NOTE

Correlation Between Chopin and AACC Methods of Determining Damaged Starch[1]

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ABSTRACT

Damaged starch values were determined in 58 commercially produced patent flours by the enzymatic laboratory method approved by the American Association of Cereal Chemists and a rapid iodometric method using the recently introduced Chopin SD4 instrument. For all flours, damaged starch values obtained by the laboratory method averaged 7.5%; those obtained by the Chopin method averaged 5.6%. The correlation value was 0.90. For the Chopin method, recalibration of the instrument to flours with known damaged starch levels may be necessary to improve agreement between the two methods of determining damaged starch.

During the milling of wheat, a portion of the starch granules sustain mechanical damage (Gibson et al 1992). Damaged starch granules hydrate rapidly and are susceptible to enzymatic hydrolysis.

Some starch damage is desirable because it optimizes hydration and promotes fermentation activity during breadmaking. However, excessive starch damage can overly hydrate the dough and subject it to accelerated enzymatic action, resulting in sticky doughs and problems with slicing and handling the bread (Medcalf and Gilles 1965, Finney et al 1988, Gibson et al 1992). Consequently, measuring the percentage of damaged starch in flour samples has become a routine test in the milling and baking industries.

Although some nonenzymatic procedures have been studied, the preferred measurement of damaged starch is usually based on enzymatic methods. Three or four such methods are currently available. Of these, method 76-30A of the American Association of Cereal Chemists (AACC 1983) is widely used in North America. This method requires over an hour to perform a single determination. An automated method based on the iodine-absorption characteristics of starch (Medcalf and Gilles 1965) was recently introduced using the Chopin SD4 (Seedburo Equipment Co., Chicago, IL). This method requires approximately 10 min per sample and can perform several determinations in rapid succession. However, the Chopin method can be a method of choice only if damaged starch values can be measured accurately. Our study was undertaken to assess this accuracy.

MATERIALS AND METHODS

Flours

Samples of 58 commercial flours from flour mills in Kansas and other areas were used. Samples included a variety of wheat types (Tables I and II). In addition, one hard spring flour was purposely damaged in a ball mill for varying lengths of time (0–4 hr) using a 250-g sample for each run to progressively increase the level of starch damage. All flours were properly bagged and stored under refrigeration until needed.

Analytical

Flours were analyzed for moisture, protein, and ash using the standard AACC methods (AACC 1983). Damaged starch values were determined by AACC method 76-30A and the Chopin SD4 method. The AACC method defines percent of starch damage as grams of starch subject to α-amylase hydrolysis per 100-g sample on 14% moisture basis. The Chopin method measures damaged starch amperometrically, based on the absorption kinetics of iodine. In principle, the method converts the intensity of current flowing through the iodine solution into corresponding AACC method values by means of an internal calibration curve. Before its use in this study, the Chopin SD4 instrument had been calibrated by a chemical procedure by the manufacturer. For flours with moisture ranges outside 13–15% or protein levels outside 10–14%, certain necessary corrections were specified by the manufacturer.

Statistical

Correlation values were determined and mean comparisons were made using the Statistical Analysis System (SAS 1982).

RESULTS AND DISCUSSION

Flours

The majority of the flours tested were bread flours—hard wheat flour and blends (Table I). They all differed minimally in average moisture and ash content, despite considerably varying range values. The protein content presented a different picture. As anticipated, hard spring flours had the highest average at 13.2%; soft white flours had the lowest average at 7.8%.

Damaged Starch Values

Damaged starch values for all flours averaged 7.5% using the AACC method and 5.6% using the Chopin method (Table II). This suggests that the Chopin method underestimated equivalent AACC damaged starch values. However, this conclusion may be more valid where starch damage is high, as in hard wheat flours, than where it is low, as is usual in soft wheat flours (Table II). The two methods measured starch damage values of soft wheats with a much narrower difference. However, only a few soft flours were tested (Table I); a large pool of soft flours may yield different results.

Excluding soft wheat flours, all other flours and blends showed a high degree of correlation between the two methods (Table II). This may mean that the use of a correction factor could allow more accurate determination of AACC starch damage values from Chopin results.

To further test the efficacy of correlation between the two methods, a hard spring wheat flour was increasingly damaged in a ball mill for up to 4 hr. Damaged starch values were determined by both methods. Again, we found a high degree of correlation ($r = 0.90$). Results of the ball milling (Table III) indicate that the magnitude of underestimation of damaged starch values by the Chopin method widened increasingly as damage levels increased.

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TABLE I
Composition of Flour Types Tested

	Composition, %					
	Moisture		Protein[b]		Ash[b]	
Flour Type[a]	Average	Range	Average	Range	Average	Range
Hard winter (25)	12.7	9.8–14.5	11.5	10.1–12.7	0.51	0.45–0.63
Hard spring (10)	11.7	8.6–13.7	13.2	11.6–14.1	0.54	0.37–0.84
Soft winter (7)	12.0	9.7–13.4	8.9	8.2–9.5	0.46	0.38–0.56
Soft white (4)	12.5	12.0–13.0	7.8	6.2–8.8	0.48	0.42–0.53
Hard winter and spring blend (8)	13.1	12.6–13.9	12.1	11.4–12.7	0.52	0.42–0.58
Hard and soft blend (4)	12.3	10.4–13.1	10.9	10.3–11.7	0.49	0.48–0.50

[a]Number of samples tested is indicated in parenthesis.
[b]Expressed on 14% moisture basis.

TABLE II
Percent Damaged Starch in Flours Tested

	Method[a]			
Flour Type	AACC	Chopin	r Values	Probability
Hard flour (all)	8.4 ± 1.6	6.2 ± 0.9	0.79	<0.01
Hard winter	7.7 ± 1.2	5.8 ± 0.7	0.56	<0.01
Hard spring	10.1 ± 1.2	7.2 ± 0.4	0.85	<0.01
Soft flour (all)	3.1 ± 0.9	2.4 ± 0.9	0.05	NS[b]
Soft winter	3.2 ± 0.7	2.2 ± 1.0	0.36	NS[b]
Soft white	2.9 ± 1.3	2.8 ± 0.6	−0.22	NS[b]
Blends (all)	9.1 ± 2.2	6.7 ± 0.8	0.84	<0.01
Hard winter and spring blend	9.1 ± 2.5	6.8 ± 0.8	0.86	<0.01
Hard and soft blend	9.0 ± 1.9	6.4 ± 0.9	0.93	<0.05
All flours	7.5 ± 2.7	5.6 ± 1.8	0.90	<0.01

[a]Corrected to 14% moisture basis.
[b]Not significant.

TABLE III
Measurement of Damaged Starch Values by the Two Methods for Mechanically Damaged Flour[a]

Time Damaged (hr)	Percent Damaged Starch[b]	
	AACC Method	Chopin Method
0.0	8.2	5.2
0.5	12.0	8.3
1.0	16.1	9.8
1.5	19.8	10.8
2.0	22.9	11.4
2.5	25.2	11.6
3.0	31.6	11.8
3.5	33.1	12.1
4.0	34.7	12.3

[a]Hard spring wheat.
[b]$r = 0.90$.

CONCLUSIONS

For all types of flours, especially bread flours, the Chopin method appears to underestimate damaged starch values when compared with the AACC method. In addition to the chemical means of calibration, the Chopin unit can also be calibrated to flours of known damaged starch levels. For laboratories routinely analyzing only one type of flour (e.g., soft wheat flour), this approach may produce a more accurate prediction of damaged starch levels that is comparable to the AACC method. This alternative method of calibration was not tested in this study.

LITERATURE CITED

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 1983. Official Methods of the AACC, 8th ed. Method 08-01, approved April 1961, revised October 1976 and October 1981; Method 44-15A, approved October 1975, revised October 1981; Method 46-10, approved April 1961, revised October 1976, September 1985; Method 76-30A, approved May 1969, revised November 1972, October 1982, and October 1984. The Association: St. Paul, MN.

FINNEY, P. L., KINNEY, J. E., and DONELSON, J. R. 1988. Prediction of damaged starch in straight-grade flour by near-infrared reflectance analysis of whole ground wheat. Cereal Chem. 65:449.

GIBSON, T. S., AL QALLA, H., and McCLEARY, B. V. 1992. An improved enzymatic method for the measurement of starch damage in wheat flour. J. Cereal Sci. 15:15.

MEDCALF, D. G., and GILLES, K. A. 1965. Determination of starch damage by rate of iodine absorption. Cereal Chem. 42:546.

SAS. 1982. SAS User's Guide: Statistics. SAS Institute Inc.: Cary, NC.

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