



Virginia Tech

Aroma and flavor studied through electronic nose technology

By Ted Rieger, Senior Feature Editor

This is the first in a series of articles highlighting key research that is being conducted by academic and research institutions across North America and beyond.

Virginia Tech (VT), located in Blacksburg, Va., has played a major role in the growth of the Virginia wine and grape industry for the past two decades.

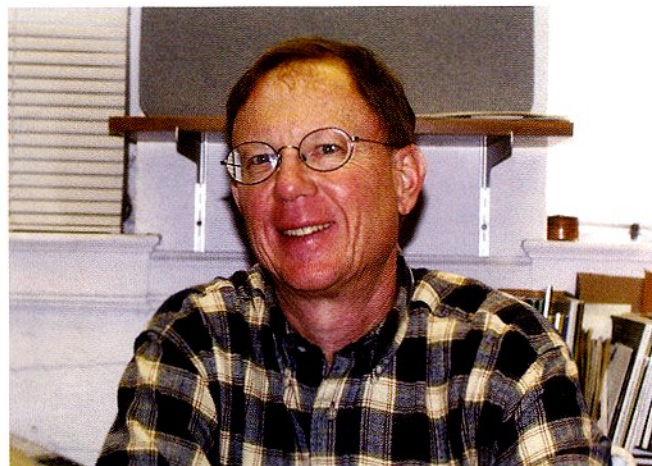
Its viticulture and enology program has four primary components: research, teaching, extension services and enology lab services. Academic coursework, research and industry services are under the umbrella of the College of Agriculture and Life Sciences, with two full-time faculty members focused on viticulture and enology.

KEY FACULTY

Bruce Zoecklein, professor of food science and technology, joined the VT faculty in 1985. He is head of the Wine/Enology-Grape Chemistry Group, and the state extension enologist. The author or co-author of numerous articles for professional journals and trade publications – including V&WM – and an active member of the American Society for Enology and Viticulture, Zoecklein is well-known industry-wide as co-author of the comprehensive text/reference book, "Wine Analysis and Production."

Tony Wolf, professor of horticulture, has been at VT since 1986. He is the state extension viticulturist and director of the Alson H. Smith Jr. Agricultural Research and Extension Center (AREC), located in Winchester, Va., Wolf has evaluated a number of grape varieties for production suitability in Virginia, including some that

are now commonly grown in the state, such as viognier, petit manseng and petit verdot. He was the principal editor and author of "Wine Grape Production Guide for Eastern North America," a new reference book published in 2009, and is co-author of the publication "Vineyard Site Selection," with John D. Boyer. Wolf also authored "The Mid-Atlantic Winegrape Growers Guide," published in 1996.



Bruce Zoecklein

Although Zoecklein and Wolf work extensively with Virginia growers and winemakers through the extension program, and viticultural studies involve cultivars and growing conditions found in Virginia, Zoecklein said, "We're not exclusively Virginia-oriented. Our focus is fairly broad-based in terms of the overall research and information we provide."

Zoecklein produces an online bimonthly newsletter, "Enology Notes," that goes to an e-mail subscription list of 3,500 people worldwide. Wolf also produces a bimonthly newsletter, "Viticulture Notes," available through subscription online at <http://pubs.ext.vt.edu/author/wolf-tony-res.html>.

AT A GLANCE

- Virginia Tech's viticulture and enology program includes research, teaching, extension and enology lab services.
- A major focus of Virginia Tech research is on grape-derived aroma and flavor.
- Recent research has evaluated electronic nose technologies for measuring volatile compounds in grapes and wine.

In addition to academic courses for students, the university provides seminars, technical study tours and online extension courses for a wider off-campus audience. Zoecklein's recent efforts have included seminars and publications for the industry on winery planning and design, sustainability and winery tasting room design and marketing.

The VT Enology Service Lab is a fee-based, full-service lab that provides chemical, physical, microbiological and sensory analyses of wines. It is designed to provide a rapid turnaround on results with precision and accuracy. Although it was established to meet the lab service needs of the Virginia and regional wine industry, services are available to wineries in any state, as well as to importers and wholesalers. Zoecklein oversees the lab, and Ken Hurley is lab director.

RESEARCH FOCUS AND RECENT PROJECTS

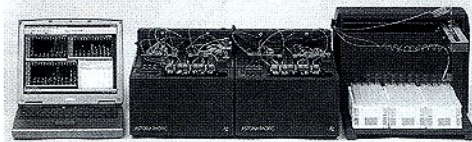
According to Zoecklein, a primary focus of VT's research program is wine aroma and flavor, or more specifically, grape-derived aroma and flavor. Based on the premise that

grape quality is the most important parameter governing wine quality, a major direction of VT's research is to evaluate the effects of vineyard management practices on grape-derived free volatiles, and bound aroma and flavor precursors, such

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as glycosidically bound grape components.

VT has a research winery to perform experiments and analyses, which include investigating the conversion of bound grape components to odor-active forms.

"Most of the research we're doing is applied," Zoecklein said.

"We try to keep things practical from an industry standpoint, with the goals of either decreasing the cost of production or increasing product quality."

As at most universities, research projects are collaborative efforts with student research assistants, sometimes with faculty from

other campus departments such as chemistry and engineering, and sometimes faculty experts at other universities, who share work and co-author published papers.

Past VT research highlights listed by Zoecklein include:

- **Closures:** A recent study conducted with natural cork, two types of synthetic corks and screwcap closures compared oxidation degradation and other wine-aging characteristics. The results were in the process of being compiled and written at press time.
- **Delestage vs. Punchdown:** Delestage (rack and return) with partial seed deportation with merlot was compared with manual cap punchdown. Delestage with partial seed deportation with cabernet sauvignon was compared with mechanical punchdown. The results showed the delestage wines had a larger percentage of polymeric pigments that contribute to color stability. They also tended to be more fruit forward, with a richer tannin structure, and less bitterness and astringency.
- **Brett:** *Brettanomyces* isolates were studied in a cooperative project with CSU Fresno (where Zoecklein was a researcher prior to joining VT). The study followed their growth in wine over two years and highlighted the wide diversity of Brett species in relation to their production of volatile compounds. This study also highlighted deficiencies of the culture plating process for analysis by showing Brett's ability to have viable but non-culturable cells.

Wolf's research focus has been grape cultivars, clones and training system evaluation. A recent project looked at optimized grape potential through root system and soil moisture manipulation, and Wolf is also conducting a study on vigor control.

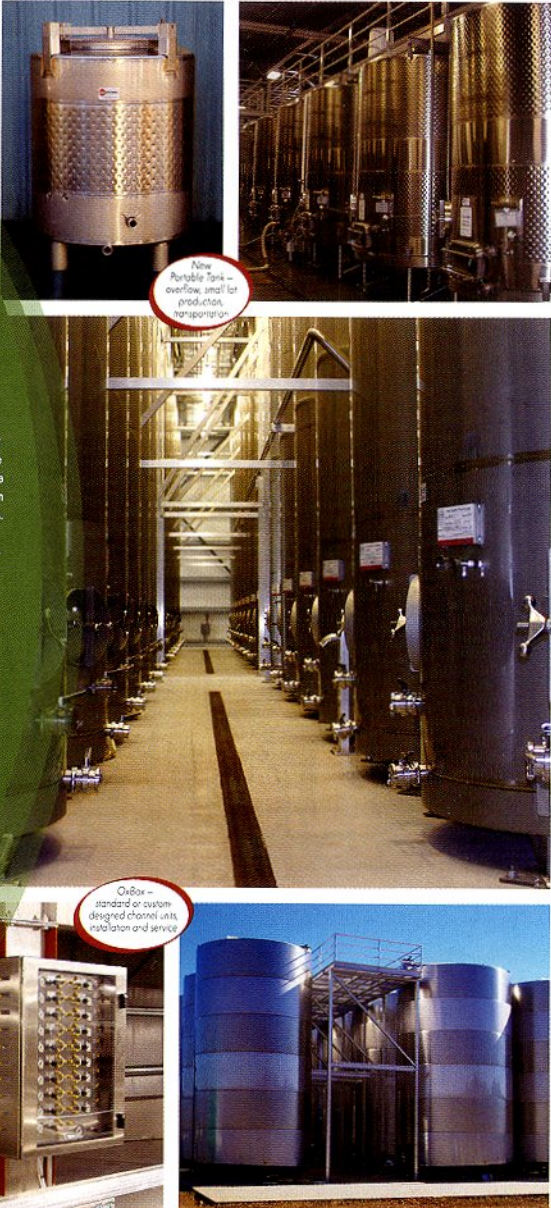
Zoecklein and Wolf have collaborated on projects to evaluate the effects on grape and wine composition of different trellis and training

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Virginia Tech horticulture professor Tony Wolf (far right) and two graduate students take measurements using a device that measures and integrates the wavelength range of sunlight effective for photosynthesis.

systems for viognier and cabernet franc, two varieties commonly produced in Virginia. They have also collaborated and co-authored papers on the effects of leaf removal, shoot thinning and crop levels on grape and wine composition.

ELECTRONIC NOSE RESEARCH

A major area of research interest at Virginia Tech, currently and for the foreseeable future, is evaluat-

ing electronic nose technology and the different tools available to monitor volatile compounds in vineyard fruit and wines.

Electronic noses are multi-sensor arrays designed to measure head-space volatiles. Each sensor type differs in its affinity for a particular chemical class or group of compounds. The adsorption of volatiles on the sensor surface causes a physical or chemical change in the sensor, allowing a specific reading for a sample in a unique "fingerprint" of the volatiles present. Enose systems operate in an analogous way to a human nose, where multiple nerve cells in the olfactory epithelium provide responses so



Major research at Virginia Tech focuses on the use of electronic nose devices.

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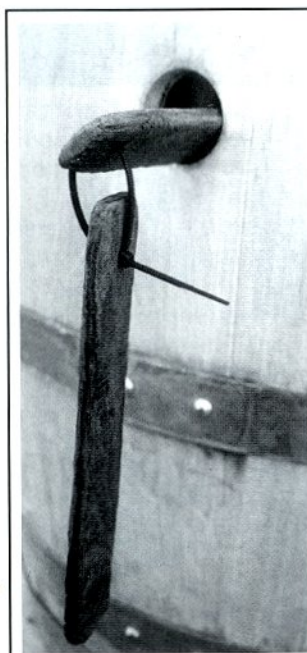

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the brain can identify and characterize aromas. Enose technology is a possible alternative to volatile measurement in some applications.

Electronic nose (Enose) technology has existed for about 35 years, but major improvements in sensor technology and informa-

tion processing have occurred in recent years. Zoecklein has worked with Kumar Mallikarjunan, associate professor of biological systems engineering at VT, to develop Enose technology to analyze grape maturity. Graduate students in the Enology-Grape Chemistry Group

that have conducted Enose studies include Denise Gardner, Yamuna Devarajan, Amanda Martin and Ahmad Athamneh.

In a recent paper written by Zoecklein summarizing VT's Enose research, he noted that a major challenge for the grape and wine industry is to replace time-consuming laboratory analyses with new tools and techniques that are fast, precise and accurate. Conventional analyses of grape and wine volatiles use gas chromatographic (GC), GC mass spectrometry (GC-MS) and GC olfactory (GCO) methods that require expensive equipment, and are time and labor intensive.

Potential advantages of Enose systems over conventional technologies are speed, cost, and they usually require limited or less sample volume. Limitations of Enose systems include: They must be optimized for the particular application; most current Enose detectors

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provide little information on specific compound concentrations, so they must be compared with reference samples provided by GC-MS or sensory evaluation; and most cannot quantify specific volatile compounds, instead providing a pattern of a mixture of volatiles that can be more important than detection of individual compounds.

Some wine industry applications and studies using Enose during the past 15 years include: monitoring oak barrel toasting levels; evaluating changes in wine aroma after bottle opening; Spanish wine identification; comparing wine varieties, and white wine classification.

Electronic noses are comprised of three technological elements: chemical sensors, electronic system controls and information-processing systems and pattern-recognition software. Zoecklein described four classes of Enose systems VT has evaluated and which differ mainly by sensor type: quartz-microbalanced sensors (QMS); conducting polymer sensors; metal oxide sensors (MOS), and sensors based on surface acoustic wave (SAW) that include zNose-type systems (a zNose is a type of electronic nose).

Recent Enose research projects at VT include several to evaluate grape volatiles based on vineyard management practices. Fruit clusters developing on vines were wrapped in polyethylene bags for 45 minutes, then analyzed non-destructively in place with an Enose using the headspace within the bags.

The following research studies have been performed to date or continue in progress:

- Effects of grapevine canopy side on fruit volatiles in cabernet franc.
- Effects of training systems on wine volatiles, with studies of vertical shoot position (VSP), Smart-Dyson and Geneva double curtain (GDC) systems with viognier and cabernet franc.
- Electronic discrimination of cabernet sauvignon wines from grapes treated with aqueous ethanol post-bloom.

Zoecklein concluded that electronic nose technology has potential as both a vineyard and a winery monitoring tool. Each type of Enose has different sensor systems that have different detection limits for particular types of components. Zoecklein said research will contin-

ue with the electronic nose in relation to VT's overall research focus on wine aroma and flavor. "We want to study the electronic nose to see if we can gain greater understanding of management practices in the vineyard and winery and their effects on wine quality," he said.

More information about VT research, publications and program updates is accessible at www.vtwines.info. ■

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 Ted Rieger, CSW, is a writer and photographer based in Sacramento, Calif., and has been a contributing editor for V&WM since 1990.


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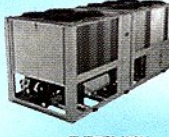
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