The Do-Corder as a Possible Tool to Evaluate the Bread-Making Properties of a Dough

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ABSTRACT

Do-Corder curves distinguished between a bromated dough (two peaks in the curve at 75 and 85°C), a dough with added ascorbate (one peak at 75°C), and control dough with no additive (one peak at 85°C). These three doughs produced loaves with good, medium, and poor volumes, respectively. Do-Corder curves were somewhat different among flours with different bread-making performance. In the presence of bromate, however, all curves were alike and the quality of breads was much improved for all flours. Forty one compounds were tested with the Do-Corder in the presence of ascorbic acid. Nineteen gave two peaks in their Do-Corder curves and were thus similar to bromate in their effect on the curve. Aspartic acid, glutamic acid, cystine, and potassium bitartrate were randomly chosen for straight-dough and sponge-dough baking tests. When incorporated in a dough with ascorbic acid, each of them improved to some extent the quality of bread baked by the straight-dough method. Bread baked from a dough containing cystine and ascorbic acid by the sponge-dough method showed the same baking performance as bread baked from bromated dough. The Do-Corder is a promising tool for predicting the baking performance of a dough containing certain improver additives.

Several rheological and chemical measurements currently employed on dough serve as indices which, when properly interpreted, enhance the probability of satisfactory end-performance. To date, however, none of these is capable of fully predicting the bread-making performance of a dough with or without additives.

In a previous article (Tanaka et al 1980), the Do-Corder showed quite different responses to a variety of oxidants when the instrument was operated at high temperatures. The Do-Corder curve for potassium bromate, the most widely used oxidant, showed two distinct peaks (one at 75 and another at 85°C), whereas the curves for L-ascorbic acid and potassium iodate had only one peak, at 75 and 85°C, respectively.

The research reported here was designed to study the correlation between the Do-Corder curve and the bread-making performance of a dough. A further aim was to investigate the effects on the Do-Corder curve of many other reagents in the presence of L-ascorbic acid and to compare the resulting curves with the curve obtained with bromate.

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MATERIALS AND METHODS

Flour

The flours used for this study were milled on an experimental Buhler mill from the following wheats: No. 1 Canada western red spring (1CW), dark northern spring (DNS), dark hard winter high protein (HP), and Australian prime hard (PH). They were analyzed for protein, ash, and moisture contents according to AACC methods (1962) as shown in Table I. All chemicals used were of standard reagent grade.

TABLE I
Analytical Data (%) on Flours Milled from Various Wheats

Wheat[a]	Protein[b]	Ash	Moisture
1CW	12.7	0.41	14.4
DNS	12.8	0.42	14.6
PH	13.0	0.40	14.2
HP	12.2	0.43	14.3

[a] 1CW = No. 1 Canadian western red spring, DNS = dark northern spring, PH = Australian prime hard, HP = dark hard winter high protein.
[b] N × 5.7 (AACC 1962).

Operation of Brabender Do-Corder

A Brabender Do-Corder was operated as described by Tanaka et al (1980).

Baking Test

Breads were baked by the straight-dough and sponge-dough methods, formulas are given in Table II.

In the straight-dough procedure, doughs were mixed in a Kantoh mixer for 3–4 min at 80 rpm, 2–4 min at 150 rpm, and then 6–7 min at 250 rpm. The times varied among the flours. The dough temperature was 27°C. Fermentation was for 2 hr at 27°C and 75% rh. The dough was punched by hand, given a 20-min intermediate proof at 20°C and 75% rh, and molded on an Oshikiri molder. Proofing was at 38°C and 85% rh for 45 min, and loaves were baked at 215°C for 30 min.

In the sponge-dough process, both sponge and dough received a 1-min premix at 80 rpm to blend ingredients. The sponge was mixed for 2 min at 80 rpm and for an additional 2 min at 150 rpm; its temperature after mixing was 24°C. A 4-hr fermentation at 27°C and 75% rh was used. The mixing time for the dough stage was the same as for the straight-dough method. The dough temperature was 27.5°C and floor time 20 min. The dough was rounded by hand and given an intermediate proof of 20 min at 20°C. The rest of the baking process was the same as for the straight-dough procedure.

The external and internal characteristics of the loaves were scored by a panel one day after baking.

Added Compounds

Forty-one compounds that are allowed as food additives under the Japanese Food and Drug Act (except ethylenediamine tetraacetic acid) were investigated with regard to their effects on the Do-Corder curve when added to doughs at a level of 1,200 ppm based on flour. The flour milled from DNS was used.

Each compound was also added to the flour in the presence of L-ascorbic acid to investigate their combined effect on the Do-Corder curve. Four of the compounds were used in baking tests with the straight-dough method and one with the sponge-dough method.

TABLE II
Formulas for the Two Baking Methods

Ingredients	Straight-Dough	Sponge-Dough: Sponge	Sponge-Dough: Dough
Flour (g)	2,000	1,400	600
Yeast (g)	40	40	...
Salt (g)	40	...	40
Sugar (g)	100	...	100
Nonfat dry milk (g)	...	...	40
Shortening (g)	100	...	100
Water (ml)	1,400	800	500

TABLE III
Effect of Bromate on the Baking Performance of Flours with Different Baking Qualities

Flour from Wheat[a]	Water Absorption (%): Control	Water Absorption (%): Bromated[b]	Loaf Volume (cc): Control	Loaf Volume (cc): Bromated
1CW	76.2	76.2	1,750	1,840
DNS	76.0	76.0	1,730	1,820
PH	71.9	71.9	1,680	1,800
HP	75.2	75.2	1,600	1,800

[a] 1CW = No. 1 Canadian western red spring, DNS = dark northern spring, PH = Australian prime hard, HP = dark hard winter high protein.
[b] Added amount is 10 ppm.

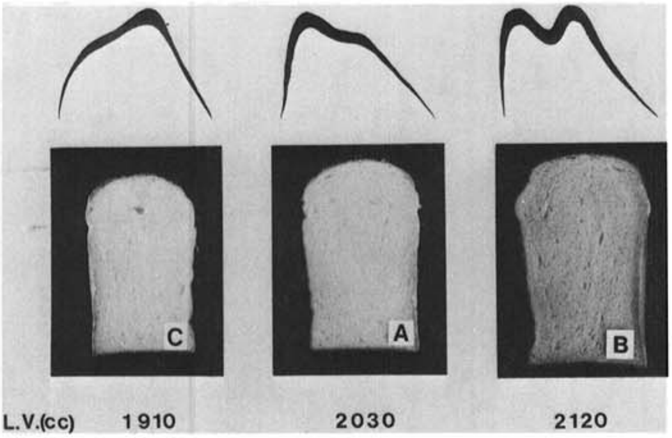

Fig. 1. Comparison of Do-Corder curves at 70% absorption and bread-making performances by the straight-dough method. C = Control, A = ascorbated, B = bromated, L.V. = loaf volume.

TABLE IV
Effects of Compounds on the Do-Corder Curve

Compound	Do-Corder Curve[a]: 75°C Shoulder	Do-Corder Curve[a]: Two Peaks in Presence of Ascorbic Acid
Amino acid		
Glycine	+[b]	−
Alanine	+	+
Glutamic acid	+	+
Aspartic acid	+	+
Methionine	+	+
Histidine	+	−
Cystine	+	+
Cysteine	−	−
Tryptophan	−	−
Leucine	−	−
Arginine	−	−
Organic acid salt		
Malic acid	+	−
Ferrous lactate	+	+
Sodium pantothenate	+	−
Potassium bitartrate	+	+
Ferric citrate	+	−
α-Ketoglutaric acid	+	+
Succinic acid	+	−
Ferric ammonium citrate	−	−
Monosodium succinate	−	−
Monosodium citrate	−	−
Citric acid	−	−
Fumaric acid	−	−
Inorganic salt		
Sodium metaphosphate	+	+
Ammonium alum	+	+
Potassium alum	+	+
Magnesium chloride	+	−
Sodium sulfate	+	−
Sodium tripolyphosphate	−	−
Others		
Caffeine	+	+
EDTA[c]	+	+
Tannic acid	+	−
Albumin	+	+
D-Sorbitol	+	−
Nicotinic acid	+	+
Nicotinamide	+	−
Linoleic acid	+	+
Stearic acid	+	+
GDL[d]	+	+
Pectin	+	−
Xylose	−	−

[a] All compounds gave a peak at 85°C.
[b] + = Present, − = absent.
[c] Ethylenediamine tetraacetic acid.
[d] Glucono delta lactone.

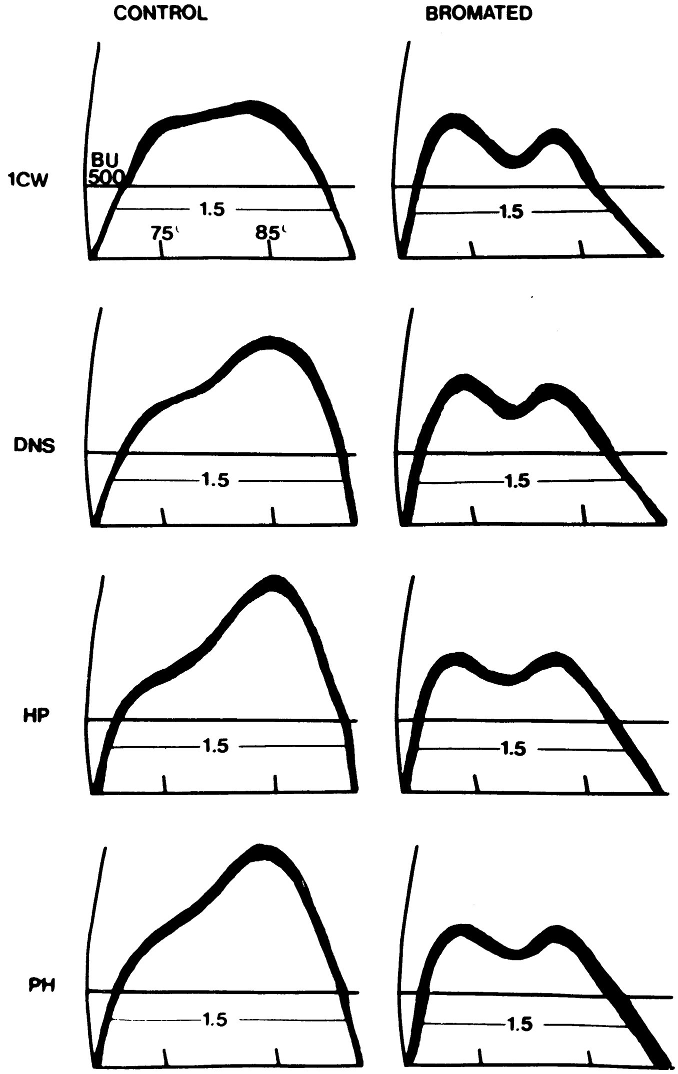

Fig. 2. Effect of bromate on Do-Corder curves for flours with different baking quality. 1CW = No. 1 Canada western red spring, DNS = dark northern spring, HP = dark hard winter high protein, PH = Australian prime hard.

RESULTS AND DISCUSSION

Relationship Between Bread-making Performance and Do-Corder Curve

The Do-Corder curve provided a good reflection of bread-making performance, as indicated by loaf volume of bread baked by the straight-dough method using the flour milled from 1CW (Fig. 1). the loaf from the bromated dough showed the largest loaf volume, whereas that from the untreated one showed the smallest. L-ascorbic acid improved bread-making performance (loaf volume) to a certain extent but not as much as did bromate.

The Do-Corder curve for each dough showed a characteristic and different shape, which might be related to bread-making quality. We postulated that a Do-Corder curve with two distinct peaks at 75 and 85°C (as for bromated dough) would predict good baking quality with a large loaf volume. A dough that gave a curve with one peak at 85°C was likely to produce a poor loaf, such as that for the control dough. One distinct peak at 75°C might indicate intermediate bread-making performance, similar to that of the ascorbated dough. However, if a compound that caused a distinct peak at 85°C (indicative of poor bread-making quality) were incorporated with L-ascorbic acid into a dough, the combination might bring about a curve with two peaks (indicative of good bread-making quality) as observed for the bromated dough. This possibility was tested by screening many compounds for Do-Corder curve characteristics.

Effect of Bromate on Flours with Different Baking Performances

Typical spring and winter wheats mainly used for breadmaking were investigated by determining Do-Corder characteristics and bread-making performance in the absence and presence of bromate. The Do-Corder curve for the control flour from 1CW was different from those of the others (Fig. 2). The curves for HP and PH were similar to each other but somewhat different from the curve for DNS.

In the presence of 1,200 ppm bromate, however, all curves became similar, with two peaks at 75 and 85°C, as described by Tanaka et al (1980).

Test baking by the straight-dough method was conducted for all the flours (Table III). Loaf volume for spring wheats (1CW and DNS) was higher than for winter wheats (HP and PH) in the absence of bromate. With the addition of bromate (10 ppm), loaf volume for all breads increased. The increase for spring wheats was 90 cc and for winter wheats as much as 100–120 cc. Regardless of the type of wheat, bromate improved the quality of bread in terms

TABLE V
Effects of Various Compounds on Bread-Making Properties Using the Straight-Dough Method

	Dough or Bread										
	A	B	C	D	E	F	G	H	I	J	K
Compound ppm											
Potassium bromate	...	10	...	...	...	...	...	...	...	...	...
Ascorbic acid	...	...	6	6	6	6	6	6	6	6	6
Aspartic acid	...	...	...	15	30	...	...	...	...	...	...
Glutamic acid	...	...	...	...	...	15	30	...	...	...	...
Cystine	...	...	...	...	...	...	...	15	30	...	...
Potassium *d*-bitartrate	...	...	...	...	...	...	...	...	...	15	30
Bread property											
Loaf volume (cc)	1,890	2,030	1,950	2,010	2,000	2,010	2,020	2,010	2,020	1,970	1,970
Loaf volume rating[a] (1–15)	11.1	13.3	12.5	13.1	13.0	13.1	13.2	13.1	13.2	12.7	12.7
Crust color rating (1–10)	7.5	7.7	7.7	7.7	7.6	7.4	7.5	7.8	7.8	7.5	7.5
Crust characteristic rating (1–15)	9.8	11.6	11.0	11.6	11.0	11.3	11.3	11.6	11.9	11.4	11.3
Crumb color rating (1–10)	6.4	7.5	7.5	7.4	7.4	7.7	7.7	7.5	7.4	7.5	7.5
Grain rating (1–20)	12.4	15.4	15.0	15.2	15.2	15.0	15.0	15.0	15.4	15.2	15.2
Texture rating (1–20)	13.2	15.4	15.2	15.2	15.2	15.2	15.4	15.0	15.0	15.0	15.0
Flavor rating (1–10)	7.4	7.5	7.5	7.4	7.4	7.5	7.5	7.5	7.5	7.4	7.4
Total[b]	68.6	78.4	76.4	77.6	76.8	77.2	77.6	77.5	78.2	76.7	76.6

[a]In all rating systems, 1 = least desirable.
[b]100 possible.

of loaf volume.

The amount of bromate used to produce the Do-Corder curve was greater than the level (10–30 ppm) employed in the baking of bread. However, the effects of bromate could not be clearly detected by the Do-Corder unless the oxidant level was greater than 500 ppm (results not shown). The amount of 1,200 ppm was arbitrarily chosen to accentuate the effects of this oxidant.

Effect of Compounds on Do-Corder Curve

The results of the addition of compounds are summarized in Table IV. The compounds may be classified into two groups. The first group comprised those causing a peak at 85°C with a shoulder at 75°C in the curve. The second group is made up of those causing a single peak at 85°C without a shoulder.

Combined Effect with L-Ascorbic Acid

Each compound in Table IV was added in turn to flour milled from DNS in the presence of L-ascorbic acid. Some in the group that showed a shoulder at 75°C caused two peaks (at 75 and 85°C) when mixed with L-ascorbic acid and gave a curve similar to that of a bromated dough. Those compounds are also listed in Table IV. None of the compounds in the group without the 75°C shoulder showed this combined effect.

Baking Performance

Further evaluation was performed on four of the compounds in Table IV, ie, aspartic acid, glutamic acid, cystine, and potassium *d*-bitartrate. The results are summarized in Table V for the straight-dough method.

The best overall baking performance was given by bromated dough (B) and the worst by the control dough (A). Ascorbated dough gave intermediate performance (C). Some of the compounds, when incorporated with ascorbic acid, improved bread quality compared with that of bread baked from ascorbated dough. The aspects of bread quality improved were loaf volume, crust characteristics, and crumb texture. For other aspects, however, a clear trend was not observed, and some of the loaves scored less than the loaf from the ascorbated dough.

Among the compounds tested, cystine showed the best effect when combined with ascorbic acid. Therefore, this combination of additives was subjected to baking tests using the sponge-dough method. As shown in Table VI the trend of the results was similar to those obtained in the previous baking test. Cystine, in the presence of ascorbic acid (bread O), improved the loaf to make it similar to bromated bread (m). Again, the control (L) showed the lowest score, and ascorbated bread (N) had an intermediate rating.

The results obtained in our baking tests were not conclusive enough to definitely say that all compounds that showed a Do-Corder curve similar to that of bromated dough would be capable of improving bread. More baking tests must be done to test this hypothesis. However, the present study suggests the possibility of employing the Do-Corder to evaluate the baking performance of a dough by the characteristic shape of the curve.

TABLE VI
Effects of Various Compounds on Bread-Making Properties Using the Sponge-Dough Method.

	Dough or Bread			
	L	M	N	O
Compound (ppm)				
Potassium bromate	···	10	···	···
Ascorbic acid	···	···	10	10
Cystine	···	···	···	30
Bread property				
Loaf volume (cc)	2,000	2,140	2,040	2,140
Loaf volume rating[a] (1–15)	13.0	14.4	13.4	14.4
Crust color rating (1–10)	7.7	7.8	7.8	7.8
Crust characteristic rating (1–15)	10.4	11.6	11.4	11.9
Crumb color rating (1–10)	7.4	7.6	7.7	7.8
Grain rating (1–20)	14.2	15.6	14.8	15.2
Texture rating (1–20)	14.8	15.6	15.2	15.6
Flavor rating (1–10)	7.4	7.5	7.6	7.4
Total[b]	74.9	80.1	77.9	80.1

[a]In all rating systems, 1 = least desirable.
[b]100 possible.

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