Enology Notes

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To: Regional Wine Producers

From: Bruce Zoecklein, Head, Wine/Enology-Grape Chemistry Group, Virginia Tech

Subject: Sauvignon blanc aroma/flavor; Virginia Tech Enology Sercice Lab

I. Sauvignon blanc aroma/flavor. In previous editions of Enology Notes, I reported on research discussed at the Sauvignon blanc conference I participated in in Marlborough, New Zealand, in November 2004. I have just returned from participating in several additional conferences in New Zealand. The following is a review of some of the important considerations discussed and reviewed, regarding Sauvignon blanc aroma and flavor compounds. While much of the following is directed to Sauvignon blanc, issues regarding grape-derived aroma/flavor and methods to maximize aroma/flavor apply to other white varietals, as well.

Sauvignon blanc juice has a simple aroma that develops considerably during fermentation, and is dominated by relatively few volatile compounds. The volatiles that contribute to the varietal character are present in the grapes, and formed during winemaking from specific aroma/flavor precursors. Very potent pyrazine compounds are involved in the vegetative, herbaceous, or capsicum-like aromas. Additionally, a number of important thios, or sulfur-containing compounds, contribute to Sauvignon blanc varietal character (Dubourdieu).

As discussed in Enology Notes #101, some sulfur-containing compounds contribute reductive odor defect, while others are important contributors to varietal character. Those thios responsible for varietal character, and the important pyrazines, are listed below.

Table 1. Threshold, concentrations and olfactory descriptions of the methoxypyrazines and volatile thiols in Sauvignon blanc wine (Tominage et al., 1998; Ribereau-Gayon et al., 2000)

Compound	Perception threshold *(ng/l in water) ** (ng/l in model wine)	SB Wine (ng/l)	Olfactory descrip
2-methoxy-3-isobutyl pyrazine (MIBP)	2*	5- 50	capsicum/earthy
2-methoxy-3-isopropyl pyrazine (MIPP)	2*	<10	capsicum/earthy
2-methoxy-3-*sec*-butyl pyrazine (MSBP)	1*	<10	capsicum
4-mercapto-4-methyl-pentan-2-one (4MMP)	0.8**	4-40	cats pee/broom
3-mercaptohexan-1-ol (3MH)	60**	200-5000	grapefruit /passion
3-mercaptohexanol acetate (3MHA)	4.2 **	0-500	broom/passion fru

At the New Zealand Cool Climate Symposium, there were some interesting discussions regarding the role of climate and climate change on grape aroma/flavor compounds. In the next 50 years, the climate could warm by 1-4°C. As suggested by Dr. Richard Smart, this change may appear to be small, but could be catastrophic. We already see the movement of insect species to new regions, a sensitive gauge of climate change.

Smart believes that UV light, and possible changes in UV light, represent a large unknown for our industry. We know that UV interception is different in different parts of the world. This may be impacting grape-derived aroma/flavor compounds currently and, to a greater degree, in the future.

UV radiation in the southern hemisphere is higher than in the northern hemisphere. This may be one reason why New Zealand, and notably the Marlborough region, produces Sauvignon blanc with relatively high concentrations of certain thio-based aroma/flavor compounds that correlate positively to wine quality.

Additionally, there may be a very important crop-level to leaf-area impact. The vast majority of research on grape crop level has related crop and leaf area to primary metabolites, such as Brix, acid, or pH. As such, many in the research community have used the traditionally established 12-16 cm2 of leaf area per gram of fresh fruit as being optimum. However, this ratio may need to be reevaluated. Important secondary metabolites, including aroma/flavor compounds, are produced by different metabolic pathways than primary components, such as Brix, and may require more leaves, particularly sun-exposed leaf area.

In a multi-year study we are conducting on Viognier, Cabernet franc, and Traminette on different training systems (GDC, VSP, and Smart-Dyson up and down), we have noted that even with large crops on GDC-trained vines, we can produce fruit with a high level of important aroma/flavor compounds, possibly due to the increased level of sun-exposed leaves. In the future, there will be added focus on the impact of the exposed-leaf-area to fruit-weight ratio, and secondary metabolite production.

In Sauvignon blanc, thio-based aroma/flavor precursors are not evenly distributed in the grape. Approximately 80% of the 4-MMP precursors are found in the juice, while 50% of the 3-MH precursors are in the skins. Therefore, initial processing impacts the extraction from the fruit.

The thio concentration changes during Sauvignon blanc fermentation. This is a reason why Sauvignon blanc wines have much more varietal character than the fruit. Fermentation converts a portion of the non-odorous precursors to their odor-active form. For this conversion to occur, thio-based precursor compounds must enter the yeast cells, be cleaved (converted to their odor-active form), and excreted from the yeast cell into the surrounding environment.

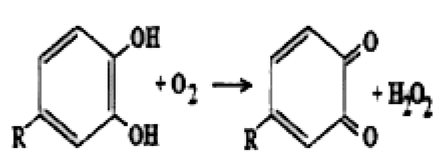
Factors impacting these steps include must composition, yeasts, and oxygen.

It is believed that thios, like 4-MMP and others, are hydrophobic enough to get inside the cell without an active transport system. Yeasts differ notably in their ability to convert thios to their odor-active form. Different strains have different genes for cleavage enzymes, and the enzymes for precursor cleavage of compounds, such as 4-MMP and 3-MH, may be different. This may suggest the merit of fermentations conducted by multiple vs. single genus or strains.

Currently, our processing is a very inefficient means of optimizing aroma/flavor. Regardless of yeast, it appears that only about 1-5% of the precursor compounds get converted to their odor-active form.

Thios are easily oxidized, resulting in loss of aroma/flavor. After excretion, thios must be stabilized in order to impact aroma/flavor. As such, phenol extraction and oxidation must be adequately controlled. Phenols can oxidize to form quinones (brown phenols) and produce hydrogen peroxide, a process known as coupled oxidation (see below).

Coupled Oxidation



$$H_2O_2 + CH_3CH_2OH \rightarrow CH_3CHO + 2\,H_2O$$

Because oxidative degradation results in the loss of aroma/flavor, and because thios are easily oxidized, the concept of hyper-reduction has developed. As reported in Enology Notes #102, hyper-reduction involves processing steps to help minimize oxidative degradation by keeping wines in a reduced or low oxygen state. How well the varied procedures used in hyper-reduction work, such as carbon dioxide blanketing, has not been fully evaluated or documented.

However, there are some important steps known to have a positive impact on minimizing oxidation and the loss of aroma/flavor. These include the following:

- No copper
- Low concentration of phenols
- Protection from oxidation via sulfur dioxide, glutathione, and/or lees storage

As previously reported, copper is a strong inorganic oxidative catalyst. Copper in the must from late-season Bordeaux mix vineyard sprays, or any other source, can lower the longevity of wines like Sauvignon blanc.

Copper inactivates glutathione. The role of glutathione as an oxidative buffer is receiving considerable attention. Glutathione is a polypeptide produced by the grapevine and by yeast at the end of fermentation. It is a strong antioxidant. Research conducted by Dr. Denis Dubourdieu's group has shown that grape glutathione concentration declines at the beginning of fermentation, and then increases again at the completion of fermentation.

The following are important relationships regarding glutathione:

- There is a positive correlation between glutathione and the freshness and longevity of Sauvignon blanc wines.
- There is a positive correlation between the concentration of glutathione in the must and concentration in the young wine.
- There is a positive correlation between the juice free amino nitrogen concentration and the glutathione concentration at the end of alcoholic fermentation.
- Minimizing the loss of glutathione is the key to white wine making.

Dr. Dubourdieu is conducting trials with the addition of 10 mg/L glutathione at bottling to help control oxidative degradation. Such additions, and/or the management of native grape and yeast glutathione, may be important steps for maximizing white wine aroma/flavor.

II. Virginia Tech Enology Service Lab. We are pleased to announce that the Enology Services Lab will begin accepting samples March 1st, 2006. We will be offering more services over time, but currently the following analyses are available:

- **General Wine Chemistry**

Alcohol	Formol Nitrogen	Lactic Acid	Malic Acid
pH	Glucose+Fructose	Free SO2	Total SO2
Tartaric Acid	Titratable Acidity	Volatile Acidity	

- **Microbiological Profiles**

MLF Viability Yeast Viability

- **Phenols**

Anthocyanins	Hue	Intensity	Total Phenols
Copigmented Anthocyanins			

- **Sensory**

Oxidative/Degradative Defects	Palate Structural Defects
Volatile Sulfur Compounds	

- **Wine Stability**

Atypical Aging	Chill Haze	Protein (Heat) Stability
Turbidity	Cold Stability	Filterability/Glucan/Pectin Test

- **Analytical Panels**

Basic Wine Chemistry	QC Panel	Post-Fermentation Panel
Stability Panel	Stuck Fermentation	Microbiological Panel
Phenol/Color Panel		

Groups of analyses or "Analytical Panels", based on the most commonly requested services, are available. Details regarding this service, and announcements of enhanced services and additional Analytical Panels, will be made on the Enology Group's website (www.vtwines.info) and the Enology Service Lab website.

Analysis results will be posted, and password-protected and viewable only by Enology Service Lab Staff and the winemaker. The website also contains links for sample submission forms, sample requirements, and cost of analyses. To preview the data reporting, an Example Analysis Report can be found in the system under "Links". If you have any trouble accessing any part of the site, please email me at Enology.Services@vt.edu with any problems or suggestions you may have for this new website.

We are excited to open the doors to the Service Lab and start sharing my analytical expertise with the wine industry.

- Ken Hurley, Lab Director

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