Note on the Sodium Dodecyl Sulfate Test of Breadmaking Quality: Comparison with Pelshenke and Zeleny Tests[1]

D. W. E. AXFORD, E. E. McDERMOTT, and D. G. REDMAN, Flour Milling and Baking Research Association, Chorleywood, Rickmansworth, Herts., WD3 5SH, England
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Small-scale tests of breadmaking quality are essential in wheat-breeding programs in order to select suitable varieties at an early stage. In a commonly used method (Pelshenke 1930), heavily yeasted doughballs are placed under water. After sufficient gassing, the doughballs rise to the surface and eventually disintegrate. Those from strong wheats remain intact for longer periods. However, the potential of a new method based on the sedimentation behavior of whole meals and flours in sodium dodecyl sulphate (SDS) solution was illustrated recently (Axford et al 1978).

This note presents results of comparative tests of the SDS and Pelshenke methods and also includes results from another established small-scale sedimentation test (Zeleny 1947). All three tests depend on protein quality.

MATERIALS AND METHODS

Wheats were from the 1977 U.K. winter wheat harvest. The 56 samples comprised 10 varieties grown at five sites and two varieties grown at three of these sites. The varieties were chosen to include hard-milling and soft-milling wheats and also to cover a range of breadmaking quality. Grains were conditioned overnight to 15 or 15.5% moisture content for soft-milling and hard-milling varieties, respectively, and were milled on a Bühler mill.

SDS Test

Whole meals were prepared on the Tecator Cyclotec Mill (previously known as the Udy Cyclone Mill) with the 1-mm screen.

SDS (as sodium lauryl sulphate "specially pure") and AnalaR 88% lactic acid were from BDH. The SDS-lactic reagent was prepared by dissolving 20 g of SDS in 1 L of water and adding 20 ml of stock diluted lactic acid solution (one part lactic plus eight parts water by volume). Whole meal (6 g) or Bühler flour (5 g) was added to 50 ml of water in a 100-ml cylinder (measuring approximately 160 mm from the 0 to the 100-ml mark), a stopclock set going, and the material dispersed by rapid shaking for 15 sec. The contents were again shaken for 15 sec at 2 min and 4 min. Immediately after the last shake, 50 ml of the SDS-lactic reagent was added and mixed in by inverting the cylinder four times before restarting the clock from zero time. Inversion (four times) was repeated at 2, 4 and 6 min before the clock was started once again from zero time. The contents of the cylinders were allowed to settle for 20 min (whole meals) or 40 min (flours) before the sedimentation volumes were read. The procedure allows four samples to be assessed together. During all parts of this procedure, except during shaking

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or inverting, the cylinders were in a thermostatically controlled water bath at 22°C. The SDS-lactic reagent and the water in the cylinders were pre-equilibrated to this temperature.

Pelshenke and Zeleny Tests

The Pelshenke test was performed by AACC method 56-50 with modifications by Pushman and Bingham (1975). The doughballs were supported at the surface by wire rings following the suggestion of Hinton (unpublished).

The Zeleny test was performed on flours prepared on a Brabender Sedimat mill, according to ICC Standard 116.

Baking Procedures

Bühler flours were baked either by the long-fermentation procedure (LFP) of Fuller and Stewart (1970) or by mechanical development (CBP) (Axford et al 1978), except that the oxidant for CBP was ascorbic acid (30 ppm) and potassium bromate (45 ppm). Loaf volumes were measured by a seed displacement procedure.

Falling Numbers

Falling numbers (FN) were obtained following AACC method 56-81 B.

TABLE I
Correlation Coefficients Between Test Results and Loaf Volumes

	56 Wheats	23 Wheats	
	LFP[a] Volume	CBP[b] Volume	LFP[a] Volume
SDS volume			
Whole meal	0.80[c]	0.84[c]	0.82[c]
Bühler flour	0.82[c]	0.78[c]	0.78[c]
Pelshenke time			
Whole meal	0.42[c]	0.69[c]	0.52[d]
Zeleny volume			
Sedimat flour	0.76[c]	0.57[c]	0.71[c]
Protein content			
Whole meal	0.43[c]	0.12	0.28
Bühler flour	0.52[c]	0.19	0.38

[a]LFP = long-fermentation baking process (Fuller and Stewart 1970).
[b]CBP = mechanical development baking process (Axford et al 1978).
[c]Significantly different from zero ($P = 0.01$).
[d]Significantly different from zero ($P = 0.05$).

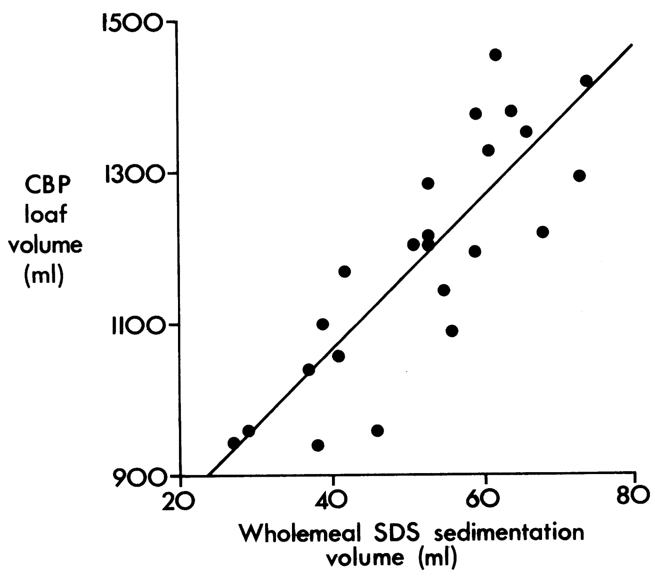

Fig. 1. Relationship between volumes of loaves baked by a mechanical development procedure (CBP) and sodium dodecyl sulfate (SDS) sedimentation volumes.

RESULTS AND DISCUSSION

Correlation coefficients for the three tests against loaf volumes are given in Table I. Correlation coefficients for whole meal and flour protein contents against loaf volumes are included for comparison. Williams' modification (1959) of Hotelling's test for the equality of dependent correlation coefficients was used to determine whether the correlation coefficients were significantly different from each other.

The correlations in the first column are for LFP volumes of the 56 wheats. The correlations 0.80, 0.82, and 0.76, derived from SDS volume (whole meal and flour) and Zeleny volume, respectively, are significantly different from the correlations 0.42, 0.43, and 0.52 (Pelshenke time and whole meal and flour protein contents, respectively) at the 1% level, but they are not significantly different from each other. Therefore the sedimentation tests (SDS and Zeleny) are markedly superior to the Pelshenke test for this series of wheats, and their correlations are also superior to those obtained by protein content alone.

The last two columns contain results on the smaller sample of 23

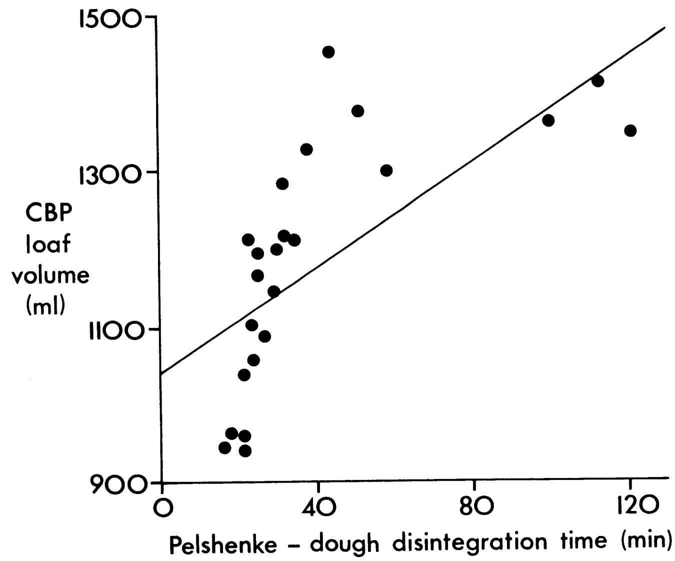

Fig. 2. Relationship between volumes of loaves baked by a mechanical development procedure (CBP) and Pelshenke dough disintegration times.

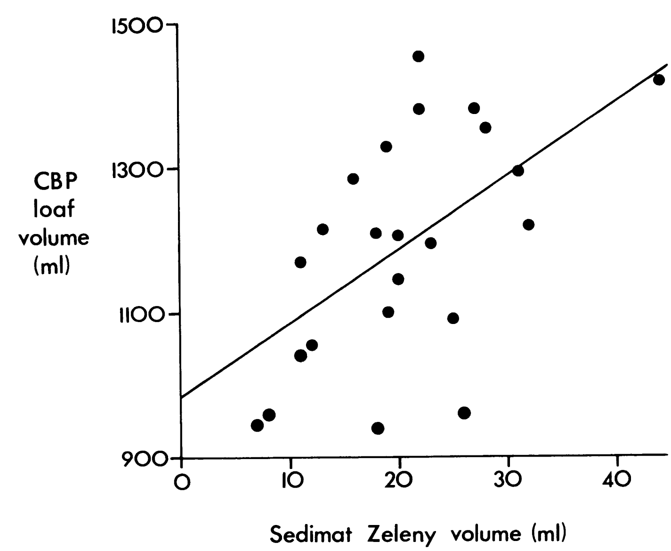

Fig. 3. Relationship between volumes of loaves baked by a mechanical development procedure (CBP) and Zeleny sedimentation volumes.

wheats (CBP and LFP volumes). In the case of CBP volumes, the correlation coefficients derived from the SDS tests were significantly different at the 1% level from that derived from the Zeleny test but not significantly different from the coefficient from the Pelshenke test. For LFP volumes, the correlations from the SDS tests and Zeleny tests were not significantly different from each other. The correlations from the SDS tests, but not from the Zeleny test, were significantly different at the 5% level from that derived from the Pelshenke test.

No advantage is gained by performing the SDS test on Bühler flours rather than on whole meals. This is a point of great importance, particularly as the Zeleny method does not work satisfactorily on whole meals.

The plots of CBP volume against the SDS whole meal test, the Pelshenke test, and the Zeleny test are shown in Figs. 1, 2, and 3, respectively. The figures show the linear regression lines obtained from the data, although the Pelshenke test shows only a poor linear relationship.

In conclusion, the SDS method has confirmed its earlier promise and has worked well in a year in which U.K. wheats were likely to contain high levels of α-amylase. (Table II shows that only 17 of the samples had FN greater than 180 and 15 had FN less than 100.) The ability of the test to give useful information about protein quality even in the presence of high amylase levels is important to wheat breeders because the susceptibility of varieties to preharvest germination may be treated as a separate issue. The SDS method has given good results with U.K. wheats over a wide range of flour protein contents. (Table II shows protein contents [N $\times$ 5.7] at 13.5% moisture basis.) The SDS test, in addition to giving good correlations with loaf volumes, was also considerably more convenient to use than the Pelshenke or Zeleny tests. The test may be done also on whole meals prepared on a KT mill supplied with the falling number apparatus.

In addition to its potential value to wheat breeders, the test also can be used by millers at mill-intake to rapidly assess the suitability of wheats for breadmaking.

TABLE II
Properties of Wheat and Flour Samples Used in Small-Scale Tests

Falling Number (Wheat)		% Protein Content (Flour)	
Range	Frequency	Range	Frequency
60–100	15	6.6– 7.4	9
101–140	11	7.5– 8.4	12
141–180	13	8.5– 9.4	20
181–220	10	9.5–10.4	11
221–259	7	10.5–11.2	4

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