A New Approach to the Pearling Test for Grain Hardness

R. Rodney
Chevalier College
Bowral, NSW, Australia

S. Uthayakumaran
I. L. Batey
C. W. Wrigley
Wheat CRC and Food Science Australia
Sydney, NSW, Australia

Grain hardness has been described as "the most important aspect of wheat utilization" (5). Indeed, grain hardness determines grade classification for international trade and process methods in milling and food manufacture. Hard wheats produce a degree of damaged starch, needed for most baking processes, whereas low starch damage is required for cookies, grocery flour, wafers, and some noodles and steamed buns. A century ago, the wheat breeder was required to have a good set of teeth with which to test hardness by biting the grain (1). However, the need for an objective means of hardness testing was soon realized and two methods were developed for this requirement, namely, tests for particle-size index (PSI) (3; also adopted as AACC International Method 55-30) and for pearling resistance (PR) (4).

The PSI test determines the extent to which the endosperm falls apart under standard milling conditions by sieving the resulting wholemeal. A large proportion passing the sieve is indicative of grain softness. On the other hand, grain softness is indicated in the PR test by the removal of a relatively large proportion of the outer layers of the grain, leaving small "pearls." The PR test may also be influenced by the shape of the grain, as a long grain may appear to be more susceptible to the pearling action. Nevertheless, this factor has not created significant difficulties in

doi:10.1094/CFW-52-6-0307

- Hard wheats produce a degree of damaged starch, needed for most baking processes, whereas low starch damage is required for cookies, grocery flour, wafers, and some noodles and steamed buns.
- Grain hardness is routinely determined by near infrared spectroscopy, but the relevant equipment must be calibrated on the basis of particle size index or pearling resistance results.
- The particle size index has often been adopted in preference to pearling resistance because of difficulties in obtaining access to and using the Strong-Scott barley pearler.
- The Kett Pearlest rice pearler proves to be a satisfactory means of determining grain hardness quantitatively using the principal of the traditional pearling-resistance test.

the main aim of providing a clear distinction between hard and soft types of grain.

At present, grain hardness is routinely determined by near infrared (NIR) spectroscopy, either with whole grain or milled samples, but the relevant equipment must be calibrated on the basis of PSI or PR results. Of these two major alternatives, the PSI method has often been adopted in preference to PR because of difficulties in obtaining access to and using the Strong-Scott barley pearler on which the original pearling test is based.

To overcome this difficulty with the pearling test, we have used the Kett rice pearler to provide a simpler alternative for millers and breeders to test grain hardness. The Kett is small (measuring 10 cm wide, 13 cm deep, and 17 cm high) and easy to use, taking a convenient sample size of ten grams of grain. It has proved to be a satisfactory means to determine grain hardness quantitatively, providing differentiation between many samples of hard and soft grain.

Materials and Methods

A commercial flour miller (Allied Mills, Australia) provided grain samples and relevant NIR calibrations, based on PSI results. These included 35 hard wheats (varieties Sunco and Sunvale, with protein contents ranging from 10.0 to 15.2% and moisture from 9.1 to 12.2%) and 23 soft wheats (Sunsoft and QAL2000, with protein contents ranging from 8.5 to 12.0% and moisture from 9.7 to 11.3%). Additional samples were provided from the breeding program of the Plant Breeding Institute, University of Sydney.

The optimized procedure involved placing 10.0 grams of cleaned grain into the Kett Pearlest rice pearler (Kett Electric Laboratory, Tokyo, Japan, http://www.kett.co.jp) (Figure 1). The rubber disc, rubber ring, and polishing plate used for rice milling were replaced with the more abrasive disc, ring, and plate provided as

Fig. 1. The Kett Pearlest rice pearler, fitted with highly abrasive disk and rotor, suitable for wheat grain pearling.

optional accessories by Kett. After pearling for 2 minutes at the regular motor speed, the resulting pearls were weighed, and the result ("pearling resistance") was expressed as a percentage with respect to the original grain mass.

Results and Discussion

As the procedure was being optimized, it was evident that the amount removed by abrasion after two minutes of pearling decreased progressively for grain loads up to about 10 grams and then decreased again for larger sample sizes. On the other hand, the amount removed continued to increase with longer pearling times, but a two-minute period was optimal for hard-soft differentiation.

Good differentiation was provided between the sets of hard and soft grain samples when the optimized pearling test was applied in duplicate. Reproducibility was also good, with a standard error of about 2%. In Figure 2, the comparison is provided between the PR (Kett) results and the routine use of NIR reflectance analysis of wholemeal samples, based on calibration with the PSI test (arbitrary units). The "tightness" of grouping samples was similar for the two methods.

Higher-than-expected PR values have been reported to be given by very moist grain samples (2). This effect was also encountered with the use of the Kett pearler, but the changes in PR values were not enough to be considered significant in the moisture range normally encountered.

A reliable and convenient test for hardness in many small samples is needed in breeding programs, especially when hard X soft crosses are made. In addition, hardness is affected by growth conditions to some extent, being partly related to the protein content of the grain. Grain samples from a breeding program were also evaluated by the Kett pearling test. Pearling resistances for the known varieties (Chara and Rosella) were correct for their known hardness types, according to the ranges in Figure 2. In addition, several advanced lines were tested, coming from a hard X soft crossing program. The results for these covered much of the range of pearling resistances in Figure 2, but they were mainly soft.

Conclusion

The Kett rice pearler proves to be a satisfactory means of determining grain hardness quantitatively using the principal of the traditional pearling-resistance test of McCluggage (4), but with much more convenient equipment. The modified test is simple and fast to use, suiting both breeder and mill laboratories.

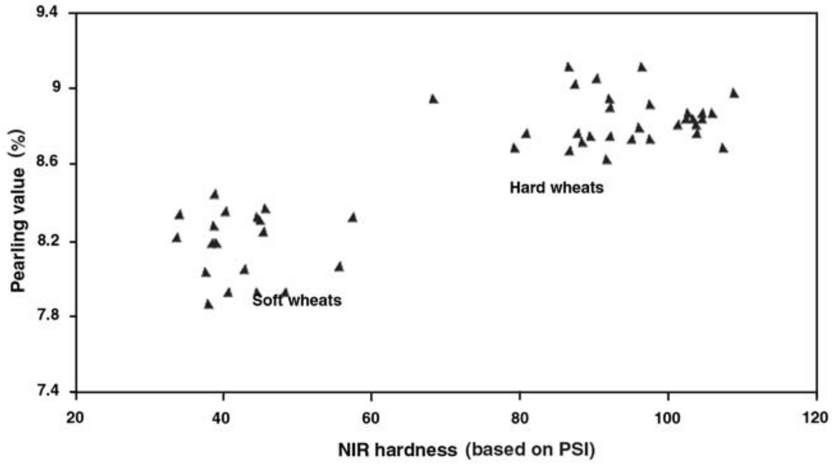

Fig. 2. Grain-hardness results obtained for 58 grain samples using the optimized Kett pearling resistance test and the routine near-infrared method (calibrated for particle size index). Hard-grain samples (top right) were well distinguished from the soft-grained samples (lower left) by both tests. PSI—particle-sized index.

Acknowledgments

We appreciate the loan of the Kett pearler by Tony Blakeney. Grain and NIR results were provided by Di Miskelly and John Dines, Allied Mills, Australia. Breeder samples came from Akram Khan, Plant Breeding Institute, University of Sydney. Ewa Orszulok also contributed to the study. The project was a part of the Student Research Scheme of CSIRO, carried out by Rachael Rodney.

References

1. Buller, A. H. R. *Essays on Wheat.* The Macmillan Company, New York, 1919.
2. Chesterfield, R. A modified barley pearler for measuring hardness in Australian wheats. J. Aust. Inst. Agric. Sci. 37:148-151, 1971.
3. Cutler, G. H., and Brinson, G. A. The granulation of whole wheat meal and a method of expressing it numerically. Cereal Chem. 12:120-129, 1935.
4. McCluggage, M. E. Factors influencing the pearling test for kernel hardness in wheat. Cereal Chem. 20:686-700, 1943.
5. Morris, C. F., and Rose, S. P. Wheat. Pages 1–54 in: *Cereal Grain Quality*. R. J. Henry and P. S. Kettlewell, eds. Chapman & Hall, London, UK, 1996.

Rachael Rodney was a vacation student at Food Science Australia. She has also been involved with research at the Plant Breeding Institute, which is connected to the University of Sydney. She is currently studying in the faculty of veterinary science at the University of Sydney.

Surjani Uthayakumaran is a research scientist at Food Science Australia. She completed her Ph.D. in cereal chemistry from the University of Sydney while working at Grain Quality Research Laboratory, CSIRO Plant Industry. She then held post doctoral positions in the Department of Mechanical Engineering, University of Sydney, and Agriculture and Agri-Food Canada. Her research interests include diagnostic testing of cereals to enable better selection of grain for particular end-use quality.

Ian L. Batey is an honorary retirement fellow at Food Science Australia. He holds a Ph.D. from the University of Sydney and has worked at Purdue University, West Lafayette, IN, and Cambridge University, UK, as a post-doctoral fellow. He spent 25 years at CSIRO Grain Quality Research Laboratory before becoming a research consultant to the Value Added Wheat CRC. Batey can be reached at Ian.Batey@csiro.au.

Colin W. Wrigley, Ph.D., spent almost 40 years at the CSIRO Wheat Research Unit and Grain Quality Research Laboratory before retiring. He is now a project consultant with the Value Added Wheat CRC and an honorary fellow at Food Science Australia. He is the author of numerous papers, has written many book chapters, and is the editor of several books. Wrigley can be reached at Colin.Wrigley@csiro.au.