Baking quality of genetically diverse wheat populations

Over the last few decades evidence has been accumulating that increasing genetic diversity in the crop offers several advantages over the use of monocultures. Extremely high genetic diversity is created in ORC's composite cross populations of winter wheat, where several varieties are crossed with each other and the entire offspring is used in the seed mix. This diversity has agronomic benefits, but is there a trade-off in the shape of reduced baking quality? ***Thomas Döring*** *and* ***Helen Pearce*** *review the results.*

The agronomic benefits of in-crop diversity are becoming well known: for example, the advantages of variety mixtures over monocultures are reported to include lower plant disease levels (Finckh and Wolfe 2006), increased buffering capacity (e.g. against unexpected weather) and improved efficiency of resource use (e.g. regarding water and nutrients in the soil).

In ORC's ongoing research programme, we have been investigating the agronomic and quality parameters of winter wheat where extremely high genetic diversity is created in composite cross populations or CCPs (Döring et al. 2011). One question is how higher diversity affects specific parameters of baking quality.

To evaluate this, we compared test results from two populations. One, called QCCP, was created by crossing 12 parents with high baking quality. The other, a very diverse population called YQCCP, was derived from 20 parent varieties, including high yielding varieties and those used to create QCCP.

Based on the genetic background of the two populations, we would expect that genes responsible for high baking quality would be diluted in the more diverse YQCCP compared with the QCCP. Our hypothesis was therefore that baking quality would be lower in the YQCCP than in the QCCP. To test this, we measured baking quality in the two populations.

We determined grain protein content, the Hagberg falling number (HFN) and the height of test loaves baked from grain samples of the two populations. In additional assessments, the baking volume of the loaves was determined in a subsample. Height and volume were well correlated.

Grain samples of the two populations were obtained from several organic and non-organic farms across England. Tests were replicated over three years. The grain samples were milled to flour and baked at one of two bakeries, each with their own milling and baking method. One was a roller mill using the standard Chorleywood process; while the other bakery stone ground the wheat and used a traditional sourdough baking method.

The YQCCP showed a significantly ($p<0.05$) lower protein content (13.0%) than the QCCP (13.2%). However, site and year effects were much more pronounced than the differences between the two populations. Also, HFN (average 192 seconds) and loaf height were not significantly different between the two populations.

These results indicate that the increased diversity and yield potential of the YQCCP was not traded off with a loss in baking quality and are further encouragement for the use of high genetic diversity in cropping.

Andrew Whitley with loaves of bread in the baking trial

The study also shows that protein as a single factor was not well correlated with loaf height. Although there is not sufficient data to challenge the assumption that protein content is well linked with baking quality, our results lead us to question the universal validity of this parameter as a quality predictor.

More broadly, it needs to be asked if the way in which baking quality is assessed is appropriate; i.e. should greater emphasis be placed on factors such as nutritional quality rather than loaf height? And, particularly for the organic sector, is the Chorleywood process the best method to use for test bakes of organic flour, or should a more artisanal approach be used?

Acknowledgements and references

We thank Andrew Whitley (Bread Matters) and Kelvin Ellam (W & H Marriage & Sons Ltd) for conducting the baking tests. We are grateful for research grants from Defra through the Sustainable Arable LINK programme (LK0999).

Döring TF, Knapp S, Kovacs G, Wolfe MS, Murphy K. 2011. Evolutionary plant breeding in cereals– into a new era. Sustainability 3: 1944-1971.

Finckh, M.R., and M.S.Wolfe. 2006. Diversification strategies. In: Cooke, B.M., D.G. Jones, and B. Kaye (eds.), The Epidemiology of Plant Diseases, 2nd ed. pp. 269–307. Berlin: Springer.