NOTE

# Comparison of Methods for Gluten Strength Assessment

C. S. Gaines,[1,2] J. Frégeau Reid,[3] C. Vander Kant,[4] and C. F. Morris[5]

Cereal Chem. 83(3):284–286

**ABSTRACT**

Five methods that employed very different testing principles and procedures for assessing gluten quality were compared for 33 North American soft red and white wheats. The three methods analyzed flour (alveograph work, lactic acid solvent retention capacity, and mixograph peak time) and two methods employed ground wheat meal (Glutomatic gluten index and SDS sedimentation volume). Compared against the normalized mean of all five assessments, the ability of the assessment methods to evaluate gluten quality decreased in the order: alveograph work, lactic acid solvent retention capacity, mixograph peak time, Glutomatic gluten index, and SDS sedimentation volume. The methods utilizing flour were substantially superior predictive methods; however, the two meal-based methods could be sufficient for early generation screening when flour is not available.

Wheat gluten quality (strength) is assessed by several methods worldwide. To assess or screen the gluten quality among North American wheats of the soft wheat market class, it is common to employ an alveograph, lactic acid solvent retention capacity (SRC), a mixograph, the Glutomatic system, and SDS sedimentation volume.

The choice of assessment method is influenced by several factors such as country, wheat class, intended end use, as well as whether the assessment is made for screening large numbers of test lines and completed by wheat breeders and quality evaluators, or used for end use quality prediction by wheat millers and bakers. Some screening procedures must utilize whole ground wheat meal, whereas other procedures require flour or have flour available for analyzes. Utilizing flour adds an additional sample preparation step which may not be practical for early generation quality screening. Furthermore, grain quantities available in early generation often cannot accommodate milling enough grains for the amount of flour required for a method like the alveograph. Of the assessments used in this study, the alveograph, mixograph, and lactic acid SRC methods employ wheat flour, whereas the SDS sedimentation procedure and the Glutomatic instrument employ wheat meals, which make those methods particularly suitable as quality screening methods. All of the methods can analyze flours, when it is available.

The objectives of this study were to compare the assessment methods and procedures used to evaluate soft wheat gluten quality and to determine which of those procedures produce least variance while consistently evaluating gluten strength and perhaps which are most interchangeable due to high correlation. We also wished to determine the assessment utility of two procedures that employ wheat meals and three procedures that require flours for analysis.

[1] U.S. Department of Agriculture, Agricultural Research Service, Soft Wheat Quality Laboratory, Ohio Agricultural Research and Development Center, Ohio State University, Wooster, OH 44691. Names are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the product, and the use of the name by the USDA implies no approval of the product to the exclusion of others that may also be suitable.

[2] Corresponding author. Phone: 330-263-3891. Fax: 330-263-3651. E-mail: gaines.31@osu.edu

[3] Grain Quality, Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, 960 Carling Avenue, Ottawa, Ontario K1A 0C6, Canada.

[4] Hyland Seeds-W.G. Thompson & Sons, P.O. Box 250, #2 Hyland Drive, Blenheim, Ontario N0P 1A0, Canada.

[5] USDA ARS Western Wheat Quality Lab., Washington State University, E-202 FSHN - Facility East, Pullman, WA.

DOI: 10.1094/CC-83-0284



## MATERIALS AND METHODS

### Wheats and Milling

Thirty-three soft red or white winter wheats (Augusta, Caledonia, E0025, M99-3096, OTF13-081, Pioneer 25R26, Pioneer 25W60, SR30-481L, Superior, TW044-065, TW044-094, TW060-075, TW108-162, TW110-062, TW111-005, TW111-159, TW114-128, TW115-122, TW122-001, TW128-149, TW129-123, TW137-003, TW139-153, TW140-045, TW161-075, TW165-065, TW168-082, TWF020-038, Watford, Webster, Whitby, Whitney, and Wonder) were each grown in two locations (Nairn and Watford, Ontario) in 2002/2003. The wheats were cleaned and milled into flour using a Brabender Quadrumat Sr. mill which was setup following the method of Gaines et al (2000). Wheat meals were produced by grinding using a Udy grinder with a screen opening size of 0.8 mm.

### Flour Analyses

Flours were evaluated in duplicate for α-amylase activity by the amylazyme method (Approved Method 22-05, AACC International 2000), protein content (Approved Method 46-12), alveograph work and peak/length ratio (Approved Method 54-30A), mixograph mixing time and peak height (Approved Method 54-40A), and lactic acid SRC (Approved Method 56-11). Wheat meals were evaluated for SDS sedimentation (Approved Method 56-70) and Glutomatic gluten index and wet gluten content (Approved Method 38-12A) keeping the volume of Glutomatic wash solution to 4.8 mL for all samples.

### Statistical Analyses

Data were analyzed using *t*-test statistics, analysis of variance, and linear correlation coefficients. For some analyses, all data were normalized to a scale of 0–100. The means across all methods of those normalized data were calculated and used as a reference from which to determine deviations for each individual method.

## RESULTS AND DISCUSSION

The *t*-tests revealed that only α-amylase values were different ($P = 0.037$) for location of growth, with a mean at Nairn of 0.098 absorbance units and a mean at Watford of 0.105 absorbance units. That difference is not large and α-amylase activity (and flour protein content) was not well correlated with any gluten quality assessment data. Therefore, wheat values across location were averaged and subsequently analyzed.

Table I shows the mean and range values for each protein quality assessment method. Range values were typical of the soft wheat market class. Thus, coefficients of correlation (Table II) among 33 wheats can be considered realistic of soft wheat market classes across Ontario and the northeastern United States.

Among the gluten strength assays employed in this study, parameters of the three flour methods (alveograph work, lactic acid SRC, and mixograph peak time) produced higher correlations than did the two meal methods (Glutomatic gluten index and SDS sedimentation volume). Correlations decreased in the order: alveograph work, lactic acid SRC, mixograph peak time, Glutomatic gluten index, and SDS sedimentation.

For all assessment methods, data were normalized (0–100) from the ranges of all of the flours. An overall mean for all methods was calculated across all of the normalized data. This was used as a reference from which to compare each of the individual methods. The reference mean was considered the best expression of the gluten strength of the 33 flours. For each gluten strength assessment method, absolute deviations from the reference mean was calculated and the means, ranges, and standard deviations from of those deviations were determined (Table III). Smaller deviation means, ranges, and standard deviations indicate better agreement with the reference mean. Alveograph work and lactic acid SRC had much better agreement with the reference mean than did the other gluten strength methods. Additionally, the gluten strength assessment methods were correlated with the reference mean as follows: alveograph work ($r$ = 0.95), lactic acid SRC ($r$ = 0.93), mixograph peak time ($r$ = 0.89), Glutomatic gluten index ($r$ = 0.80), SDS sedimentation volume ($r$ = 0.73), α-amylase activity ($r$ = –0.41), protein content ($r$ = 0.34), alveograph peak/length ($r$ = 0.34), Glutomatic wet gluten ($r$ = 0.30), and mixograph peak height ($r$ = 0.25).

Those large differences in deviations from the reference mean values do not necessarily suggest that the two meal assessment methods are reacting differently to gluten quality of the flours. However, the results of the two meal methods may variously have been influenced by dilution of the test medium by ground bran particles that affected the analyses as measured. The Glutomatic

**TABLE I**
**Means and Ranges of Gluten Strength Assessments for 33 Soft Wheats**

| Source | Mean | Minimum | Maximum | Range | Quartile Range | SD |
|---|---|---|---|---|---|---|
| Alveograph work ($J \times 10^{-4}$) | 105.8 | 53.0 | 219.5 | 166.5 | 36.0 | 35.4 |
| Lactic acid SRC (%) | 89.1 | 69.3 | 119.7 | 50.4 | 17.4 | 12.1 |
| Mixograph peak time (min) | 2.1 | 1.3 | 4.3 | 3.0 | 0.8 | 0.7 |
| Glutomatic gluten index (%) | 36.8 | 0.0 | 95.0 | 95.0 | 40.5 | 26.7 |
| SDS sedimentation volume ($cm^3$) | 39.4 | 23.8 | 69.0 | 45.3 | 14.5 | 10.9 |
| Alveograph peak/length | 1.0 | 0.6 | 2.2 | 1.6 | 0.5 | 0.4 |
| Glutomatic wet gluten (%) | 21.1 | 0.0 | 29.8 | 29.8 | 4.6 | 5.5 |
| Mixograph peak height (MU) | 3.5 | 2.9 | 4.5 | 1.6 | 0.7 | 0.4 |
| Flour protein content (%) | 8.0 | 6.8 | 9.2 | 2.4 | 1.0 | 0.6 |
| α-Amylase activity (abs) | 0.101 | 0.083 | 0.137 | 0.054 | 0.013 | 0.012 |

**TABLE II**
**Coefficients of Correlation for Gluten Strength Assessments**

| Source | Alveograph Work | Lactic Acid SRC | Mixograph Peak Time | Glutomatic Gluten Index | SDS Sed. Volume | Alveograph Peak/Length | Glutomatic Wet Gluten | Mixograph Peak Height | Flour Protein Content |
|---|---|---|---|---|---|---|---|---|---|
| Lactic acid SRC | 0.92* | | | | | | | | |
| Mixograph peak time | 0.88* | 0.76* | | | | | | | |
| Glutomatic gluten index | 0.67* | 0.66* | 0.69* | | | | | | |
| SDS sedimentation volume | 0.62* | 0.67* | 0.49* | 0.37* | | | | | |
| Alveograph peak/length | 0.34 | 0.37* | 0.14 | 0.28 | 0.31 | | | | |
| Glutomatic wet gluten | 0.36* | 0.31 | 0.31 | 0.08 | 0.27 | –0.28 | | | |
| Mixograph peak height | 0.41* | 0.24 | 0.35* | –0.14 | 0.31 | 0.05 | 0.54* | | |
| Flour protein content | 0.44* | 0.32 | 0.44* | –0.04 | 0.36* | –0.10 | 0.66* | 0.90* | |
| α-Amylase activity | –0.37* | –0.31 | –0.42* | –0.32 | –0.36* | –0.18 | –0.18 | –0.31 | –0.33 |

[a] * Indicates significance at $P < 0.05$.

**TABLE III**
**Absolute Deviations from the Mean of All Normalized Assessments**

| Source | Alveograph Work ($J \times 10^{-4}$) | Lactic Acid SRC (%) | Mixograph Peak Time (min) | Glutomatic Gluten Index (%) | SDS Sedimentation Vol. ($cm^3$) | Alveograph Peak/Length | Glutomatic Wet Gluten (%) | Mixograph Peak Height (MU) | Protein Content (%) | α-Amylase Activity (abs) |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 5.6 | 7.8 | 10.5 | 12.6 | 12.8 | 22.4 | 38.1 | 23.8 | 24.6 | 29.1 |
| Range | 17.3 | 28.0 | 41.6 | 47.0 | 39.7 | 67.3 | 74.7 | 63.2 | 81.3 | 76.0 |
| SD | 4.6 | 7.0 | 9.3 | 11.8 | 10.8 | 15.8 | 21.5 | 17.9 | 20.8 | 21.8 |

gluten index method for wheat meals has a washing step to remove large bran particles. This bran removal may contribute to the higher correlation of this whole meal method over the SDS sedimentation method with the reference means and with the other gluten strength assessments.

## CONCLUSIONS

In this study, the methods for assessing gluten strength among soft wheats were variously suitable to the task, employing very different testing principles and procedures. The three methods that used flour (alveograph work, lactic acid SRC, and mixograph peak time) were substantially superior predictive methods compared with the two methods that used ground wheat meal (Glutomatic gluten index and SDS sedimentation volume). However, the two meal-based methods could be sufficient for early generation screening in some programs if use of flour is not possible.

## LITERATURE CITED

AACC International. 2000. Approved Methods of the American Association of Cereal Chemists, 10th Ed. Methods 22-05, 38-12A, 46-12, 54-30A, 54-40A, 56-11, and 56-70. The Association: St. Paul, MN.

Gaines, C. S., Finney, P. L., and Andrews, L. C. 2000. Developing agreement between very short flow and longer flow test wheat mills. Cereal Chem. 77:187-192.

Guttieri, M. J., Becker, C., and Souza, E. J. 2004. Application of wheat meal solvent retention capacity tests within soft wheat breeding populations. Cereal Chem. 81:261-266.

[Received September 22, 2005. Accepted January 4, 2006.]