Microbes in pressed grapes may predict flavor metabolites in the finished wine

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The microbial mix found in grape juice during the winemaking process may help shape the terroir of a finished wine, report food scientists at the University of California, Davis. In a study published in the May/June

issue of *mBio*, an online open-access journal from the American Society of Microbiology, the researchers found that the microorganisms found in must - freshly-pressed grape juice, before fermentation - can be used as biomarkers to predict which metabolites will be found in the finished wine. Metabolites are chemical compounds that help shape the flavor and texture of a wine.

In the future, winemakers might use microbial analyses to improve their products by identifying bacteria and fungi associated with desirable metabolites, or by finding troublesome taxa before they cause spoilage or other problems during fermentation

The process of making wine begins when grapes are harvested and pressed into must. David Mills, senior author on the new study, says he and his collaborators wanted to know if the microbes in must - as well as in later stages of fermentation - could be used to describe a winery-specific microbial population.

"We were curious about the 'house microbiome,' as it were," he says.

They used high-throughput gene sequencing to identify individual microbiomes in each of nearly 700 samples of must and wine, collected in 2011 from eight stages of the fermentation process. Far Niente and Nickel & Nickel, neighboring wineries in Oakville, California, provided the samples, and Mills says was acquiring those was a Herculean undertaking for the wineries.

"Literally every production lot from the 2011 was sampled," he says. "They had to do an incredible amount of sampling to make this project possible."

Winemaker Greg Allen, who collected the samples, is a co-author on the paper and a former graduate student in Mills' lab. The study grapes

included those used for Chardonnay and Cabernet Sauvignon wines and had been harvested from vineyards throughout Napa and Sonoma counties.

The researchers measured changes in the abundances of particular bacteria and fungi taxa during the fermentation process and correlated the microbiome of the must to the metabolome of the finished wine. Their results corroborated previous studies that identified some bacterial families - including Enterobacteriaceae, Pseudomonas, Sphingomonas, and Methylobacterium - that increase during fermentation. These microbes don't have a well-known role but may still contribute to fermentation performance and wine flavor.

Nicholas Bokulich, Ph.D., a former graduate student in Mills' lab, led the study, which built on his previous work. In 2013, he and his collaborators showed that microbial populations on the surface of wine grapes vary from region to region, in patterns consistent with climate variation. Grapes grown for Cabernet Sauvignon in the Central Coast have different microbes than those grown in Sonoma or the North San Joaquin Valley, for example.

Researchers have long sought to understand the science underlying a wine's terroir - how the climate, soil, and other environmental factors influence the regional characteristics of a wine. In the last few years, many scientists have turned their attention on non-pathogenic bacteria and fungi, either in the soil or on the grapes.

"This is an area that is developing fast, and lots of other wine researchers around the world - in Australia, France, Chile - are following these kinds of leads and looking at their own microbial terroir," says Mills. "That's a good thing."

He cautions that the new study suggests - but doesn't prove - a microbial

influence on the terroir of a wine. "We don't know the relative contribution that the microbes play in the eventual flavor and sensory characteristics of the wine," he says. At the same time, it does represent a step toward that effort, by demonstrating how microbial populations can predict metabolite abundances - even before fermentation.

It's unlikely that bacteria and fungi could ever be used to completely synthesize every aspect of terroir, Mills says, since a wide variety of known and unknown environmental factors leave their fingerprint on a wine. But "maybe we can modulate flavor simply by finding the right correlated microbes."

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