vinetur

# Study finds infected grapes emit distinct chemical signals before spoilage becomes visible

The markers identified for Aspergillus carbonarius and Alternaria alternata could help scientists detect mycotoxin-related contamination earlier without cutting fruit open

Wednesday, November 25, 2026



A study published Tuesday, November 24 in Food Quality and Safety found that grape berries infected by two important toxin-producing fungi show different biological responses and give off different volatile compounds, a result that could help scientists build earlier and less invasive ways to detect contamination.

The research examined infections caused by Aspergillus carbonarius and Alternaria alternata, two fungi that threaten grape quality and food safety because they can produce mycotoxins. Using a comparative multi-omics approach, the researchers combined transcriptomics, metabolomics and volatile organic compound profiling to track how grape berries reacted to each pathogen and to look for chemical signals that might distinguish one infection from the other.

The study reported that the berries did not respond to both fungi in the same way. Instead, each pathogen triggered a distinct defense pattern. Researchers found differences in the expression of genes tied to defense signaling pathways and to the production of secondary metabolites, which are compounds plants make during stress or attack. Those differences suggest that grape berries can recognize the two pathogens separately and activate different protective mechanisms.

The metabolomics results also showed pathogen-specific changes inside the fruit. According to the study, each infection produced its own metabolic signature, with shifts in phenolic and antioxidant compounds. Those compounds are important because they are linked not only to plant defense, but also to grape quality. Changes in them can reflect how strongly the fruit is reacting to infection and may offer another way to identify contamination before visible spoilage becomes severe.

One of the study’s main findings was in volatile profiling. Volatile organic compounds are molecules that evaporate easily and can be detected from the air around plant tissue. The researchers identified candidate volatile markers associated with each fungal infection, raising the possibility of using those compounds as early warning signs. Because volatile monitoring does not require cutting open or destroying the fruit, the approach could eventually support non-destructive checks on grape health.

The paper says those markers could provide tools for earlier detection and management of fungal contamination in vineyards. Earlier detection matters because mycotoxin problems are often difficult to control once infection has spread or once contaminated fruit has entered the supply chain. Finding reliable signals before damage becomes obvious could help growers separate affected grapes sooner, lower contamination risks and protect more of the crop.

The work also adds to the scientific picture of how grapes interact with fungal pathogens. Multi-omics studies try to link several layers of biology at once: gene activity, chemical changes inside the tissue and the compounds released into the air. By comparing all three layers in the same infected berries, researchers were able to show that the two fungi leave different molecular footprints rather than a single general stress pattern. That could help guide future work on disease monitoring and crop protection strategies that are more targeted.

For the beverage industry, the findings could become relevant well beyond vineyard disease research. Wine, juice, spirits and other grape-based products depend on raw fruit quality, and contamination by toxin-producing fungi can lead to economic losses and safety concerns. If the volatile markers identified in the study hold up in real production settings, they could eventually support faster screening of incoming grapes and improve efforts to keep contaminated lots out of processing. The current study, however, points to that use as a future possibility rather than a demonstrated commercial tool.

The research may also feed into precision agriculture efforts, where sensors and data systems are used to monitor crops more closely and respond to problems earlier. In that context, volatile markers are of interest because they could be measured without removing large numbers of berries from the vine. A practical field system would still need to show that the same signals remain detectable under changing weather, ripeness levels and vineyard conditions.

The study focused on grape berries, including Muscat Hamburg fruit, and was designed to identify candidate markers rather than deliver a ready-to-use detection device. Even so, the findings offer a clearer map of the biological changes linked to Aspergillus carbonarius and Alternaria alternata infection. Further validation will be needed to

determine whether the proposed markers remain accurate during harvest, transport, storage and winery handling, where many other odors and chemical changes can affect measurements.