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To: Grape and Wine Producers

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Subjects:

1. **Viognier Wine Balance**
2. **Sensory Monitoring**
3. **Factors Influencing Sulfur Off-Odors in Wines**
4. ***Winery Planning and Design*, Edition 16, Available**

1. Viognier Wine Balance. Today's consumers expect a well-balanced Viognier, with a symphony of integrated aromas and flavors. Balance and harmony are two descriptors often used to denote wine quality. Unpleasant coarseness, or aftertaste involving bitterness and/or the tactile sensations of astringency or hotness, negatively impacts balance and harmony and the overall perception of this important grape variety.

To attain balance requires an understanding of the grape, the impact of vineyard management, and how winemaking variables influence the integration of fruit, yeast and bacterially-derived aromas/flavors, and wood.

For most varieties, grape aroma/flavor development is linear and relatively predictable, increasing at an even pace. Viognier, however, undergoes an engustment (a rapid respiratory change) only in very late season, that creates the varietal aroma associated with the grape variety including lychee, musk, rose, pear, apricot, peach, nectar, ginger and citrus.

Engustment occurs quite often, with a relatively high potential alcohol (over about 14.5%) linking aroma/flavor balance and palate balance. Viognier varietal aroma/flavor is largely the result of C_{13}-norisoprenoids and terpenes. Yeast-derived aromas are mainly from esters produced as a result of the metabolism of fatty acids and amino acids. These are less stable than the grape-derived aromas. The relatively high alcohol in Viognier can impact both varietal and fermentation aroma/flavor.

Structural/textural components interact in a palate balance "equation" depicted in Figure 1.

Figure 1 – Palate Balance

Volume, Body, Sweetness	↔	**Acid**	**+**	**Phenolics**
Carbohydrates		Organic		Skin, seed, and stem phenols
Polysaccharides				Barrel phenols
Ethanol				Enological tannins
				Volatile phenols

While not an equation in an algebraic sense, this simple association suggests an increase in the perception on one side of this relationship decreases the perception of components on the other. The converse is also true. With this in mind, it is easy to understand how perception of structural/texture components interrelate.

The sweetness, volume, and body elements in a Viognier are mainly derived from carbohydrates, polysaccharides, mannoproteins, gums, and ethanol. The acid elements are usually the result of grape-derived organic acids or acid addition. The phenolics include sensations derived from the skins, seeds, and stems, and may include winemaker intrusions, such as barrel and enological tannins.

Integration of structure and texture components is important because perceptions occur in different parts of the palate and, therefore, at different time intervals. Thus, we initially taste sweetness at the front of the palate, followed by acidity, and finally the taste of bitterness and tactile response of astringency near the back of the palate. Yet, we expect a high "quality," well-integrated, and balanced Viognier not to have these as separate sensations, but as a harmonious whole.

The structural/textural balance of Viognier is impacted by the quantitative and qualitative nature of components in the “equation” above and wine temperature. A low (under 50°F) wine temperature increases the perception of acidity, while lowering the perception of the sweetness, body, and volume elements. Warming the wine a few degrees reverses this by increasing the perception of the sweetness, volume, and body elements, thus lowering the perception of those components on the right side of the “equation.” This highlights the inverse nature of this relationship and serves as a reminder of the important of specific serving temperature recommendations, essential for optimum wine enjoyment.

The relative interaction of the structure/texture components of Viognier are outlined below. Plus signs (+) indicate a positive correlation, negative signs (-) a negative correlation. These generalizations follow most winemakers' empirical observations.

Balance of Volume, Body, Sweetness, and Acid

<u>**Volume, Body, Sweetness**</u> ↔ Acid + Phenols (tannin intensity, astringency, bitterness, and dry tannins)

+ Ethanol
+ Polysaccharides and mannoproteins
+ Gums, like Gum Arabic

Ethanol, an important Viognier component, impacts wine mouthfeel, being bitter-sweet and producing palate hotness.[8] A high (above 14.5%, for example) alcohol level may enhance the negative textural characteristics of roughness and bitterness (see below). It is essential that Viognier producers understand the sugar-to-ethanol conversion rate specific to their vineyard sites.

Lees management can impact palate balance. Mannoproteins in the yeast cell wall are bound to glucans, and exist in wines as polysaccharides and proteins. They are released from the cell wall by the action of an enzyme (β-1,3-glucanase) and can impact aroma, oxygen buffering, and wine stability.[1,5] Additionally, they provide a sense of sweetness, as a result of increasing the perception of volume, body, and sweetness and, thereby, lowering the perception of acidity and phenolic elements. For this reason, winemakers in some regions add glucanases and/or age wine *sur lie* after primary fermentation.

Newly-fermented Viognier is frequently settled for 24 hours, sometimes longer, to remove gross yeast lees. Subsequent racking removes secondary lees, which contain macromolecules such as polysaccharides and mannoprotein.[3] Such removal may go counter to the optimal integration of structural and textural components.

Additionally, if Viognier is fined prior to aging, some macromolecules are removed. This can exert a negative influence on structure and texture integration when the rate of elimination reaches approximately 30%.[2]

Volume, Body, Sweetness ↔ **Acidity** + Phenols (tannin intensity, astringency, bitterness, and dry tannins)

- Sugar
+ Tannins
- Polysaccharides and mannoproteins
+/- Body/volume
+ Tannin intensity
+ Dry tannins
+ Bitterness

Increasing the perception of acidity usually increases the perception of the phenolic elements, including tannin intensity, astringency, bitterness, and dry tannins. This frequently results in a lower perception of the sweetness, body, and volume elements.

Viognier fruit, particularly if over-cropped, moisture-stressed and/or with protracted hang-time, can have a relatively high pH (above 3.7). Must pH is increased with skin contact by about 0.2 pH units. Because high pH is a common feature of this variety, acid addition to lower the pH is common. Questions to consider include:

- What is the optimum pH in the finished wine to achieve balance and help preserve aroma/flavor?
- What level of acid provides what pH reduction?

- How much acid can be added to lower the pH while still achieving a balance of structure and texture?

While there is usually some acid reduction due to precipitation of potassium bitartrate during or post-fermentation, determining the optimum acid addition pre-fermentation is not always easy. The relationship between the addition of acid and the extent of pH reduction is governed mainly by the buffering capacity of the juice, that is, the resistance to change. This resistance is related to the cation concentration, largely potassium. As such, there is a positive correlation between the buffering capacity and the must potassium concentration.

Winemakers using the same source of fruit generally develop an empirical understanding of the buffering capacities which can greatly aid in their decision-making. Measuring buffering capacity is described in *Wine Analysis and Production* by Zoecklein et al. (1999).[10]

Phenol balance

The qualitative and quantitative nature of phenols impacts their sensory characteristics and wine balance. Winemakers frequently attribute Viognier coarseness to phenolic elements. Causes of structure and texture coarseness have been reviewed by R. Gawel et al.[4] and include:

- Phenols, including hydroxycinnamic acids, flavonols, flavanols, and tyrosol
- Oxidative products
- Glycosides
- Alcohol
- Acidity

Viognier fruit processing methods (whole cluster pressing, destemming, crush and drain) impact phenol extraction from this relatively high-phenol grape. Modification of the phenol concentration may be achieved post-fermentation with protein-fining agents that generally remove higher molecular weight phenols (tannins). However, the difference in the phenol concentration before and after fining is not often large. This suggests that the sensory impact may be due, in part, to changes in the colloidal complexes, not simply a change in phenol concentration. This would help to explain the matrix effect, why wines react differently to the same type and concentration of fining agent.

Volume, Body, Sweetness ↔ Acid + Phenols **(<u>tannin intensity</u>**, astringency, bitterness, and dry tannins)

Tannin Intensity

+ Acidity
+ Volume/body/sweetness
+ Yeast in suspension
+ Non-soluble solids
- Polysaccharides

In Viognier, tannin intensity may not strongly correlate with the total phenol concentration. Tyrosol has been estimated to comprise 10% of the total phenolic content of white wines.[6] Tannin taste has been correlated to tyrosol. It is thought to be formed from the amino acid tyrosine by yeast during fermentation.[9]

Concentration is believed to depend mainly on yeast strain and initial concentration of sugars and tyrosine in the must. Winemaking practices, such as oxidative must handling, may affect tyrosol concentrations.

Volume, Body, Sweetness ↔ Acid + Phenols (tannin intensity, **<u>astringency</u>**, bitterness, and dry tannins)

Astringency

+ Grape and oak tannins
+ Acidity
0 Sugar
- Ethanol up to about 14%, + above 14%
+ Non-soluble solids

Qualitative change in phenols due to oxidative polymerization can result in “softer” tannins, which can lower the perception of the acidity and increase the perception of sweet/volume/body elements.

Volume, Body, Sweetness ↔ Acid + Phenols (tannin intensity, astringency, bitterness and **dry tannins**)

Dry Tannins

- Ethanol up to 13%, + above 13%
0 Sugar
+ Grape and oak tannins, including seed tannins
+ Acid, mainly malic and acetic
+ Yeast in suspension
+ Non soluble solids
- Polysaccharides

The fact that dry tannins are not well-masked by sugar suggests that this common corrective approach is not always effective.

Volume, Body, Sweetness ↔ Acid + Phenols (tannin intensity, astringency, **bitterness** and dry tannins)

Bitterness

+ Ethanol
+ Grape and oak tannins, including immature seed tannins
+ Acid, specifically malic acid
+ Yeast in suspension
- Polysaccharides

A universal problem in Viognier production is that elevated levels (above about 14.5%) of ethanol can increase the perception of bitterness. The negative correlation between polysaccharides and bitterness is a reason for the use of high polysaccharide-producing yeast, and the use of fining agents such as gums, like gum arabic, and yeast fining.

Many terpene-oriented varieties, including Viognier, can have palate coarseness. A correlation between bitterness and terpene glycoside concentration has been reported.[7] The use of so-called flavor-enhancing enzymes, which contain glycosidic activity, may contribute to the problem. Glycoside hydrolysis releases volatile terpenes, possibly increasing aroma intensity, but also phenols, possibly increasing coarseness.

2. Sensory Monitoring. In the wine industry, monitoring frequently involves sensory evaluations. From testing grapes for assessment of maturity and quality in the vineyard, to evaluations of wines post-bottling, critical decisions based on sensory evaluation are made throughout the winemaking process. These decisions are often made by an individual experienced winemaker based on his/her own sensory experiences and impressions. Often, winemakers lack formal sensory training experience. Several problems in relying on a single evaluator include:

- Variation among evaluators
- Assessments based upon personal standards and personal experiences
- Possible bias due to preconceptions about the product or treatment

Bishop George Barkeley was an eighteenth century philosopher and an empiricist. He argued that our only knowledge of the world is what comes to us through our senses: *Esse est percipti* - to be is to be perceived.

Many winemakers seem to either inadvertently espouse to Barkeley's philosophy, have limited sensory skills, and/or or do not fully understand common difficulties that can occur when evaluations are performed under less-than-optimum conditions. Sensory analysis must involve an understanding of the following:

- Standardized and controlled environment
- Representative sample and condition of the sample
- Sample temperature
- Glass type, shape and fill volume

- Elimination of bias
- Importance of sample contrasts
- Evaluators, who they are and their skills
- Number of evaluators required to gain a true picture
- Minimize presentation effects (adaptation)
- Minimize physiological effects (time of day, not tasting for a period after eating or drinking)
- Number of evaluations to gain a true picture
- Using the proper testing method (triangle difference tests, duo-trio, paired comparison, sample difference tests and paired preference testing)
- Establishing if a difference exists before deciding on preferences testing

Sensory evaluation should be conducted in an environment conducive to focused concentration. Is the sample to be evaluated representative? Because of the inherent nature of barrels, each barrel must be considered its own unique entity. As such, a single barrel may not be representative. Most choose to screen barrel samples and pool samples from up to 5, or even more, barrels for formal sensory evaluation.

The specific nature of the sample, including non-soluble solids level and temperature, can certainly impact sensory responses. Samples that contain high levels of non-soluble solids may have a different mouthfeel response, simply due to the tactile impact of the solids.

Sample temperature is critical due to the obvious impact on volatiles. Temperature also impacts the structural/textural components. As outlined above, the relative harmony of the volume/body/sweet elements, with the sum of the acid and phenol compounds, is influenced by temperature. The lower the temperature, the greater the sense of acidity and, therefore, the phenols – resulting in a reduction in the sense of volume/body and sweetness.

All winemakers understand the concept of bias, but not all eliminate bias from their sensory evaluations. For example, if a winemaker is evaluating a gelatin fining trial and knows which wines have been fined and which have not, the general response may be to suggest that the fined wines have a softer palate, because that is what is expected. However, this may or may not be true of the specific wines in question.

Most of us learn by gauging against some reference. Sensory evaluations that involve pairing allows for contracting, and the ability to detect true differences, if they exist.

All factors listed above should be carefully reviewed prior to any type of formal sensory evaluation.

3. Factors Influencing Sulfur Off-Odors in Wines. An online publication titled Sulfur-Like Off Odors – A Winemaker HACCP Plan, at www.vtwines.info, provides an outline of actions to consider to help control the production of sulfur-like off odors in wine. The major headings of the best practice-like plan are provided below.

- Factors impacting yeast performance
- Measure yeast assimilable nitrogen (YAN)
- Factors impacting YAN
- Control must turbidity
- Optimize oxygen management
- Proper concentration and timing of nutrients
- Avoid carbon dioxide toxicity
- Understand oxidation-reduction potential and SLO
- Understand post-fermentation and SLO

In addition to the On-Line publication, previous *Enology Notes* have discussed various issues related to volatile sulfur compounds, including sulfur-like off odors (see *Enology Notes* Index at www.vtwines.info).

The following, adapted from Delteil, also summarizes the major impact areas that influence the production of sulfur-like off odors.

Legend:

* * * * very strong impact
* * * strong impact
* * some impact
* low impact

- Presence of certain pesticide residues on the grapes * * * * (infrequent)
- Presence of particles of sulfur on the grapes * * * * (infrequent)
- Yeast stress * * * * (very frequent)
- Strain sensitivity to stress * * *
- Rehydration without yeast sterols and micro-nutrients available (e.g. NATSTEP protection) * *
- Osmotic shock * * *
- High presence of SO_2 (>30 ppm) * * *
- Insufficient amino acids during the growth phase (initial specific gravity <30 points) * * *
- Excessive temperature during yeast growth phase (>25-26°C) * * *
- Absence of inactive yeast (e.g. the inactive yeast of Fermaid K) during the growth phase * * *
- Absence of oxygen in the growth phase * * *
- Insufficient amino acids at the beginning of the stationary phase (SG or specific gravity approximately 1,070-1,060) * * * *
- Addition of pure ammonia nitrogen when the yeast is lacking alpha-amino nitrogen * * * *
- Absence of oxygen at the beginning of the stationary phase * * * *
- Excessive temperature during the stationary phase (>25-26°C) * * *
- High liquid pressure due to the height of the tank * *
- Presence of untoasted oak during fermentation * *
- Presence of vegetal lees during the end of alcoholic fermentation, before, during and after MLF * * * *
- Trend of the *Oenococcus* strain that makes the MLF to produce sulfur off-aromas * * *
- Presence of *Brettanomyces*, *Pediococcus* or *Lactobacillus* before, during, and after MLF * * * *

4. *Winery Planning and Design*, Edition 16, Available. This publication, in CD format, is the result of a number of short courses and seminars covering various aspects of winery planning in several wine regions around the country. While not regionally specific, the information provided is from a number of authoritative sources, covering such diverse topics as sustainable design, winery equipment, and winery economics.

Winery Planning and Design, Edition 16, is available through the industry trade journal *Practical Winery and Vineyard* (phone 415-479-5819), email: donpwv@aol.com or tlv100@sonic.net.

For a full listing of the subjects covered, go to www.vtwines.info. On the right-hand side of the homepage, click Winery Planning and Design CD.

References

1. Escot, S., M. Feuillat, et al. 2001. "Release of polysaccharides by yeast and the influence of polysaccharides on colour stability and wine astringency." *Aust. J. Grape Wine Res*. 7:153-159.

2. Feuillat, M., D. Peyron, and J.L. Berger. 1987. "Influence de la microfiltration tangentielle des vins sur leur composition physicochimique et leurs caractres sensoriels." Bull. ON 60:227-244.

3. Feuillat, M. 1998. Autolyse des levures. In CEnologie: Fondements scientifiques et technologiques. C. Flanzy (Ed.), pp. 444-454. Lavoisier, Paris.

4. Gawel, R., L. Francis, and E.J. Waters. 2007. "Statistical correlations between the in-mouth textural characteristics and the chemical composition of Shiraz wines." *J. Agric. Food Chem*. 55:2683-2687.

5. Lubbers, S., A. Voilley. 1994. "Influence of mannoproteins from yeast on the aroma intensity of a model wine." *Lebensm.-Wiss. Technol*. 27:108-114.

6. Myers, T.E., and Singleton, V.L. 1978. "The non flavonoid phenolic fraction of wine and its analysis." *Am. J. Enol. Vitic*. 30:98-102.

7. Noble, A.C., C.R. Strauss, P.J. Williams, and B. Wilson. 1988. "Contribution of terpene glycosides to bitterness in Muscat wine." *Am. J. Enol. Vitic*. 39:129-131.

8. Scinska, A., E. Koros, B. Habrat, A. Kukwa, W. Kostowski, and P. Bienkowski. 2000. "Bitter and sweet components of ethanol taste in humans." *Drug Ale. Depend*. 60:199-206.

9. Singleton, V.L., and A.C. Noble. 1976. “Wine flavor and phenolic substances.” In Phenolic Sulfur and Nitrogen Compounds in Food Flavors. Charalambous, G.; Katz, I. (eds). Washington DC, Am. Chem. Soc.

10. Zoecklein, B.W., K.C. Fugelsang, G.H. Gump, and F.S. Nury. 1999. *Wine Analysis and Production*. Kluwer Academic Publishers. New York, N.Y. 612pp.

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