***Enology Notes* #157** **May 6, 2011**

To: Grape and Wine Producers

From: Bruce Zoecklein, Head, Professor Emeritus, Enology-Grape Chemistry Group, Virginia Tech

Subject:

1. **Sensory Perception**
2. **Phenols and Mouthfeel, Wineries Unlimited 2011**
3. ***Winery Planning and Design*, Edition 16, Available**

1. Sensory Perception.

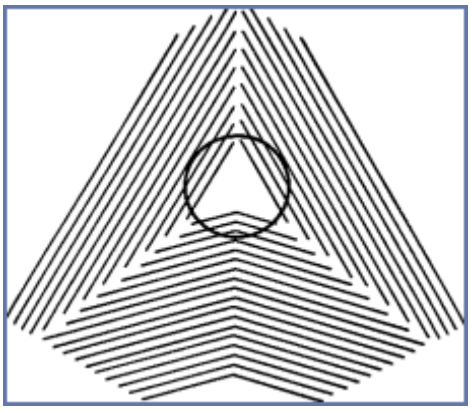
"*There are no standards of tasting in wines, cigars, poetry and prose. Each man's own taste is the standard, and a majority vote cannot decide for him or in any slight degree affect the supremacy of his own standard*." – Mark Twain, 1895

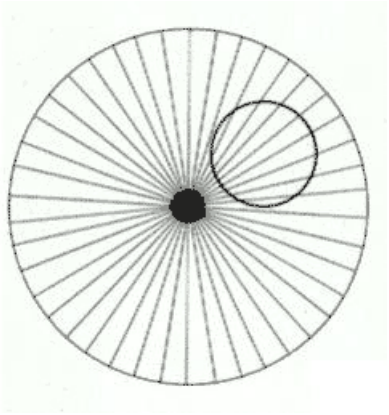
A unique feature of wine is its complexity. Indeed, more than 1000 compounds have been identified in grapes and wine. Although wine is often defined by complexity, among other things, enology does not have all the answers to help assure complexity. Our limited understanding lies with the features below, with the multifaceted interactions that occur among the numerous chemical components, and the effect of these interactions on perception:

- Adaptation
- Individual variability
- Carry-over effects
- Difficulty in separating some sensory components
- Non-standardized language
- Expectations/bias

In the first Winemakers Sensory Training session, we highlighted why consistent sensory evaluations are difficult. The following highlights some topics to be reviewed, experienced, and discussed at the Winemakers Sensory Training session #2.

During wine evaluation, the brain processes cognitive information from multiple sensory inputs, including sight, smell, taste, touch, temperature, and irritation. What we sense is the product of the physical stimuli and the mental picture that we develop from those stimuli (Shepherd 2006). Perception, therefore, is the culmination and interpretation of multiple inputs.



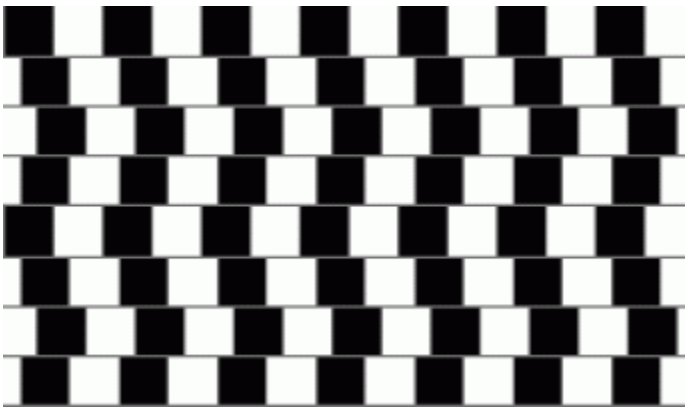


Are these perfect circles, or do they bend?

An understanding of these interactions is critical to sensory evaluation. For example, a wine served at the winery with all of the ambiance, autumn colors, and pleasant music, may be perceived quite differently than the same wine served in a loud, raucous amusement park, or even at home (Kennedy et al. 2010).

Examples of multiple sensory inputs on perception are numerous. The same two white wines, one with red food coloring, the other without, can certainly evoke a different set of aroma and flavor descriptors. Sucrose solutions spiked with fruit or berry aromas are usually judged to be sweeter than the same solutions without the aromas (Prescott 1999).

It is evident that even highly-experienced judges use all sensory information available to arrive at a judgment. Those judgments can be seriously impaired. Are green and unripe tannin descriptors due to tannin structure, or the result of aroma/flavor cues that influence the way we perceive and evaluate astringency? Perhaps green and unripe tannin descriptors are influenced by less red color intensity (Kennedy et al. 2010).



Are these lines horizontal, vertical, or do they slope?

Complex signal processing by our brains makes seemingly straightforward wine evaluations difficult and complex. An awareness of the human and wine chemistry interrelationships is essential if we are to manage and understand sensory evaluation. This, of course, is a goal of the Winemakers Sensory Training program.

More than 1000 compounds have been identified in grapes and wine, with individual concentrations varying considerably. Our ability to perceive compounds is dependent not only upon their presence at or above a sensory threshold concentration, but also upon their interaction with other components. The sensory properties of a particular wine, therefore, are dependent upon chemical and physical effects relating to the specific matrix or composition. For example, aroma/flavor compounds can bind with macromolecules, such as tannins, proteins, and polysaccharides, impacting volatility and, therefore, our ability to perceive (Kennedy et al. 2010). The stability and solubility of these colloids is likely variable. However, shear forces during operations, such as filtration, may disrupt these colloids. Colloid disruption might help explain bottle shock, or the change or loss of aroma/flavor intensity immediately post-bottling (Kennedy et al. 2010).

Additionally, two aroma compounds in isolation may be clearly noted; in a mixture, however, they can mutually suppress each other. In such circumstances, one compound may dominate the other to such a degree that the second is not perceived at all. When many aroma compounds are present together, as in a wine, the complexity is such that it is virtually impossible to predict the extent of the suppression effects, or to know what compounds will be more dominant. While suppression is the most common, in some cases aroma compounds can enhance each other, even if both are below the detection threshold.

Masking occurs with dimethyl sulfide (DMS), a volatile sulfur compound variously described as having a cabbage/cooked corn/truffle aroma at high concentrations. At sensory threshold concentrations, DMS can add to fruit intensity of red wines. This compound increases with bottle age (Siebert et al. 2010), and may help explain the relative complexity of aged wines vs. younger products.

We often use compositional information to help ensure that a wine is sound and complies with TTB regulations. For example, monitoring parameters like 4-ethylphenol is routine, with the goal of providing objective, direct information on soundness of the product. However, due to the matrix effect (the impact of other wine components on the volatility of 4-EP), it is not possible to state with assurance the level of 4-EP below which a wine will not have a Brett character and will appear sound.

The matrix effect is evident in routine cellar operations. Fining with protein and bentonite is used to remove unwanted proteins and phenolics from wine. Winemakers know that these agents can also change the aromatic properties of wine as a result of these complex interactions, as can the addition of lees, enological tannins, etc. Thus, simply quantifying aroma compounds does not provide sufficient information to predict aroma properties (Rodriguez-Bencomo et al. 2010).

An awareness of the human and wine chemistry interrelations is essential if we are to manage and understand sensory evaluation.

2. Phenols and Mouthfeel, Wineries Unlimited 2011.

The greatest obstacle to discovering the truth is being convinced that you already know it.

In the myth of Theseus and the Minotaur, Theseus, having killed the Minotaur, is able to escape from the labyrinth only because Ariadne had given him a golden cord by which he could find his path out. At the 2011 Wineries Unlimited, held in Richmond, Virginia, at the end of March, several speakers lead the audience through the complex labyrinth of *terroir*, phenols, and red wine mouthfeel.

The fact that there is no word for winemaker in several European languages points to the deeply ingrained belief that wine is made by nature, not by man. This creed, held for centuries in the Old World, is that wine at its core is the reflection of a place. Randall Grahm (winemaker, author, lecturer, and noted *terroir* seeker) of Bonny Doon Vineyard addressed this question: Does *Terroir* Matter?

Grahm contrasted the salient distinctions between *vins d'effort* and *vins de terroir* – wines that are notably marked by the imprint of human efforts, as opposed to those whose character primarily reflects their place of origin. In today's market, the consumer is left to answer this question: Did this fine wine I am enjoying come from a great vineyard, from a host of addition products, or the razzle-dazzle of some new technology – perhaps a spin on the spinning cone?

Grahm suggested that much of the modern grape-growing practices, at least in the New World, are at odds with the systematic discovery of *terroir*. The apprehension and appreciation of *terroir* may ultimately be a question of gestalt, i.e., instead of a focus on the obvious charms of fruitiness, varietal or oak character, one needs to look more deeply at the elements lurking in the background of a wine – most specifically the mineral character. Minerality, or capacitance, of the wine, the wine's persistence, gives the primary flavor a sense of soulful depth or relief, providing a shadow or added dimensionality. Randall Grahm also discussed his interest in vines grown from seeds, and the use of the soil amendment biochar (activated charcoal), a product produced by pyrolysis or combustion in the relative absence of oxygen. He concluded with a question relating to the mystery of wine: Why do some wines live, and some wines die young? "If you are not obsessing about that issue, you are not really taking your job seriously," he said.

Certainly, phenols are an element in the answer to Grahm's question. Two other speakers (Dr. Jim Kennedy, Professor and Chair, Department of Viticulture and Enology and Research Center Director, CSU-Fresno; and Mr. Clark Smith, columnist, wine educator, author, founder of Vinovation and Director of Best of Appellation awards for

Appellation America) summarized the logos and mythos of grape and wine phenols. Both discussed issues of vine balance and the evolutionary teleology of grape phenols.

Clark Smith reminded the assembled that the goals of winegrowing are the same as those of fine cuisine: visceral enjoyment of flavors, integration into a refined structure, and memorable taste expression from careful farming in living soil. He reviewed some post-modern winemaking principles, including:

- Promoting living soil
- Optimizing maturity
- Co-extraction
- Building and refining wine structure
- Protecting the wine's integrity

An important question was addressed: When optimizing phenols, what should we be looking for? Jim Kennedy outlined a study conducted in Australia comparing wine bottle price and tannin chemistry. The highest-priced wines demonstrated the highest concentration of total phenols, greatest degree of tannin polymerization, and highest skin tannin concentration (Kassara and Kennedy, 2010). Generally, there was a high positive correlation between the total phenol content, specifically skin tannins, and red wine quality.

High fruit phenols are associated with the following (Jackson and Lombard, 1993):

- High sun exposure
- Low nitrogen
- Low soil moisture
- Low soil fertility
- Moderate canopy size
- Moderate crop level

There is a widely-held assumption that lowering vine vigor impacts wine quality. Jim Kennedy shared a study (Cortell et al., 2005) that demonstrated fruit tannin differences in low vs. high vigor vines. Wines from low and high vigor vines had the same seed tannin concentration, but low vigor vines had higher skin tannins, a higher concentration of polymeric pigments (anthocyanins bound to tannins), higher color density (absorbance at 520 + 420 nm) and a lower hue (absorbance at 420/520 nm). Given the relatively strong association between skin tannin concentration and red wine quality, lowering vigor could potentially improve wine quality.

Does lowering vigor have a direct influence on skin tannins, or is the effect indirect, such as the result of increased fruit exposure? Both heat and light can impact various types of grape phenols. It is also known that lowering plant vigor can impact fruit solar exposure. Kennedy outlined that the maximum anthocyanin concentration in the fruit will be formed at about 30°C. At 35°C or so, synthesis declines, resulting in less visual red color.

He stated that research suggests that skin phenols are more affected by light than by temperature. Thus, lowering vigor may increase skin tannins as a result of enhanced light exposure, that is, as a result of plant environment. Naturally, this has implications for row orientation, training systems, and leaf removal.

The universal and lingering question follows: How much light exposure is optimum for fruit and wine quality? Likely, this is varietally-specific and perhaps relates also to wine style. Kennedy reminded the group that plotting red wine quality vs. fruit exposure creates a bell-shaped curve. The upward and downward slopes of this curve are much steeper in warmer climates and seasons. Certainly, additional research is needed to aid our understanding of the relationships between light, heat, vine phenology and wine quality.

Clark Smith spoke of the importance of reductive strength, certainly an aspect which relates to Randall Grahm's question of why some wines live and others die young. He outlined the relationships between reductive strength and fruit ripeness. Problems associated with under-ripeness include insufficient pigments, limited extraction from the fruit, and lack of rich flavors that limit tannin capacity. Over-ripeness may result in field oxidation of pigments, excessive alcohol that can de-stabilize pigment colloids, and loss of reductive strength.

He highlighted the fact that flavonol phenols are a barometer associated with light exposure, acting essentially as sunscreen for the fruit. As such, there is an association between the concentration of flavonol phenols (important pigment cofactors) and sun exposure.

While fruit composition is critical to red wine quality, so is the degree of extraction from the fruit. The factors most important for tannin extraction include:

- Fruit maturity
- Degree of berry breakage
- Time
- Temperature
- Cap management procedures

It is well established that seed tannins are perceived differently than skin tannins. An important question is this: How does the tannin amount and composition change during maceration?

Skin tannins provide astringency, which is impacted by the degree of polymerization or binding, which is influenced by the relative proportion of anthocyanins to tannins. Anthocyanins act as book ends, binding tannin at the terminus and, thus, stopping polymerization.

The lower the anthocyanin concentration, the more tannin polymerization occurs. The larger the tannin polymer chain, the greater the binding with salivary proteins, and the more astringent and 'harder' the tannins. Anthocyanins bind with tannins, limiting the

chain length and, thus, preventing the production of drying and aggressive astringency. As such, generally, the greater the anthocyanin concentration is, the finer the tannins.

During fermentation, skin tannin concentration extracted from the fruit increases with time, then plateaus. Kennedy demonstrated that the plateau concentration is influenced by the degree of berry breakage. He also demonstrated that the plateau concentration occurs much sooner with increased berry breakage, the result of a greater degree of skin tannin extraction. He suggested that if the goal is to maximize the skin tannin extraction, it may be better to crush the fruit and dejuice earlier, rather than to have minimal crushing and ferment longer.

The theme of this meeting was business sustainability, which went hand-in-hand with the technical discussions. At the opening session, I reminded the group of the importance of establishing goals and strategies; after all, luck is really the residue of design. Additionally was the suggested mantra: It is what you learn after you know it all that really counts. It was a spectacular event!

Additional information on grape and wine phenols is available at www.vtwines.info.

3. *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: tlv100@sonic.net). The entire index and additional information is available at www.vtwines.info.

References

Cortell, J.M., M. Halbleib, A.V. Gallagher, T. Righetti, and J.A. Kennedy. 2005. Influence of vine vigor on grape (*Vitis vinifera* L. cv. Pinot noir) and wine proanthocyanidins. J. Agric. Food Chem. 53:5798-5808.

Jackson, D.I., and P.B. Lombard. 1993. Environmental and management practices affecting grape composition and wine quality – a review. Am. J. Enol. Vitic. 44:409-430.

Kassara, S., and J.A. Kennedy. 2010. Colour and tannin compositional variation with wine allocation, Presented at the 14th Australian Wine Industry Technical Conference, Adelaide, SA July 3-8.

Kennedy, J., D. Jeffery, L. Francis, and M. Herderich. 2010. Science Looks at Sensory Perception Effect. *Austral. Grapegrower Winemaker*. AWRI Research Institute, Glen Osmond, Adelaide, SA 5064.

Prescott, J. 1999. Flavour as a psychological construct: implications for perceiving and measuring the sensory qualities of foods. Food Qual. Pref. 10:349-356.

Rodriguez-Bencomo, J.J., M. Ortega-Heras, and S. Pérez-Magariño. 2010. Effect of alternative techniques to ageing on lees and use of non-toasted oak chips in alcoholic fermentation on the aromatic composition of red wine. Eur. Food Res. Technol. 230:485-496.

Shepherd, G.M. (2006). Smell images and the flavour system in the human brain. Nature 444:316-321.

Siebert, T.E., M.R. Solomon, A.R. Pollnitz, and D.W. Jeffery. 2010. Selective determination of volatile sulfur compounds in wine by gas chromatography with sulfur chemiluminescence detection. J. Agric. Food Chem. 58:9454-9462.

All past *Enology Notes* technical review are posted on the Wine/Enology – Grape Chemistry Group's website at: http://www.vtwines.info.

To be added to (or removed from) the *Enology Notes* listserv, send an email message to vkeith@vt.edu with the word ADD or REMOVE in the subject line.