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Barrel Building: New Research Shows How Individual Cooper Variability Affects Barrel Composition

WSU researcher also tracks how compounds change through toasting process

Kerana Todorov

A FEW YEARS AGO, researchers began dedicating more time to fully understanding the barrel toasting process by analyzing the effects of the various toast levels on the wood grain and how that ultimately affects the wine stored in it. The goal has been to tailor the toasting process to consistently manufacture barrels with the aroma and flavor profiles that winemakers seek.

Tom Collins, assistant professor at Washington State University, began studying barrel toasting in 2009 and 2010 while working toward his doctorate at UC Davis. He presented the results of a series of studies on barrel toasting at the 2019 National Conference of the American Society for Enology and Viticulture (ASEV) and discussed the ongoing research on the Bourbon Pursuit Podcast.



SCOTT SUMMERS

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Research Indicates Protocol Does Not Ensure Consistency

There is variability in the chemical composition of barrels due to the toasting process, Collins explained during his presentations. The research indicates there is variability in how individual coopers manage their fires, even when they follow the same protocol set by the cooperage house.

“I think it’s important for the industry to understand the extent of that variability so that we can work on ways to make our barrels more consistently,” Collins said. “Some of this is communication between wineries and coopers—just to talk about what’s possible and what’s not possible.”

In one four-day trial, his team of researchers followed the work of two coopers. They tracked fire temperatures during the toasting process by placing thermocouples on the barrel staves. One cooper worked a shift that started at 5:30 a.m. The other started later in the day. Each worked on their own barrels and managed their own fires. The two followed the same protocols.

At the end of the four days, the barrels produced showed variability in their chemical composition even though the coopers had followed the same protocol and ran the same number of fires for the same amount of time, according to the research.

Differentiating Coopers by Temperature

The researchers recorded day-to-day variations in the barrel making. “There are days when you know when things, for whatever reason, are running more smoothly, and other days when it’s a little bit different,” Collins said. “Again, this is the toasting protocol where a cooper is managing a number of fires, so it comes down, in part, to how they individually manage those fires to get a consistent look across all of those barrels.”

There were also more significant temperature variations in the barrels made by the cooper who worked the later shift, Collins said. Furthermore, Collins noted that chemical analyses of the barrels could indicate which cooper made which barrel.

“We could always tell the two apart by their temperature profiles. We could also tell them apart by the composition of the barrels that they made, even though it’s the same wood and the same toasting protocol,” said Collins.

New Research into Toasting and Barrel Composition

Along the way, Collins' research evolved into a study of the compounds created during the toasting process. He is working with a computer graphic designer on 3-D models to visualize composition changes during barrel making.

The research indicated significant differences in the formation of the structural compounds during toasting. Every compound behaves differently, Collins said. After analyzing every stave at three-inch intervals from top to bottom in an experiment that included 40 barrels, Collins and his team found that compounds such as furfural, 5-methylfurfural and guaiacol vary, depending on temperature variations and other factors.

The bottom of the barrel, which is closest to the fire pot during the toasting process, heats up more quickly than the top end, Collins explained. The different formation and degradation of oak volatiles, combined with spatial variation in applied heat, results in complex patterns in the composition of the wood.

The team created maps of compounds such as 4-methylguaiacol and guaiacol—two compounds formed from the degradation of lignin. The more heat, Collins explained, the more guaiacol and 4-methylguaiacol. The maps indicated a greater concentration of guaiacol and 4-methylguaiacol toward the end of the staves, the area closer to the fire.

Compounds that produce vanilla, clove and spicy aromas are formed during the toasting process, but not at the same rate. If there is too much heat, some of these compounds volatilize and disappear.

Furfural, a product of the degradation of cellulose and/or hemi cellulose, behaved differently during the toasting process, the research indicates. For some unclear reason, more furfural was detected on some staves than others. The variation may be due to the wood density or wood moisture content, Collins said.

"There is definitely more to come. It is still ongoing work," Collins said.

Perfection in Imperfection

Phil Burton, a sales representative for Barrel Builders in the Napa Valley, said every barrel is a little different in spite of pyrometers and "exacting toasting regimes."

"Everything from residual moisture in the wood, to variations in grain between adjacent staves, and even what mood the cooper is in, all contribute to differing nuances of flavors and aromas," Burton said. "And, of course, different coopers have slightly different toasting styles, even though the cooperage strives for consistency," he added. "For instance, the cooperage we work with, Tonnellerie Marchive, is known for a slightly citrusy note that comes out, especially in Chardonnay."

"Why this happens is a bit unclear to me, although I've been working with barrels for more than 40 years and we've seen similar tasting notes from winemakers over and over with several different coopers doing the toasting," Burton said. "Since there are so many variables in the process—both the wood in the barrel and the wood being burned are natural products—there are always slight variations. And this is a good thing, much as the flavors in the grapes are slightly different every year in spite of similar climate and management conditions." **WBM**

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