A Dough Height Tracker and Its Potential Application to the Study of Dough Characteristics[1]

R. H. KILBORN and K. R. PRESTON

ABSTRACT

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An instrument, the Grain Research Laboratory dough height tracker, which can be used to follow the expansion (or fall) of doughs during fermentation and proofing, is described. It consists of a lightweight low friction piston that is placed on the dough surface. The movement of the piston is translated into an electric signal proportional to the dough height. The instrument is designed for small scale to medium scale doughs (300 g of flour or less) and can measure changes in dough heights of up to 110 mm. No noticeable dough deformation is produced by the instrument, allowing further processing without any adverse effects.

Changes occurring in the gas retention properties of wheat doughs during the fermentation and proofing stages of bread production play an important role in end-product quality. A number of instruments have been described for the measurement of gas retention in dough. They can be grouped into two major types. The first type, reviewed by Bloksma (1971), involves the measurement of changes in dough volume in closed containers with instruments normally designed to measure gas production. In these techniques, carbon dioxide escaping from the dough is absorbed in alkali solution. The other major type, designed to measure changes in dough height, involves instruments such as the Brabender Maturograph (Shuey 1975), the Brabender Oven-Rise Recorder with modifications (Marek and Bushuk 1967), and the Riseometer, which measures changes in dough height of commercial sized doughs (Garnetz et al 1949). However, with the exception of the Riseometer, the major disadvantage of these instruments is that

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further processing of the doughs to bread is generally not possible.

In our laboratory, studies have been initiated to determine the relationships between the gas retention properties of fermenting and proofing doughs and bread quality. This paper describes an instrument, the Grain Research Laboratory (GRL) dough height tracker, that can be used to record the expansion (or fall) of doughs during fermentation and/or proofing and that allows the same piece of dough to be further processed into bread.

MATERIALS AND METHODS

Two flours, one milled from No. 1 CWRS-13.5, a Canada Western red spring wheat (CWRS), and one from a No. 1 Canada Western red winter wheat (CWRW), were used in the present study. Properties of these flours are shown in Table I.

Modified Sponge-and-Dough Procedure

For demonstrating the use of the dough tracker, the GRL sponge-and-dough procedure (Kilborn and Tipples 1968) was used with modifications. This procedure was designed to test the performance of flours under conditions of high speed mixing (GRL-200 mixer, 135 ± 2 rpm using a 6-sec time base for speed measurement) for both sponge and dough stages in which a long fermentation time was given to a high proportion of the flour. It included ingredients and ingredient levels similar to those of commercial practices. Table II shows the ingredient formulas used for the sponge and dough. The sponge was made from 70% of the total flour at 2% below final absorption and was mixed for 2.5 min. The sponge was then placed directly into a lightly greased glazed crockery bowl (ID = 148 mm, height = 100 mm) with a vertical wall and fermented for 270 min in a dual chamber proofing cabinet at 27 ± 1°C and a relative humidity of 90 ± 2%. The sponge and the remaining 30% of the flour and other ingredients, as shown in Table II, were then mixed to approximately 10% (either time or energy) past peak consistency as judged from the mixing curves. Final dough temperature was 30.0 ± 0.5°C. Doughs were rested in a fermentation cabinet at 30.0 ± 0.5°C for 15 min, punched, and returned to the cabinet for a further 15-min period. Doughs were then sheeted and molded, placed in baking pans, proofed for 70 min at 37.8 ± 0.5°C, and baked for 30 min at 216°C.

Good loaf volume reproducibility was demonstrated with the method by baking eight loaves of a CWRS wheat flour each day for three days. Means and standard deviations for the three days were calculated as 2,000 ± 26.7 cc, 2,035 ± 40.4 cc, and 2,041 ± 42.1 cc.

TABLE I
Properties of No. 1 Canadian Western Red Spring (CWRS)[a] and No. 1 Canadian Western Red Winter (CWRW) Flours[b]

	CWRS	CWRW
Flour		
Yield (%)	74.2	75.6
Protein (%)	13.0	10.1
Ash (%)	0.47	0.46
Starch damage (Farrand units)	32	21
Amylograph peak viscosity (BU)	535	350
Farinograph		
Absorption (%)	64.5	58.7
D.D.T. (min)	5.25	5.50
Extensigraph area (cm^2)	135	120

[a]Officially designated No. 1 CWRS-13.5, indicating guaranteed protein content.
[b]Data based on 14% moisture basis.

TABLE II
Formulas Used for Modified GRL Sponge-and-Dough Method

Ingredients	Sponge (g)	Dough (g)	Total[a] (%)
Flour	140	60	100
Yeast	4.0	···	2.0
Salt	0.30	4.5	2.4
Ammonium phosphate	0.20	···	0.1
Sucrose	···	10.0	5.0
Shortening	···	6.0	3.0
Skim milk powder	···	4.0	2.0
Malt syrup (60°L)	0.40	0.20	0.3
Water with:			
Canadian Western red spring flour[b]	90 (64%)	42	66
Canadian Western red winter flour[b]	85 (61%)	41	63
Potassium bromate[b]	0.003	0.001	20 ppm

[a]On flour weight basis (14% moisture).
[b]Added at optimum levels.

Description of GRL Dough Tracker

The GRL dough tracker is shown schematically in Fig. 1. Changes in dough height are measured by the vertical motion of a Teflon pad attached to a counterweighted low-friction Teflon piston. This vertical motion is converted to rotary motion through a rack and gear arrangement. The hub of the gear is attached to the shaft of a linear potentiometer with very low torque, to which is applied a precision-regulated voltage. The movement of the piston is thereby translated at the slider of the potentiometer into a voltage, the magnitude of which is directly related to the position of the piston. This voltage drives a differential amplifier that supplies voltage to a chart recorder. Each tracker amplifier is calibrated to produce

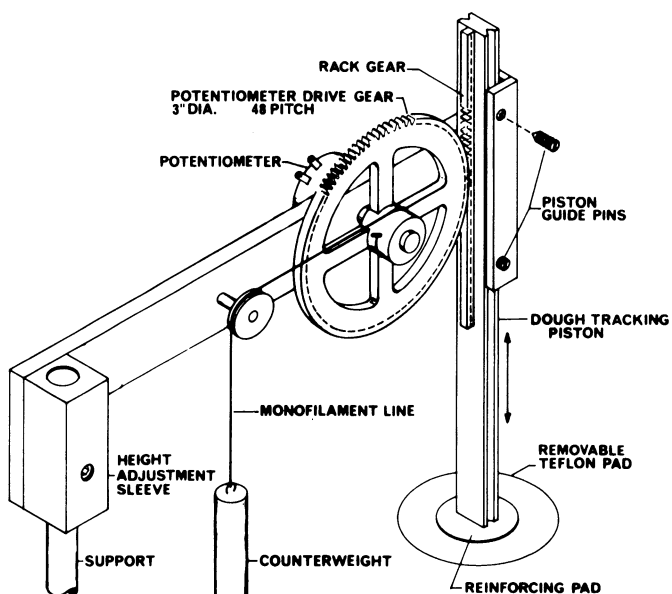

Fig. 1. The Grain Research Laboratory dough height tracker.

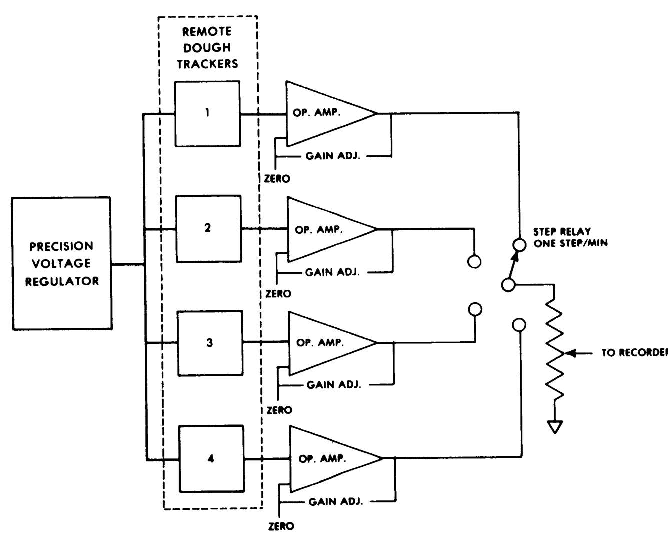

Fig. 2. Tracker output signal control.

full-scale deflection for 100-mm movement of the dough tracker piston. The maximum travel range of the piston is 110 mm. By adjusting the height of the support sleeve, dough heights up to 160 mm can be measured with tracking beginning at 50 mm.

Normally four dough trackers are used simultaneously with one recorder. A step relay controlled by a timer supplying one stepping pulse each minute sequentially selects the output signal from each amplifier (Fig. 2). Differentiation of recorder traces for each of the four doughs being tracked is normally achieved by offsetting the zero levels by different amounts on the recorder.

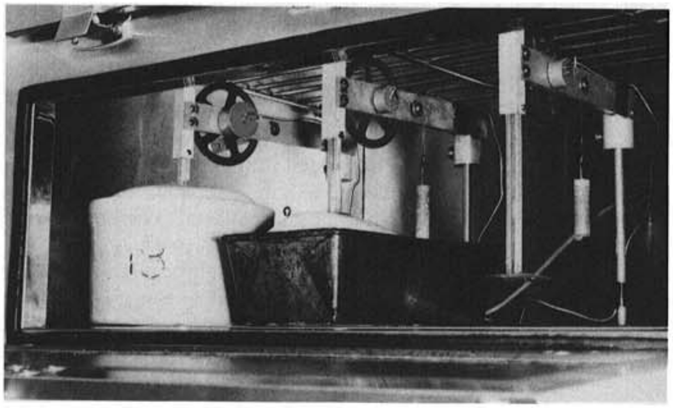

Fig. 3. Right, GRL dough height tracker; **middle,** final (pan) proofing of dough made from No. 1 Canadian Western red spring-13.5 flour; **left,** sponge made from same flour.

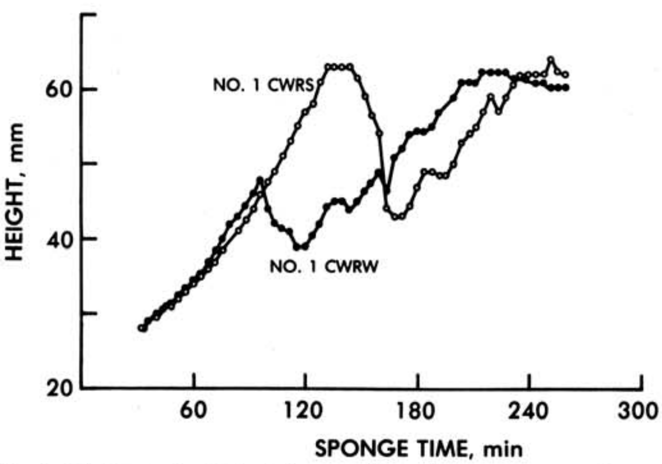

Fig. 4. Heights, during 270-min fermentation, of sponges prepared from a No. 1 Canadian Western red spring-13.5 (CWRS) flour and a No. 1 Canadian Western red winter (CWRW) flour.

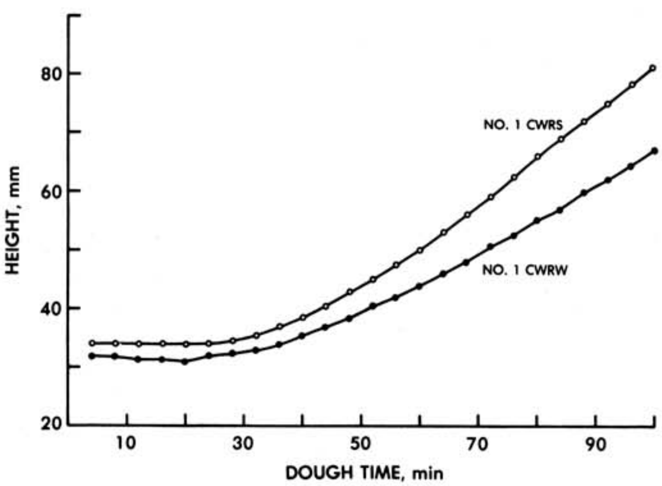

Fig. 5. Heights, during 100-min recovery time, of doughs prepared from a No. 1 Canadian Western red spring-13.5 (CWRS) flour and a No. 1 Canadian Western red winter (CWRW) flour.

RESULTS AND DISCUSSION

Application of Tracker to Fermenting and Proofing Dough

The two wheat flours were processed by the modified GRL sponge-and-dough procedure to illustrate the application of the dough tracker. Loaf volumes obtained with the CWRS and CWRW flours were 2,100 cc and 1,700 cc, respectively. Use of the dough tracker at any of the processing stages had no noticeable effect upon final bread characteristics.

Figure 3 illustrates the dough tracker and its use during final (pan) proofing and sponge fermentation with the CWRS sample. Curves obtained during the sponge stage from the two wheat types over a period of 270 min are shown in Fig. 4. Initial rise and fall characteristics with respect to peak time and height were distinctly different, with the CWRS sponge attaining a much higher height at a later time than did the CWRW sponge. After a 4-hr fermentation, however, both sponges attained similar heights. Good reproducibility of sponge curves was obtained. For example, the means and standard deviations for initial sponge peak height, time to initial peak, and final sponge height (after 270 min) for eight CWRS sponges measured on different days were 64.2 ± 3.3 mm, 131 ± 7.3 min, and 62.3 ± 5.3 mm, respectively.

Figures 5 and 6 show curves for the dough recovery and proof stages, respectively, for the two wheats. In the example shown in Fig. 5, the normal dough time of 30 min was extended to 100 min with no punching. Differences in the initial (zero time) heights of the two doughs did not change up to about 40 min of dough time, but thereafter the height of the CWRS dough increased more rapidly than did that of the CWRW dough. This suggested that, as expected, the gas retention properties of the CWRS dough were greater than those of the CWRW dough. Differences in proof heights between the two doughs (Fig. 6) were even more dramatic. Differences in dough heights were evident after only 10 min. After the normal proof time of 70 min, the CWRS dough was 21 mm higher than the CWRW dough. This difference in gas retention properties is probably partially responsible for the larger loaf volume of the bread produced from the CWRS dough.

Reproducibility of dough heights during proofing was excellent.

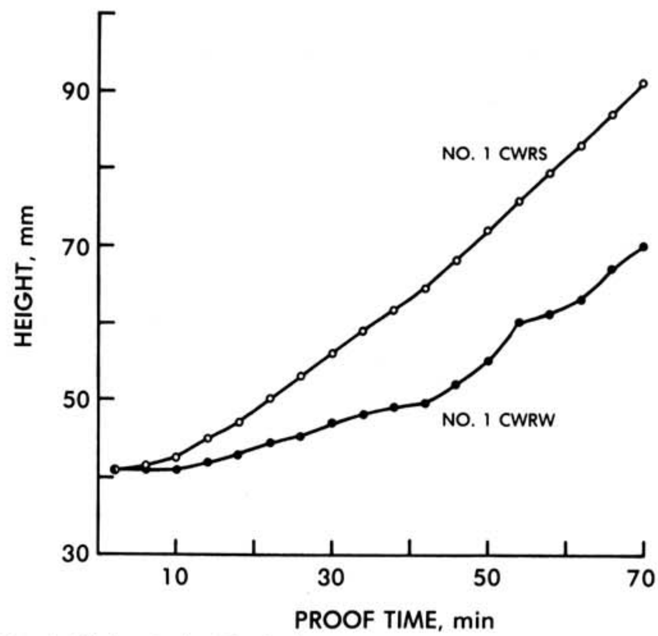

Fig. 6. Heights, during 70-min final (pan) proofing, of doughs prepared from a No. 1 Canadian Western red spring-13.5 (CWRS) flour and a No. 1 Canadian Western red winter (CWRW) flour.

For the CWRS flour, the mean and standard deviation of four doughs after 40 min of proofing was 61.4 ± 0.5 mm and after 70 min, 90.1 ± 1.4 mm.

Although in the present study, the use of the GRL dough tracker has been restricted to a sponge-and-dough procedure, other studies in our laboratory have shown that this instrument is equally effective for following dough rise characteristics with straight dough and Chorleywood types of baking procedures. In addition to studies of wheat class and varietal differences in dough rise characteristics during various stages of bread-making procedures, we have found the dough tracker useful for studying the effects of various ingredients such as oxidants, reductants, yeast, and salts upon dough rise properties of fermenting and proofing doughs.

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