Intercontinental study sheds light on the microbial life of sourdough

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A jar of sourdough starter. Credit: Lauren Nichols

In a study of 500 sourdough starters spanning four continents, scientists have garnered new insights into the environmental factors that contribute to each sourdough starter's microbial ecosystem, and how different types of microbes influence both a sourdough's aroma and how quickly the sourdough rises. The results may surprise sourdough enthusiasts.

"We didn't just look at which microbes were growing in each starter," says Erin McKenney, co-author of the paper and an assistant professor of applied ecology at North Carolina State University. "We looked at what those microbes are doing, and how those microbes coexist with each other."

"There have been quite a few small studies on microbial ecosystems in sourdough," says Benjamin Wolfe, co-author of the study and an associate professor of biology at Tufts University. "We think this is the first large-scale study, building on all of that previous work."

For this study, the researchers collected 500 samples of sourdough starter, primarily from home bakers in the United States and Europe, though there were also samples from Australia, New Zealand and Thailand.

The researchers performed DNA sequencing on all 500 samples. Based on those findings, the researchers then selected 40 starters as being representative of the diversity they saw across the 500 submissions. Those 40 starters were then cultured and assessed in three ways.

First, the researchers worked with an expert panel of sensory professionals (think of them as super-sniffers) to assess each starter's aroma profile. Second, the researchers performed a chemical analysis of the volatile organic compounds being released by each starter. This analysis allowed the scientists to determine the structure of these aromatic compounds, as well as the relative amount of each of those compounds being released by each starter. Lastly, the researchers measured how quickly each of the forty starter doughs rose.

One of the findings that immediately struck the researchers was that geography didn't really matter (sorry, San Francisco).

"This is the first map of what the microbial diversity of sourdoughs looks like at this scale, spanning multiple continents," says Elizabeth Landis, co-lead author of the study and a Ph.D. student at Tufts. "And we found that where the baker lives was not an important factor in the microbiology of sourdough starters."

In fact, the findings challenge a lot of the conventional wisdom regarding sourdough.

"Lots of bakers felt sure that specific factors were responsible for variation between types of sourdough," McKenney says. "But what we found is that, while there could be tremendous variation between the microbial ecosystems of different sourdoughs, we could not find any single variable that was responsible for much of that variation."

"What we found instead was that lots of variables had small effects that, when added together, could make a big difference," says Angela Oliverio, co-lead author of the study and a former Ph.D. student at the University of Colorado, Boulder. "We're talking about things like how old the sourdough starter is, how often it's fed, where people store it in their homes, and so on."

The researchers were also surprised to see that 29.4% of the samples contained acetic acid bacteria (so named because they produce acetic acid).

"The sourdough research literature has focused almost exclusively on yeast and lactic acid bacteria," Wolfe says. "Even the most recent research in the field hadn't mentioned acetic acid bacteria at all. We thought they might be there to some extent, since bakers often talk about acetic acid, but we were not expecting anything like the numbers we found."

And, the researchers note, those acetic acid bacteria played a powerful role in shaping both the aroma of the sourdough and how quickly it grew. Specifically, the presence of acetic acid bacteria slowed the rise of sourdough, and gave it a vinegary smell.

Some of the findings were less surprising. For example, about 70% of the starters contained Saccharomyces cerevisiae, or baker's yeast. On the other hand, many people may be surprised that 30% of the sourdough starters didn't include the yeast most people associate with baking bread.

In fact, while the median starter contained only one type of yeast, the researchers found 70 different types of yeast across all 500 sourdough samples. So the potential variety is tremendous.

"I think it's also important to stress that this study is observational—so it can allow us to identify relationships, but doesn't necessarily prove that specific microbes are responsible for creating specific characteristics," Wolfe says. "A lot of follow-up work needs to be done to figure out, experimentally, the role that each of these microbial species and environmental variables plays in shaping sourdough characteristics."

"And while bakers will find this interesting, we think the work is also of interest to microbiologists," Landis says. "Sourdough is an excellent model system for studying the interactions between microbes that shape the overall structure of the microbiome. By studying interactions between microbes in the sourdough microbiome that lead to cooperation and competition, we can better understand the interactions that occur between microbes more generally—and in more complex ecosystems."

The paper, "The Diversity and Function of Sourdough Starter Microbiomes," appears in the open-access journal *eLife*.

More information: Elizabeth A Landis et al. The diversity and

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