NOTE

Rapid Evaluation of Frozen and Fresh Doughs Involving Stress Conditions

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The quality of frozen dough varies according to ingredients and processing conditions. It is expected that the use of flour with strong gluten properties will give frozen dough with improved stability. Specific wheat cultivars such as Glenlea have been proposed for frozen dough (Inoue and Bushuk 1991, 1992). Other cultivars with extra-strong gluten properties are worthy of investigation for the frozen-dough market.

Breadmaking tests have been described for small quantities of flour (Blackman and Gill 1980, Shogren and Finney 1984). However, baking tests are very difficult to standardize and results depend greatly on breadmaking techniques (Tipples 1979). For frozen dough, quality evaluation is usually performed after it has been stored in the freezer for several weeks. A rapid test for yeast viability in frozen dough has been proposed (Gélinas et al 1993). This article presents a rapid baking test, intended either for frozen or fresh doughs; it is based on the use of stressing conditions after overproofing frozen-thawed or fresh doughs. Overproofing is obtained when dough is prepared with a much larger amount of yeast than normally used. Dough in beaker is weakened by fermenting it beyond its optimum capacity of gas retention and stressed by letting it slide on a slope. This test was designed to mimic physical stresses on proofed dough in commercial bakeries such as movements and impacts on the production lines. This study was part of a research project on the evaluation of wheat cultivars with extra-strong gluten, especially for frozen doughs.

MATERIALS AND METHODS

Sixteen hexaploid wheat cultivars were grown in 1993 at Indian Head, SK, Canada. Their protein content is presented in Table I. Samples were tempered to 16.5% mc and milled into straight-grade flour using a Bühler pneumatic laboratory mill. Flour protein content (14% wb) was determined by near-infrared spectroscopy (Lukow 1991). Farinograph absorption and stability were performed by AACC method 54-21 (AACC 1995).

Four replicates of dough were prepared (150 g, flour basis), using the formulation: flour 100%, sucrose 4%, compressed yeast 13.3% (30% solids, corresponding to ≈4% dry weight; bought from Lallemand, Montreal), shortening 3%, salt 2%, ascorbic acid 100 ppm, and distilled water 51.5–60.7% (depending on dough water absorption in a mixer). Dry ingredients were mixed for 15 sec in a 100–200 g mixer (National Mfg. Co., Lincoln, NE), then water (4°C) was added. In preliminary studies, dough was mixed to optimum development in a National mixer, as determined by test baker (hand feel), and based on stability data in a farinograph (data not shown). Whatever the mixing time, dough temperature was kept between 20 and 23°C by adding various proportions (30–100%) of ice in the water. These preliminary tests on dough temperature were mainly performed with commercial flour (Robin Hood Multifoods, Montreal) and cultivars Fielder, Neepawa, Glenlea, and Laura. Later tests results were confirmed for all cultivars.

After mixing, the dough was bench-rested for 15 min at room temperature, then sheeted-molded with a sheeter-molder (L & M Co., Downsview, ON, Canada). Dough was divided into 6- × 35-g pieces, rounded and sheeted by hand to fit in the bottom of a 250-ml Pyrex beaker (68 mm, i.d.; 90 mm height). The control consisted of two pieces of dough which were immediately incubated for 35 min at 35°C, 85% rh. After proofing, dough height (mm) was measured then dough was stressed twice by letting the beaker slide on a 30° slope made of a piece of stainless steel (35.5-cm long) deposited inside a polystyrene box; beakers were rotated before the second run. The height of the dough was then recorded, and dough in the beaker was immediately baked in a revolving oven (Equipement de boulangerie L. P., Victoriaville, PQ, Canada) at 204°C for 15 min. After cooling for 30 min, the height and weight of the bread were measured. Loaf volume was determined by rapeseed displacement.

For the rapid freezing test, two 35-g pieces of sheeted dough were placed into plastic bags and immersed into an ethanol bath at –45°C for 30 min. Each frozen dough was then transferred into a 250-ml beaker, thawed-proofed for 90 min at 35°C, 85% rh, then processed as for standard dough (including stressing before baking). For the storage test, two 35-g pieces of dough were processed as for the rapid test, except that they were placed in freezer at –30°C and stored for 12 weeks, then thawed-proofed.

For each cultivar, the decline in dough height was evaluated by analysis of variance (ANOVA). The mean of the difference (MD) between the readings before and after abusing the dough was compared to the standard error of difference (SED) calculated for each test (control, rapid freezing test, and storage freezing test).

RESULTS AND DISCUSSION

Nonfrozen Doughs

In preliminary tests, the effects of mixing time and temperature were estimated. When dough temperature was kept constant (±1°C), differences of 1 min in mixing times did not affect dough proof time and loaf volume (data not shown). As shown in Table I, mixing times for most cultivars were close (8–10 min), except for Castan (5.5 min), Darius (6 min), and Fielder (3 min).

In general, after fermentation for 35 min, all doughs proofed at 40–50 mm before abuse and, for some cultivars, height of dough declined substantially after stress. The decline in height of proofed dough after abuse (MD) was used to determine the stability of dough prepared from flour of different cultivars (Table I). Most of the 16 cultivars were tolerant to stress, but cultivars Fielder, Castan, and Darius were significantly intolerant ($P < 0.05$) with mean difference between dough height before and after abuse exceeding 9 mm.

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TABLE I
Protein Content, Mixing Time, and Mean Difference of Dough Height Before and After Abuse for Nonfrozen and Frozen Doughs[a]

			Mean Difference of Dough Height (mm)		
Cultivar	**Protein (%)**	**Mixing Time (min)**	**Nonfrozen**	**Frozen (Rapid)**	**Frozen (Storage)**
Glenlea	9.6	11.0	0.00 a	2.13 ab	1.13[b]
Pembina	10.5	9.5	0.38 a	1.63 a	2.00[b]
Wildcat	10.6	9.5	0.50 a	2.38 ab	2.38[b]
Katepwa	10.5	8.5	0.88 a	10.25 d-f	8.75 a-c
Blue Sky	9.3	10.5	0.88 a	9.25 c-e	7.50 a-c
Florence	10.6	9.5	0.88 a	3.75 a-c	6.38 ab
Laura	10.4	7.5	1.13 a	7.25 a-d	8.25 a-c
Grandin	10.5	8.5	1.13 a	10.25 d-f	5.38 a
Manital	10.3	9.0	2.50 ab	8.00 b-d	11.75 a-c
Stoa	10.2	8.5	2.63 ab	7.88 a-d	7.88 a-c
Roblin	10.7	8.0	2.88 ab	16.38 f	13.13 c
Primqual	9.3	8.5	4.75 b	15.50 ef	8.00 a-c
Neepawa	10.3	5.5	5.25 b	16.50 f	11.88 bc
Darius	8.1	6.0	9.75 c	15.25 ef	1.13 a-c
Castan	8.4	5.5	10.63 c	13.13 d-f	11.50 a-c
Fielder	7.6	3.0	12.00 c	10.63 d-f	6.38 ab
SED	...	...	1.443	3.112	0.802[b] 3.166

[a] Mean difference between dough height before and after abuse. Means with the same letter within the same column are not significantly different ($P < 0.05$)
[b] Results were not significantly different ($P < 0.05$) but cannot be compared to the others because the variance standard error of difference (SED = 0.802) was not homogenous to other group of cultivars (SED = 3.166).

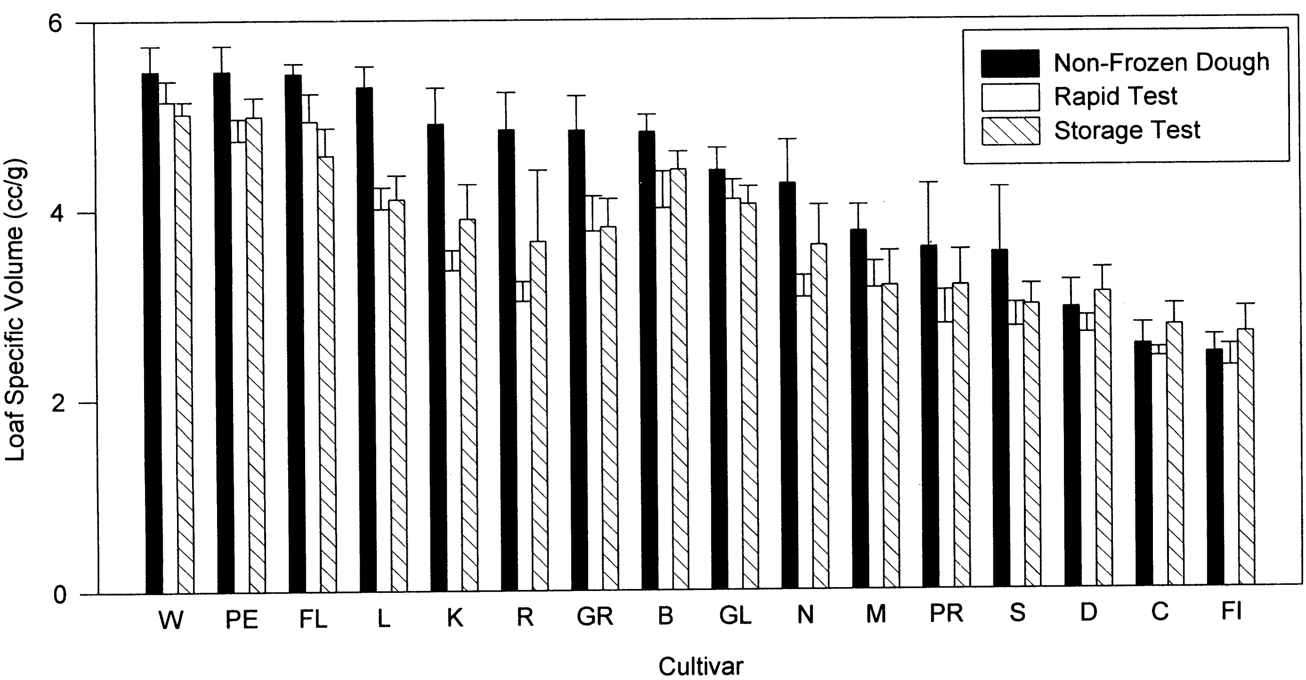

Fig. 1. Specific volume (cm^2/g) of breads prepared from nonfrozen doughs or frozen-thawed doughs (rapid and storage tests), all submitted to stress conditions after proofing. Culitvars: W = Wildcat, PE = Pembina, FL = Florence, L = Laura, K = Katepwa, R = Roblin, GR = Grandin, B = Blue Sky, GL = Glenlea, N = Neepawa, M = Manital, PR = Primqual, S = Stoa, D = Darius, C = Castan, FI = Fielder.

Frozen Doughs

In preliminary tests for frozen-thawed dough, it was determined that a 90-min fermentation period was necessary to get 40–50 mm, an height about equivalent to that of a 35-min fermentation period for nonfrozen dough. Freezing-thawing had a deleterious effect on tolerance to stress conditions of most doughs, considering that dough height declined substantially after abuse. Four cultivars had MD <4 and were resistant to abuse after rapid freezing: Pembina, Glenlea, Wildcat, and Florence (Table I). These cultivars were significantly different ($P < 0.05$) than eight others with MD >10 (Grandin, Katepwa, Fielder, Castan, Darius, Primqual, Roblin, and Neepawa). Results from the frozen storage test (not the rapid test) show that Glenlea, Pembina, and Wildcat were very tolerant to stress conditions: MD ≤2.38. However, ANOVA could not include these three cultivars because their variance was different from the others (a prerequisite before doing ANOVA). Five cultivars (Darius, Castan, Manital, Neepawa, and Roblin) had a mean difference >9 mm. Cultivars Manital and Fielder gave variable results according to the freezing test.

Figure 1 presents cultivars according to loaf specific volume after dough stress. In general, freezing lowered the tolerance to stress conditions and oven spring of most cultivars, considering that loaf specific volumes from frozen-thawed doughs were reduced. Loaf volumes of cultivars such as Laura, Katepwa, Grandin, and Roblin were much affected by freezing. Whether from nonfrozen or frozen dough, loaf volumes for Darius, Castan, and Fielder were very low. These results confirm that the latter cultivars were not tolerant to stress conditions (high MD). Because an acceptable cultivar for fresh or frozen dough needs to be very stable to stress conditions and have high loaf volume, the cultivars Wildcat, Pembina, and Florence appeared as very promising cultivars to prepare fresh and frozen doughs.

Relevance of Breadmaking Tests

In general, coefficients of determination (Steel and Torrie 1980) for loaf specific volumes were higher than for MD of dough height before and after abuse. Loaf volume from stressed fresh doughs was correlated to results of rapid freezing test and storage freezing test ($r^2 = 0.835$–0.856). This means that the breadmaking test (loaf volume) involving abuse conditions for fresh dough could be useful to predict the tolerance of frozen dough to abuse conditions. Results of the rapid freezing test were also correlated to those of the storage freezing test ($r^2 = 0.905$), thus eliminating the necessity of performing storage tests for frozen dough. Tests on dough were of only limited value for rapidly determining the baking potential of cultivars, possibly because they did not include information on oven spring. As a consequence, coefficients of determination were: $r^2 = 0.210$ for nonfrozen-storage tests; $r^2 = 0.353$, nonfrozen-rapid test; and $r^2 = 0.668$ for rapid-storage tests. Combination of dough tests (frozen rapidly, no storage) and loaf volume tests (nonfrozen and frozen doughs) might be useful to rapidly screen cultivars either for nonfrozen or frozen dough manufacturing.

CONCLUSION

A simple test for rapidly determining the baking potential of small quantities of flour has been developed. It is based on stress conditions that include overfermentation of the dough and dropping the beaker containing the dough on a slide. Dough may be freeze-thawed before performing the test. This makes it applicable to the development of wheat cultivars for frozen dough production. Freezing-thawing had a deleterious effect on tolerance of dough to abuse conditions. Results from tolerance of dough (frozen rapidly) to abuse conditions could be combined to loaf specific volumes determination to predict frozen and nonfrozen dough stability of wheat cultivars. In this study, wheat cultivars Wildcat, Pembina, and Florence appeared most tolerant to stress conditions such as dough abuse and freezing-thawing, and gave high loaf specific volume from either abused nonfrozen or abused frozen dough.

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