***Enology Notes* #137** **November 12, 2007**

To: Regional Wine Producers

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

Subjects Discussed in *Enology Notes* #137:

1. The 2007 Harvest: Aroma/flavor, pH, Alcohol, MLF, and ATA

2. Winery Planning and Design CD available

3. Issues in Winery Layout and Design Workshop, March 7, 2008

4. Sustainable Winery Design Considerations (continued): Past, Current, and Future Technological Trends

5. Electronic Nose Research Update

6. Enology Service Lab Closed November 16 – November 26 for equipment maintenance

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

1. The 2007 Harvest. The weather in this region during the late stages of this growing season was characterized by heat and drought, creating some specific winemaking concerns. For non-irrigated vineyards, fruit was characterized by high potential alcohol, low acidity, and high pH. Adjustments required for this season were greater than most.

Aroma/flavor. Optimum formation of fruit aroma and flavor compounds can be restricted by lack of soil moisture, and qualitatively impacted by heat. In many northern Virginia vineyards, fruit ripened early (aroma/flavor ripening), and reached elevated sugar levels relatively quickly. For established white varieties in the central region impacted by the freeze, the opposite occurred. Some white grapes lacked aromatic intensity, as a direct consequence of the environmental conditions, excessive maturity, or combinations of factors.

Aroma/flavor development in red fruit was generally excellent. The possibility for optimum hang time allowed for the breakdown of methoxypryrazines (MP), thus limiting herbaceousness. Excessive herbal character can negatively impact the aroma profile and palate of red wines (see *Enology Notes* # 94, 112, 113, 114, 115). Some reds with protracted hang time have limited red-berry fruit character with more dried fruit, prune-type characters.

There appeared to have been a reduction in berry size for many cultivars. A small berry can increase the concentration of anthocyanins and tannins in the wine. Excessive heat and dry conditions can reduce the accumulation of total fruit phenols. Of greater importance was the "quality or maturity" of the phenolic elements. Extended hang time helped contribute to phenolic development of all fruit components: seed, pulp, skins, cap stems, and the rachis. This certainly increased the stylistic features.

Alcohol levels. Naturally, the dry, warm conditions created high alcohols, particularly in non-irrigated vineyards. Alcohol helps form the structural/textural profile of wines, particularly red wines (see *Red Wine Mouthfeel Components* at www.vtwines.info, and various editions of *Enology Notes*). The relatively high alcohols represent an increase in body or wine volume, providing a sense of sweetness that can lower the perception of both the acid and phenol elements.

Elevated alcohol levels commonly observed in the 2007 wines can over-balance the aromatic profile, providing a hot sensation. Each wine has a certain relatively-narrow range, referred to as the sweet spot, that maximizes the overall perception of wine volatiles. Concentrations lower or, as frequently the case this season, higher can detract from the perception of overall wine volatiles and, therefore, complexity.

Higher alcohol allowed for a greater phenol load. Because of the advanced degree of maturity, phenols were easily extracted from the fruit skin and pulp. Winemakers who understood the importance of gentle cap management produced well extracted, yet integrated, red wines. Excessive extraction produced wines that are bitter as a result of hash phenol extraction compounded by high alcohol.

Wine pH. This season was characterized by higher than usual pHs. Wine pH is the result of an enzyme system that exchanges potassium ions for protons from malic acid. This activity is accelerated by heat and dry conditions. Generally, the buffering capacity of juice, must, and wine is greater, the higher the fruit potassium, as noted this season. We saw more acid required pre-fermentation to obtain a drop in pH (optimally lower than 3.85 after yeast and MLF fermentations).

High-pH wines are more susceptible to microbiological activity, especially from *Brettanomyces* and *Acetobacter* spp. It should not be assumed that elevated alcohol concentrations will prevent spoilage growth. For a discussion on controlling Brett, go to www.vtwines.info, click On-line Publications, then "*Brettanomyces* – Practical Monitoring and Management of *Brettanomyces*."

MLF. Malic acid levels are frequently lower than in hotter, drier seasons. This means that MLF will result in less of an elevation in pH. Important MLF considerations include the following.

MLF strains should be selected with the same care as yeasts. Different MLF can impact aroma/flavor, tannin perception, body and mouthfeel. Spontaneous or uninoculated MLF may not positively impact these features and can produce relatively high levels of biogenic amines.

With some varieties (notably Pinot noir, but perhaps others), it may be best to avoid MLF immediately following fermentation, to allow for phenol-anthocyanin polymerization and, therefore, color stability. Some have reported that slow MLF increases color stability, presumably as a result of phenol polymerization. (For a discussion of red wine color, see *Enology Notes* at www.vtwines.info, click Enology Notes Index.)

The speed of MLF is impacted, in part, by the timing and yeast employed. For example, MLF during alcoholic fermentation can complete in 20 days, while the same MLF strain added post-fermentation may take 60 days to complete.

MLF organisms utilize citric acid to produce acetic acid towards the end of fermentation. This can be quite excessive. Acid adjustments must not be made with citric acid. Most research suggests there is no difference in acetic acid production between simultaneous yeast and MLF, vs. post-fermentation MLF.

Diacetyl is a by-product of MLF that contributes to the perception of butter-like aromas. In excess, this character can become very dominant and disbalance the wine. Diacetyl production is a function of strain and redox potential. The excessive buttery character from diacetyl can be lowered, if needed, post MLF by yeast fining (See *Enology Notes* # 84, 85 and108).

It may be important not to rely on spontaneous MLF for several reasons, including the control of biogenic amines, diacetyl production, yeast compatibility, and color stability.

ATA. Grape nitrogen appears to be related to a sensory phenomenon known as untypical (UTA) or atypical (ATA) aging. Wines with this taint lose their varietal character early, and take on atypical aromas/flavors, which have been described as naphthalene (moth balls), dirty dish rag, and wet towel. Some ATA wines also are characterized by a metallic bitterness. In general, ATA is induced by vine stresses. ATA appears to occur more frequently in dry vineyards and in dry years. Under certain growing conditions, the grape may accumulate excessive concentrations of certain metabolites in the bound form or precursor form. These may later be hydrolyzed, or broken, releasing the free odor-active volatiles, resulting in the taint. A screening analysis for ATA can be conducted by the Enology Service Lab (see www.vtwines.info, click Service Lab).

Dominique Delteil, the prominent international consultant and former director of the ICV, provided several excellent lectures on the subject of wine longevity during a visit to Virginia. Those are posted on my website, www.vtwines.info. Click On-line Publications, then Wine Longevity.

2. Winery Planning and Design CD Available. The Winery Planning and Design CD, Edition 13, is available through *Practical Winery and Vineyard* magazine. Email them at officepwv@aol.com, or call (415) 479-5819. Edition 13 is an expanded CD that covers many topics of interest in constructing or remodeling a winery. Each subject area is reviewed in a simple-to-read outline form. Additional information is available at www.vtwines.info.

3. Issues in Winery Layout and Design Workshop, March 7, 2008. Dr. Bruce Zoecklein will coordinate a one-day workshop on Issues in Winery Layout and Design, as part of the 2008 Wineries Unlimited program, just outside of Philadelphia, Pennsylvania. Registration information is available at www.wineriesunlimited.com.

The program will cover practical topics of interest to those establishing a new winery or expanding an existing facility. Some of the most renowned winery architects and planners in the country will be on hand to present information and answer questions. If you are considering building or expanding a winery, this program is a must. The program will include the following.

- Overview of winery layout and design issues
  Bruce Zoecklein, Virginia Tech, Blacksburg, VA

- Master planning and winery design
  Gary Hall, Hall and Bartley Architecture, Santa Rosa, CA

- Sustainable winery architecture, LEED certification
  Joe Chauncey, Boxwood Architecture, Seattle, WA

- Winery energy options, solar
  Gary Sheehan, SunTechnics Energy Systems, International

- Integration of equipment and design
  Michael Shaps, Michael Shaps Consulting, VA

- Sustainable building materials
  Gary Black, Integrated Structures, Berkeley, CA

- Cut and cover caves
  Bradley Vanderwarker, ConTech, Portsmouth, VA
  Tom Bradly, B-U Corp, Charleston, SC

- Tasting room design considerations
  Kristofer Sperry, Kristofer Sperry Architects, Akron, OH

- Winery design case studies
  Howard Bursen, winery consultant, Abington, CT

4. Sustainable Winery Design Considerations (continued). The following discussion on aspects of sustainable winery design is adapted from *Winery Planning and Design*, Zoecklein (2007), a 200-plus page review, available in CD format from *Practical Winery and Vineyard* magazine. Additional details regarding the CD are available at www.vtwines.info**.**

Efficient use of raw materials, manpower and energy are modern-day business requirements. While the wine industry likes to promote a natural and "green" image, that image does not always depict reality. Sources of energy consumption in the winery (from *A Guide to Energy Efficiency Innovation in Australian Wineries*) include:

- Refrigeration: 40-60%
- Pumps, fans, drives: 10-35%
- Lighting: 8-20%
- Compressed air: 3-10%
- Packaging and bottling: 8-30%
- Other consumption: 3-15%

Mapping the whole winemaking process correctly, and integration of a water and energy use plan into the initial planning and design stages, saves energy and money. Energy efficiency depends on many factors, including the following:

- Proper sizing of equipment for winery capacity
- Building design and orientation
- Building insulation
- Type of refrigeration system
- Refrigeration line insulation
- Tank type(s) and insulation
- Water usage, water recovery efficiency, and hot water line insulation
- Type of lighting, layout, and night-lighting used
- Utilities use and sources
  - Electrical
  - Water
  - Sewage
  - Ventilation
  - Air conditioning
  - Heating
  - Refrigeration

Achieving acceptable environmental impact is an important planning goal. Sustainable winegrowing practices have been outlined by the California Sustainable Winegrowing Alliance (www.sustainablewinegrowing.org). Sustainable practices may soon become part of the "come hither" as consumer awareness and interest continues. Such "green" branding can have many facets, including organic, biodynamics, sustainable architecture, fair-trade practices, purchase and supply regionalism, etc. These so-called "ethical consumer" issues have been around for some time, but may not be well understood. Although awareness of features such as organic farming and fair trade may be high, currently this does not seem to translate into significant purchasing power. However, this certainly may change as these practices become more mainstream. An aim of the wine industry is to secure the industry's long-term sustainability and competitiveness. The benefits of efficient consumption include:

- Valuable resources conserved
- Future supplies ensured
- Greenhouse gas emissions reduced
- Overall economics
- Positive image

Past, Current, and Future Technological Trends. Creating an efficient, functional and expandable design is also a vital winery establishment goal. A key component is flexibility. A review of merely a few changes in the production philosophy and practices that have governed winemaking over a relatively short time period highlights the importance of winery design which allows for such changes.

Past, Current, and Future Technological Trends

- Interventionist winemaking; Minimalistic winemaking
- Estate production; Custom crush and alternating premises
- Regional market concerns; International market concerns
- Indiscriminate energy and water use; Integrated energy and water monitoring and use plans
- Conventional energy; Cogeneration, solar, geothermal
- Conventional buildings; Sustainable building materials and designs
- Conventional farming; Sustainable winegrowing practices, tools to improve environmental management
- General QC programs; Specific HACCP-like plans from grapes to glass
- Harvest of large varietal blocks; Harvest based on terroir features, per acre contracts vs. per ton
- Harvest based on primary metabolites; Harvest based also on secondary metabolites, IR technology, measuring grape attributes that relate to consumer wine preferences
- Sensory monitoring of juice and wine taints; Electronic nose technology
- Screw conveyors; Belt conveyors
- Hand fruit sorting; Mechanical sorting, post-destemming sorting, electronic sorting
- Relatively aerobic processing; Hyper-reduction of some varieties, oxygen monitoring
- Screw-type press; Bladder presses, membrane, tank and the new generation of basket presses
- Simple destemmers; Destemmers with variable speed and adjustable rollers
- Tall tanks; Conical-shaped tanks, seed removal/délestage tanks, controlled permeability (CP) vessels, new generation of concrete tanks
- Tank pump-over systems; Mechanical cap punch-down, gentle cap management tools,

délestage

- Fixed tanks and refrigeration lines; Mobile tanks and quick-release refrigeration lines
- Glycol chillers; Glycol chillers and heaters
- Conventional cold stabilization; Electrodialysis
- Carbon dioxide and volatile organic compounds (VOC) release into the environment; Capture and return
- Splash racking; Microoxygenation
- Conventional tanks; Controlled permeability vessels
- Conventional barrels and barrel storage; Barrel alternatives, cigar-shaped barrels, AXO-type storage methods
- Simple in-house lab analysis; Complex lab analysis, testing kits, contract lab services, analysis of wine attributes that directly relate to consumer preferences
- Paper records; Electronic recording and monitoring systems, barrel tracking, bar-coding, scanning, PDA and radio frequency identification (RFID) systems
- Chlorine-based sanitizers; Peroxide-based sanitizers, ozone, PST, UV-light systems, high power ultrasound (HPU)
- DE filtration; Cross flow-type filtration, RO (reverse osmosis)
- In-house warehousing; Specialized wine warehousing facilities
- In-house bottling lines; Mobile bottling lines
- Cork closures; Synthetic and screw-cap closures
- Generic bottle molds; Designer molds for specific producers

An understanding of new technologies and how they may impact layout, design and wine production is essential for competitive, premium wineries of the 21st century.

5. Electronic Nose Research Update. The Enology-Grape Chemistry Group at Virginia Tech has been investigating the ability of an electronic nose to measure fruit maturity and wines.

Grape maturity is a critical attribute impacting potential wine quality. As all winemakers know, maturity evaluation is difficult, due to the many interrelated factors that impact physical and chemical changes, and limitations in the understanding of those factors. Currently, grape maturity evaluation often includes measurements such as sugar content (Brix) and primary metabolites such as grape acid level, individually or in combination. These assays may be influenced by sampling method and accuracy, and sample processing variations. Additionally, specific levels of sugar and other primary grape metabolites do not always strongly correlate to potential wine quality.

Grape-derived varietal aroma, on the other hand, is a very important wine attribute correlated to wine quality. The pool of free aroma volatile components and their precursors increases rapidly in the advanced stage of fruit maturity, referred to as *engustment*. For that reason, many winemakers sensorially, but subjectively, evaluate juice aroma and taste grapes as a maturity gauge. Because of the difficulties associated with sensorial evaluation, we believe there is a need for a reliable, simple, and objective technique for evaluation of grape maturity, based on grape volatiles.

The electronic nose is a relatively new technology utilized in a variety of applications in the medical and food industries. It is, in part, a simulation of the human olfactory system, which can aid in decision-making when volatile compounds (such as emitted by maturing grapes) correlate with sample attributes, such as wine quality. Our studies over the last three vintages evaluated the capacity of a conducting polymer-based electronic nose to monitor fruit maturity by analyzing the volatiles produced by grapes in the field.

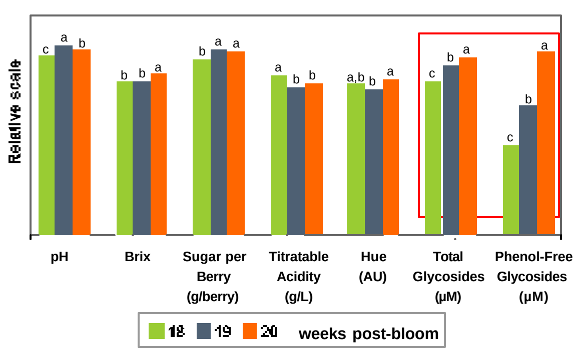
Each grape variety has a certain spectrum of aroma volatiles in the fruit. Often five to 20 aromas are sufficient to characterize a variety. In grapes, major aroma volatiles or their precursors are present in the order of 10-6000ng/kg fresh weight. This is roughly equal to eight berries in a million tons of fruit. For example, those compounds responsible for grassy aroma in white grapes are in the range of just 8 - 20ng/L. Naturally, such small quantities have significant implications with respect to measurement. The combination of aromas changes during the ripening process. In general, grassy aromas predominate early, and floral, fruity or spicy aromas evolve later in the ripening process.

Traditional electronic nose units provide no detailed information on the level of specific volatiles, but measure the whole picture. Some newer electronic noses, like the surface acoustic wave systems (zNose), act like gas chromatographs and can quantify specific volatiles. The detector reads two attributes of the volatile being analyzed, identification of the compound through a chromatogram in relation to peak retention time of a given compound, and quantification of the isolated compound by a change in frequency of the quartz crystal. We have been using several systems with different sensors and, therefore, different capabilities.

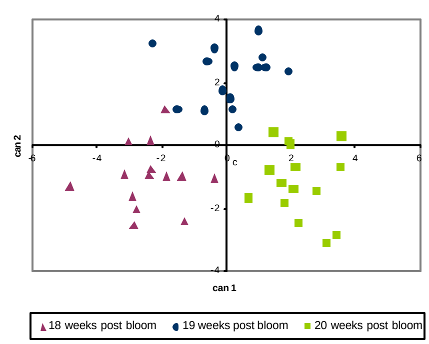
All systems are "trained" prior to use. That is, a standard smell print on record usually is a baseline and provides the recognition pattern.

In our maturity evaluations, electronic nose measurements were compared with 11 physical and chemical indices used to evaluate fruit maturity (berry weight, pH, Brix, sugar per berry, titratable acidity, total phenols, color intensity, hue, total anthocyanins, and two groups of aroma/flavor precursors).

Mean Values of Grape Maturity Indices (a=0.05) (2005)



Canonical Plot of Chemical Analyses of Fruit 18, 19, and 20 Weeks Post-bloom (2005)

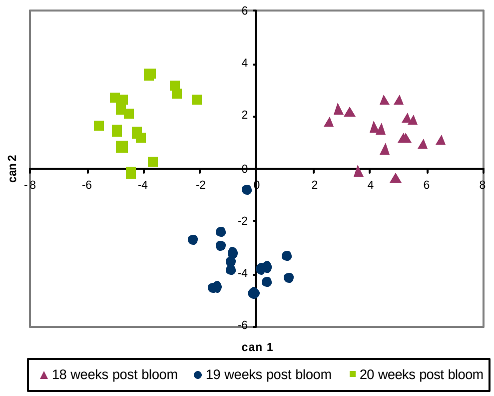


Electronic nose (enose) data on grape berries performed in our laboratory, and the enose data from intact grape clusters measured in the vineyard, produced similar separations in fruit maturity, as did the analysis of the chemical and physical indices.

We compared these indices with non-destructive electronic nose measurements of clusters on the vine during various stages of fruit maturity. With one measurement, the field enose measures favorably compared to those based on the 11 physical and chemical indices.

Samples could easily be classified according to sampling week, indicating the ability of the electronic nose to differentiate among the maturity groups. This study was conducted over several seasons with similar results.

Canonical Plot of E-nose Measurements of Fruit 18, 19, and 20 Weeks Post-bloom (2005)



In a related effort, we used an electronic nose to help differentiate fruit from different canopy locations. Fruit on different sides of the grapevine canopy may vary in maturity due to variations in sunlight exposure and heat. In this study, using north-south running vineyard rows, traditional grape maturity indices such as sugar, pH and acidity were not different in fruit from one side to the other of the grapevine canopy. However, the electronic nose was able to differentiate between samples from east vs. west canopy side, due to variations in volatile compounds produced by the fruit.

In our studies, an electronic nose was able to differentiate grape maturity based on one non-destructive measurement of grape volatiles from clusters on the vine. The success of this approach is likely due to the vast number of volatile compounds that contribute to grape varietal character, most of which are generally not considered in maturity analyses. We believe this research demonstrates the potential for this relatively new technology to be used as a rapid and objective tool for evaluating grape maturity, which may contribute to maximizing wine quality with minimum cost.

6. Enology Service Lab Closed November 16 – November 26. The Enology Service Laboratory will be closed from November 16 through November 26 for equipment maintenance. We are pleased that this lab service has been so well received. Thank you for your support!

For information regarding this laboratory service at Virginia Tech, go to my website at www.vtwines.info, and click on Enology Service Lab.

All past *Enology Notes* newsjournals 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 rakestra@vt.edu with the word ADD or REMOVE in the subject line.

Bruce Zoecklein
Professor and Head, Enology-Grape Chemistry Group
Department of Food Science and Technology (0418)
Virginia Tech, Blacksburg, Virginia, 24061
Enology-Grape Chemistry Group website: **www.vtwines.info**