Chefs and Microbiologists Break Bread Anew

Top chefs, artisanal food producers, and microbiologists join forces to explore new tastes and textures

Melanie D. G. Kaplan

In New York City, Dan Felder, head of the culinary lab at the restaurant Momofuku, is experimenting with miso soup. Instead of adding soybeans to fermented rice, he swaps out the beans for pistachios, creating a rich, creamy alternative. Across the Atlantic in Copenhagen, Lars Williams, head of research and development at the top-rated Noma restaurant, is bullish on insects. One of his latest triumphs: grasshopper garum—a terrestrial twist on a traditional fermented fish sauce, whose preparation involves pureeing grasshoppers, wood grubs, and *Aspergillus orzyae*-dusted barley, and then culturing that mix for 10 weeks.

Felder and Williams, chefs and dabblers in food microbiology for two of the most-celebrated restaurants worldwide, e-mail each other photographs of these and other examples of their novel dishes. When they have technical questions that cannot be answered in their kitchens—or by one another—they are apt to consult university-trained microbiologists. For those scientists, the queries allow them to explore a side of food and microbes beyond the traditional micobiologically oriented studies involving questions of hygiene and food safety. The chefs for whom they consult, filled with curiosity and the desire to create something new and tasty, find themselves at the forefront of a culinary movement, investigating the microbial side of the gourmet dinner plate.

Food Microbiology Breaks from Tradition

"On the food side—bacteria [were] used for tens of thousands of years, but today, with technological advances, we can ask more complicated questions," says biophysicist Amy Rowat of the University of California, Los Angeles, who developed and teaches a course on science and food. "We understand so little about the dynamics of microbial communities and how they are evolving in the food we eat. Now, some of the world's leading chefs at higher-end restaurants are using bacteria for flavors and textures."

Ben Reade, head of culinary research and development at the Nordic Food Lab in Copenhagen, Denmark, is taking his interest in microbiology a step further. Last year, he took a traditional course on the microbiology of food and beverage. He says chefs are excited about having access to new flavors. "You can't go out and buy celery vinegar," he says. "You have to go make it. Same with fish sauce from a certain fish. Or a fermented pheasant breast sauce. The more you know about fermentation, the more you can master it. It's fascinating, and cooks are recognizing that it's important."

Fermentative Microbes as Integral Ecosystems

For generations, microbiologists have worked with and helped to develop artisanal food products, but it is only in the era of celebrity chefs that microbial diversity has become a recognized area of study relevant for gourmet dishes, according to Harold McGee, author of *On Food and Cooking* and *Keys to Good Cooking*. "Chefs have be-

SUMMARY

- **Chefs from top-notch restaurants are reaching out to microbiologists, seeking advice that goes beyond traditional food safety or conventional food-processing concerns.**
- **With or without professional scientific advice, some chefs and food producers are doing their own microbiological experiments, seeking new flavors and textures.**
- **In turn, some microbiologists are helping chefs and food producers to develop a deeper understanding of the science underlying their new fermented foods, including cheeses, sauces, and pickles.**
- **Fermented foods point to a new understanding of ecological resilience and another of the deep and varied links between humans and microorganisms.**

FIGURE 1

Dan Felder, head of the culinary lab at the New York restaurant Momofuku, at work in his lab. (Photo courtesy of Gabriele Stabile.)

come a big deal culturally," he says. "At the same time, innovation and novelty have become important to those chefs. That's how they get their names out—discovering things or rediscovering things that have been forgotten." As chefs delve into fermentation, food scientists are collaborating with them in novel ways, hoping the experimentation will yield a better understanding of microbial diversity and of how best to prepare dishes with desirable flavors and textures.

McGee says that some food scientists are "just jumping on the bandwagon," and that, for them, this search for exotic new food flavors and textures is nothing more than a hobby. But for others among this set of young scientists, he says, "there is a much more fundamental interest in the complexity and how little we know about the science of every day life. For them, I don't think it's just a passing fancy. I think it's going to be the foundation of their work."

One of those young scientists is microbiologist Rachel Dutton of Harvard University in Cambridge, Mass. Dutton, who is studying microbial ecosystems found on the surface of cheeses as models for the behavior of microbes and complex communities, is considered the go-to academic scientist for high-end food producers from the culinary lab at Momofuku to cheesemakers in Vermont.

Although her collaboration with chefs constitutes a fraction of her work, she finds it rewarding to help artisanal food makers identify microbes and understand processes that are vital to the quality of their products. She says her interest in fermented foods began years ago, reflecting her love of cooking, eating, and gardening. "I'd be making beer and cheese at home, reading about science and getting really nerdy about food," she says. "Fermented foods were fun things to play around with at home. I started connecting the dots, [realizing] that these fermented foods were examples of reproducible microbial ecosystems."

For the most part a lone wolf in her collaborations with chefs and other food producers, Dutton says this realm of microbiology is a neglected area of research. "We have this opportunity to

FIGURE 2

Rachel Dutton of Harvard University (r) and postdoctoral fellows Benjamin Wolfe (back) and Julie Button (l) during a research trip to Jasper Hill Farm and Cellars in Vermont to collect rind samples from the cheeses that are aged in the caves at Jasper Hill.

look back at these microbial communities that have been cultivated for thousands of years," she says. "There's been this revolution where we can use DNA sequencing technologies to observe what's going on, so we have the power to look at any microbial system. And it hasn't been applied to these ancient fermented foods."

Curiosity about Microbial Activity Drives Chefs To Experiment

The realization that microbial activity controls much of how some foods end up tasting and feeling is driving Dutton and a number of chefs to explore the concept of using new and old microbes and processes to better understand how ingredients are transformed into tasty foods. It also helps them better understand how one might swap out different microbes to build different communities that are better suited for innovative ingredients.

Dutton's connection with the Momofuku Restaurant in New York, N.Y., began when chef-owner David Chang tried to recreate katsuobushi, a traditional fish base for Japanese soup stock, with pork. At first, he merely wanted to know if the fermented product was safe to eat. Realizing that she could not immediately answer that question, Dutton soon began teaching Chang and his staff how to care for microbes—a series of rudimentary lessons on how to grow them, what they like to eat, preferred humidity levels, and how to avoid encouraging the growth of pathogens. "They sort of ran with it, and started making misos," she says, referring to a Japanese condiment that is traditionally made by fermenting soy beans, rice, and other ingredients.

The culinary lab at Momofuku, which *Bon Appetit* calls the "most important restaurant brand of the past decade," is decidedly low-tech, which suits age-old fermentations just fine. There are refrigeration and incubation areas, temperature and humidity monitors, flasks for making vinegars, and a Pacojet, a special appliance for pureeing frozen foods or making ice cream. On her visits, Dutton teaches members of the Momofuku team, for example, about the microbial process for making koji, the starter mixture that is used for making miso and sake. They, in turn, teach her how to cook basic foods such as rice to suit their standards.

"We started looking around our kitchens," Felder says. "There's this massive list of foods that are kitchen staples, that are a result of complex fermentation, that we reach for every day, like soy sauce." Reviewing that inventory helped him to recognize the difference between using an ingredient and knowing how to make it. "As soon as we had a relatively functional understanding of the food-related microbes, we wrote out the fermented foods we wanted to make—miso, soy sauce, cheese, beer, wine, bread—all the big ubiquitous ferments across cultures."

Felder compares learning about and experimenting with traditional Asian-style fermentations to any other artisanal food pursuit—taking a trip to a winery or visiting cheesemakers, for instance. "We have the luxury of time to delve deeply and then share it with the people we work with," he says. "The more educated we are, the better the food will be."

Yet even with many newfound microbial insights, Felder says the level of his own ignorance still surprises him. "I've been cooking for so many years and have used soy sauce so many times, and I didn't know how it was made," he says. "It was

about accepting things the way they are and not questioning them. Now, through the collaboration with Rachel [Dutton], we have the freedom to start making our own iterations of miso and soy sauce from a wide range of ingredients, and that's where we've devoted a lot of our energy."

Microbiology No Mere Black Box

Thousands of years before the *New York Times* deemed fermentation as one of the top dining trends for 2013, hungry humans began manipulating microbial communities to enhance foods and beverages. Part of what interests chefs today is looking back at those traditional techniques, as well as exploring microbial communities that are specific to making foods of a certain region or season.

At Noma in Copenhagen, which some critics consider the best restaurant in the world, Felder's counterpart calls his work "a collaborative effort with the microbes. We're using processes people have traditionally used for quite a while in terms of preserving food," Williams says. "Then we're applying our aesthetic to it—and our local microbes—and making a very different product." As far as he knows, no one else is making grasshopper garum, and he is proud that it has made its way onto the daily tasting menu. "We have kilos and kilos of it bubbling away," he says. Although he consults frequently with microbiologists at the University of Copenhagen, especially on food safety issues, his inexperience and impetuosity allow him to forego their advice to try things he might not attempt if he were a scientist, he says. "When it fails terribly, that's often when I have to call a scientist and ask why."

The food-fermentation trend is not limited to high-end restaurants. Chefs and food artisans around the country are experimenting with fermentation and teaching themselves about microbiology and ancient techniques. "Microbiology had been a little bit of a black box for me," says cheesemaker Mateo Kehler, who founded Jasper Hill Farm in Greensboro, Vt., a decade ago. "Culture companies are not very forthcoming, so the opportunities to learn about what goes into cheese from a microbiological perspective is pretty opaque."

Through his work with Dutton, however, Kehler has sought to validate the idea that there is a microbial terroir, building on the French concept that local bacteria, molds, fungi, and other factors can give food (or especially wines) distinctive flavors. He also wants to understand what practices produce various food-associated microbial communities. The origins of these communities can be traced back to farming practices. "That's a very old idea," he says, "using farming as a means to create the right conditions for the microbial communities you're looking for. What I'm most excited about is the opportunity to have identified original strains, interesting cheese-making microbes that are indigenous to our chain, on our farm, in the cellars." For example, when he learned that the local strains outcompete commercial strains, he stopped buying some of the latter.

Kehler, who finds his plunge into practical microbiology exhilarating and contemplates enrolling in a formal degree program, can identify strains of yeast that are problematic and recently traced a *Pseudomonas* problem to contaminated water. Perhaps more importantly, he says that the cheese he is making is more flavorful and aromatic. "And it's a great story," he says. "You want a local food? Well, this is it."

Pickles, Another Artisan Product of Fermentations

Shawn Brock, the award-winning executive chef of Husk Restaurant in Charleston, S.C., is known for his pickling and canning skills. He is especially fond of lactobacillus bacteria-based fermentations, on which he relies to make vinegars whose quality depends in part on infusions from his grandmother's 40-year-old vinegar. Similarly, food writer and artisanal producer Lauryn Chun was inspired to replicate kimchi that is featured in her mother's California restaurant and, in 2012, as the kimchi craze began to take hold, her *Kimchi Cookbook* hit the shelves.

Kevin and Alex Farley, who run the Cultured Pickle Shop in Berkeley, Calif., began fermenting and purveying custom pickle products two decades ago, soon after they bought their first Japanese aspergillus spores from a company called GEM Cultures, based in Lakewood, Wash. Today, the couple is best known for their sauerkraut but also make many other, more exotic pickled food items, including cherry blossom kombucha, burdock root pickled in sake lees, and watermelon rind kimchi.

Recently, the Farleys began experimenting with nuka pots—a 16th-century Japanese process

that involves pickling vegetables that are cloaked with rice bran, and adding new vegetables daily to form a rich microbial bed that will pickle each addition of vegetables overnight. They recently sent a nuka pot to the Dutton lab at Harvard, asking them to use DNA sequencing to determine what microbial species are responsible for the fermentations that go on in those bran beds.

Ecological Resilience of Fermented Foods

On a houseboat that is docked near Noma in Copenhagen harbor, Ben Reade of the Nordic Food Lab keeps himself busy with experiments focused on local foods. The nonprofit, independent organization explores traditional and modern Nordic cuisine, and its other main goal is to educate chefs, academic researchers, and the public about its findings. These days, Reade is making fermented teas from herbs and flowers and using wild molds in plant juices to produce aromas.

Reade's masters thesis at the University of Gastronomic Sciences in Italy, "Flavour Exploration and Biotechnology in the New Nordic Cuisine," provides an early signal of his main interest in life. Now, he describes himself as a "glutton for the raw, rotten, and stolen," but admits to being fascinated with the broad sweep of microbiology.

"I realized there's a huge intersection between humans and microbes," Reade says. "So many strains we use today for food and drink wouldn't exist without the human interaction selecting the most successful batches. Humans who have had access to beneficial microbes have done better, and the microbes that have had access to humans have done better. There's been this nexus of collaboration between multiple species." He also understands that the more he knows about a specific type of microorganism, the more he can encourage its growth and help it defeat its enemies. "A lot of the time we don't know the species we're working with, so we don't have the scientific classification," he says.

Reade's interest in microbiology began with his study of viticulture and grape-growing as well as of sourdough starters. He once took a swath of meat in an old meat-curing cellar and added it to his starter to see how it would affect the bread dough. Being able to experiment with raw materials and create new food products allows for creative expression of the craftsman, he says. "Chefs are recognizing that things once made by outsiders—like soy sauce—they can now make themselves. That allows them to come up with new sources of deliciousness, and it's really a game-changer. If I have a sauce that no other chef has, that may express something about me or the food that wouldn't be possible otherwise."

Creating new products leads to what Reade calls "ecological resilience"—a movement away from industrial processes and toward more personally expressive foods. "Think about how we get bored with foods—even the most delicious foods," he says. "The more diversity, the more potential to be excited."

Part of what is thrilling to Reade is providing chefs with entirely new skill sets. Even if they do not understand the science behind what makes their bread flavorful, they know how to make it better and to enjoy their results. He recognizes that he and his peers are taking a very different approach from that taken by the scientists whom he calls on for expertise. "You often find biotechnologists who might not be able to make bread or brew beer because they are too focused on the metabolic processes," he says. "By being unafraid to work with things, we can concentrate on getting a feel for it and working with the strains. We have a lot of freedom. What a magnificent opportunity I have been granted here. I see no reason to be anywhere else."

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