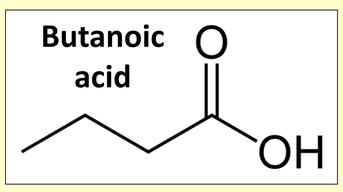
Understanding variation between grapevine (*Vitis*) species through analysis of polyphenolic and aromatic compounds

Lindsay Lesniak[1], Molly Carroll[2], Kyra Battaglia[2], Lindsay Brown[2], and Ben Gutierrez[2]

[1]Hobart and William Smith Colleges, Geneva, NY 14456
[2]Plant Genetic Resource Unit, USDA, Agricultural Research Service, Cornell AgriTech, Geneva, NY 14456

Introduction

The evolution of grapes (*Vitis*) has resulted in nearly sixty species of *Vitis* worldwide, varying in characteristics including, skin color, sweetness, acidity and the focus of this research, aroma. The sample used for analysis was comprised of 151 accessions from the **Geneva Grape Repository at the USDA Cornell AgriTech Station in Geneva, New York** and the **USDA-ARS Vitis Clonal Repository in Davis, California**. The presence of common polyphenolic compounds such as butanoic acid and Furfural are a few of many that influence variation in aroma and taste between *Vitis* variants. Accessions in this sample were pre-selected based on flavor-descriptors and distinct aromas to bet compare phenolics.



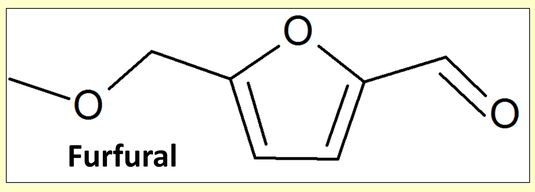


Figure 1. Polyphenolic compounds present in high concentrations in Vitis species.

Objectives:

1. Identify phenolic compounds within samples from *Vitis viniferia* and *Vitis* hybrids.
2. Determine major phenolic compounds in varying accessions and analyze flavor and aromatic compounds
3. Measure soluble solid concentration to have additional information as to how cultivars descending from similar origins compare.

Materials and Methods

Juicing → Volatile Extraction → GC/MS Analysis

Juicing

Samples were collected at or before maturity during the months of August and September 2018. The fruit was stored at -20°C until transferred to -4°C before being processed in summer 2019. Accessions were individually removed and placed in weighing boats to thaw before being massed and juiced using a centrifuge fruit juicer with 90 grade cheesecloth. Grape pedicel, seeds and stems were disposed of. The volume of juice collected was recorded as well as total soluble solids using a refractometer (°Brix). 2.5 grams of sodium sulfate was then added to the solvent before being stored at 4°C.

Figure 2. Grape samples dethawed for standard solid-phase extraction

Volatile Extraction

Juice samples were placed in a water bath at 55°C before centrifuged at 10,000g for 10 minutes until visibly clear and free of particulate matter. Samples were then transferred to new Falcon PPC test tubes to 25ml and diluted to 50ml with Barn water. 100µl of compound, 2-octanone standard was added to each test tube immediately before volatile extraction. 50ml of solution for each sample was run through pre-conditioned 6ml LiChrolut SPE columns during the standard extraction process.

Gas Chromatography/Mass Spectrometry

Each run, 12-24 GC vials were placed into the loading tray and run using a standard method.

Results & Discussion

15 identified polyphenolic compounds were detected during GC/MS analysis in both species. 2-octanonone was used as a quality control check, wherein compound was converted to be reported in 2-octanone equivalents (mg/ml). Chromatograph indicated the highest concentration of Furfural in comparison to other phenolics located at the peak at 9.2 min in Concord Seedless (Fig. 3A). Furfural gives off a sweet, caramel-like aroma (cittte). Winchell had the highest concentration of Phenylethyl Alcohol compared to other phenolics, this compound is located at 14.1 min (Fig. 3B). Butanoic acid was present in all tested samples, the compound gives off a rotten aroma in grapes, particularly unpleasant in high quantities (citeee). This aroma may have been higher in concentration is some accessions due to the chemical break down of the cell wall. Soluble solid compounds measured and averaged for each species (see Table 1). Some notably high cultivars from each

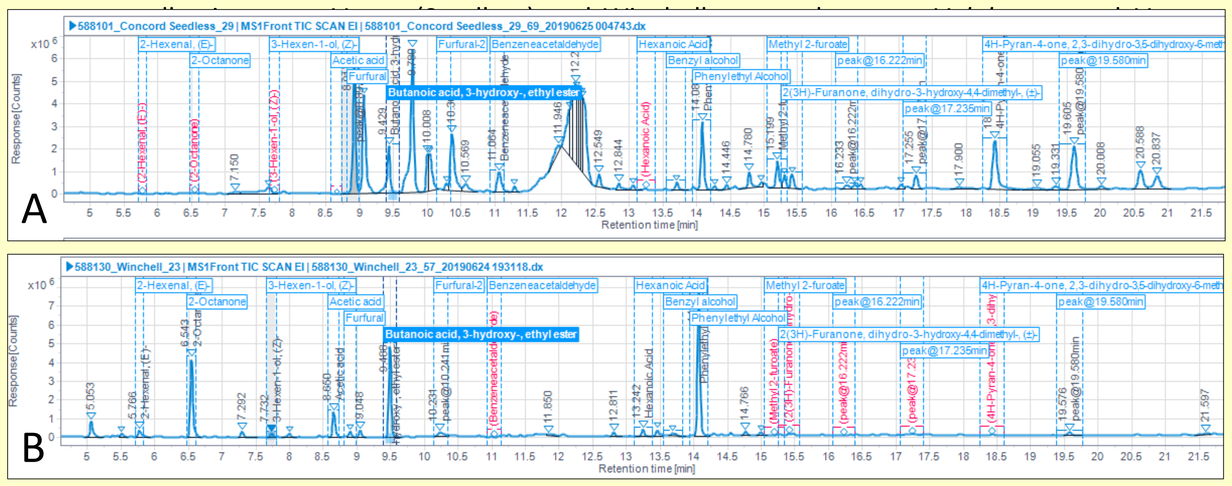


Figure 3. Chromatograms of identified polyphenolics in Concord Seedless and Winchell hybrid. Concord Seedless (A) and Winchell (B).

Vitis Species	Total Soluble Solids (°Brix)
V. vinifera	17.3
Venus Seedless*	21.9
V. hybrid	15.7
Winchell*	23.3

Table 1. Averaged total soluble solids (°Brix) from the *V. vinifera* hybrid collections. *Indicates the accession with greatest Brix level.

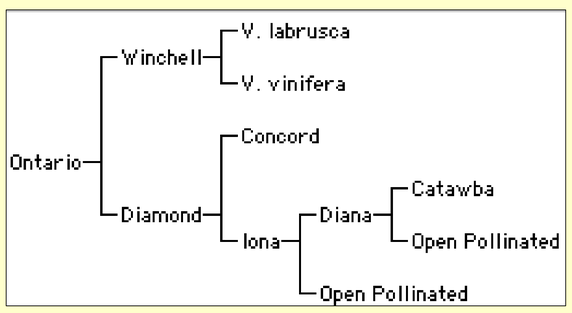


Figure 4. Tree diagram of linkage between varying accessions of hybrid *Vitis* spp.[6]

Conclusion

- Abundant phenolic compounds are comparable to determine linkage between *Vitis viniferia* and hybrid crosses between *Vitis* species.
- *Vitis* hybrids have been domesticated for specific flavor and aromatic compounds that are favorable for wine production and table grape consumption
  - Extension includes determining the pH content of each accession from both grape repositories. Using this data in collaboration with soluble solids and phenolic information to best study aromatic differences between Vitis species.
  - This data is a continuation of research performed on Vitis *viniferia* grape species concerning Phenolics in; [1]*Polyphenolic composition and content in the ripe berries of wild Vitis species (2012).*

References

[1]Liang, Z., Yang, Y., Cheng, L., & Zhong, G.-Y. (2012). Polyphenolic composition and content in the ripe berries of wild Vitis species. *Food Chemistry*, *132*(2), 730–738. https://doi.org/10.1016/j.foodchem.2011.11.009
[2]Sun, Q., Gates, M. J., Lavin, E. H., Acree, T. E., & Sacks, G. L. (2011). Comparison of Odor-Active Compounds in Grapes and Wines from Vitis vinifera and Non-Foxy American Grape Species. *Journal of Agricultural and Food Chemistry*, *59*(19), 10657–10664. https://doi.org/10.1021/jf2026204
[3]Terral, J.-F., Tabard, E., Bouby, L., Ivorra, S., Pastor, T., Figueiral, I., … This, P. (2010). Evolution and history of grapevine (Vitis vinifera) under domestication: new morphometric perspectives to understand seed domestication syndrome and reveal origins of ancient European cultivars. *Annals of Botany*, *105*(3), 443–455. https://doi.org/10.1093/aob/mcp298
[4]Xia, E.-Q., Deng, G.-F., Guo, Y.-J., & Li, H.-B. (2010). Biological Activities of Polyphenols from Grapes. *International Journal of Molecular Sciences*, *11*(2), 622–646. https://doi.org/10.3390/ijms11020622
[5]Xu, Y., Burton, S., Kim, C., & Sismour, E. (2016). Phenolic compounds, antioxidant, and antibacterial properties of pomace extracts from four Virginia-grown grape varieties. *Food Science & Nutrition*, *4*(1), 125–133.
[6]http://www.hort.cornell.edu/reisch/grapegenetics/genealogy/ontario.gif

Acknowledgements

My gratitude to the Biology department at Hobart and William Smith Colleges for introducing me to this internship program through the USDA-ARS at Cornell AgriTech. We are also grateful for Benjamin Gutierrez for overseeing our research during this time and help making this project possible.