SUCCESS STORY

Better bread: How researchers are using genomics to predict bread quality and accelerate wheat variety development

With funding from the U.S. Agency for International Development Feed the Future Initiative, a team of breeders and geneticists at K-State and the International Maize and Wheat Improvement Center (CIMMYT), are using DNA markers to predict important quality traits for bread wheat, such as dough strength and loaf volume.

Historically, the main focus of wheat breeding has been grain yield and the selection of lines with the best performance and disease resistance. Quality traits are usually evaluated at the very end of the selection cycle due to high cost and the large quantity of grain needed for testing. The typical wheat breeding cycle takes eight to 10 years – a lengthy amount of time to wait before being able to test the quality of bread.

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Dr. Jesse Poland

The team used wheat quality data generated in the test baking lab and built algorithms using DNA marker information for predicting quality traits in new generations of candidate wheat varieties. Using the prediction algorithm, they were able to advance wheat quality screening by at least a year and predict over 10 times more candidate varieties than can be tested in the quality lab.

"Wheat quality testing starts with analyzing grain morphology, hardness and protein content," said Carlos Guzman Garcia, head of the Wheat Chemistry and Quality Laboratory at CIMMYT. "The testing continues milling with wheat kernels into flour then determining protein content and how much water is optimal for dough-making in different rheological tests. Then the flour is mixed with water in a mixograph."

The curve can then be investigated to determine the strength of the dough from one candidate variety to another. For example, Kansas hard red winter wheat needs to have a stronger dough as it mostly goes to industrial bakers and needs to be able to withstand industrial processing.

Dough strength, amount of mixing time and extensibility are all measured and bread is baked as a final test of performance. From all this data, decisions can be made on whether the wheat line is good enough to keep — but this question cannot be addressed until six to eight years into the breeding cycle.

"Using DNA from single plants, we can use these new prediction models to get an assessment of the quality much earlier in the breeding cycle," said Poland, the study's senior author. "This is long before we have enough seed for quality testing."

Making these adjustments could increase the selection efficiency for quality two or three times above what is currently possible. The results also show that wheat breeding programs can use genomic selection for wheat quality, along with their traditional breeding pipeline, to more effectively and efficiently use resources through out the whole breeding program.

Poland said this prediction method allows the elimination of many lines early in the breeding process, which will not be able to pass the final test of wheat quality. Accurate processing and end-use quality prediction models, such as genomic selection, will allow breeding programs to cull unacceptable lines or target specific lines before time and resources are invested in lines that will not pass the final test.

Battenfield, S. D., C. Guzmán, R. C. Gaynor, R. P. Singh, R. J. Peña, S. Dreisigacker, A.K. Fritz and J. Poland (2016). Genomic selection for processing and end-use quality traits in the CIMMYT spring bread wheat breeding program. *The Plant Genome*. DOI: 10.3835/plantgenome2016.01.0005