Chemical Analysis of *Vitis vinifera* Germplasm

Alexa Kennel[1], Erin Galarneau[2], Tori Meakem[2], and Ben Gutierrez[2]

[1]Department of Environmental Science, Goshen College, 1700 S Main St, Goshen, IN 46526, United States

[2]United States Department of Agriculture-Agricultural Research Service, Plant Genetic Resources Unit, Geneva, NY 14456

Introduction

When creating a new grape cultivars, breeders look at several important physical traits; the most important of these include disease resistance and taste. The taste of grapes is impacted by the quantity of soluble sugars (BRIX), acidity, tannins, and phenolics in the grapes. As the climate changes and leads to more difficulties growing typical grape cultivars, breeders need to create new cultivars that have better durability but still meet consumer expectations for fruit quality.

The phenolics present in grapes vary greatly within *Vitis vinifera.* These phenolics can have health benefits and impact how the wine tastes and ages. The term phenolics refers to the chemical compounds present in grapes that have multiple phenol rings (Fig. 1) in their structure, such as flavonoids and tannins. Phenolic concentration can be affected by winemaking and aging processes. For example, tannins are found primarily in the skins and seeds of the grape, so they are found in greater quantities in red wine, where the wine is fermented on the skins and seeds (Waterhouse, 2002).

The goal of this study is to evaluate fruit quality in 242 accessions within the Davis, CA collection of wine and table grapes. This study will observe the variation in pH, soluble sugar, titratable acidity, total tannins, and total phenolics, allowing breeders to identify grapes that can satisfy consumer preferences and are resistant to disease.

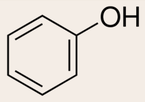


Figure 1. Phenol ring structure.

Materials and Methods

Figure 2: Refractometer used to measure BRIX.

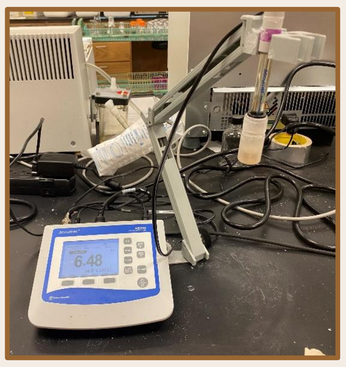


Figure 3: pH meter.

- Grapes were obtained from the collection in Davis, CA and juiced in 2018.
- BRIX measured with refractometer shown in Fig. 2.
- pH measured with an Accumet pH meter (Fig.3).
- Titratable acidity measured after heating the samples at 55C, diluting 10ml of juice in 40ml of water, and placing into an auto-titrator

- Tannins and phenolics were tested using a spectrometer (Figure 4).
- **Total phenolics:**
  - Add 50 µl of juice to a mix of water, sodium bicarbonate, and 1N Folin-Ciocalteu reagent.
  - Measure on a microplate at 725 nm, using a gallic acid standard to determine phenolic concentration.
- **Total tannins:**
  - 1 ml of juice washed with petroleum ether 2x and ethyl acetate 2x
  - 200 µl of this extract diluted with n-butanol/acid reagent and an iron reagent.
  - placed on a heat block at 95 degrees C for an hour.
  - Read on microplate (Figure 5) at 550 nm against a Yb-extracted tannin curve.

Figure 5: Microplate with tannin samples. Samples would turn this darker color once heated.

Figure 4: Spectrometer used to test phenolic and tannin absorbance.

United States Department of Agriculture
National Institute of Food and Agriculture

Results

- Tannin concentration and Phenolic concentration increase as grape color darkens (Figure 7).
- Tannins and phenolics show a strong positive correlation, with an R^2 value of 0.69 (Figure 8).
- Tartaric acid and pH have a negative correlation with an R^2 value of -0.55. (Figure 9)
- **Means and ranges of all variables:**
  - pH: 3.9± 0.3, 3.1-4.5
  - Phenolics: 730.7±197.9, 270.768-1134.243 µg/ml
  - BRIX: 23.6±3.5, 15.2-31.6%
  - Tartaric Acid: 5.51±2.07, 2.334-15.445 g/L
  - Tannins: 7.19±5.06, 0.906-27.714 mg/ml

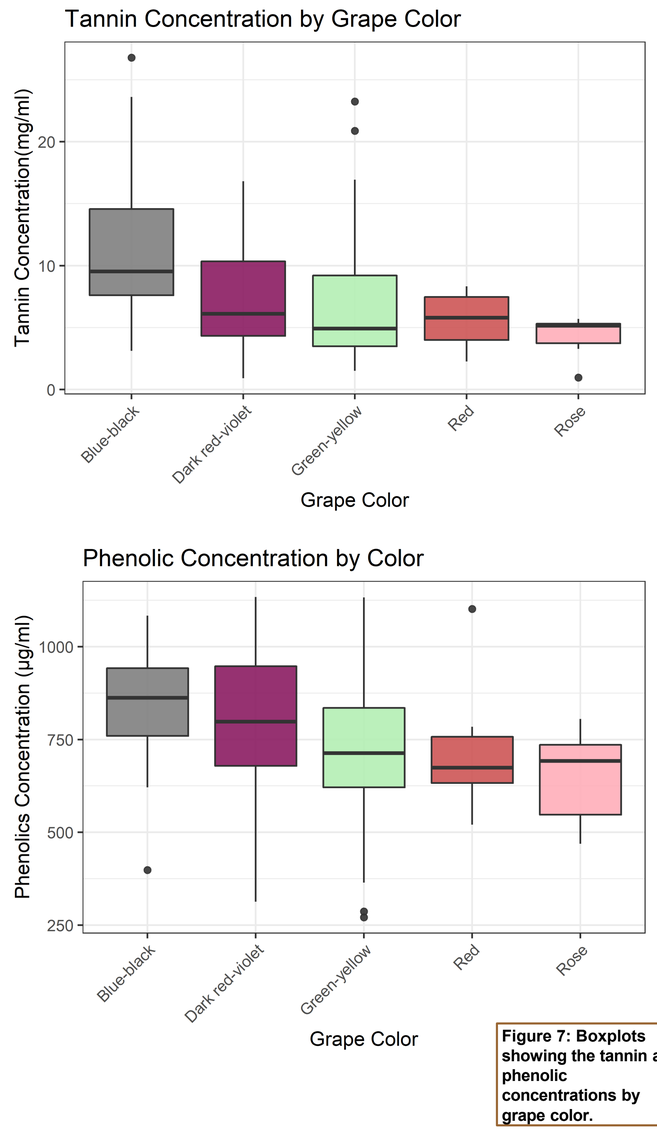


Figure 7: Boxplots showing the tannin and phenolic concentrations by grape color.

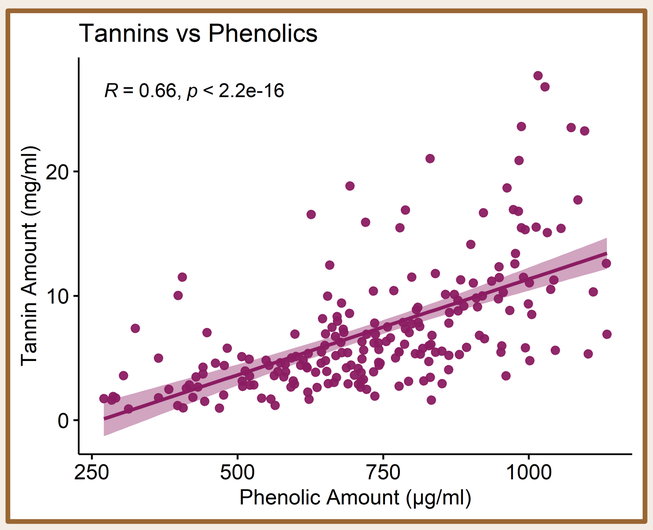
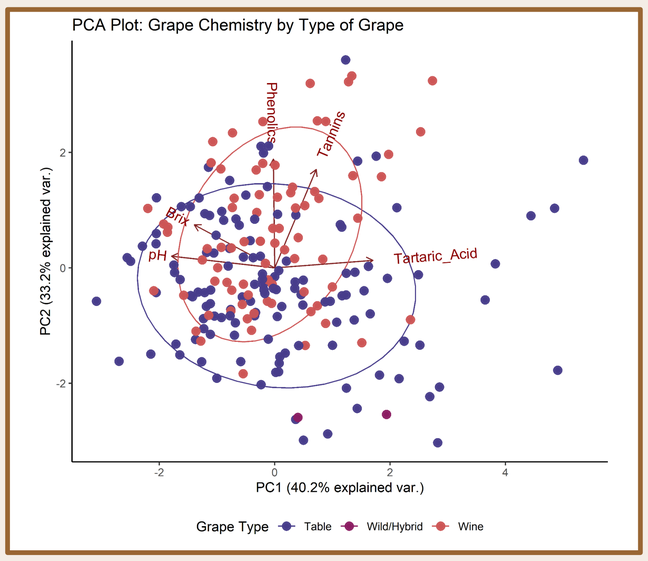


Figure 8: Linear correlation between tannin and phenolic concentration, p-value shows correlation to be significant.

Discussion

- The negative correlation between tartaric acid and pH shows that as acid amount increases, the pH decreases.
- The increase in tannins and phenolics overall as color becomes darker indicates that phenolics and tannins are influenced by an increase color, as shown in past research. (Waterhouse, 2002).
- Wine grapes shown in Figure 8 cause much of the relationship between phenolics and tannins, while table grapes are more related to the relationship between BRIX and pH, as expected with their higher sugar content. The ellipses show that wine has a higher level of phenolics and tannins, while table grapes have a higher BRIX.
- Outliers shown in the boxplots and PCA can be attributed to variation in maturation at time of collection (not all grapes were picked at the height of ripeness) and human error in transcribing data or misunderstanding labels.

Figure 9: PCA plot of traits grouped by grape type. Ellipses show the grouping of table and wine grapes.



Best Wine Grapes :

Red: Grape #258, Calzin
- BRIX: 23.8
- pH: 3.62
- Phenolics: 1084.0224 µg/ml

White: Grape #205, Jurancon Blanc
- BRIX: 24.7
- pH: 3.44
- Phenolics: 521.6032 µg/ml

(Haibach, 2020)

Conclusions

- Phenolics and tannin concentration is related and influenced by grape color and by wine grapes more than table grapes.
- Darker colored grapes show higher tannin and phenolic amounts.
- Data could be used to observe relationships between region, family, and type of wine in the future.

References

- Waterhouse, Andrew L. (2002). Wine phenolics. *Annals of the New York Academy of Sciences*, *957*(1), 21–36. https://doi.org/10.1111/j.1749-6632.2002.tb02903.x
- Haibach, R. (2020, July 4). *Optimal sugar and acid levels for popular wine grape varieties*. winemaking. Retrieved July 27, 2022, from https://www.smartwinemaking.com/post/optimal-sugar-and-acid-levels-for-popular-wine-grape-varieties

Acknowledgments

We are grateful to Erin Galarneau, Ben Gutierrez, Tori Meakem, and Dan Meyers who assisted with lab protocol, data collection, and who provided guidance through the writing and analysis of this project. We also thank the Cornell Geneva Summer Scholars Program, partially funded by a grant from USDA-NIFA (grant no. 2021-68010-34652/project accession no. 1025959) for providing financial support to Alexa Kennel.