A 30-Minute Conditioning Method for Micro-, Intermediate-, and Large-Scale Experimental Milling of Soft Red Winter Wheat

P. L. FINNEY and L. ANDREWS[1]

ABSTRACT

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Conditioning wheat in 30 min involved a 2% pretemper for 15 min, a prebreak, a final temper for 15 min and an optional second prebreak. The method was highly successful for milling 200 g of soft red winter wheat on two Quadrumat Juniors, 1.5 kg on an Allis-Chalmers mill, or 10 kg on a Miag Multomat mill. Flour moisture, yield, ash, damaged starch, and cookie quality were comparable whether tempered 18–24 hr or tempered a total of 30 min using the prebreak methods described.

Finney and Bolte (1985) described a 30-min temper for micromilling hard winter wheat. Flour yield, moisture, protein, and ash values of straight-grade flour were comparable to those of flour micromilled from wheat tempered 18–24 hr. Those authors reviewed the pertinent literature on micromilling and tempering.

The primary purpose of this study was to determine whether soft wheat could also be given a 30-min temper time and produce micromilled flours with yield, moisture, ash, damaged starch, and cookie quality comparable to those tempered 18–24 hr. The secondary purpose was to determine whether 1.5 or 10 kg quantities of soft wheat tempered for 30 min and experimentally milled on an Allis-Chalmers or Miag Multomat mill would yield straight-grade flours comparable to those tempered for 18–24 hr.

MATERIALS AND METHODS

Wheat Samples

About 90 kg of soft red winter (SRW) wheat from a commercial mill was separated into two lots. Half of the mix was maintained at the original moisture of 11.9%; the other half was dried in a forced-air oven (95° F) until the moisture was reduced to 10.2%.

Each wheat lot was blended thoroughly, lightly cleaned on a modified Carter-Day dockage tester, and scoured on a modified Forster scourer. Samples usually are scoured after tempering before milling; however, because of the treatments involved, there was no second scouring.

Moisture and Ash Contents

Moisture and ash contents of wheats and flours were determined by AACC approved methods 44-15A and 08-01, respectively (AACC 1983). Damaged starch levels were estimated as described

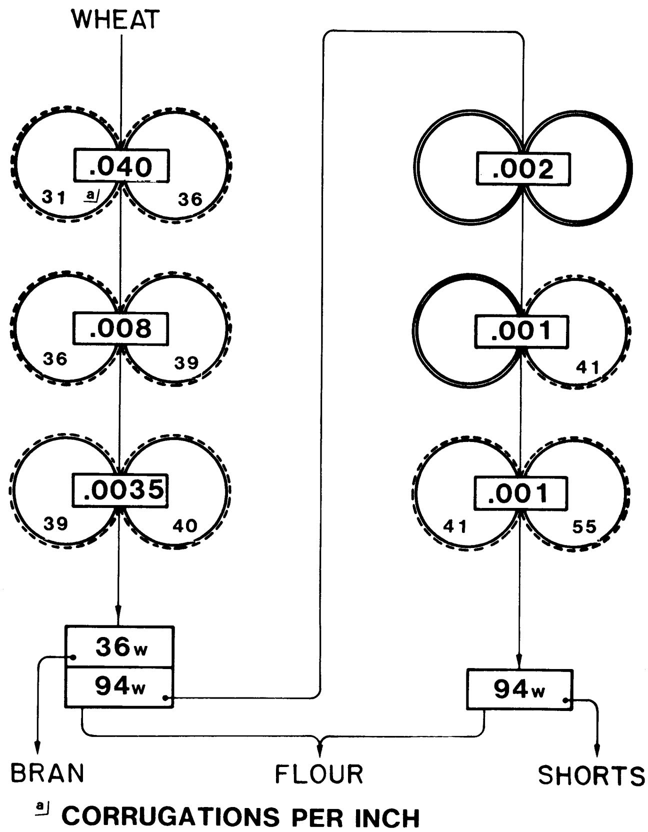

Fig. 1. Flow diagram for the two Quadrumat Junior mills. Roll corrugations vary from 31 to 55/in. Roll gaps vary from 0.001 to 0.040 in. Wire (W) mesh sieves are 36 and 94 squares/in.

[1]Research food technologist in charge and biological technician, respectively, Soft Wheat Quality Laboratory, USDA-ARS, Ohio Agricultural Research and Development Center, Department of Agronomy, Wooster 44691.

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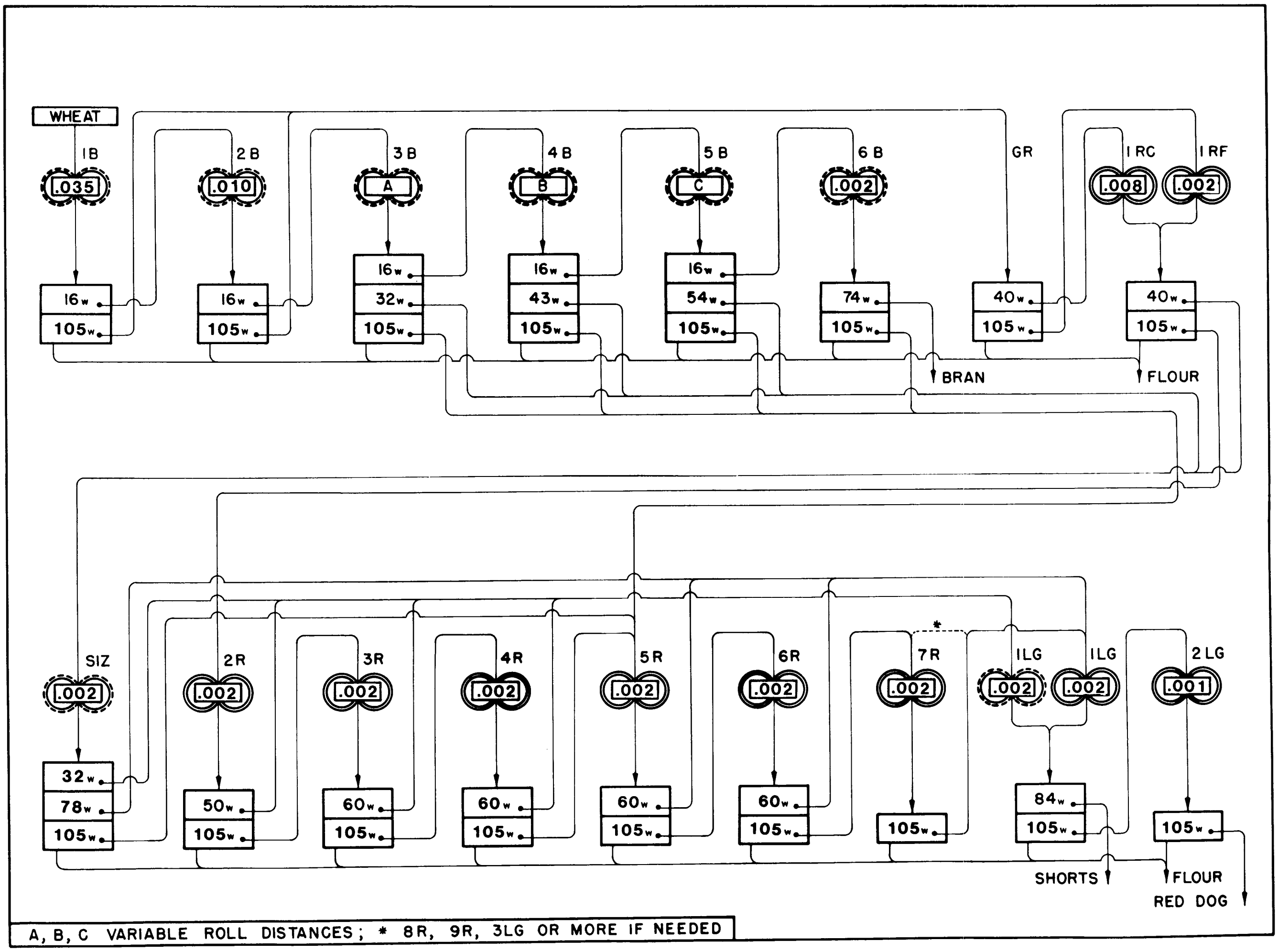

Fig. 2. Flow diagram for the six-break Allis-Chalmers mill with variable reductions. Roll corrugations for the six breaks are 14, 20, 20, 20, 20, and 24/in., respectively. Roll gaps vary from 0.001 to 0.035 in. Wire (**W**) mesh sieves vary from 16 to 105 squares/in.

by Donelson and Yamazaki (1962). Cookies were produced using the micro method D, as described by Finney et al (1950).

Tempering and Prebreak Methods

Tempering water was sprayed on the wheat samples as they rotated in closed stainless steal tumblers. Soft wheat lots (200 g) were tempered to 14.0% for milling on the Quad Junior. For Allis-Chalmers (1.5 kg) and Miag Multomat (10 kg) milling, the soft wheats were tempered to 15.0%.

Wheats were tempered and prebroken by six procedures designated I to VI. Method I: 2% pretemper for 15 min, prebreak through Tag-Heppenstahl (Tag) corrugated rolls (28 corrugations/in., 0.063-in. gap); a second 15-min temper to achieve final milling moisture; a second prebreak through the Tag rolls; then milled on all experimental mills. Method II: Same as method I, except the Allis-Chalmers mill first break was at a 0.020-in. instead of 0.035-in. gap. Method III: Same as method I, except 2nd prebreak was omitted. Method IV: Same as method III, except the Tag rolls were smooth. Method V: Same as method III, except prebreak was on the Miag Multomat reduction rolls (0.055-in. gap) Method VI: Same as method III, except prebreak was on the Allis-Chalmers 1st break rolls (0.067-in. gap).

Experimental Mills

Three mills were used to evaluate the tempering and prebreak methods. The two Quradrumat Junior mill stands had four finely corrugated rolls in the head stand and two smooth and two finely corrugated rolls in the tail stand (Fig. 1). The Allis-Chalmers mill had six breaks and a variable number of reductions (Fig. 2). The 6-in. diameter Allis-Chalmers roll pair had 14 corrugations per inch

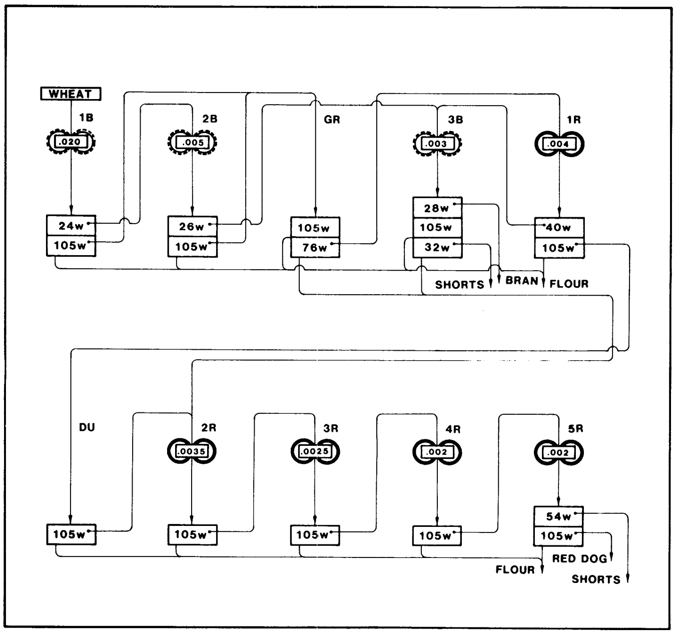

Fig. 3. Flow diagram for the three-break Miag Multomat mill with five reductions. Roll corrugations for the three breaks are 13, 19, and 24/in., respectively. Roll gaps vary from 0.020 to 0.002 in. Wire (**W**) mesh sieves vary from 24 to 105 square/in.

and a roll speed differential of 1.5 to 1 rotating dull to dull. Various milling parameters included break flour yield, straight-grade flour yield, endosperm separation index, and friability. The Miag Multomat mill consisted of three breaks and five reductions. The Miag reduction rolls were 10 in. in diameter, frosted, and had a 1.5 to 1 speed differential. The mill flow (Fig. 3) was slightly different from the usual.

RESULTS AND DISCUSSION

Quadrumat Junior Milling

The SRW wheat control (11.9% moisture) had a straight-grade flour yield of 68.2%, and flour moisture and ash contents of 13.0% and 0.363%, respectively (Table I). The control flour was estimated to contain 2.52% damaged starch. Method I, which involved a pretemper of 2.1% for 15 min, a prebreak, a 15-min rest, and a second prebreak, yielded 67.8% flour with 0.364% ash. Method VI substituted a single prebreak on the Allis-Chalmers first break after the pretemper for the double Tag prebreak in Method I. Method VI gave a flour yield of 68.5%, with a flour moisture, ash, and damaged starch content of 12.8%, 0.363%, and 2.54%, respectively (Table I). Similar flour yield, moisture, and ash data were obtained for the SRW wheat that contained 10.2% moisture (Table I).

Allis-Chalmers Milling

Prebreaking with Tag rolls. The SRW wheat control (11.9% moisture) yielded 75.3% of straight-grade flour with 0.384% ash and 2.08% damaged starch (Table II). Method I yielded 74.2% flour (significantly different from the control) with 0.38% ash and 1.95% damaged starch. It was assumed that the first-break roll gap of 0.035 in. on the Allis-Chalmers was too great. When the roll spacing was adjusted to 0.020 in., and the treatment repeated (method II), the yield only increased slightly to 74.4%. There appeared to be an excessive cutting of the bran by the Tag rolls. Usually the bran flakes are retained at as large a size as possible for as long as possible to produce high flour yield with minimum ash.

TABLE I
Pretemper, Temper Time, and Prebreak Study on Soft Red Winter Wheats Milled on the Quadrumat Junior

Treatment	First Prebreak Rolls & Gap (in.)	Second Prebreak Rolls & Gap (in.)	Flour[a] Moisture (%)	Yield (%)	Ash (%)	Damaged Starch (%)	Cookie Diameter (cm)
Control (18-24 hr temper)	···	···	13.0	68.2	0.363	2.52	18.0
Wheat moisture 11.9%[b]							
I	Tag (0.063)	Tag (0.063)	12.8	67.8	0.364	···	17.9
VI	Allis-Chalmers (0.067)	···	12.8	68.5	0.363	2.54	17.9
Control (18-24 hr temper)	···	···	13.0	68.1	0.359	···	18.0
Wheat moisture 10.2%[c]							
I	Tag (0.063)	Tag (0.063)	12.7	67.8	0.369	···	17.9
VI	Allis-Chalmers (0.067)	···	12.8	68.0	0.377	···	17.9
Standard deviation				0.30	0.006	0.073	
Least significant difference ($n = 9$; $P = 0.05$)				0.68	0.014	0.147	

[a]Reported on a 14% moisture basis.
[b]2.1% Pretemper for 15 min, prebreak, 15-min wait, second prebreak when indicated, and milled.
[c]Final temper to 14.0%.

TABLE II
Pretemper, Temper Time, and Prebreak Study on Soft Red Winter Wheats Milled on the Experimental Allis-Chalmers

Treatment	First Prebreak Rolls & Gap (in.)	Second Prebreak Rolls & Gap (in.)	Allis-Chalmers Mill 1st-Break Gap (in.)	Flour[a] Moisture (%)	Yield (%)	Ash (%)	Damaged Starch (%)
Control (15% temper for 18–24 hr)			0.035	13.6	75.3	0.384	2.08
Wheat moisture 11.9%[b]							
I	Tag (0.063)	Tag (0.063)	0.035	13.7	74.2	0.380	1.95
II	Tag (0.063)	Tag (0.063)	0.020	13.7	74.4	0.382	···
III	Tag (0.063)	···	0.035	13.5	74.6	0.379	···
IV	Tag smooth (0.063)	···	0.035	13.7	74.9	0.376	2.08
V	Miag smooth (0.055)	···	0.035	13.5	74.8	0.366	2.28
VI	Allis-Chalmers 1st break (0.067)	···	0.035	13.7	75.1	0.379	2.24
Standard deviation					0.08	0.004	
Control (15% temper for 18–24 hr)			0.035	13.5	74.5	0.358	···
Wheat moisture 10.2%[b]							
I	Tag (0.063)	Tag (0.063)	0.035	13.3	74.8	0.392	···
II	Tag (0.063)	Tag (0.063)	0.020	13.3	74.1	0.379	···
III	Tag (0.063)	···	0.035	13.5	74.8	0.381	···
IV	Tag smooth (0.063)	···	0.035	13.2	74.9	0.382	···
V	Miag smooth (0.055)	···	0.035	13.5	75.2	0.388	···
VI	Allis-Chalmers 1st break (0.067)	···	0.035	13.2	75.2	0.387	···
Standard deviation					0.15	0.007	
Standard deviation, all samples					0.14	0.005	0.073
Least significant difference ($n = 20$; $P = 0.05$)					0.28	0.010	0.147

[a]Reported on a 14% moisture basis.
[b]Final temper to 15.0%.

Thus, the method was modified by eliminating the second pass through the Tag rolls (method III), resulting in a slightly higher flour yield of 74.6% (significantly different from the control) and a flour ash of 0.379%. The lower flour yield prompted us to investigate the zero differential of the Tag rolls by replacing the corrugated Tag rolls with a pair of smooth rolls (method IV). Method IV produced a 74.9% flour yield with flour ash and damaged starch content of 0.376% and 2.08%, respectively. This was a distinct improvement, because the ash was significantly lower than the control ash of 0.384% (Table II). A slight adjustment during the milling process could easily increase the yield without producing ash higher than the 0.384% of the control flour (Table II).

Similar flour yields were obtained for the SRW wheat that contained 10.2% moisture when prebreaks were made with Tag rolls, but flour ash contents averaged 0.383%, which was 0.025% higher than that of the control (0.358%). The average ash of 0.383%, however, is desirably low for a straight-grade flour and is equal to that of the flour from SRW wheat that contained 11.9% moisture.

Prebreaking with Miag Multomat rolls. The Miag Multomat first reduction rolls spaced at 0.055 in. (method V) gave a flour yield (74.8%) that was slightly less than the control, but the flour ash content was only 0.366% (Table II). Thus, this procedure was successful because only minor mill adjustments would be needed to increase the extraction to that of the control (75.3%) without exceeding the control flour ash of 0.384%. The lower ash content likely resulted from less shattering of the bran by the smooth prebreak rolls. However, the damaged starch content of the flour produced by method V was slightly higher than the control (2.28%). The low-moisture (10.2%) lot of wheat performed well when the Miag smooth rolls (0.055 in.) were used for the prebreak, especially in relation to the control at 11.9% moisture.

Prebreaking with Allis-Chalmers break rolls. Method VI produced a flour yield of 75.1%, a flour ash of 0.379%, and a damaged starch content of 2.24% (Table II). The slight increase in yield over the other treatments may be attributable to the corrugated rolls of the first break at the 1.5 to 1 differential. The differential rolls open the kernel without excessive bran shattering and also provide some scraping of the bran to remove flour. The Miag reduction rolls opened the kernel and produced minimal bran breakage, but did not scrape the bran. The corrugated Tag rolls crushed the kernel somewhat and also left deep, undesirable slashes in the seed coat. Using corrugated rolls in conjunction with roll speed differential caused the slow roll to hold the grain while the faster roll broke open the kernel without cutting the bran excessively. It is apparent that a 30-min, two-stage temper can be applied successfully so that milling yields and flour ash contents are essentially equal to those for wheats tempered for 18–24 hr.

The low-moisture (10.2%) wheat performed well when the Allis-Chalmers first-break rolls spaced at 0.067 in. were used for the prebreak, especially in comparison with the control at 11.9% moisture. A flour ash content of 0.387% is desirably low for an SRW straight-grade flour.

Miag Milling

The Miag milling of SRW wheat after a temper time of only 30 min presented no problems. Flour yields and ash contents for both wheats (11.9% and 10.2% moisture) were similar to those of the control (Table III). In addition, both the control and method VI (with wheat at 11.9% moisture) contained comparable starch damage. It appears that, with the aid of a prebreak, 30 min was sufficient time for the water to penetrate the seed and disperse throughout the endosperm.

TABLE III
Pretemper, Temper Time, and Prebreak Study on Soft Red Winter Wheats Milled on the Miag Multomat

Treatment	First Prebreak Rolls & Gap (in.)	Flour[a] Moisture (%)	Yield (%)	Ash (%)	Damaged Starch (%)
Control (18–24 hr temper)	···	13.1	71.2	0.363	2.60
Wheat moisture 11.9%[b]					
III	Tag (0.063)	13.2	70.7	0.375	···
VI	Allis-Chalmers 1st break (0.067)	12.9	71.4	0.373	2.54
Control (18–24 temper)	···	12.8	71.2	0.371	···
Wheat moisture 10.2%[b]					
VI	Allis-Chalmers 1st break (0.067)	12.4	70.6	0.371	···
Standard deviation, all samples			0.17	0.005	0.073
Least significant difference ($n = 8$; $P = 0.05$)			0.40	0.010	0.147

[a]Reported on a 14% moisture basis.
[b]Final temper to 15.0%.

CONCLUSION

Important Considerations

These methods may also be applicable commercially for saving time, equipment, and space. Eliminating the relatively long period between tempering and milling would allow continuous processing of dry wheat into flour and permit quick changes in mill mixes. The 30-min conditioning would virtually eliminate the need for large holding tanks for tempered wheat. Only one relatively small tank would be required for continuously holding wheat for about 30 min after first cleaning and then conditioning the desired mill mix. An additional benefit would likely be for the refrigerated dough and other food-processing industries that require low microbiological counts in their flours. The 30-min conditioning method, however, would make a breakdown in the cleaning operations more critical. Back-up cleaning equipment would probably be required.

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