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Researcher's Picture

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300-word grant summary:

The "Oregon Wheat Quality Evaluation Program" has a series of objectives designed to address the wheat quality needs of Oregon. The ongoing objective is to provide preferred wheat variety lists. The longer term objectives are to develop improved quality-screening tests for the wheat breeding program, to enhance the quality profiling of Oregon wheats, and to explore the reasons why individual varieties can show quality differences across environments. The program employs an integrated approach to wheat quality that is centered on a core of simple, but indispensable, quality tests. These are performed by the USDA ARS Western Wheat Quality Laboratory, which acts as a central reference laboratory. The program has been deliberately structured this way so that central results are compatible across the region. This is critical as these essential data are used to calculate the quality ratings for the preferred lists. The OSU quality labs also use the centrally generated data as a stable frame of reference against which to assess the performance of new and innovative quality tests, and to underpin a wider spectrum of biochemical and end-use tests that are being trialed to extend the quality profile of Oregon wheats. One important longer-term aspect is the observance of changes in the quantitative expression of gluten proteins across environments. It is anticipated that this will allow us to target gluten proteins that are more stable in synthesis levels. If uncovered, these proteins could be targeted in the breeding program in an attempt to narrow the range of dough strength exhibited by a single variety when grown in a number of locations. Grain for the program comes from the OSU breeding program's multilocation elite yield trials, which are located across the major agro-climatic regions of Oregon.

-This months article is about selecting for wheat quality, and it relationship to preferred variety lists.

Selecting for Quality.

Comprehensive wheat quality determinations can be complex undertakings. The complexity arises from two key elements. Wheat has a complex chemical composition, and it has a large variety of end-uses. Nonetheless, despite its complexity, intrinsic wheat quality can perhaps be reduced to six primary factors:

- protein content
- kernel texture
- milling characteristics (flour yield and ash)
- gluten strength
- starch composition
- enzymatic activity

Of these factors, grain protein content and alpha-amylase activity[1] are the most influenced by environment. The other factors are more genetically predetermined, but this is not to say that the environment cannot have profound effects. Of the six factors, protein content generally has more impact on overall processing characteristics than any other single factor, although under certain circumstances, this perception can be misleading. One example of this is Udon noodles, where starch composition has an equal impact.

Various combinations of these six factors have the potential to predict the suitability of wheat for particular end-uses. For example, protein content, gluten strength, grain hardness, and enzyme activity, in that order, are all important in determining breadmaking quality. However, for Udon noodles, the factors, and their order, change. Here quality is determined mostly by starch composition, protein content, enzyme levels, and milling quality. Other differences are also apparent. The enzymes most critical in noodlemaking are generally different enzymes than those that are important in breadmaking. The list changes again for cookies, where the predictive factors are grain softness, protein content, and low pentosan content. So, we can see, in predicting end-use suitability, various combinations of the six factors appear, and the importance placed on each factor, changes depending on market class and end-use.

The breeding program usually has enough grain to test for quality at around the 4th generation (F4). At this juncture, the quality program applies an approach that uses three of the six critical factors, The three factors we target could all be called inflexible quality traits. One example is softness. Although it seems blindingly obvious, if it is hard, it is not going to be acceptable in the soft white class. As a result, we mercilessly discard those lines that don't make the cut, unless they provide a specific source of adaptation not found elsewhere in the program. For soft wheats, after eliminating the lines that are too hard, the remainder are assessed for

[1] alpha-amylase breaks down starch

enzyme activity, specifically polyphenoloxidase (PPO). PPO makes noodles, and some refrigerated doughs, darken undesirably. Lines high in PPO are again eliminated. Then, the remaining lines are screened for gluten strength, if time permits, and we have a clear idea of the target. Gluten strength could be predicted using either a traditional test, called SDS sedimentation volume, or one of a number of potentially more effective tests being trialed as part of this OWC funded research project. For early generation hard whites, the tests are the same, but the order of testing and elimination is different. This change of order reflects a different spectrum of end-uses. As hard whites are specifically targeted at the noodle market, then low PPO activity is the most inflexible trait, and is therefore selected for first. High PPO lines are eliminated, and the remainder tested for grain hardness, and then gluten strength.

Our mid- to late-generation testing uses a core of straightforward quality tests performed by the PNW's central reference laboratory for wheat quality, the USDA ARS Western Wheat Quality Laboratory in Pullman WA. The results of this testing are used to decide which lines are retained from season to season. We make these decisions by comparing the performance of the new lines to agreed check varieties. The heaviest selection pressure is placed on those quality factors that we agree are most important. Using the example of soft wheats, we select in this order; large cookie diameter, low single kernel hardness, good milling performance, appropriate dough strength, and high test-weight. We observe starch characteristics to watch for partial waxy lines, and we monitor wheat and flour protein contents. Here we see again the repetition of all or some of the six critical factors. Even test weight and cookie diameter are indeed related to them, even though don't appear specifically in the six critical factors. Cookie diameter acts as an overall index of soft wheat quality, and test-weight is a loosely associated measure of milling potential. Unlike the primacy of protein content in commercial buying decisions, protein content is not weighted heavily as a selection factor in breeding, as it is primarily environmentally determined.

The decision making process applied in selection for quality throughout the breeding program can be seen reflected in the weightings used to calculate the scores that form the basis of the preferred variety lists. End-use quality is 50% of the score. Cookie diameter alone makes up a further 40%, as does milling quality. Wheat protein makes up only 8% of the score, reflecting the fact that it is largely controlled by the environment. These scores are computed in comparison to the same check varieties used in breeding. So, from two perspectives, check varieties, and relative importance of specific quality traits, there is a logical continuity between the decision making process applied for quality improvement in the OSU breeding program, and the weightings used to define quality for the preferred lists.

The lists, the calculations, and the weightings are reviewed annually. The weightings and quality classifications need to be stable over the short- to medium-terms to provide a clear signal to the industry regarding what varieties are of preferred quality. But, the weightings and lists also need to be responsive over the long-haul to changes in the demands of the market, as these are communicated to us through credible market intelligence sources. Indeed, over the long-term the

preferred lists, the weightings, and the test protocols themselves need to be also responsive to the planned-for overall improvement in quality, and with it, the eventual, and inevitable need to “raise the bar”, by applying new and better check varieties.