Virginia Wine Board Grant
Final Report

5/27/2022

Joy Ting
Winemakers Research Exchange
325 Winding River Lane, Suite 202
Charlottesville VA 22911
USA

Title: Calibrating benchmarks for Virginia grapes and wine using historic data sets
Proposal Number: n/a
Project Type: ☒ Research ☐ Education ☐ Marketing
This grant was initially funded in 2020-2021. The grant period was extended through the 2021-2022 period. This is the final report for this grant.

Original Funding Amount: $25,000
Remaining Balance: $21,516.51

Objectives and Results:
In its seven years of operation, the Virginia Winemakers Research Exchange has gathered data on grapes and wine as part of evaluating more than 300 practical vineyard and winery experiments. These data were initially reported with the experiments for which they were measured. The objective of this project was to gather these and any other available historic data into a single organized, searchable database to be used to define ranges and norms for Virginia Wine. The initial objectives of this grant were to:

- Gather six years of grape and wine data generated by wineries and certified wine labs for VWRE experiments into a single searchable database
- Search published literature for additional datasets on Virginia wine and grapes
- Analyze these data to generate ranges of each metric reported during that time, with attention paid to variety, vintage, and location when possible
- Report summary statistics such as average, variation, and range for use by growers and winemakers to evaluate vineyard practices, grape pricing, winemaking decisions, and when interpreting future laboratory results

With the extension of enological research services to cider in January of 2022, an additional objective was added to this grant to program a database for cider metrics that could be utilized for future projects and updated on an ongoing basis.

In 2020 we contracted appropriate personnel to build the electronic infrastructure for the database, to enter data from archived materials, and to analyze these data for useful statistical measures.

- Jessica Trapeni, formerly production manager at Michael Shaps Wineworks and currently at Imbibe Solutions, set up the infrastructure for the database using Google Sheets including separate experiment lists for wine and cider experimentation and translator modules for commonly used wine and cider analysis panels.
- All prior and current projects were assigned a unique identifier that allowed cross-referencing back to the research report for further information on the study. This crucial information allows future users of the database to better understand the context from which the data arose. For example, though coded as “Cabernet Franc”, fruit information from project 18-071 (Developing a protocol for Rosé stabulation using Laffazyme THIOLS (Laffort) and Fermoplus Tropical (AEB)(2018) would be inappropriate to use for an analysis of Cabernet Franc Brix at harvest, since this fruit was harvested for Rosé rather than red wine. All supporting reports were made available on the WRE website.
- Corry Craighill, winemaker at Septenary, and Franco Sferrella, cellar assistant at Veritas Vineyards, were initially contracted to enter archived data from previous years. The WRE Exchange Coordinator, Jenna Barazi, joined this work in January 2022. This included combing through research reports from 2014-2018 for all data reported and manually entering them into the database. Data from 2019-2020 were added using direct downloads from Vintrace, a winery software system piloted in this season.

To facilitate better data entry for current and future projects, Ms. Trapeni programmed a series of translators that allows batched uploads of service lab data as soon as they are reported. Each service lab reports data in its own format. The translators transform these data into a common format that can be cut and pasted into the master sheet. Inputting data “on time” has become part of the normal workflow of the Exchange Coordinator (Jenna Barazi), ensuring the spreadsheet will be kept up to date for years to come. Timely uploads also allow for better interpretation when data do not match previous uploads or need further explanation. Direct uploads of data from the 2020-2021 experiments has been completed.

Though we initially proposed to include data from previously published papers (for example, from Zoecklein, Wolf, and other Virginia researchers), these were not included in the final database for several reasons. Interpretation of data from small experimental lots adds another level of complexity when compared to juice and wine from production scale operations. Small scale experiments done in academic laboratories have more flexibility to pick very early or very late without jeopardizing a full production lot, therefore introducing a wider range of values than would be feasible for production lots. Also, the time and effort needed to search for these data was considered a poor use of resources for comparatively few data points. If these data are found during the course of a normal literature review, they will be added to the database with an asterisk to indicate they are from small batch winemaking efforts.

Data inputs through 2020-2021 were complete as of March 2022. At that time, both the Research Enologist and Exchange Coordinator began using the database for normal WRE operations. For example, searching for average potassium of finished wines when preparing to present new experiments looking at potassium levels. During beta testing, several bugs were found. For example, one service lab sometimes reports potassium and tartaric acid levels and sometimes does not. This discrepancy caused erroneous formatting for the translator for that lab, as it was initially programmed to look for a specific order of metrics. In this case, the bug was fixed by changing the way data was looked up by the translator to include the name of the metric rather than just its position in the original list. Other bugs included labs using different names for the same metric when they were associated with different testing panels. As bugs have been found, Ms. Trapeni has been consulted to work around or fix the problem. This beta testing is ongoing. We anticipate fewer bugs moving forward, however when they are found, we will continue to refine the database programming within normal WRE funding.

At the time of this writing (May 24, 2022), there are 856 entries into the database. Database categories include metrics from juice panels, wine panels, phenolic panels, and microbiological panels (Table 1). Some summary statistics have been generated from the 2014-2020 vintage data. Examples can be found in Appendix A. Data from the 2021 vintage have been entered into the database as they were received, however they have not been completed as some experiments are still ongoing. These will be completed after the completion of the grant cycle as part of normal WRE operations. Additional summaries will be prepared after 2021-2022 data have all been entered.

The Cider database has been programmed and unique identifiers have been assigned to each experiment and treatment. These data are in the process of being entered at the time of this writing. At present, too few metrics are available to generate summary statistics. As additional experiments are completed in cider, data will be added and summary statistics will be compiled as appropriate.

Overall Benefit for Virginia Wine Industry:
The overall benefit of this work for the Virginia Wine Industry lies in utilizing the benchmarks outlined here. Following are a few examples:

- A grape grower is setting a long-term contract to sell 50 tons of Cabernet Franc each year. The 2021 Commercial Grape Report lists the average price of Cabernet Franc as $2600 per ton, with a range of $2400 - $2800 between the 25th and 75th percentile. The grape grower wants to set attainable quality targets for pricing. How can these targets be determined? What Brix and pH at harvest would distinguish her fruit and justify a higher price? Data reported in Appendix A may help quantify these values.
- A second grape grower has a single lot of Merlot that consistently tops off at 20 °°Brix, regardless of the vintage. He has already utilized many vineyard management techniques to help the crop attain ripeness. Is this “normal” in Virginia or is there something about his site, or grapevine stock, that is causing this? Appendix A Figure 1a and Table 1 report state-wide norms over 6 years.
- A winemaker has been trained that white wine volatile acidity should always be lower than 0.4 g/L. Her Petit Manseng consistently comes in at 0.55 g/L or above. Is she doing something wrong, or is the “normal” for the variety? A short search, outlined in Appendix A, reveals the average volatile acidity of in Petit Manseng produced as part of WRE trials is 0.55 g/L with a range of 0.17 – 0.89 and standard deviation of 0.22. If she were curious if these values presented as having high volatile acidity, sensory responses from reports for experiments with high VA values could also be accessed using their unique ID.

Each of these questions and more can begin to be answered using the benchmarks reported here. Though the dataset is not a random sample of all of Virginia Wine, it does begin to locate Virginia grape chemistry and assist grape growers and winemakers when setting prices, assessing progress, and adjusting winemaking techniques.

Publications and Activities Associated with Project:
These results have not yet been published. A brief update on this project was presented at the VVA meeting in May 2022. Results will be written into a research report and presented as part of an upcoming WRE newsletter to be published in summer of 2022. Benchmarks will also be incorporated into WRE reporting for other projects, when appropriate.

Future Work:
With the infrastructure created here, both wine and cider databases will be added to annually as part of normal WRE operations. At the end of each year, results will be added to existing summaries and made available on the WRE website. Future entries will also include source location for grapes, allowing for better description of norms by region.

Final Budget and Justification:

Item Type	Original Awarded Amount	Final Amount Spent

Personnel	$22,000	$3167.60
Fringe	[$0.00]	[$0.00]
Travel	[$0.00]	[$0.00]
Supplies & Materials	$3000	$315.89
Contractual	[$0.00]	[$0.00]
Other	[$0.00]	[$0.00]
Total	$25,000	$3483.49

There is a considerable portion of the funding left unspent. The initial budge overestimated the amount of time that would be needed to complete the work once the spreadsheet and translators had been programmed. The initial budget included personnel funding for both non-specialized data entry ($15-25 per hour) and specialized database creation and statistical analysis work ($40-50 per hour). The bulk of the work was done at the non-specialized rate. Jessica Trapeni was contracted to create the database for wine. The same framework was used for cider. Ms. Trapeni worked efficiently and was able to complete the work in less time than initially expected. Due to the nature of the data, complex statistical analysis was not possible. The data came from too many different sources and not enough entries are yet available within a given category to report beyond simplex metrics. Therefore, specialized consulting for data analysis was not employed at this time. Data entry also proceeded faster than expected because several of the service labs used for initial data collection were able to provide historical data in a format that could be uploaded directly to the database once properly formatted by the programmed translator rather than being coded manually.

Table 1: Metrics included in analysis panels

Experiment Information	Vintage, Variety, Regions, Vineyard, Winery, Experiment Description
Juice Panel	Date, Brix, pH, titratable acidity, malic acid, YAN, NTU
General Wine Chemistry Panel	Ethanol, residual sugar, pH, titratable acidity, volatile acidity, malic acid, lactic acid, total SO_2, free SO_2, molecular SO_2, potassium
Color Panel	Absorbance at 420 nm, 520 nm, 620 nm, Hue (420/520), Intensity (420 + 520), Intensity (420 + 520 + 620)
Red Wine Phenolic Panel	Caffeic acid, caftaric acid, catechin, epicatechin, gallic acid, malvidin glucoside, monomeric anthocyanins, polymeric anthocyanins, quercetin, quercetin glycosides, tannin, total anthocyanins
Wine Microbiology	*Lactobacillus kunkeei, L. brevis/hilgardii/fermentum, Zygosaccharomyces species, Brettanomyces bruxellensis,* Acetic acid bacteria*, Pediococcus species, Lactobacillus plantarum/casei/mali, Saccharomyces cerevisiae, Oenococcus oeni*

Appendix A: Example summary statistics generated from the VWRE Historical Data Sets Database

Brix at harvest

To determine average °Brix at harvest for red and white varieties, all entries with °Brix were sorted. Experiments for which the same °Brix was used for multiple treatments (for example, juice that was split after pressing), a single value was used. Entries were then sorted by variety, then by °Brix to create ordered lists of °Brix at harvest. Summary statistics were prepared for varieties with adequate number of observations only. Box and whisker plots indicate the mean, quartiles, and outlying data points (Figure 1). Number of entries per variety are indicated in the legend. Numerical values for these statistics can be found in Table 1. To visualize vintage effects, all data for Cabernet Franc (the most commonly measured red variety) were further sorted and plotted by vintage (Figure 2).

Figure 1 °Brix at harvest from 2014 - 2020 for (a) five red wine varieties and (b) three white varieties in Virginia.

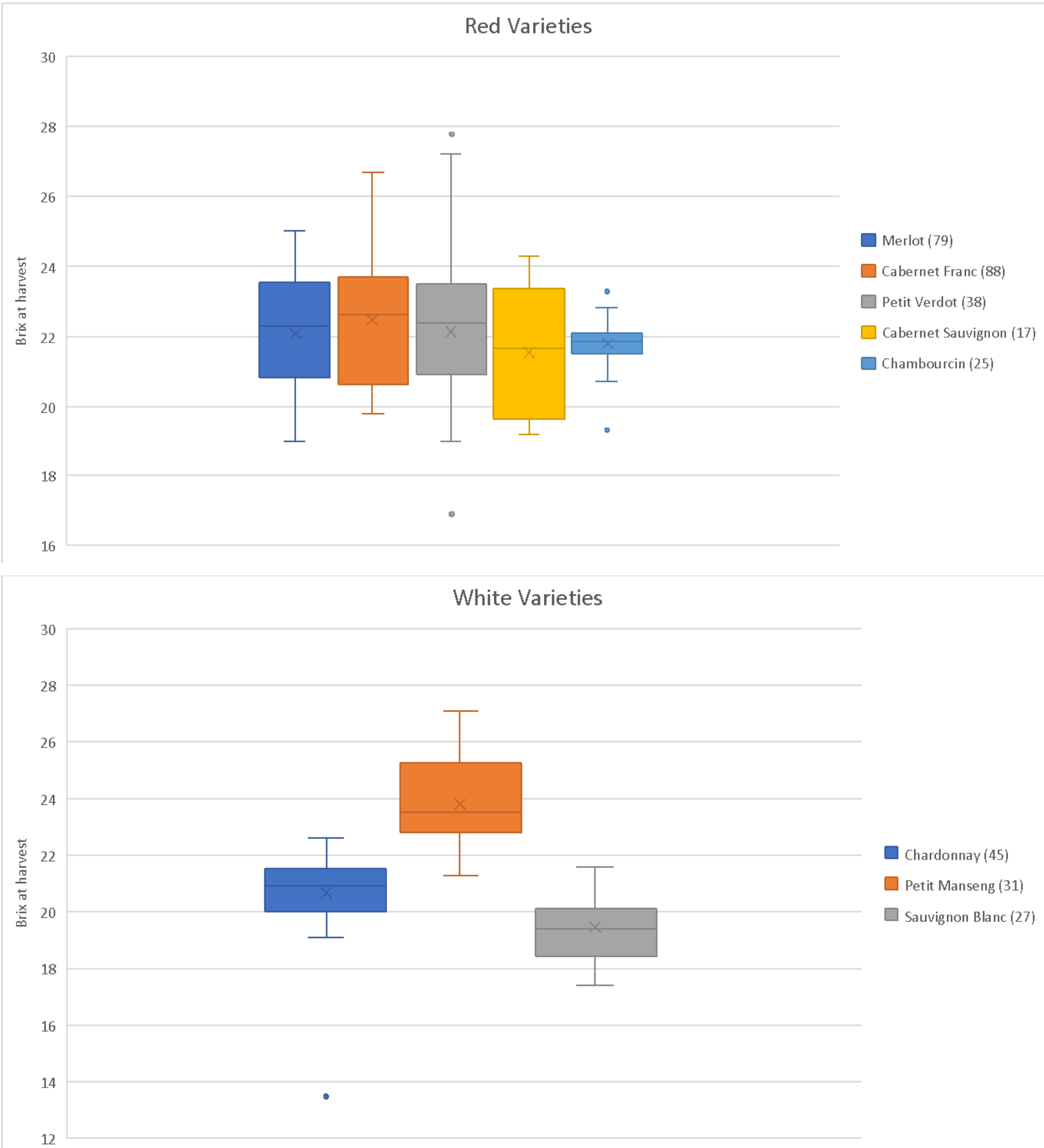
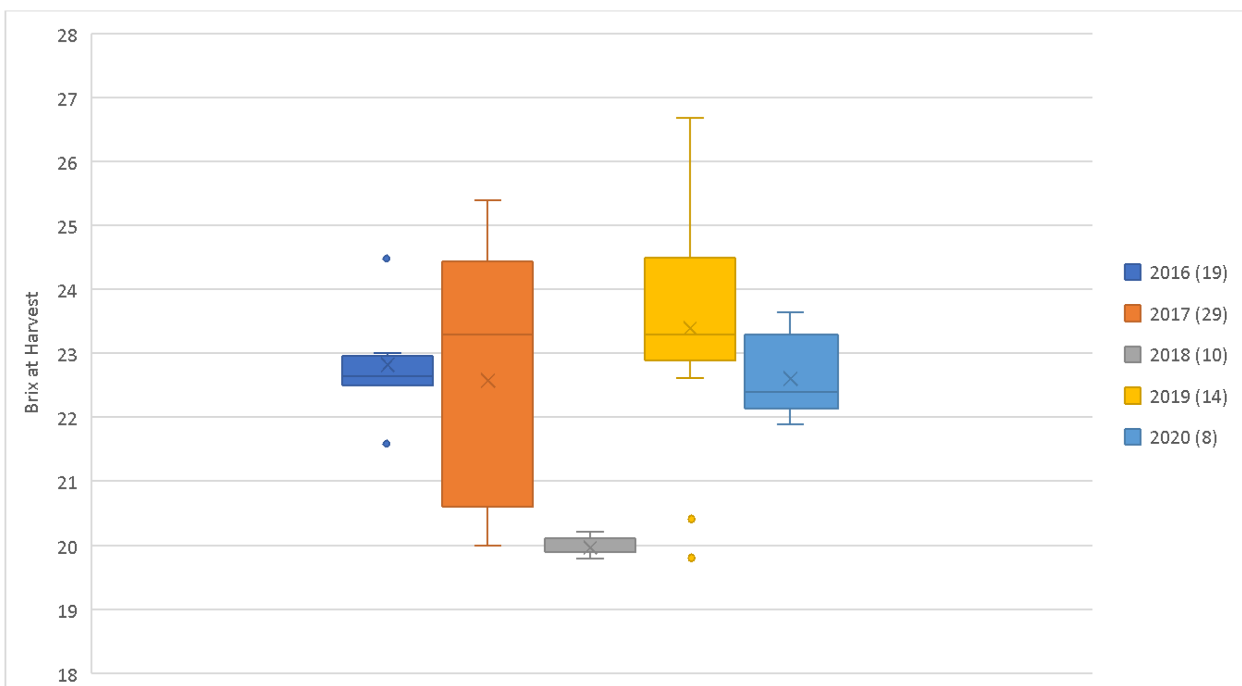


Table 1: Summary Statistics, °Brix at harvest, for 5 red varieties and three white varieties

	Average	SD	Range	Number
Merlot	22.1	1.63	19-25	79
Cabernet Franc	22.5	1.73	19.8-26.7	88
Petit Verdot	22.1	2.35	16.9 - 27.8	38
Cabernet Sauvignon	21.5	1.73	19.2-24.3	17
Chambourcin	21.8	0.71	19.3 - 23.3	25
Chardonnay	20.7	1.43	13.5 - 22.6	45
Petit Manseng	23.8	1.48	21.3 - 27.1	31
Sauvignon Blanc	19.5	1.18	17.8 - 21.6	27

Figure 2: Cabernet Franc °Brix at harvest over 5 vintages



Average Volatile Acidity in Petit Manseng

To determine the average volatile acidity in Petit Manseng, the whole database was sorted for Variety. All Petit Manseng entries were examined to determine if they were individual fermentations or post-fermentation treatments. Duplicates were removed so that each fermentation was counted only once. These entries were then sorted by volatile acidity to determine a range (0.17 – 0.89 g/L). Excel calculations were used to determine average (0.55 g/L) and standard deviation (0.22).