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Chinese Researchers Build a Model to Predict How Terpenes Shape Wine Aroma

The study found that terpene mixtures often amplify floral and fruity notes, offering winemakers a more precise blending framework.

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Researchers in China have developed a method to better predict how terpene compounds shape the smell of wine, a step that could help winemakers adjust floral and fruity aromas with more precision.

The study, published on July 15 in npj Science of Food, examined how 28 terpenes are perceived on their own and in mixtures across three different matrices: red wine, white wine and model wine. Terpenes are a major source of floral and fruity notes in wine, but their sensory effect can change when they are combined with one another and when they are placed in different wine environments.

The authors, from Northwest A&F University in Yangling, reported that odor thresholds for the 28 compounds ranged from 2.7 micrograms per liter to 4.0 milligrams per liter. In simple terms, that means some terpenes can be detected by smell at very low concentrations, while others require much higher levels. The thresholds followed a clear order across the three matrices: red wine had the highest thresholds, followed by white wine, then model wine. That suggests the more complex composition of real wines can make some aroma compounds harder to detect.

The researchers also found differences tied to chemical structure. Linear terpenes were more often linked to floral and fruity notes and tended to have lower odor thresholds. Cyclic terpenes, by contrast, were associated more with herbal and woody notes.

A central part of the work focused on odor interaction, or what happens when aroma compounds are smelled together rather than alone. The team tested 105 binary mixtures and found that 35% showed synergistic effects, meaning the combined aroma intensity was stronger than expected from the individual compounds. Another 50% showed enhancement effects, while 13% showed inhibition, where one compound reduced the perceived intensity of another. The paper said synergistic effects were even stronger in ternary mixtures.

To turn those observations into a predictive tool, the researchers established what they described as a unified relationship between odor intensity and the natural logarithm of odor activity value, a common measure used to compare an aroma compound’s concentration with its detection threshold. They then tested three prediction models for binary and multicomponent mixtures. According to the study, a modified vectorial model performed best in predicting odor intensity.

The findings add to a growing body of work aimed at making aroma design less dependent on trial and error. In practical terms, the research could support more precise blending decisions based on terpene concentration and interaction, especially for wines where floral or fruit-driven profiles are important. For the beverage industry more broadly, that raises the possibility of faster and more objective aroma adjustment in what producers often describe as precision enology.

The paper says the results provide theoretical support for precise aroma modulation in terpene-based wine blending. That does not mean wineries can immediately translate the model into commercial production without further validation under cellar conditions, but it offers a framework for doing so.

The study was led by Hongcong Song, Wenyan Li, Xingjie Wang, Aihua Li and Yongsheng Tao. The work was supported by the Shaanxi Provincial Science and Technology Project for Innovation Team, the National Natural Science Foundation of China and central university research funds from China's Ministry of Education. The authors declared no competing interests.

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