PHENOLIC CHANGE ASSOCIATED WITH POST-FERMENTATION SKIN CONTACT FOR TWO WHITE WINE VARIETALS

A PROJECT PAPER PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL OF CORNELL UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PROFESSIONAL STUDIES IN AGRICULTURE AND LIFE SCIENCES, FIELD OF VITICULTURE AND ENOLOGY

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MAY, 2019

ABSTRACT

Orange wines, amber wines, or skin-fermented white wines are synonymic with one another. This style, most commonly referred to as orange wine, is made in one of the oldest recorded methods of winemaking. However, because of advancements in production equipment, this style had largely been abandoned until recent years. Growing interest, minimal research, and increasing popularity of this style prompted the developement of this study. One of the challenging aspects of producing orange wine is the highly oxidative nature of extended skin contact. In orange wine, the time allowed for skin contact is prolonged with the intent to increase phenolic extraction from the grape seeds and skins (Lago-Vanzela et al. 2014). In this study, two different hybrid white wine varietals, Cayuga white and Vidal blanc, were monitored and sampled for 6 six months post-fermentation. Color and phenolic content were measured each month to monitor phenolic extraction.

BIOGRAPHY

River Allan holds a Bachelor of Arts (*cum laude*) from Marymount Manhattan College, New York, New York in Photography with a minor in Mathematics conferred upon him in 2007. He hails from North Carolina, has lived in Brooklyn, New York City since 2002, and hopes to spend the next many years in the Hudson Valley. From 2018-2019 he was a student in Cornell's Agriculture and Life Science department (CALS) persuing his Master of Profession Studies degree in Food Science specializing in the field of Enology and Viticulture. His degree will be conferred in 2019.

ACKNOWLEDGMENTS

The author wishes to thank Patrick Gibney, for his lab guidance, overall kindness, and masterful grape selection and crushing skills, as well as the members of the Gibney lab for their support, insight, and encouragement throughout this project. In addition, he would like to acknowledge Dwayne Bershaw, without whom this topic would have never been birthed, Kathleen Arnink who graciously donated the grapes, lab space, and materials used in this study, as well as the other members of Cornell's Enology and Viticulture program that regularly provided knowledge and guidance- Russell Moss, Anna Katharine Mansfield, Gavin Levi Sacks, and Justine Vanden Heuvel. He would also like to thank the members of Dr. Anna Katharine Mansfield's lab for their support, in particular Catherine Dadmund who regularly assisted in pulling samples. A special recognition goes to Gilbert Sotomayor who mentioned orange wine in passing to the uninformed author and is guilty of getting this whole project started. Lastly, the author would like to thank and praise Nath Ann Carrera for being an ever-constant travelling companion and a willing guinea pig for all the orange wines sampled along the way.

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CHAPTER 1: INTRODUCTION

Orange wine: While the name may be misleading, orange wine is a grape-based wine similar to red, white, or rosé. Thought to have been named by David A. Harvey in 2004, orange wine can be interchangibly be referred to as a skin-fermented white or an amber wine (Amoxes 2016). In its simplest description, orange wine is made by processing white wine grapes in a red wine style. The resulting product has "distinctive dry and tannic" qualities that are not commonly associated with white wines (Robinson 2015).

This resurging wine style is perhaps the earliest production method of wine ever made. Originating from the area which is now the Republic of Georgia, orange wine was traditionally made by fermenting grapes in buried wax-lined clay vessels called "qvevri" (MacNeil 2015). Remnants of these vessels, pronounced "kway-vree", are the oldest biomolecular evidence of winemaking dating back to 6000 BC, the Neolithic period (McGovern et al. 2017). This production style is still commonly used in the Republic of Georgia and is recognized by the United Nations for its historical significance (UNESCO 2017). Georgian wine has become so popular in the United States that between 1995 and 2013 the export price increased by over a factor of ten (Anderson 2014).

Countries in proximity to the Republic of Georgia have been regularly producing wines in this style, particularly Slovenia and the Friuli-Venetzia region of Italy. However, orange wine production has spread world-wide to Australia, South Africa, USA, and many other countries in the last decade. The traditional method for producing this wine involves crushed grapes and must being placed in an underground qvevri. The earthen placement of the qvevri is thought to help maintain lower temperatures throughout fermentation and storage. Punchdowns are performed throughout fermentation through an opening at or slightly above ground level (see figure 1.1). Once fermentation is completed, the qvevri is sealed with all of the contents remaining inside and then left undisturbed for five to six months. If an orange wine is said to be produced in the traditional Georgian style, the former steps can be assumed (Barisashvili 2011). After this time, methodology can vary. Some wines may be immediately bottled, some may be oak aged, some may be blended. Aside from skin contact during fermentation, there is little continuity between orange wine production methods outside of the "traditional Georgian" style (Woolf 2015). For these non-traditional techniques, skin contact time varies, aging varies, ferementation vessels vary, and more.

Figure 1.1 – sketch of qveri punchdown (Horkey and Tan 2016)

Processing and chemical differences: There are many aromatic and sensory characteristics where orange wines and white wines differ. However, phenolic compounds, specifically tannins, bring about the taste and tactile sensory characteristics most commonly associated with orange wines and they are easily quantified. In previous studies, phenolic content was doubled in skin fermented Chenin blanc (J.L. Aleixandre-Tudo et al. 2015). The words "dry", "bitter", and "astringent" are sensory and mouthfeel descriptors associated with red wines and commonly seen in orange wines descriptions.

White wines are typically produced in a stylistic way to minimize phenolic extraction and in doing so these type of sensory characteristics are purposefully avoided (Sacks, Jeffery, et al. 2016). This is done by pressing the juice off of the grape skins and seeds before fermentation. This leads to a lighter and fruitier wine. In contrast, red wines are fermented in contact with grape skins to assist in phenolic extraction.

Another phenolic compound present primarily in red wine grape skins are anthocyanins, a natural red colorant. These compounds are present in white wine grapes but in significantly lower quantities[1] (Negri et al. 2015). While these phenolic

[1] Due to genetic variation between grape varieties, anthocyanin levels vary. Some white wine grapes, like Pinot gris or Gewurtraminer, have grey or pink berries and higher levels of anthocyanins. Additionally, some white wines, like Blanc de noirs, are produced using gently harvested red grapes that are immediately pressed to avoid skin contact and anthocyanin extraction.

compounds are responsible for the color associated with red wines, the interaction between anthocyanins and other phenolic compounds can also form complexes leading to tannin retention in wine (Singleton and Trousdale 1992).

Need for exploration: Orange wines truly have developed their own niche both in culture and in sensory characteristics. Neither light and fruity like a white wine nor heavy and robust like a red wine, it exists somewhere between in a genre of its own. Food pairings and menu placements are growing for this versatile and unique product that matches well with food (Bonné 2009). However, as old as this style may be and as popular as it has become, there is little research on the processing methods that result in distinctive orange wine characteristics, including extended skin contact as a method for increased phenolic extraction. The majority of research studies on extended skin contact applies to red wines. As previously outlined, because of anthocyanin-tannin interactions, these wines would differ chemically in make-up and reactivity than an amber wine and therefore applicability is unknown (Arapitsas et al. 2015). One of the studies specific to measuring phenolic content of white wines produced by extended skin contact also oak ages the wines (Lukić et al. 2015). As oak aging imparts wine-soluble tannins from the oak tree's heartwood, this would be an external source of phenolic content, and may not be a reflection of tannin extraction from grape skins and/or seeds (Puech et al. 1999).

As phenolic content, whether due to processing or genetics, is the main class of compounds responsible for the stylistic differences, it seems to be a logical place to start exploration. In addition to this, extended skin contact, also referred to as extended maceration, can lead to an increase in oxidative characteristics and negatively influence the perception of a wine (Casassa et al. 2013). Simply stated, the inherent process of making this style wine has risks. While this paper is done for exploratory purposes, it is done in a way to investigate risks versus rewards due to the high variation between production methods. In other words, does the risk associated with extended skin contact reap rewards of greater phenolic extraction?

CHAPTER 2: MATERIALS AND METHODS

Grapes: Cayuga white was harvested on 10/10/18 and analyzed by ETS on 11/14/18. Vidal blanc was harvested on 9/21/18 and analyzed by ETS on 11/14/2018. Analysis is listed below in table 3.1.

Fermentation: Treatments began on 11/8/18. Due to high levels of spoilage this season, grapes were individually picked off the rachis and hand sorted into *Home Brew Ohio Wide Mouth* one gallon fermentation jars. A 3-liter level was measured, marked, and each jar was filled approximately to this point. The musts were chaptalized to 22 °Brix. Lalvin yeast ICV-D254 was rehydrated with goFerm according to manufacters specs (Scott Labs). Based on analysis from prior use of both grapes, Fermaid K was used to make a 30ppm YAN addition to Cayuga white and 90 ppm to Vidal blanc. An additional 45ppm addition of diammonium phosphate (DAP) was made to Cayuga white on 11/12/18 and 85ppm to Vidal blanc. Both treatments received 30 mg/L of SO_2 at inoculation and 50 mg/L when fermentation was complete. Jars were sealed with a bubble airlock and placed in a 16°C temperature controlled room (figure 2.1). Cayuga white was steadily fermenting by 11/11/19 and had dropped to an average 3.9 °Brix by 11/14/18 (figure 2.2). Vidal blanc began a day later and had an average 1.8 °Brix by 11/20/19. Sugar level checks and punch downs were performed twice a day throughout fermentation. All equipment was cleaned and sterilized between each use. All fermentations were performed in triplicate.

Figure 2.1. Day of innoculation

Figure 2.2. Three days after inoculation

Sampling: Once fermentation was estimated to be finished for all treatments, monthly sampling for phenolic measurements began. All treatments were moved from fermentation vessels into sterile 3L *Le Parfait Jars* (figure 2.3) with screw top lids on 11/29/18 and remained in 3-5°C storage through the duration. Samples were taken on 11/29/18, 12/29/18, 1/28/19, 2/25/19, 3/28/19, and 4/27/19 by inserting a washed and sanitized stainless steel hop kettle screen directly into the center of the grape skin cap. A 50 mL volumetric pipette was then placed inside the kettle screen and liquid was drawn in from the bottom of the kettle screen. The pipette was intentionally overdrawn 1-2 inches. A 1.5mL sample was placed into a 2mL vortex tube. The remaining sample was placed in a 70mL tube. All samples were labeled and frozen (figure 2.4). Between sampling the kettle screen was rinsed and boiled prior to reuse. All pipettes were cleaned and sanitized prior to each use. Each treatment was opened in a chamber filled with CO_2 and topped off again with CO_2 post-sampling. Lids were also sealed with parafilm. All treatments were regassed bi-weekly between sampling periods.

Figure 2.3. Cayuga white and Vidal blanc treatments, December 13 2018

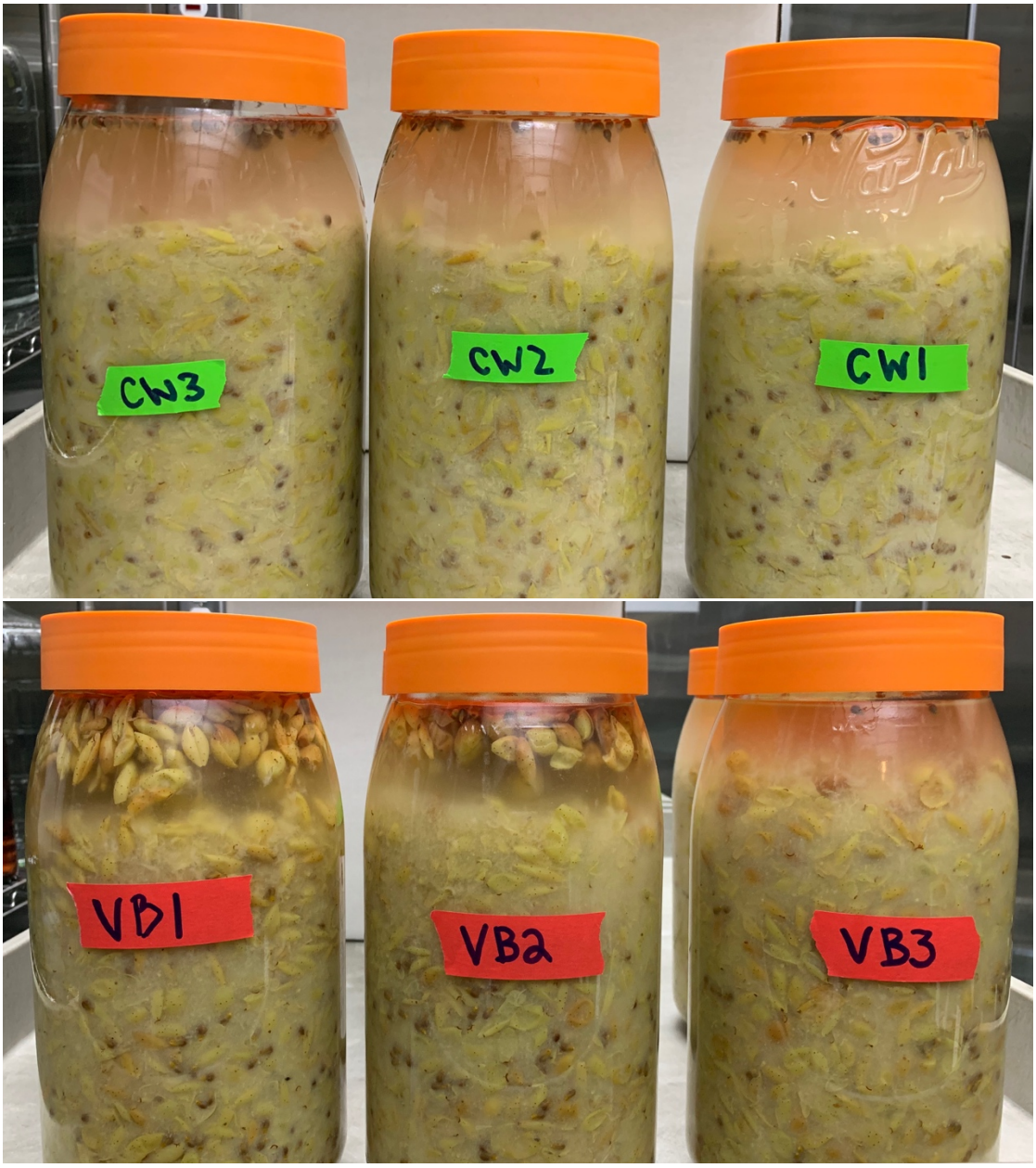


Figure 2.4. Samples

Phenolic content and color determination: Phenolic and color quantification was done using a Thermo Genesys 6 UV-Vis Spectrophotometer. Absorbance at 440 nm (brown color), 420 nm (yellow), and 280 nm (phenolic content) was recorded (Iland 2013). Reference measurements were taken with the following wines: 2015 Woodbridge Cabernet sauvignon (a red wine control), 2015 Woodbridge Chardonnay (an oaked white wine control), 2016 Gotsa Chinuri (an orange wine control), and 2015 Atwater Dry Reisling (an unoaked white wine control).

CHAPTER 3: RESULTS AND DISCUSSION

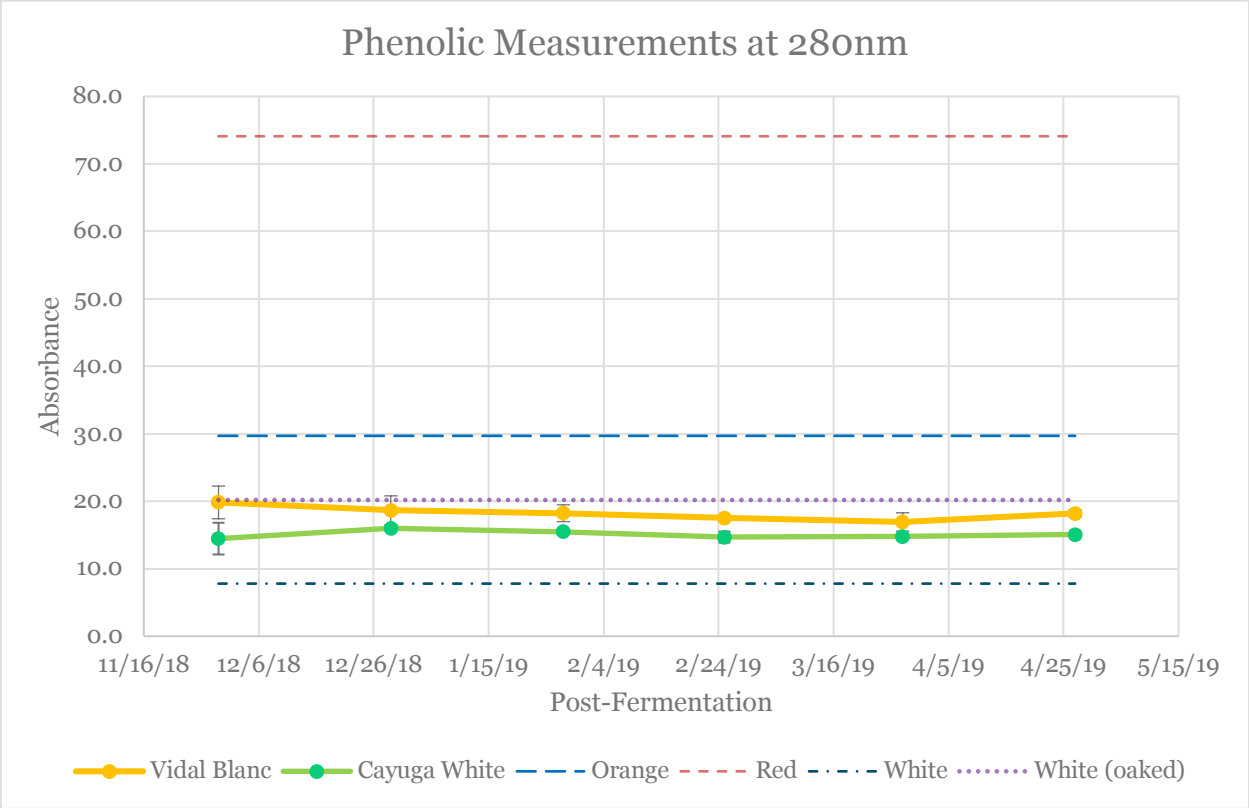
Quantitative analysis:

Table 3.1. Initial chemical parameters of must

Sample	°Brix	pH	TA g/L	YAN mg/L	Potassium
Cayuga white	18.1	3.28	6.8	287	1480
Vidal blanc	21.1	3.58	6.1	90	1660

Spectrophotmetric analysis:

Table 3.2. Results of phenolic analysis



Analysis of the phenolic content (table 3.2) demonstrated that there is no significant change during the period of post-fermentation skin contact for Cayuga white or Vidal blanc. It is unclear as to why this is the case. However, these results suggest that for these two varietal wines and under these production conditions, extended skin contact is unnecessary for increasing phenolic content. Pressing the wine post-fermentation could reduce the chance of oxidation and oxidative qualities often associated with this style.

There are many variables that may result in a different outcome and could be subjects for future research studies. The most obvious of these would be to conduct this same experiment with other grapes, specifically, *V. vinifera* as both of the grape varieties used in this research are hybrids. Other variations could be done by changing maceration style or rate, adjusting holding temperature, using fermentation vessels that allow for microoxygenation, and more.

Taken together, this study has demonstrated that post-fermentation skin contact does not increase phenolic content in orange wine production using these two types of hybrid grapes. This study provides a framework for production of hybrid grape orange wines that will decrease potential oxidative spoilage issues while allowing for the sensory benefits of phenolic inclusion.

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