Research BULLETIN

WEST COAST SMOKE EXPOSURE TASK FORCE

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In November 2024, USDA's Agricultural Research Service (ARS) and the National Grape Research Alliance hosted a workshop at Oregon State University with wine industry stakeholders and the scientific community. Dr. Arran Rumbaugh, of USDA-ARS, developed a research roadmap – **Following the Smoke Signals: Elucidating the Future of U.S. Smoke Exposure Research** – that summarized workshop outcomes and highlighted critical research priorities. The West Coast Smoke Exposure Task Force is publishing a seven-part Research Bulletin series to provide summaries of the roadmap. The full document is available at wcsetf.org.



BULLETIN NO. 4

Current and Future Research Directions

RAPID DETECTION AND RISK ASSESSMENT

Rapid detection of smoke marker compounds in grapes and wine is crucial for winemakers and growers to assess exposure to smoke and mitigate the risk of undesirable flavors in the final product. Traditional methods, such as liquid chromatography and gas chromatography coupled to a mass spectrometer, are highly accurate but time-consuming and expensive, making them impractical for field-level testing.

The wine industry needs rapid screening, low-cost, portable tools that can provide immediate, actionable results on-site. Methods such as spectroscopic techniques (e.g., UV-Vis, Raman, fluorescence), handheld devices and microbial sensors are being explored. This approach recognizes the trade-off between speed and precision and would serve as an initial screening tool to identify clear positives and negatives. Such tools could help reduce laboratory congestion and lower costs for growers and wineries when extensive testing is not required.

A tiered strategy – beginning with cost-effective methods for initial risk assessment and advancing to more precise analyses for confirmation – has been proposed as an effective and scalable solution.

KNOWLEDGE GAPS IDENTIFIED

One major challenge is the lack of uniformity in analytical methods used, making comparisons difficult across studies. The detection of thiophenols, key compounds responsible for smoke taint, remains challenging, particularly with handheld devices that may not have the required sensitivity or specificity. The correlation between atmospheric sensors and chemical analysis is not fully established, and more research is needed to understand how compounds measured by sensors relate to sensory perceptions of the final wine.

There is also a need for a more complete list of compounds that impact smoke exposed grape and wine aromas. Finally, the cost of deploying rapid detection systems must be low enough to be accessible for growers, but methods must still maintain an adequate level of sensitivity and specificity.

RESEARCH AIM 1: STANDARDIZATION OF ANALYTICAL METHODOLOGIES

The development and standardization of reliable and uniform analytical methodologies are essential for accurately detecting smoke taint in vineyards and wineries. While good progress has been made in this area, effort is needed to refine primary methods such as liquid chromatography (LC) and gas chromatography (GC) to improve sensitivity and selectivity and ensure consistency across labs and analytical tools. Robust analytical protocols that correlate chemical analysis to sensory perceptions of wine need to be established.

Objectives

- Standardize primary analytical methods (LC, GC) to ensure consistency across different laboratories and instruments through a national ring test. A ring test is a quality assessment method in which blind, spiked samples are distributed to participating laboratories, and a central lab evaluates individual and inter-laboratory performance to assess methodological accuracy and consistency.
- Institute an annual, national ring test (i.e., interlaboratory study) to ensure consistency across different labs.
- Develop methods that balance sensitivity and selectivity, especially for thiophenol detection and other volatile compounds associated with smoke taint.

RESEARCH AIM 2: DEVELOPMENT OF RAPID SCREENING METHODS

The need for fast, cost-effective and user-friendly methods for detecting smoke taint at early stages is critical. Rapid screening tests must be accessible to unskilled labor, easy to deploy in the field, and inexpensive. A tiered testing approach is suggested, with an initial low-cost screening tool followed by more expensive, detailed testing for confirmation. The goal is to develop methods that offer quick results within 30-60 minutes, while maintaining enough sensitivity to provide accurate risk assessments.

Objectives

- Develop a rapid screening test (30-60 min.) for smoke taint detection that costs under $50.
- Explore various rapid detection technologies, including portable sensors, handheld spectroscopic devices and colorimetric or enzymatic assays).
- Test and refine tiered approaches, starting with low-cost, lower-sensitivity sensors that indicate high, medium or low levels of concern, followed by more precise analyses.
- Address the challenges of interpreting field-based results and providing actionable recommendations for growers based on the initial detection.

RESEARCH AIM 3: CORRELATION OF SMOKE MARKER COMPOUNDS TO SENSORY

Better understanding is needed of how smoke marker compounds detected in grape, juice and wine relate to sensory experiences in the finished product. This project will focus on linking chemical markers of smoke exposure with sensory evaluations from winemakers, aiming to refine risk assessments and improve detection strategies. This research will help provide a more comprehensive understanding of smoke taint and its impact on wine quality.

Objectives

- Identify and analyze smoke marker compounds that correlate with sensory attributes such as smoky and ashy flavors that can affect wine quality.
- Develop a list of compounds that impact the aroma of smoke and assess their detection thresholds across different wine types and varietals.
- Explore the relationship between chemical measurements (using methods like LC/GC and spectroscopic techniques) and sensory analysis of the wine.
- Conduct studies to understand how different cultivars react to smoke exposure and whether certain varieties can serve as sentinel plants for smoke detection.
- Use findings to refine thresholds for risk assessment and to develop more effective methods for quantifying smoke taint after fermentation, including during barrel aging. These research projects aim to create a more reliable, standardized and cost-effective framework for smoke taint detection, benefiting both growers and winemakers by improving the accuracy of early-stage testing, streamlining analysis and correlating chemical data with sensory results.

The full roadmap, which includes explanatory graphics, is available at wcsetf.org.



The **West Coast Smoke Exposure Task Force** is a coalition of industry leaders committed to providing timely communications, resources and best practices to help winegrape growers and vintners navigate the challenges of wildfire smoke. The task force serves as a central hub for updates, education and collaboration to support industry resilience and informed decision-making.