IMPROVED TEMPERING AND MODIFIED MILLING TECHNIQUES FOR SMALL SAMPLES OF WHEAT[1]

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ABSTRACT

A rotary shaker is described for tempering wheat samples for a modified short milling procedure which permits milling 80 or more 100–150 g. samples per day by one operator. The method requires a shaking time of 15 minutes, and twelve samples can be tempered each 7.5 minutes. A micro mill was more suitable than the standard Allis mill for this work, since the micro mill flour yield was approximately 25% higher, resulting in a saving of both wheat and time required.

In genetic and inheritance studies with wheats, as well as in wheat breeding programs, mounting pressure has been brought to bear on the cereal technologist to increase the number of samples milled per day. Coupled with this pressure is the need for tests on a smaller sample, so that some concept of quality is available at an earlier stage in the breeding program.[3] This led to a study of the possibility of

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[3] Various methods were examined, one a quick method developed by the North Dakota State Mill & Elevator using an Allis Experimental mill. This required a relatively large amount of wheat and would be unsuitable for nursery samples. (Private communication.)

shortening the procedure used in this laboratory for milling nursery samples with a micro mill and resulted in what seems to be a satisfactory modification. Although the method developed requires a substantial amount (over 100 g.) of wheat, it permits many more samples to be milled in one day than the micro method described by Sibbitt, Scott, and Harris (4).

The increased number of samples possible to mill in a day by the modified method focused attention on the problem of tempering. This department customarily added the required quantity of distilled water and stirred the wheat manually. This method consumed the entire attention of the technologist, and probably also lacked uniformity. Consequently the procedure was modified.

This paper describes the method and apparatus involved in tempering and milling and includes some representative data obtained from milling hard red spring wheats by the modified procedure.

Materials and Methods

Tempering. A modification of the apparatus described by Seeborg *et al.* (5) was not satisfactory because of the limited number of samples handled. A rotary mixer capable of treating at least 10 to 12 samples at one time was a necessity. Tempering by placing the sample in an open container exposed to refrigerated and relatively humid air, as was done by Seeborg when tempering 5-g. samples, would entail a much longer time for 100-g. quantities than was desirable, and would mean a number of stirrings to ensure uniform moisture distributions within each sample.

Preliminary tests using the rotary shaker described by Harris and Johnson (3) indicated that a faster rate of revolution was required than 14 r.p.m., and construction of the shaker itself was not well adapted for the number of samples milled by the modified method. Therefore a larger mixing unit was devised, capable of holding twelve jars of wheat. After a number of experiments a rotation rate of 24 r.p.m. and a mixing time of 15 minutes was selected as satisfactory.

Figure 1 is a line drawing of the apparatus finally adopted for tempering the samples for fast micromilling. Essentially this consists of two frames enclosed on three sides but open on the remaining side to facilitate inspection and removal of the samples, which were enclosed in glass 1-pt. jars. The top of each frame was hinged along the back and fastened with metal clips at the front. A support was fastened in the center of each for extra strength. The bottom and top were recessed to hold the jars firmly. Twenty-four jars can be accom-

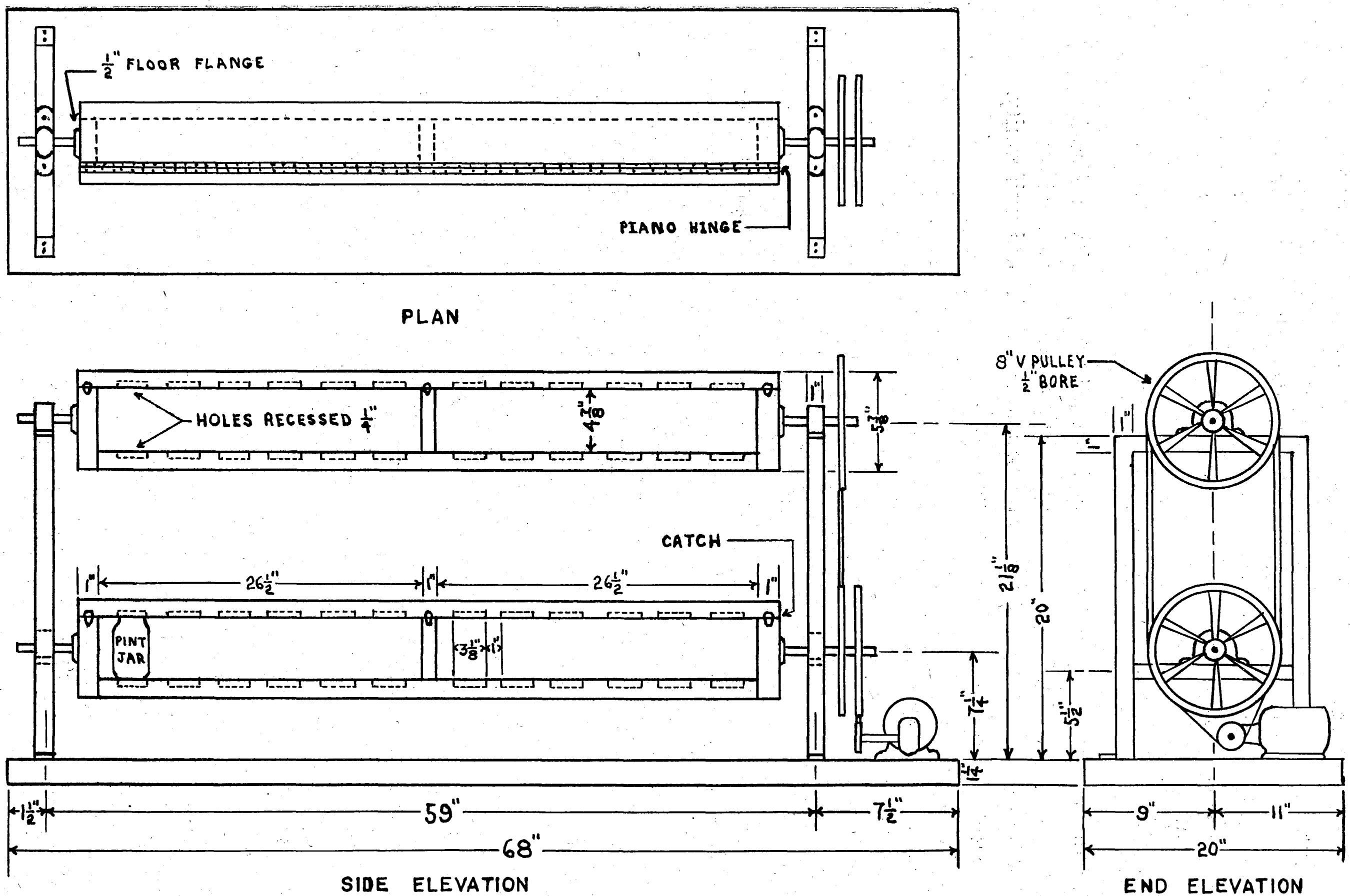

Fig. 1. Tempering apparatus for wheat samples for the modified micromilling procedure.

modated at one time. A 1/12 h.p. motor with attached reduction gear served to rotate the frames at 24 r.p.m. The upper unit was driven from the lower by a pulley and belt. By disconnecting the belt, the lower one could be operated independently. For tempering, a dispenser with finger-tip control connected to a suitable reservoir proved advantageous.

Tempering was as follows: To the weighed wheat samples sufficient distilled water was added to attain a final moisture content of 16.3%. The sample was then shaken thoroughly by hand. Twelve samples were thus treated, then placed in the mixer. Mixing was continued for 7½ minutes, after which the machine was stopped, and each sample jar turned to remove kernels adhering to the sides of the jars. Twelve additional samples, which had been tempered while the first twelve were mixing, were now placed in the upper unit. The lid was then fastened and mixing resumed for another 7½ minutes, yielding a total of 15 minutes of mixing for the first lot, which were now removed from the mixer, shaken for the second time by hand, and set aside until the following morning for milling. The second lot of twelve sample jars was also turned in the mixer as for the first lot of samples, and a third set of twelve tempered samples placed in the machine and rotation resumed. Thus twelve samples can be tempered every 7½ minutes by this procedure after the first 15-minute period.

Milling. A small-scale experimental mill as described by Geddes and Frisell (1) was used. This mill consisted of a bolter, one set of break rolls, and one set of reduction rolls. A modification of the micromilling method described by Geddes and Aitken (2) and Sibbitt, Scott, and Harris (4) was made; this consisted of reducing the number of breaks and reductions to yield a shorter-extraction flour. The milling time per sample was decreased from approximately 20 to 5 minutes, increasing the number milled to approximately 80 per day. The flow

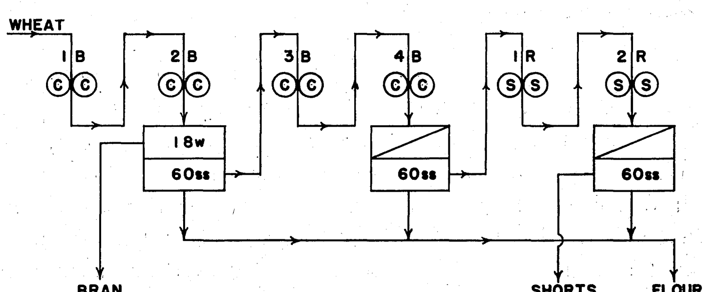

Fig. 2. Flow sheet used in the modified micromilling procedure for hard red spring wheats. W = wire; SS = stainless steel.

sheet used is shown in Fig. 2. It consists of four breaks and two reductions, with bolting after only the second and fourth break and the second reduction. First break rolls were set 0.020 in. apart. The material was then repassed through the break rolls at the same setting and then bolted, using 18W and 60SS sieves. Bran remaining on the 18W sieve was discarded. Material on the 60SS sieve was ground on the third break, using a roll spacing of 0.003 in., then passed through the fourth break at the same setting without bolting. The stock was then sifted through the 60SS sieve and the material remaining on the sieve passed through the first reduction with the rolls barely touching. The material was then passed through the second reduction at the same roll spacing. Material remaining on the 60SS sieve which consisted of shorts and low-grade flour was discarded. The throughs consisted of the 50% extraction flour.

Abnormal milling characteristics were easily detected by this new method. Preliminary studies made on a series of wheats by both the standard micromilling procedure and the modified rapid method showed a good relationship between the quality factors examined.

The baking method employed was malt-phosphate-bromate with 5% sucrose and a 3-hour fermentation period (4). The 25-g. flour doughs were mixed in a National micro mixer using variable mixing times.

The method used for evaluation of the mixograms is one developed in this laboratory and consists of a series of eight standard curves which range from a "very strong" to an "extremely weak" classification. A numerical score is assigned to each classification to facilitate obtaining an average figure when necessary. Included in these standards are the mixing time, mixing tolerance, and band width. An unknown curve is compared against the standards and the proper classification assigned. This procedure is very rapid, eliminates the necessity of measuring each individual curve, and gives a single-figure score, which is most desirable.

Results

Table I shows representative data obtained from a series of flours milled by this method. Several of the hybrids were not baked because of unsatisfactory mixing charateristics. In a previous (unpublished) study it was found that flour protein and ash content corresponded very well with those obtained from flour milled by the original micro method. Naturally, by the modified milling method flour yield was much lower, but varied significantly between samples. The flour was darker and more specky. Loaf volume and crumb color tended to be

TABLE I

MISCELLANEOUS DATA ON SAMPLES MILLED BY THE MODIFIED METHOD

1958 Lab. No.	Wheat Protein [a]	Flour Protein [a]	Flour Ash [a]	Flour Yield	Mixo-gram Classification [b]	Loaf Volume	Crumb Color [c]
	%	%	%	%		cc	
197	14.8	13.9	0.45	53.7	3	200	7.0
203	14.4	13.4	0.38	52.5	6	135	6.0
215	15.9	15.0	0.46	49.7	4	190	6.0
218	16.5	15.6	0.45	47.1	3		
221	15.2	14.6	0.45	46.7	3		
230	16.0	14.8	0.46	49.9	2		
236	16.3	15.4	0.49	46.5	4	185	5.5
244	16.7	16.3	0.52	52.0	4	175	5.5
253	16.0	15.1	0.43	46.5	7	150	6.0
259	15.6	14.1	0.44	51.3	5	145	5.5
266	16.4	14.7	0.43	51.9	4	175	6.0
271	17.0	15.7	0.45	51.1	3	220	7.0
280	15.3	14.5	0.49	48.3	4	180	6.0
296	16.6	15.5	0.52	47.1	2		
302	13.8	12.7	0.41	51.2	7	195	6.0
307	13.4	12.2	0.45	52.5	6	180	6.0
309	13.4	11.2	0.41	47.5	6	175	7.5
311	13.5	11.8	0.49	53.4	6	185	5.5
314	13.7	12.6	0.43	54.7	5	200	5.5
319	13.0	12.3	0.56	49.5	6	180	5.5
323	14.0	12.8	0.48	54.8	6	195	8.0
325	13.7	12.4	0.46	49.5	4	185	6.5
330	13.6	12.2	0.43	53.1	6	180	7.5
333	14.3	12.7	0.46	53.1	6	190	6.5
338	13.7	12.4	0.46	53.3	4	185	5.5
340	13.9	12.5	0.46	53.1	4	185	7.0
342	13.5	12.4	0.46	48.7	5	175	6.0
344	14.1	12.5	0.49	49.5	3	170	5.5
Mean	14.8	13.6	0.46	50.7	4.5	181	6.2

[a] Expressed on 14.0% moisture basis.
[b] Mixogram classifications: 1, 2, 3 are unsatisfactory curve types; 4, 5 are questionable curve types; 6, 7, 8 are satisfactory curve types.
[c] Crumb color: perfect score 10.0.

below the values of flour milled by other procedures. Mixogram patterns were determined at a constant absorption level, and resembled those obtained from the flour produced by the standard micromilling method using the baking absorption.

For early testing and screening of wheat samples the modified method should be more suitable than the original procedure. More samples can be milled in one day, and a slightly smaller quantity of wheat is needed. It is particularly advantageous for obtaining an early concept of mixing requirements, and assists in determinations of probable baking quality.

The method was also used with the Allis to see whether this mill could be substituted for the micro mill, since most cereal laboratories

TABLE II

RESULTS OBTAINED FROM ALLIS MILL WITH MODIFIED METHOD

SAMPLE WEIGHT	MILLING TIME		YIELD [a]	
g	*minutes*	*seconds*	*g*	*%*
2000	14	20	655.0	32.8
1000	8	15	320.0	32.0
500	7	5	180.0	36.0
200	5	55	57.8	23.9
150	4	30	43.0	28.6
100	4	25	27.5	27.5

[a] Bran high in endosperm content.

do not have the latter. The results obtained with samples of various sizes are shown in Table II. While the time required to mill 200 g. or less of wheat corresponded closely to that of the micro mill, the flour yield was much lower (by about 25%). At least 200 g. of wheat would be needed to yield sufficient flour for mixogram and baking tests, and this increases the milling time per sample approximately 1 minute. The more important consideration, however, is the larger quantity of wheat necessary to produce sufficient flour for adequate testing.

It was not possible to clean up the bran, and this contributed to the low flour yield. The flour compared satisfactorily with that produced in the micro mill. On the third and fourth break a reduced feed rate was required to prevent flaking. Somewhat more time was found necessary to clean the mill between samples and remove adherent flour from the mill interior than with the micro mill.

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