Tannin research on Pinot Noir in Oregon: challenging climate, challenging variety

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In the August issue of the GWRDC newsletter, R&D At Work, published in Grapegrower & Winemaker*, we were introduced to the AWRI's new manager of the chemistry research group, James Kennedy. This article comprises further background information on Kennedy, and particularly his work on tannins in Pinot Noir at Oregon State University in the US.*

Introduction

When I was hired by Oregon State University in 2001 to develop a research program focusing on grape and wine phenolics, I was excited to have the opportunity to contribute to that state's wine industry. Although I knew little about the state I would call home for the next eight years, I did know that the wine industry there was dedicated to the production of high quality wine, mainly Pinot Noir. I subsequently learnt that the Oregon wine industry is unique in its character and in its challenges. With an average rainfall of 800-1200mm and a heat summation of 1050-1250 degree days (Celsius), Oregon's climate is marginal for viticulture. While much of the rain comes during the winter months, it unfortunately falls all too often during harvest. Some would say only a masochist would attempt to produce wine under these conditions. As a tannin chemist, however, the time I spent in Oregon was priceless. Trying to figure out how to accelerate fruit and tannin development to ensure that fruit could be harvested before the autumn rains settled in, and working with a variety that is widely considered to be the most difficult variety to manage from a textural standpoint, provided an abundance of challenges for me as a researcher.

A summary of Oregon and its wine industry

Oregon lies on the West Coast of the United States and the majority of its wine industry is on the west side of the Cascade mountain range, between 44-46 degrees N latitude. Its weather is maritime-influenced and is dominated by abundant winter rainfall and dry summers. The majority of Oregon's vineyards are situated within the larger Willamette Valley in regions classified as 1 and 2

according to the Amerine and Winkler growing degree classification system. Viticulturally, the most persistent challenges for Oregon are the accumulation of growing degree days and, as mentioned above, the onset of autumn rains.

Despite these challenges, the Oregon wine industry has thrived. In my time at Oregon State University, the vineyard acreage increased from 5,536 to 11,210 acres and the number of wineries from about 130 to 395. The major grape variety produced in the state is Pinot Noir, representing 58.8% of the planted acreage and 50.6% of the harvest tonnage. The total fruit harvest in 2008 was 17,571 tonnes. With this in mind, it is apparent that Oregon is a rapidly growing wine industry dominated by Pinot Noir production, yet remains quite small compared to other wine production regions of the world.

Oregon produced 0.3% of the United States wine volume in 2006. The average winery size is quite small (5600 cases per winery on average), and the production yield for Pinot Noir was 2.02 tonnes per acre in 2008. In order for the Oregon wine industry to thrive, it has had to focus on the production of high value wines. Considering these statistics, my charge while at OSU was to conduct research that would maximise the quality of wine produced to effectively compete with other high value wine regions in the world. Given the importance of Pinot Noir, much of my research focused on the development of knowledge and tools to maximise its mouth-feel quality.

Research in the vineyard

My first research project was designed to understand how the phenolics in Pinot Noir changed with grape maturity. Wines were produced from grapes harvested at increasing levels of maturity and the phenolics analysed. A number of interesting conclusions were revealed from this three-year study conducted by Master's student Jose Luis Pastor del Rio, including:

- unlike previous studies on later maturing varieties such as Cabernet Sauvignon and Shiraz, extractable Pinot Noir seed tannins change in amount and composition throughout harvest.
- the extractable tannin concentration in Pinot Noir on a fruit weight basis is higher than that observed in varieties such as Cabernet Sauvignon and Shiraz, which are varieties that are considered to produce wines that have a higher concentration of tannin. This provides some indication for why this variety is inherently more challenging to work with.
- the proportion of seed tannin extracted during wine production, and as a function of grape maturity, does not decline. This is not consistent with conventional wisdom on the perceived increase in tannin quality with maturity.

A pinot Noir trial vineyard in Oregan.

Trial tests in progress.

Once the work on maturity concluded, my vineyard research program investigated how vine vigour influenced grape and wine tannin chemistry. This study, conducted by PhD student Jessica Cortell and in cooperation with Archery Summit Winery, started with the observation that despite two adjacent blocks having the same clone, rootstock and vine age, the wines produced from these blocks were quite different in winemaker quality assessment and subsequent price point. From the winemaker's description of the differences, the higher price point wine was much higher in phenolic concentration, balance and tannin ripeness.

An examination of the tannins produced in the vineyard revealed that the portions of the vineyard with lower vigour were producing an abundance of skin tannins, and these tannins were carried through to the wine. What was also of interest was that the concentration of seed tannin contained in the wines did not vary with vine vigour. Evaluation of the site indicated that reductions in vine vigour were related to soil water holding capacity. One potential conclusion that could be drawn from this work is that wine tannin quality could be improved with a reduction in vine vigour and this could be achieved by reducing the water availability.

An alternative conclusion was that it was not the reduction in vine vigour *per se* that was improving skin tannin production, but was an increase in fruit exposure that resulted from vigour reduction. In the second year of the study, Cortell manipulated the fruit exposure within an area of constant vine vigour, and the results of this study indicated that fruit exposure could achieve the same effect as vine vigour reduction. This study suggested that the winery could manage fruit tannin via canopy management, an important finding given the higher production level of the high vigour site.

The influence of vine vigour on wine phenolic composition and the results regarding fruit exposure led to a follow up investigation into

the separation of light from temperature. This study was conducted by PhD student Seth Cohen, in collaboration with the US Department of Agriculture. The goal from this project has been to try to determine what is driving the production of tannins in the vineyard. The outcome of this study indicates that an increase in preveraison growing degree days under constant light marginally increases the concentration of tannin in fruit. On the other hand, this story suggests that light exposure prior to veraison is critically important if maximising tannin production is a concern. An additional outcome from this research was that a reduction in diurnal temperature range accelerated overall berry development. This is a very interesting observation for the Oregon situation, given that autumn rains that often interfere with harvest. With additional research it is hoped that a passive means for reducing the diurnal temperature range of the fruit can be found, and if so, there is potential for increasing vintage success through accelerated ripening.

Research in the winery

In my life prior to living and working in Oregon, it seemed as though I had worked on every variety BUT Pinot Noir. One of the biggest issues that I found while working in Oregon was just that, Pinot Noir. All of the clichés that have been said about this variety seem to be true, this is one tough variety to grow and to vinify. From the standpoint of mouth-feel quality it is very difficult to get it right. While trying to achieve wine that merits those round, soft, silky, velvety descriptors, all too often you end up with a wine described as thin, bitter and hard. I spent a considerable amount of time trying to provide a better understanding of the underlying chemistry of these descriptors, and how wine production practices could be used to influence mouth-feel quality.

It is almost a universal maxim that if the fruit ripeness is not right at harvest, then the wine can never be what was hoped. In Oregon, the onset of autumn rains all too often presents winemakers with the tough decision of making a guaranteed quantity of wine, albeit of mediocre quality, versus waiting and hoping that the rains ease up long enough to allow for continued fruit development.

To challenge the idea that fruit needs to be attached to the vine at this stage of fruit development, I collaborated with visiting Professor Dr Jorge Moreno to conduct a study in which fruit was harvested prematurely and allowed to 'develop' off of the vine. Preliminary small-scale experiments were successful in producing wines that had riper fruit character and riper mouth-feel qualities. This study was extended to a commercially produced wine, and the results of this study have been positive. Fruit flavour and mouth-feel development continued and the wine produced was similar to wine produced from fruit left on the vine longer. While a significant amount of further research needs to be conducted to optimise post-harvest storage conditions, the results of this study suggest that it may be possible to reduce the risk of loss due to inclement weather by harvesting fruit early and storing.

A significant amount of research in my years at OSU was spent investigating the relative extraction of skin and seed tannins during wine production. Sensory studies suggest that seed tannins are harder and more aggressive than skin tannins and because of this, the relative extraction of these tannins is of interest. In 2002-2003, I was fortunate enough to have an industry-sponsored postdoctoral fellow in my laboratory conducting research. The winery, Willakenzie Estate, was interested in understanding how punch down and pump over cap management practices influenced seed and skin tannin extraction. Dr Catherine Peyrot des Gachons, a PhD graduate from the University of Bordeaux, was hired by Willakenzie as an assistant winemaker and as a researcher in my lab. She developed an analytical method to monitor seed and skin tannin extraction.

Berries are numbered as part of research work.

What we have learnt from this analytical method is that various winemaking practices which are used to manipulate seed and skin tannin extraction often influence aroma and flavour attributes as well. In the case of punch down versus pump over operations, it was found that punching down increased both the overall rate of extraction as well as the proportion of seed tannins in wine. Pump over operations led to an increase in skin tannin extraction and an elevation of wine fruitiness.

In a separate study on the influence of berry crushing on seed and skin extraction, conducted with Master's student Fiorella Cerpa-Calderon, it was found that with an increase in fruit crushing there was an increase in the rate of total tannin extraction as well as skin tannin extraction. In all cases, the total extraction of skin tannin plateaued, and the plateau concentration increased with crushing. Seed tannin extraction, as observed by others, increased late in fermentation. Many Pinot Noir producers try to avoid crushing fruit prior to fermentation, preferring to destem but not to crush. One explanation for this preference is that by leaving the berry intact, you reduce the rate of tannin extraction and seed tannin in particular, thus reducing harsh and bitter attributes. The significance of this research showed that a much higher proportion of skin tannin extraction could be achieved by crushing the fruit and pressing sooner. While flavour differences are expected to result from variation in the proportion of whole berry, if the texture of wine needs to be improved, this study indicates that changing the proportion of whole berry material will influence the proportion of skin tannin in the fruit.

Conclusion

The time that I spent in Oregon was a rewarding time in my life, professionally and personally. Professionally, the students, visiting scientists, and collaborators I was fortunate enough to have in my laboratory, and the research that we were able to accomplish, have left me with a deep sense of accomplishment. Research papers on their work, along with others that I did not mention above, are listed below. Personally, the friendships I made and the places I visited will be missed. Oregon is a place of indescribable beauty and bounty and its wines and its wine industry are a must see for anyone interested in wine.

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Riesling in class of its own at organic wine show

The 2009 Australian/New Zealand Organic Wine Show was a triumph for Mudgee producer, Thistle Hill Vineyard. Organic since inception in 1976, Thistle Hill Vineyard's 2009 Riesling won best white wine of show and the best in show trophy.

Judge and wine critic, Max Allen, said the Riesling was the best of more than 146 wines entered into the competition from throughout Australia and New Zealand over 16 classes.

Thistle Hill winemaker Michael Slater said the wine bucked a trend in wine competitions for a white wine to win over red, yet the Riesling stood out in a class of its own. "Entries in the organic wine show grew by 30% this year, making it one of Australia's most competitive wine shows. To have Thistle Hill stand out as the best wine of the show is a tribute to the premium grape quality, organic growing and the rich soils in the Erudgere valley - just out of Mudgee.

"The wine has a classic Riesling style, yet the concentration of the organic grapes makes the wine both generous and complex. The rich flavours yet crisp finish really brings the wine into a class of its own.

"One of the best qualities of organic wines, and the Thistle Hill Riesling in particular, is that the quality of the fruit is so superior, and allows you to take a minimalist approach to the winemaking process so the fruit shines through in the end product," Slater said.