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Story by Ching Lee • Photos by Matt Salvo

Rising to the occasion

California lab puts wheat to the test

The smell of freshly baked bread may not be what you'd expect wafting from a laboratory where flasks and beakers are more prominent than measuring cups and teaspoons.

But every year, especially during the summer, when much of the state's wheat crop has been harvested, scientists at the California Wheat Commission churn out hundreds of loaves of bread, other baked goods and batches of pasta—all in an effort to test the quality of that season's crop and the best use for the wheat.

Baking is the final test, but before that, there is much lab work that needs to be done. Because the art of baking is also an exact science, knowing the chemistry behind the flour you're working with is every bit as important as having a good recipe, explained Claudia Carter, director of the commission's milling and baking quality lab.

In other words, if that loaf of bread came out of the oven like a brick or that birthday cake didn't turn out as light and fluffy as you'd hoped, you may want to check the flour you used.

Wheat is the most common grain used in making flour, and millers formulate different types of flour for making different products, including bread, cake, pastry and pasta. Their differences come down to the wheat that was used.

"Wheat is not just wheat," said Janice Cooper, executive director of the commission. "Wheat has different classes, different varieties and then different end uses."

Flour power

Back at the commission's lab, Carter and her assistant, Teng Vang, analyze samples of wheat with scientific acumen, running them through a battery of tests that measure the wheat's characteristics, and then report on how that wheat is expected to perform.

Their reports go to clients such as Jeff Daniels, operations manager of Central Milling in Utah, which produces flour for some of the nation's major bakeries, food manufacturers and retailers, including Acme Bread Co., Amy's Kitchen, Alvarado Street Bakery, Whole Foods, Safeway and Costco.

The company buys more than 2 million bushels of grain annually, testing samples of what it buys from farmers to decide how to mix the different wheats to provide a consistent product to its customers.

"We design specific flours for specific customers based on wheat variety and wheat quality, blending anywhere from three to four to five different types of wheat together," Daniels said.

But wheat quality can vary widely depending on when and where it was grown and the crop's growing conditions, with weather being a major factor. Quality differences present a problem for professional bakers and food manufacturers who need their flour to be consistent, especially those making huge batches of dough or batter, said Craig Ponsford, an artisan baker, product developer and consultant based in Marin County.

"The chemistry of baking is complicated, so bakers really need to know what exactly is going on in their bag of flour," he said.

The science behind the decisions

Farmers grow hundreds of varieties of wheat, but those varieties tend to fall into one of six classes: hard red winter, hard red spring, soft red winter, soft white, hard white and durum. The different classes of wheat make different types of flour and can be mixed to achieve a certain quality.

Wheat differs in its hardness, color and kernel shape, but when determining flour quality and how a particular type of flour is expected to perform, what millers, bakers and other professional flour users really want to know is the wheat's protein content, Carter said.

Wheat actually has two proteins: glutenin and gliadin. When flour is mixed with water and then kneaded, it transforms the two proteins into gluten, which gives dough its elasticity and strength. The harder the wheat, the higher the protein content of the flour.

Claudia Carter, near right, director of the California Wheat Commission milling and baking quality lab, and assistant Teng Vang make bread and pasta as a final step in testing the performance of different kinds of wheat, the most common grain used in making flour, above.

One of several tools used in flour analysis, the alveograph, right, tests gluten strength and extensibility by inflating a piece of dough like a bubble. At far right, Teng Vang runs a piece of dough through a sheeter, which acts as a fancy rolling pin used during the final bread-baking test.

Hard red spring

Hard red winter

Hard white

Durum

Soft white

Soft red winter

The six classes of wheat: From top left, hard red wheats are ideal for making breads, rolls, croissants and bagels, while hard white wheat is often used for pan breads, flat breads, tortillas and Asian-style noodles. Durum is traditionally used for making pasta. Soft white and red wheat are excellent for cookies, cakes, pastries, crackers and pretzels.

For making bread, bakers generally like to use bread flour, which is made from hard wheats with high protein. But the hardest of all wheats—durum—makes semolina, a coarse flour resembling cornmeal used primarily for pasta, egg noodles and couscous. Soft wheats, which are low in protein, are better for cookies, crackers, cakes and pastries. Cake flour is made from soft wheat.

All-purpose flour tries to achieve a happy medium by blending hard and soft wheats so that it can be used for a wide range of baking. While it is a staple of many home kitchens, this most common flour is probably not the flour of choice for professional bakers looking to achieve very specific results, Carter said.

"For muffins or banana bread, all-purpose flour is probably OK," she said. "But if you're making a chiffon cake or angel food cake, then I'd go with cake flour, because it would make your cake much better quality—and better looking, too."

Cake flour, Vang further explained, absorbs very little water, and when mixed with ingredients such as butter, sugar and eggs, it remains light and fluffy to achieve a soft and smooth batter, whereas flour made with a harder wheat would toughen up, which is desired when making bread.

25 years and counting

While Carter and Vang are more inclined to sport white lab coats than aprons, they are by no means rookies in the kitchen. Carter has a bachelor's degree in food science and a master's in cereal science. She likes to bake pastries, cakes and cookies at home, but at the lab, her specialty is pasta. Vang is an experienced baker, having been trained at the San Francisco Baking Institute, where he learned artisan bread making.

Built in 1990, the commission lab provides the tools needed to test the quality of California wheat, to improve its marketability, Cooper said, adding that the state's farmers grew about 500,000 tons of wheat last year. Before the lab was created, she said much of the state's wheat was sold for livestock feed, which does not earn as high a value for the farmer.

The lab also works closely with plant breeders at the University of California, Davis, who are developing new wheat varieties that help growers, such as with disease resistance, Carter said. The lab tests these new varieties to ensure they would work well for the end user: the miller, baker or pasta maker.

"It ends up affecting what consumers will have on their plate," Carter added.

Ching Lee
clee@californiabountiful.com

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What's the difference between whole grain and whole wheat? The experts answer at www.californiabountiful.com.

Baking Q&A

Because baking is such a precise science, knowing some of the chemistry behind the ingredients and their interactions is half the battle. As a scientist and baker, Teng Vang helps to break down some of the mystery.

Why did the loaf of bread turn out like a brick? Vang said it could be a variety of factors: not enough yeast, not enough flour or using the wrong flour. Understanding the function and effect of sugar and shortening on bread is also important. Adding both will make the loaf and crust softer. Asian bread, for example, is very soft; it has 20 percent sugar. Hawaiian bread is very soft and sweet because it has more sugar. If a crusty bread is desired, forgo the sugar and shortening and just add water, he said.

Why does the dough need to rise and then be punched down? This process is important for flavor and making bread fluffy. "It degasses the dough so you don't have those big bubbles, so it's even. It helps distribute the dough," Vang said. Punching the dough strengthens it and makes it more elastic. This fermentation process helps to produce more flavor, which comes from the flour itself. Shorter fermentation time results in less flavor. In artisan bread making, fermentation can take hours to achieve a more complex flavor, he noted.

What's the trick to working with whole wheat flour? Because whole wheat has more fiber, it absorbs more water, so when making bread using whole wheat flour, you should add 25 percent more water. "If your dough is sticky, it's OK," Vang said. "Over time, your whole wheat flour will start to absorb more water. Don't be afraid that it's too wet or too sticky. Let it sit two, three hours for fermentation and your dough will be OK."