EARLY GENERATION SELECTION FOR MILLING QUALITY

W. B. Griffin
Crop Research Division, DSIR
Private Bag, Christchurch

ABSTRACT

Milling quality testing for our wheat breeding programmes begins in the F_4 generation and is carried out by the Wheat Research Institute, DSIR. A quick and simple milling test that could be carried out in earlier generations by the breeders would considerably improve the efficiency of selection.

The relationships between a number of grain characteristics and milling quality are discussed, and a test based on bran separation after grinding is described. Two seasons' data show that this Hand Grinding test agrees well with the present milling tests.

INTRODUCTION

Milling quality in the Crop Research Division's (CRD), wheat breeding programmes is measured by a micro-milling extraction and a flour-grittiness test, the Q test, both conducted by the Wheat Research Institute (WRI). The grittiness measurement (Baruch 1974), expressed as the Q figure, is used in the fourth generation to give the first indication of milling quality. The following season there is enough grain for the first actual milling test by a Brabender Quadrumat Junior mill.

The milling process involves detaching the endosperm from the rest of the grain by a series of rollers and then sieving it clean. The sifting property of flour is therefore, a major factor of milling quality and is directly measured by the Q test. Sifting behaviour is also the main determinant of the Brabender extraction (Cawley pers. comm.). Consequently the other aspects of milling quality, the total amount of endosperm available for extraction and the ease with which it can be detached from the rest of the grain, maybe underestimated by the present milling tests. If further tests independant of flour-sifting behaviour are developed a broader basis for selection could be used. Of particular benefit would be a quick and simple test using a small amount of grain that the breeders could apply to early generation material. With these aims the relationships between several physical grain characteristics and milling quality have been investigated. A simple Hand Grinding test for endosperm-bran detachment is presented.

MATERIALS AND METHODS

The Hand Grinding Test

This test is based upon a similar method used by Dr G. Sage, Plant Breeding Institute, Cambridge. Ten wheat grains and a little silica sand are ground with a mortar and pestle for 10 seconds. The endosperm adherance is compared to the appearance of several milling standards and visually scored on a scale of three. In the last two seasons all breeding material from CRD Lincoln tested by the WRI has also been screened by this Hand Grinding test.

Starch Determination

A number of lines representing the range of Q and Brabender quality values were milled on a Buhler-Miag Laboratory Disc mill and then mechanically shaken over a 22-grade sieve. The screenings were treated with boiling 80% ethanol to remove any sugars (Karbassi *et al* 1971), and then digested with amyloglucosidase (from *Rhizsopus*, Phase Separations Co) in 0.1M pH 4.5 acetate buffer (Hilliard and Daynard 1974). The glucose produced was measured by the glucose oxidase method (MacRae 1971) and from this the starch percentage calculated.

Percentage Endosperm Content

The endosperm content of several good and poor quality wheats was determined by a modified Matveef papain digestion method (Simmons and Meredith, in press). The crushed grain was digested for seven hours in 0.5% (w/v) papain solution and then washed through a 180 mesh sieve. For each line five measurements were made and the mean used as the endosperm percentage of that line.

Simple Grain Measurements

The grain weight, dimensions, texture and groove shape were recorded for a number of wheats with a range in milling quality.

RESULTS AND DISCUSSION

Table 1 compares the Hand Grinding test results from two seasons with the WRI results. Two-thirds of the 152 lines milled on the Brabender in 1977/78 were also tested in the previous season and so appear twice in the table. Considering the simplicity of the Hand Grinding test and that essentially different aspects of milling quality are being measured, there is very good agreement between the different tests. The high scoring of some lines in the Hand Grinding test is acceptable because the test would only be used for an initial screening of the breeding material, and any poor milling lines missed would be detected by the WRI tests. Failure to identify some lines with acceptable quality is more serious, as these might be discarded before testing by the WRI. However, this error compares well with the accuracy of the Q test and is small considering the nature of the test.

In the 1977/78 season 22 lines from the previous season's F_4 material that the Hand Grinding test had classified as non-milling, were milled by the WRI

TABLE 1: A comparison of the wheat milling classifications produced by the Hand Grinding and other milling quality tests.

	1976/77 Hand Grinding Test		1977/78 Hand Grinding Test		Percentage of lines wrongly classified by the Hand Grinding Test
	Non-Milling[1]	Milling	Non-milling	Milling	
Q test. Non-milling[2]	13	6	11	11	41[4]
Milling	6	120	8	110	6
Brabender Non-milling[3] and/or	37	7	39	8	16
Q test. Milling	4	104	9	96	6

1. Lines scoring below 2.
2. Lines scoring below 19. These were F_4 lines, not tested by Brabender extraction.
3. Lines yielding 10% less flour than a Kopara standard and/or with Q below 19.
4. Another 70 lines scoring below 2 in the Hand Grinding test were not tested by the WRI. Of those that were milled in the 1977/78 season 71% had Q below 19. Adjusting for these lines gives an estimate of 33% of non-milling lines wrongly classified by the Hand Granding Test.

TABLE 2: The behaviour of wheat lines classified as non-milling by the Hand Grinding test

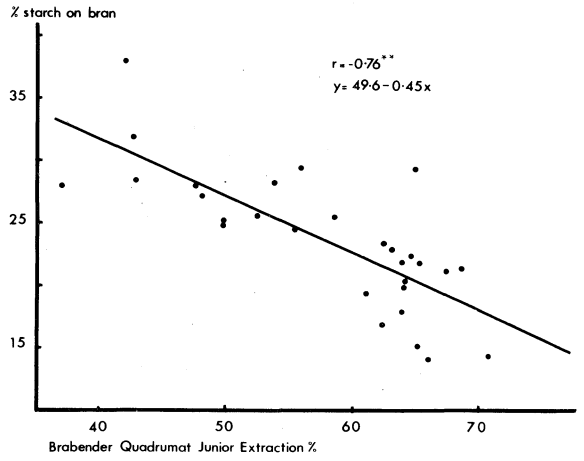
	1976/77 Hand Grinding Test		1977/78 Hand Grinding Test	
	Non-milling	Milling	Non-milling	Milling
No test	22	0		
Brabender Non-milling and/or			18	0
Q test Milling			1	3

(Table 2); again the errors associated with the Hand Grinding test are within acceptable limits.

The Hand Grinding test will only segregate milling quality into two categories. To further quantify the endosperm-bran detachment character, starch determinations on the bran produced from a simple disc milling were made. There is a reasonably close relationship between the starch content of the bran and the Brabender extraction values (Figure 1). The starch determination procedure will not measure large numbers of samples quickly and so would be of little use for screening early generation progeny. However, at a later stage such a measurement would provide a valuable check on the performance of a line in the Q test and Brabender mill. This close relationship also means that the Brabender mill extraction is largely determined by the endosperm-bran detachment character. Considering that sifting behaviour is thought to be the main determinant of the Brabender extraction, it is likely that these two aspects of milling quality are not independent.

Baker and Golumbic (1970) found a close inverse relationship between flour yield and mill bran yield, but not when they used two chemical methods to measure the bran content. Crewe and Jones (1951) found significant variation in bran thickness between cultivars, but that this was not related to their milling quality. Similarly, Table 3 shows there is a significant variation in the endosperm content of New Zealand wheat cultivars, but that this is not closely related to their milling quality. The endosperm content is also highly environment dependant because of the variation in the rate and duration of carbohydrate synthesis. This variability probably masks any close

Figure 1: Relationship between Brabender milling yield & the starch content of bran after milling.



relationship to milling quality; and until the environmental influence of this character is defined it's relationship to milling quality will remain uncertain.

None of the other simple grain characters investigated show any close relationship to milling quality. All have been implicated in milling quality (Shuey and Gilles 1972, Baker *et al* 1976/77, Bares and Kosner 1975), but usually within a particular cultivar or class of wheat, or from an artificial range in the grain character. In the 1977/78 season 212

TABLE 3: The percent endosperm contents of milling and non-milling wheat lines

Non-milling wheats		Milling wheats	
Arawa	83.8	Kopara	84.2
Rowi	83.5	Takahe	86.0
Ruru	85.2	Oroua	85.2
2805,01	85.6	Rongotea	84.6
2744,01	85.1	Karamu	84.5
2723,01	84.9		
Mean	84.7		84.9
Range of Brabender extraction percentages	40-56		60-70

different breeding lines that were tested by the WRI also had their grain weights measured. The variation in grain weight explained only 5% of the variation in milling yields. Grain texture, or vitreousness, ranged from 0% to 80% both within a cultivar and between cultivars, but showed no relationship to milling quality.

CONCLUSIONS

The Hand Grinding test gives a very quick and simple indication of wheat milling quality. It provides additional information to that from the Q test, and so these together will allow a more reliable early generation screening of the breeding material. The test can be carried out by the breeders therefore allowing a more efficient use of the WRI resources. None of the other grain characters investigated were sufficiently easy to measure or related closely enough to milling quality to be of use as a screening test.

The reasonably close relationship between a quantative measurement of the endosperm-bran detachment character and the Brabender extraction shows that this mill provides an overall assessment of milling quality. Wheat Research Institute experience and results such as those of Baker and Golumbic (1970) show that in general the Brabender mill ranks cultivars similarly to larger mills and provides an effective small-scale milling test.

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