Baking Sure New Wheats Measure Up

SCOTT BAUER (K7219-2)

Wheat breeders, farmers, millers, and bakers have special problems in meeting the challenges associated with delivering our daily bread to our dinner tables.

Millers and processors demand varieties developed for specific end uses. Information needed for every stage of production is available from four ARS wheat quality laboratories located in Manhattan, Kansas; Wooster, Ohio; Fargo, North Dakota; and Pullman, Washington. These laboratories were established to help breeders improve the quality of wheat varieties grown in their respective regions. The labs were charged with determining what factors are important to wheat quality and developing reliable tests for measuring these factors.

Before a new wheat seed is ever made available to growers, the researchers at these quality labs have thoroughly analyzed the milling and baking quality of thousands of experimental breeding lines from federal, state, and private breeders.

For Bread and Buns—Hard Winter Wheat

Each year, at the Hard Winter Wheat Quality Laboratory in Manhattan, Kansas, researchers evaluate about 5,000 hard winter wheat samples from 3 federal regional breeding nurseries and 18 state and private breeders. Hard winter wheat is used to make white pan bread and hot dog and hamburger buns.

To obtain accurate information, the Manhattan researchers have adapted two powerful analytical tools: near-infrared reflectance and single-kernel wheat characterization.

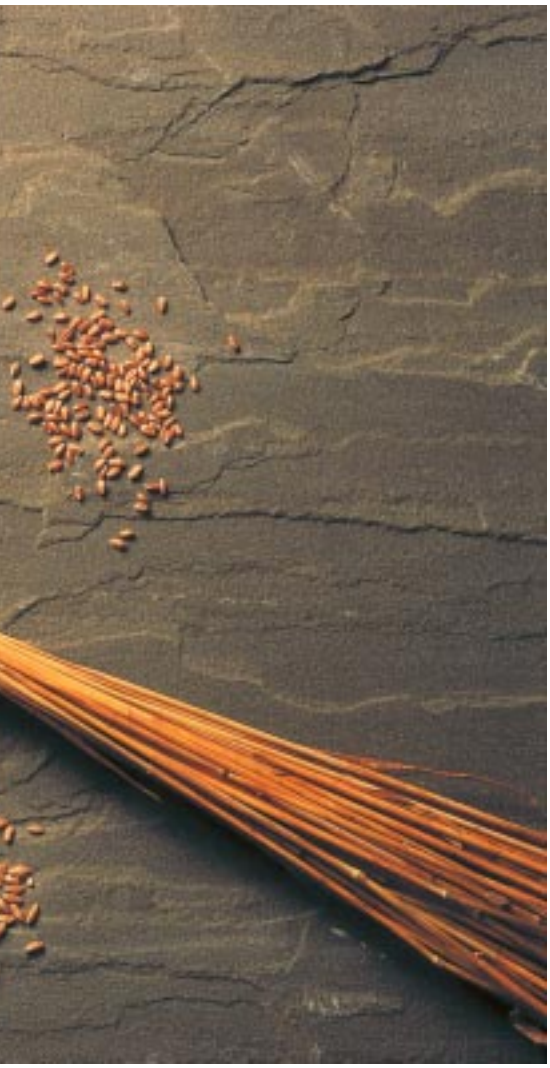
The data on protein, moisture, and ash from these predictive measurements and from biochemical analyses help ARS food technologist Bradford W. Seabourn and chemist Okkyung Kim Chung develop end-use quality prediction equations. The analyses show the relative quantity and composition of proteins, lipids, enzymes, and starches in many wheat lines so that scientists can see how these differ and how the differences between varieties are related to the differences in end-use quality.

In 1998, Seabourn, Chung, and South Dakota State University researchers developed a relational database now available to breeders through the World Wide Web. Instead of poring through a thick publication, breeders can opt for a user-friendly computer file to zero-in on a wheat line's major deficiencies and rank each line based on its milling and baking qualities.

Because protein plays a major role in the quality of bread each wheat variety produces, ARS chemist George L. Lookhart has adapted capillary electrophoresis to quickly identify protein patterns as genetic fingerprints. These can be used to distinguish between varieties and to predict end-use quality.

Lookhart also developed a fast method for measuring the amount of insoluble polymeric protein. The more there is in a wheat, the better the dough-mixing properties of its flour.

One important accomplishment has been the adaptation of methods using small quantities of flour for a mixograph analysis of dough strength. These methods, which have reduced the flour needed



from 35 grams to 5, permit earlier evaluation of potential varieties.

"Occasionally, breeders can't supply enough flour from their experimental wheat lines to perform adequate baking tests. To overcome this problem, we designed thimble-sized baking pans that hold tiny loaves made from only 2 grams of flour," says ARS baker Margo S. Caley in Manhattan.

"Our location in the Great Plains is important to our customers—the growers and breeders of hard winter wheat," says Chung, who leads the Grain Quality and Structure Research Unit and directs the Hard Winter Wheat Quality Laboratory at Manhattan.

"We know firsthand the environmental factors influencing this class of wheat. The same varieties grown in different environments may vary greatly. About 60 percent of the variations in wheat quality are caused by environmental influences."

For Cakes and Cookies—Soft Red Winter Wheat

Future generations will likely benefit from wheat flour improvements made today by researchers at the Soft Wheat Quality Laboratory in Wooster, Ohio.

"We're working on the wheat flour that will be used in your wedding cakes," says ARS food technologist Charles S. Gaines to young people touring the laboratory.

He says that because it takes 8 to 14 years to breed a new commercial wheat variety, and it'll be about that long before these students will begin to marry. Since 1992, Wooster scientists have been coordinating a worldwide consortium for mapping the genome of soft red winter wheat varieties, which are used to make cookies, cakes, pastries, and crackers.

ARS food scientist Patrick L. Finney says that today's mapping technology is allowing wheat scientists at the Wooster lab to tie all their knowledge about the functional properties of soft red winter wheat to individual genes.

"We're focused on the practical side—milling and baking—but we're still dealing in genetic engineering, physics, chemistry, biology, and food technology," says Finney, who directs the Wooster lab.

The number of new wheat variety releases has risen sharply since the 1930s, or even the 1970s. For the past decade, Wooster researchers have evaluated more than 8,000 wheat samples a year submitted by about 20 public and a dozen private breeding organizations.

Researchers are devising tests for more realistic assessments of wheat condition than the current method of weighing test batches. Gaines found a way recently to separate shriveled kernels from rain-puffed ones. Both lower a grain's test weight and market value. But unlike shriveled kernels, rain-puffed ones have all the flour that millers expect and are softer than nonpuffed kernels.

When breeders are really serious about a variety and close to releasing it, scientists do the final quality test: They use the flour to bake cookies. The larger and softer the cookie, the better the wheat.

For Asian Noodles and Flatbreads—Soft White Western Wheat

The ARS Western Wheat Quality Laboratory in Pullman, Washington, helps bring tasty Asian and Middle Eastern dishes to the table. Flatbreads, noodles, and Japanese sponge cakes, as well as some traditional American cookies and cakes, are made with soft white wheat grown in the Pacific Northwest.

"Farmers in this region grow all market classes of wheat except soft red winter," says ARS cereal chemist Craig F. Morris, director of the Pullman lab. But soft white wheat is predominant. Most of it is exported to Pakistan and Pacific Rim countries to make dozens of types of flatbreads and noodles.

Each year, the lab evaluates up to 7,000 genetically unique samples ranging from a few tablespoons to 2 bushels each. As at the other wheat quality labs, Pullman researchers tell how each line or variety performs in milling and baking trials so breeders can make the best choices.

"Out of 2,000 samples, only 1 or 2 may eventually become commercial varieties," says Morris.

The Pullman lab is also leading one of the biggest research efforts in North America on waxy wheat through a cooperative research and development agreement with a major food company. Waxy wheat contains a natural mutation that prevents the kernels from making a starch called amylose that is present in other wheats.

"Starch from waxy wheat absorbs much more water than normal wheat starch, stays gooey after heating and cooling, and doesn't lose water when frozen and thawed," says Morris.

What are these traits good for? "That's what we hope to find out," he says. "It's almost like going to the Amazon jungle and bringing back a new plant species. We've never had this kind of wheat before."

ARS provides the wheat and quality testing, while company researchers look for ways to use the wheat. Japanese udon noodles already use wheat with a related mutation, called partially waxy.

For Pizza, Pasta—Hard Red Spring and Durum Wheat Classes

At the ARS Wheat Quality Laboratory at Fargo, North Dakota, researchers evaluate up to 2,000 hard red spring wheat breeding lines for milling and baking quality and up to 1,000 durum wheat breeding lines for milling and pasta quality. Durum wheat is used primarily for pasta and noodles. Hard red spring wheat is noted for its high gluten content, which accounts for good loaf volume.

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Food technologist Gary Hareland and physical science technician Dehdra Puhr evaluate the quality of test bread loaves made with a blend of durum and spring wheats .

Food technologist Gary A. Hareland, director of the Fargo lab, explains, "Gluten imparts flexibility and strength to dough as it rises and helps maintain structure during baking."

About half of the hard red spring wheat grown in the United States is exported. Much of the rest is blended with winter wheat flour to improve the quality of white pan bread. The flour is also used in non-pan breads such as bagels, pizza crust, and hard rolls.

Durum wheat breeding lines used to make pasta are also rated for firmness and weight of cooked spaghetti. The scientists are studying ways to measure spaghetti stickiness, which is unacceptable to consumers.

Durum prices vary more from year to year than prices of other wheats. "To help even out the price swings," says Hareland, "we're trying to find another niche for durum besides pasta."

Traditionally, 65 percent of a durum kernel is milled into semolina, a granular material that is mixed with water and

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The quality of pasta made from semolina—the purified middlings of milled durum wheat—is an important consideration in breeding new varieties. To evaluate the semolina, physical science technician Jadene Wear extrudes spaghetti, which will be dried and test-cooked.

A National Wheat Quality Assurance System

In response to demands from wheat growers and processors for improved varieties suitable for their geographic regions, the U.S. Congress established four ARS wheat quality laboratories.

1936—To correct poor milling and baking qualities of commercial soft red winter wheat varieties, the Soft Wheat Quality Laboratory was established at Wooster, Ohio.

1937—To answer the requests of Great Plains wheat growers seeking improvements in hard winter wheats, the Hard Winter Wheat Quality Laboratory was established in Manhattan, Kansas. Whereas there were only three varieties in the 1930s, today there are hundreds. This lab helped standardize quality analysis for these wheats.

1946—To analyze and evaluate the quality of wheat (mostly soft white) grown in the Pacific Northwest, the Western Wheat Quality Laboratory was established in Pullman, Washington.

1963—To put researchers closer to growers of hard red spring and durum wheat classes, the Hard Red Spring and Durum Wheat Quality Laboratory was relocated from Washington, D.C., to Fargo, North Dakota.

extruded into pasta. Another 10 to 12 percent of the kernel is milled into flour for noodles or, if the quality is low, into livestock feed. Durum's use in noodles may decline with the advent of new white winter and spring wheats.

Coming to the rescue are durum breeding lines for dual-purpose bread and pasta wheat. The feat involves transferring certain glutenin protein genes from bread wheat to durum wheat.

But even conventional durum flour could find its way into more bread.

Hareland and colleagues have discovered a way to make a good loaf with up to 60 percent durum. Durum flour makes a more flavorful bread with a slightly nutty taste. Until now, baking qualities of such breads have been poor unless the flour mix included no more than 25 percent durum.—By **Linda McGraw, Don Comis, Kathryn Barry Stelljes,** and **Ben Hardin,** ARS.

SCOTT BAUER (K8424-1)

To better understand milling performance, ARS food technologist Gary Hareland (right) and North Dakota State University food technician Merle Skunberg evaluate the quality of semolina from a cultivar of durum that was milled in the pilot mill.

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Food technologists Charles Gaines (left) and Ron Martin watch as a stream of air in the large tube separates light, shriveled kernels of soft red winter wheat from fully filled out, higher density kernels. The amount of flour produced from the heavier kernels will represent the full genetic flour yield potential of the wheat.

This research is part of New Uses, Quality, and Marketability of Plant Products, an ARS National Program described on the World Wide Web at http://www.nps.ars.usda.gov/programs/cppvs.htm.

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