WINES & VINES

Feature Article from the June 2015 Magazine Issue

Growing Wine Quality: Thiols

Adoption of vineyard practices can enhance fruit aromas in certain cultivars

by Russell Moss

Leaf removal (as seen here at Glen Manor Vineyards in Front Royal, Va.) has been shown to increase thiol concentrations in Sauvignon Blanc.

The varietal aromas of wines made from grapes such as Sauvignon Blanc, Petit Manseng, Riesling, Semillon, Gewürztraminer and Cayuga White are all dependent, to varying degrees, upon the tropical fruit aromas that arise from volatile thiols. This class of aromatic compounds is especially important in Sauvignon Blanc wines, within which volatile thiols are found in significantly high concentrations. This article describes methods by which the vintner can manipulate thiol concentrations in the resulting wine through vineyard practices. A subsequent article will address methods within the winery that may impact thiol concentrations.

Why should we care?

In Virginia, Petit Manseng, Riesling and Sauvignon Blanc are the fourth, fifth and sixth most planted white *vinifera* grapes

respectively. Using data extrapolated from the Virginia 2013 Commercial Grape Report, the white grape varieties with the highest per-acre revenue potential for a grower are Sauvignon Blanc and Petit Manseng (Virginia Wine Marketing Office, 2014). Both of these varieties produce wines with passion fruit, grapefruit and guava aromas that come from volatile thiols. Sauvignon Blanc, specifically, represents an excellent opportunity for the "savvy" (no pun intended) vintner to capitalize on an international grape that can produce relatively high yields and has potential for high grower returns.

However, the choice to grow Sauvignon Blanc will be determined by one's *terroir*. If the site has a propensity for high vine vigor, cold damage and bunch rots, then one might consider planting Petit Manseng. This variety is relatively hardy in the Virginia climate and can consistently ripen, while Sauvignon Blanc may have trouble ripening in some years.

KEY POINTS

- Volatile thiols give Sauvignon Blanc wines their characteristic tropical fruit aromas. Certain vineyard practices, such as moderate water stress of vines after fruit set, can increase the amount of thiol precursors in the grapes.
- Researchers have found that thiols increase significantly when foliar urea is applied immediately before or after véraison to increase yeast assimilable nitrogen in vineyards deficient in nitrogen.
- Leaf removal has been found to increase thiol concentrations in Sauvignon Blanc wines, and machine-harvested fruit also has higher concentrations.

A matter of style

High-quality Sauvignon Blanc is typically described as having "fresh" or "crisp" acidity with flavors and aromas of passion fruit, grapefruit, guava, gooseberry and green pepper. In the eastern United States, the acid profile of Sauvignon Blanc presents a significant challenge, as the ripening season is characteristically hot and grapes tend to lose a lot of acidity when compared to cooler regions such as Sancerre, Pouilly Fume in France and Marlborough, New Zealand. However, the clever vintner can compensate for the loss of acidity by making two picks (an acid pick and a flavor pick) and/or the careful addition of tartaric acid in the winery, followed by blending. Petit Manseng maintains its acidity in hot climates and is typically made into sweet and semi-sweet styles, as one often has to leave the fruit on the vine until ~29° Brix before the sugar and acid levels reach an optimal balance.

If acidity is not a problem, what about flavors and aromas? One of the characteristics that has made Sauvignon Blanc so

successful is its relatively simple aromatic profile. The aromas of this variety are not subtle or hidden behind layers; they are straightforward, and the comparison to their corresponding descriptors is clear to even the most novice wine drinker.

A survey of Sauvignon Blancs from around the world determined that the only clearly distinguishable Sauvignon Blanc wines, by country, came from New Zealand. This was due to their high concentration of passion fruit, grapefruit, gooseberry and guava aromas, which arose from the volatile thiols (Benkwitz, et al., 2012).

New Zealand Sauvignon Blanc has rapidly been gaining market share in the United States. It now represents approximately 29% of all the Sauvignon Blanc sold in the United States (New Zealand Trade and Enterprise, 2014) and has had an average annual growth of 17% by volume over the past five years (New Zealand Winegrowers, 2013). This competition from New Zealand may present a qualitative challenge for American vintners, but it may be curbed as winemakers develop an understanding of how to increase the varietal intensity of Sauvignon Blanc wines.

Vineyard practices

It is understood that moderate water stress of grapevines after fruit set produces wines of a high quality (van Leeuwen et al., 2004). Moderate water stress of Sauvignon Blanc after fruit set has been demonstrated to increase the concentration of the conjugated thiol precursors (Peyrot des Gachons et al., 2005). However, these researchers only evaluated aroma potential and did not vinify the fruit and analyze the volatile thiols in wines. As it has been shown that thiols may be formed during fermentation from other precursors, the effect of water status on the volatile thiols in wine is not fully understood and requires further research.

Peyrot des Gachons et al. also found a correlation between the thiol conjugates and nitrogen. The vines that were not in a nitrogen deficit had fruit with significantly higher concentrations of conjugated thiols compared to vines that were deficient in nitrogen.

Chone et al. (2006) made a soil application of 60 kg of nitrogen per hectare (53.5 pounds per acre) of ammonium nitrate at

berry set to Sauvignon Blanc that was historically low in nitrogen. The fruit of the control had a yeast assimilable nitrogen (YAN) concentration of 29 ppm at harvest, whereas the fruit from the treated vines had a YA N concentration of 174 ppm. All of the cys-conjugated thiols increased significantly with nitrogen application. A 30% reduction in phenols with a 670% increase in glutathione was observed with nitrogen application. Polyphenol quinones can cause the oxidation and loss of aromatic potential (Blanchard et al., 2004). Glutathione can combat oxidation and react with quinones (Ugliano et al., 2011), and therefore thiols will be less likely to oxidize in wines made from juices of a sufficient YAN concentration.

Foliar urea applications are an effective means of increasing YAN concentrations when applied immediately before or after véraison. This practice can increase YAN without incurring increased vine vigor. Dufourcq et al. (2009) observed significant increases in berry YAN with foliar applications of urea around véraison. The modulations were variable, and in some cases modulation was not demonstrated, illustrating the unpredictable variability of plant response to fertilization. However, they also found that musts with higher YAN concentrations correlated with higher 3MH and 3MHA concentrations in the wine. Thiols increased most significantly among nitrogen treatment plots in vineyards that were historically nitrogen deficient. They also evaluated the co-application of foliar-applied micronized sulfur and nitrogen. On average, the researchers found a three- to 12-fold increase in volatile thiols in wine in the treatments sprayed with nitrogen and sulfur compared to the control.

Lacroux et al. (2008) found that volatile thiols in Sauvignon Blanc wine did not increase from a soil nitrogen application of 30kg nitrogen per hectare (26.6 pounds per acre) as ammonium nitrate when compared to an unfertilized control. 4MMP was increased by a foliar urea treatment (10kg nitrogen per hectare [8.9 pounds per acre] split over two applications before *véraison*) when compared to the control, but this was the only volatile thiol to significantly increase in the foliar N treatment. 3MH, 3MHA and 4MMP were all at the highest concentrations in wines produced from an N + S treatment (10kg nitrogen per hectare of urea and 5kg of micronized sulfur per hectare). A tasting panel found that the N + S treatment

was more aromatically intense when compared to the foliar N alone.

It should be noted that there is a possibility to enhance the susceptibility of the fruit to fungal pathogens (especially Botrytis) through foliar urea applications. However, Lacroux et al. (2008) did not find an increased incidence of Botrytis.

While winemakers can add nitrogen to musts that are low in YAN, questions exist as to whether naturally occurring nitrogenous compounds in musts are superior to exogenously added nitrogen. Deed et al. (2011) reported that the addition of diammonium phosphate (DAP) had no impact upon volatile thiol concentrations in an actual Sauvignon Blanc wine. In contrast, another study found that the addition of DAP in a Sauvignon Blanc must can cause a significant decrease in volatile thiol concentrations in the resulting wine (Subileau et al., 2008). Therefore, if the fruit is nitrogen deficient coming into the winery, the winemaker will not be able to ameliorate low aromatic potential with a DAP addition and may even decrease potential varietal aroma, thus highlighting the importance of vineyard practices that correct low YAN levels.

Aromas of grapefruit and tropical fruits are a defining characteristic of Sauternes, which are derived from Sauvignon Blanc. Thibon et al. (2009) found a 275-fold increase in the concentration of Cys-3MH in Sauvignon Blanc juice from botrytized fruit when compared to uninfected fruit. Sarrazin et al. (2007) found a 12- to 60-fold increase of 3MH concentration in wines made from botrytized fruit. Botrytis may have not been directly responsible for the production of Cys-3MH, but it may have stimulated its formation via metabolic pathways in the grape.

Leaf removal also has been found to increase thiol concentrations in the resulting Sauvignon Blanc wines. Suklje et al. (2014) found a 47% average increase in volatile thiols in wines made from fruit that had been exposed by complete defoliation on the morning side of the vine up to about 1 foot above the cordon, when compared to a shaded control. Sensory panelists found that the wines from the leaf-removal treatments were higher in the passion fruit and grapefruit aromas associated with thiols. The shaded control possessed less tropical fruit aromas and was perceived as having an

aroma of green pepper. This green pepper aroma was associated with significantly higher concentrations of methoxypyrazines, which are known to compete with aromas arising from thiols (van Wyngaard, 2013).

Harvesting method has been found to have an influence upon the concentrations of conjugated precursors and the volatile thiols in the resulting wines, with the higher concentrations of both coming from machine-harvested fruit (Allen et al., 2011). The exact mechanisms behind this relationship are not fully understood but may be due to skin contact and higher enzymatic activity occurring when the grapes are machine harvested. If one does not machine harvest, the vintner may be able to mimic this benefit through a short period of cold soak. No study has evaluated the effect of skin contact on volatile thiols in the wine. However, it has been demonstrated that the amino conjugated thiols do significantly increase in the must of cold-soaked Sauvignon Blanc (Maggu et al., 2007; Peyrot des Gachons et al., 2002).

Conclusion

The old adage that “it takes good fruit to make good wine” may be cliché, but it seems to hold true. A vintner who is producing wine from grape varieties that are dependent upon volatile thiols may wish to maximize these aromas. To achieve this aim, the vintner must start in the vineyard. In order to increase the aromatic potential of a thiol driven wine in the vineyard, one may choose to:

- Increase exposure of clusters at fruit set with leaf removal
- Supply the vine with adequate (but not excessive) nitrogen
- Abstain from the addition of DAP in the winery
- Utilize a urea and sulfur spray regime around *véraison*
- Experiment with moderate water stress from fruit set until *véraison*, which might be approached through rigorous vineyard site selection to reduce plant available water.

Volatile thiols are also impacted by vinification practices and will be addressed in a future article.

A graduate of Lincoln University in New Zealand, Russell Moss is pursuing a master 's degree in viticulture and a master’s degree in enology at Virginia Polytechnic Institute and State

University in Winchester, Va. His major advisor is Dr. Tony Wolf, professor of viticulture. Moss is currently investigating how foliar nitrogen and sulfur sprays impact volatile thiols in Sauvignon Blanc and Petit Manseng.

Bibliography

Allen, T., Herbst-Johnstone, M., Girault, M., Butler, P., Logan, G., Jouanneau, S., Nicolau, L., Kilmartin, P. (2011). Influence of grape-harvesting steps on varietal thiol aromas in Sauvignon Blanc wines. *Journal of Agricultural and Food Chemistry*, 59, 10641-10650.

Benkwitz, F., Tominaga, T., Kilmartin, P., Lund, C., Wohlers, M., & Nicolau, L. (2012). Identifying the chemical composition related to the distinct aroma characteristic of New Zealand Sauvignon Blanc wines. *American Journal of Enology and Viticulture*, 63, 62-72.

Capone, D., Sefton, M., & Jeffery, D. (2011). Application of a modified method for 3-mercaptohexan-1-ol determination to investigate the relationship between free thiol and related conjugates in grape juice and wine. *Journal of Agricultural and Food Chemistry*, 59, 4649-4658.

Coetzee, C., & du Toit, W. (2012). A comprehensive review of Sauvignon Blanc aroma with a focus on certain positive thiols. *Food Research International*, 45, 287-298.

Darriet, P., Tominaga, T., Lavigne, V., Boidron, J., & Dubourdieu, D. (1995). Identification of a powerful aromatic component of Vitis vinifera L. var. Sauvignon wines 4-mercapto-4-methylpentan-2-one. *Flavour and Fragrance Journal*, 10(6), 385-392.

Deed, N., van Vuuren, H., & Gardner, R. (2011). Effects of nitrogen catabolite repression and di-ammonium phosphate addition during wine fermentation by a commercial strain of S.

cerevisiae. *Applied Microbiology and Biotechnology*, 89, 1537-1549.

Dubourdieu, D., Tominaga, T., Masneuf, I., Peyrot des Gachons, C., & Murat, M. (2006). The role of yeasts in grape flavour development during fermentation: the example of Sauvignon Blanc. *American Journal of Enology and Viticulture*, 57(1), 81-88.

Dufourcq, T., Charrier, F., Poupault, P., Schneider, R., Gontier, L., & Serrano, E. (2009). Foliar spraying of nitrogen and sulfur at veraison: a viticultural technique to improve aromatic composition of white and roses wines. *16th International GiESCO Symposium*. Davis. Retrieved from http://www.techniloire.com/documents/124963587/Dufourcq-FOLIAR%20SPRAYING%20OF%20NITROGEN%20AND%20SULFUR%20AT%20VERAIS

Lacroux, F., Tregoat, O., Van Leeuwen, C., Pons, A., Tominaga, T., Lavigne-Cruege, V., & Dubourdieu, D. (2008). Effect of foliar nitrogen and sulphur application on aromatic expression of vitis vinifera L. cv. Sauvignon Blanc. *Journal International des Sciences de la Vigne et du Vin*, 42(3), 1-8.

Maggu, M., Winz, R., Kilmartin, P., Trought, M., & Nicolau, L. (2007). Effect of skin contact and pressure on the composition of Sauvignon Blanc must. *Journal of Agricultural and Food Chemistry*, 55, 10281-10288.

New Zealand Trade and Enterprise. (2014, May). *Celebrate the fifth annual international Sauvignon Blanc day friday 16 may*. Retrieved from New Zealand Trade and Enterprise: https://www.nzte.govt.nz/en/news-and-media/nz-sauvignon-blanc-day/

New Zealand Winegrowers. (2013). *New Zealand Winegrowers Annual Report 2013*. New Zealand Winegrowers.

Peyrot des Gachons, C., Leeuwen, C., Tominaga, T., Soyer, J.,

Gaudillere, J., & Dubourdieu, D. (2005). Influence of water and nitrogen deficit on fruit ripening and aroma potential of vitis vinifera L cv Sauvignon Blanc in field conditions. *Journal of the Science of Food and agriculture*, 85, 73-85.

Peyrot des Gachons, C., Tominaga, T., & Dubourdieu, D. (2002). Localization of S-cysteine conjugates in the berry: Effect of skin contact on aromatic potential of Vitis vinifera L. cv. Sauvignon Blanc must. *American Journal of Enology and Viticulture*, 53(2), 144-146.

Pinu, F., Jouanneau, S., Nicolau, L., Gardner, R., & Villas-Boas, S. (2012). Concentrations of the volatile thiol 3-mercaptohexanol in Sauvignon Blanc wines: no correlation with juice precursors. *American Journal of Enology and Viticulture*, 63, 407-412.

Sarrazin, E., Shinkaruk, S., Tominaga, T., Bennetau, B., Frerot, E., & Dubordieu, D. (2007). Odorous impact of volatile thiols on the aroma of young botrytized sweet wines: Identification and quantification of new sulfanyl alcohols. *Journal of Agricultural and Food Chemistry*, 55, 1437-1444.

Schneider, R., Charrier, F., Razungles, A., & Baumes, R. (2006). Evidence for an alternative biogenetic pathway leading to 3-mercaptohexanol and 4-mercapto-4-methylpentan-2-one in wines. *Analytica Chimica Acta*, 563, 58-64.

Subileau, M., Schneider, R., Salmon, J., & Degryse, E. (2008). Nitrogen catabolite repression modulates the production of aromatic thiols characteristic of Sauvignon Blanc at the level of precursor transport. *FEMS Yeast Research*, 8, 771-780.

Suklje, K., Antalick, G., Coetzee, Z., Schmidtke, L., Cesnik, H., Brandt, J., du Toit, W., Lisjak, K., Deloir, A. (2014). Effect of leaf removal and ultraviolet radiation on the composition and sensory perception of vitis vinifera L. cv. Sauvignon Blanc. *Australian Journal of Grape and Wine Research*, 20(2), 223-233.

Swiegers, J., Capone, D., Pardon, K., Elsey, G., Sefton, M., Francis, I., & Pretorius, I. (2007). Engineering volatile thiol release in Saccharomyces cerevisiae for improved wine aroma. *Yeast*, 24(7), 561-574.

Thibon, C., Dubourdieu, D., Darriet, P., & Tominaga, T. (2009). Impact of noble rot on the aroma precursor of 3-sulfanylhexanol content in Vitis vinifera L. cv Sauvignon Blanc and Semillon grape juice. *Food Chemistry*, 114, 1359-1364.

Tominaga, T., Darriet, P., & Dubourdieu, D. (1996). Identification of 3-mercaptohexyl acetate in Sauvignon wine, a powerful aromatic compound exhibiting box-tree odor. *Vitis*, 35(4), 207-210.

Tominaga, T., Furrer, A., Henry, R., & Dubourdieu, D. (1998). Identification of new volatile thiols in the aroma of Vitis vinifera L. var. Sauvignon Blanc wines. *Flavour and Fragrance Journal*, 13(3), 159-162.

Tominaga, T., Niclass, Y., Frerot, E., & ; Dubourdieu, D. (2006). Stereoisomeric distribution of 3-mercaptohexan-1-ol and 3-mercaotpohexyl acetate in dry and sweet white wines made from Vitis vinifera (var. Sauvignon Blanc and Semillon). *Journal of Agricultural and Food Chemistry*, 54, 7251-7255.

van Leeuwen, C., Friant, P., Chone, X., Tregoat, O., Koundouras, S., & Dubourdieu, D. (2004). Influence of climate, soil and cultivar on terroir. *American Journal of Enology and Viticulture*, 207-217.

van Wyngaard, E. (2013, March). Volatiles playing an important role in South African Sauvignon Blanc wines. Stellenbosch University.

Virginia Wine Marketing Office. (2014). *Virginia 2013 Commerical Grape Report*. Richmond: Virginia Wine. Retrieved

from
http://www.virginiawine.org/system/datas/414/original/14RBM1103_GrapeReport2013_pgs_LRf.pdf?1395348589

WINES & VINES
415.453.9700 | Fax: 415.453.2517
info@winesandvines.com