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New wine test detects grape off-odors in less than one minute per sample

Researchers said the rapid screening method could speed harvest decisions and complement slower standard lab confirmation techniques.

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Researchers presented two new analytical tools for winemaking on Thursday at the American Society for Enology and Viticulture's national conference, outlining faster ways to detect off-odors in grapes and to connect tannin chemistry with astringency in wine.

The session, held from 3:45 p.m. to 4:25 p.m. in Grand Ballroom 100C, focused on method development in enology. One presentation came from Cornell University and examined rapid measurement of "green" and "moldy" odorants in grapes using direct analysis in real time mass spectrometry, or DART-MS. The other, from Penn State, described a high-throughput tannin fragmentation fingerprinting approach designed to better explain differences in wine mouthfeel.

Zoe Scott, Andre Kalenak and Gavin Sacks of Cornell said reliable and rapid screening of underripe and mold-associated off-aromas is important for harvest, sorting and blending decisions. They focused on two compounds that can limit quality: trans-2-hexenol, associated with green and grassy notes, and 1-octen-3-ol, linked to mushroom aromas.

Those compounds are typically measured with headspace solid-phase microextraction-gas chromatography-mass spectrometry, or HS-SPME-GC-MS, which the researchers described as the standard confirmation method. But they said GC-MS cycle times of about 30 minutes per sample can restrict throughput during harvest intake.

To address that constraint, the Cornell team developed a workflow that combines solid-phase mesh-enhanced sorption from headspace extraction with DART-MS/MS. Because alcohols ionize poorly under DART conditions, the researchers used in-situ derivatization with hindered nitrogenous bases to improve ionization efficiency. They tested both pre-incubation derivatization inside the well and post-incubation derivatization applied as a mist.

In aqueous model systems, the team reported that trans-2-hexenol produced strong responses and that 1-octen-3-ol reached limits of detection below its sensory threshold, allowing differentiation at low concentrations. Saturated 1-hexanol was less responsive, which the researchers said was expected. Among the reagents tested, pyridine and quinoline delivered the best sensitivity, while stronger or higher-mass bases raised

chemical background and detection limits.

The group said post-incubation application of hindered nitrogenous bases before SPMESH-DART-MS/MS enabled screening for trans-2-hexenol and 1-octen-3-ol in less than one minute per sample. They described the method as a practical high-throughput complement to HS-SPME-GC-MS for wineries and service laboratories during crush and in routine quality control. If adopted at scale, that kind of speed could help producers make faster harvest decisions, reduce losses tied to off-aromas and improve consistency across lots.

The Cornell work was supported by the New York State Wine and Grape Foundation and E&J Gallo Winery.

In the second presentation, Yanxin Lin, Helene Hopfer, Duncan Calvert, Ezekiel Warren and Misha Kwasniewski of Penn State addressed a different problem: why wines that look similar by standard chemistry can still feel different in the mouth. The researchers said conventional measures such as pH, titratable acidity, ethanol and even total phenolics or tannin assays often fail to explain astringency because phenolics are highly diverse and their sensory effects depend on molecular structure and interactions with the wine matrix and saliva.

Their study related tannin fragmentation fingerprinting data to sensory evaluation of California Cabernet Sauvignon wines. The wines were intentionally chosen to be chemically narrow by traditional measures. The fingerprinting approach uses liquid chromatography-tandem mass spectrometry methods with electrospray in-source fragmentation to generate structural fingerprints for condensed tannins, hydrolysable tannins, oxidation-derived adducts and stilbenes.

The Penn State team combined those data sets with spectrophotometric assays and basic composition measurements, then compared them with a projective-mapping sensory configuration using multivariate analysis. In PLS2 models, basic chemistry had low predictive value for both sensory dimensions, especially Dim2, where Q^2 was 0.029. Spectrophotometric assays capturing bulk phenolics predicted Dim1 well, with Q^2 at 0.664, but performed poorly for Dim2, where Q^2 was -0.588.

Tannin fragmentation fingerprinting showed the strongest match with the sensory map. According to the researchers, it produced robust prediction for Dim1 with Q^2 at 0.711 and acceptable prediction for Dim2 with Q^2 at 0.368. Loading patterns suggested that oxidation-derived features and condensed tannin features dominated Dim1, while hydrolysable tannin features and stilbene-related features contributed more strongly to Dim2.

The researchers said the results show that pairing tannin fragmentation fingerprinting with projective mapping can link phenolic structure more sensitively to astringency-related mouthfeel within a chemically narrow set of wines. For producers, that could offer a more precise way to profile tannins than basic chemistry or bulk assays alone, potentially improving blending choices and sensory consistency.

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