of must with rates of 30 g/L and 50 g/L had higher scores for positive sensory descriptors while unchaptalized wine was described as thin and acidic.
- This experiment was conducted in a warm, dry growing season (2019). The study will be repeated in 2020 to determine if these positive effects are still found in a less "ripe" vintage. The 2020 vintage has begun with a cool spring with moderate rainfall and NOAA predictions indicate conditions leading to less ripeness at harvest.

Table 1: Alcohol conversion for several chaptalization treatments of Merlot (ICV labs)

	Potential Alcohol (%)	Measured Alcohol (%)	Increase due to Chaptalization %)
Control	11	10.56	0
S30	12.6	12.24	1.68
BS30	12.6	12.3	1.74
S50	13.7	13.31	2.75
BS50	13.7	13.21	2.65

Table 2: Wine chemistry for several chaptalization treatments (ICV labs)

	pH	Titratable Acidity (g/L)	Volatile Acidity (g/L)	Free SO2 (ppm)
Control	3.53	5.63	0.77	24
S30	3.47	5.89	0.78	16
BS30	3.56	5.3	0.72	23
S50	3.53	5.49	0.78	18
BS50	3.63	5.16	0.77	17

Table 3: Sensory statistics for several chaptalization treatments of Merlot (repeated measures ANOVA, Tukey's test)

Descriptor	F	P	Descriptor	F	P
Color Intensity	13.172	<0.0001	Aromatic Intensity	6.345	0.003
	0 vs. 30	0.002		0 vs. 30	0.225
	0 vs. 50	0.110		0 vs 50	0.007
	30 vs. 50	0.394		30 vs 50	0.497
Fruit Intensity	12.038	< 0.0001	Fruit Character	16.606	< 0.0001
	0 vs. 30	0.016		0 vs. 30	0.000
	0 vs 50	0.028		0 vs 50	0.012
	30 vs 50	0.997		30 vs 50	0.483
Ripeness	12.711	< 0.0001	Herbaceous/Green	3.502	0.035
	0 vs. 30	0.002		0 vs. 30	0.727
	0 vs 50	0.001		0 vs 50	0.171
	30 vs 50	0.987		30 vs 50	0.584

Figure 1: Color Intensity for several chaptalization treatments of Merlot (ICV labs)

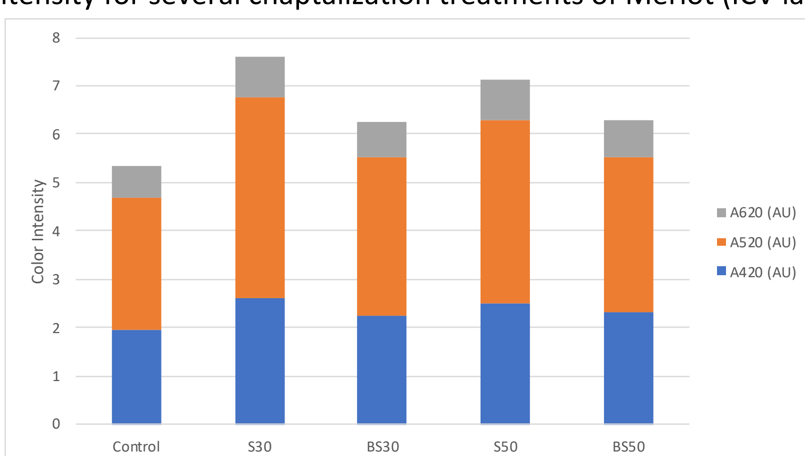
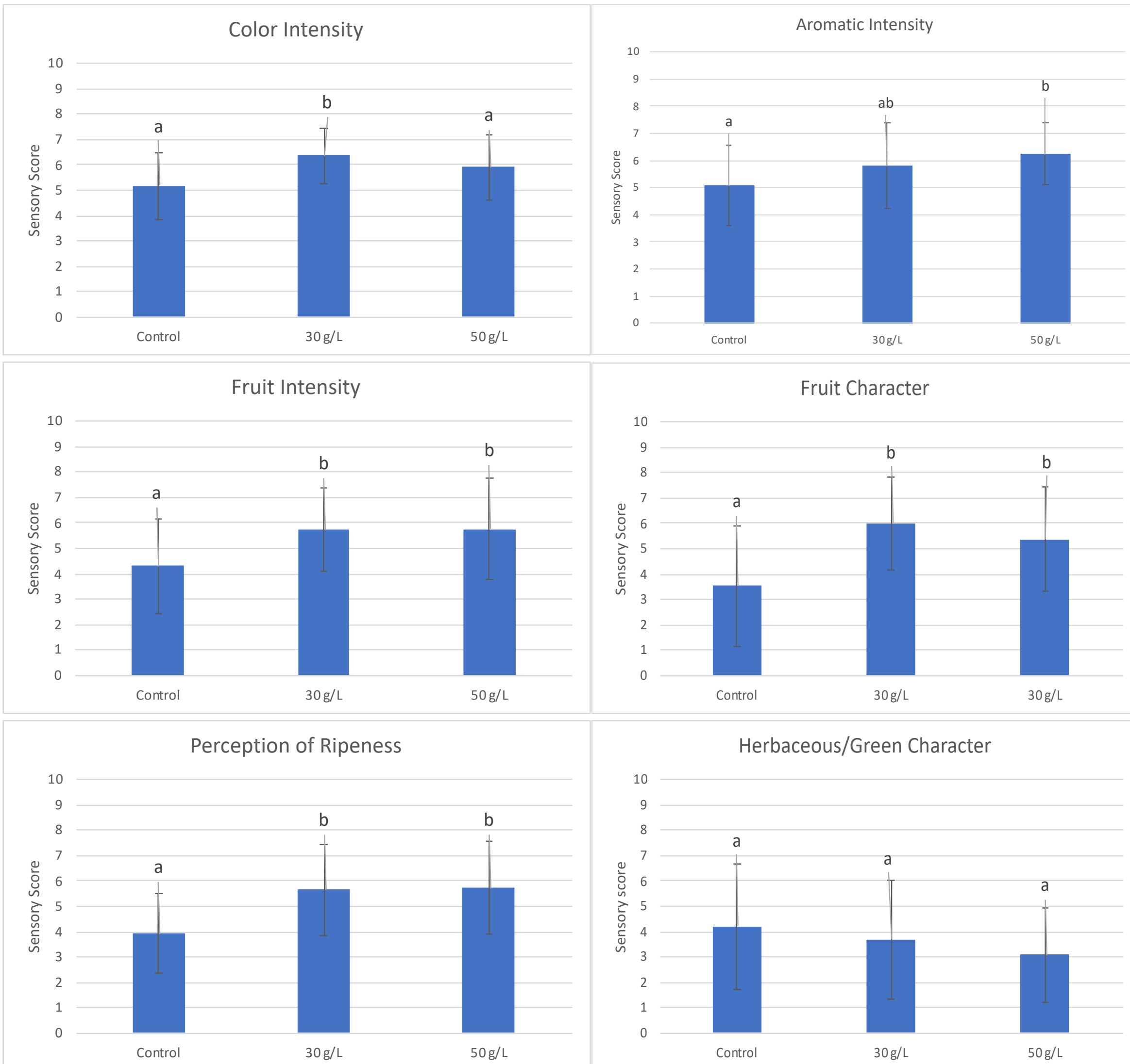


Figure 2: Sensory scores for several chaptalization treatments of Merlot



References

(1) Wood, V.; Custer, S.; Watson, K.; Alper, D. Virginia 2018 Commercial Grape Report. 11.

(2) Sogg, D. Inside Wine: Chapitalization When Augmenting Alcohol, It's a Matter of Degree. *Wine Spectator*, 2003.

(3) Jackson, R. S. *Wine Science: Principles and Applications*, 4 edition.; Academic Press: Amsterdam, 2014.

(4) Sherman, E.; Greenwood, D. R.; Villas-Boâs, S. G.; Heymann, H.; Harbertson, J. F. Impact of Grape Maturity and Ethanol Concentration on Sensory Properties of Washington State Merlot Wines. *Am J Enol Vitic.* 2017, *68* (3), 344–356. https://doi.org/10.5344/ajev.2017.16076.