NOTE

Characteristics of Bread and Sponge Cake Baked from Wheat Flour Exposed to Gaseous Ammonia

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ABSTRACT

Dough made from flour exposed to gaseous ammonia shows rheological properties similar to properties of doughs made from heat-conditioned flour or flour containing oxidizing agents. The effects of ammonia treatment on breads and sponge cakes are described.

MATERIALS AND METHODS

Flour Treatment and Analysis

Three kinds of flours, semihard patent, hard clear, and soft patent flours, were commercially milled from blends of No. 1 Canada Western spring, hard red winter (U.S.), and Western soft white (U.S.) wheats. Flours were placed in a desiccator containing 50 ml of 28% aqueous ammonia at 25° C for 48–76 hr (Terada et al 1981). The ratio of surface area of the flour to desiccator volume was ⅛ cm^2/ml. Farinograph, extensigraph, and amylograph measurements, and determination of wet gluten and pH were performed as described by Terada et al (1981). Maltose value of flour was determined by AACC method 22-15 (1962). These measurements were performed within a week after ammonia treatment.

Baking and Evaluation of Bread and Cake

Bread was made according to AACC method 10-11 (1962). Sponge ingredients were mixed for 3 min, fermented at 28° C and 70–75% rh for 4 hr, and then mixed to optimal development with other ingredients at 28° C. The resulting dough was divided into two 460-g portions, proofed at 38° C and 80–85% rh, and baked at 200° C for 25 min. Loaf volume was measured by rapeseed displacement after cooling.

Crust and crumb color and texture of bread were subjectively evaluated. Bread pH was measured on a 20% (w/v) suspension of crumb. Sponge cakes were baked, using a formula consisting of 500 g of flour (14% moisture basis), 500 g of powdered sugar (Baker's special fine sucrose), 500 g of whole fresh egg (weight of yolk averaging 38% of the whole egg without the shell), and 200 ml of distilled water. Shortening, baking powder, milk, and salt were omitted. Eggs and powdered sugar were mixed for 8 min at 320 rpm using a whipping blade with a type 10Q mixer (Kanto Kongo Co., Tokyo, Japan). Seven minutes after mixing began, water was gradually added over a 1-min period. Mixing was then continued for an additional 2 min at 200 rpm to complete foaming. The mixer blade was then changed to a flat beater, flour was added, and mixing was continued for 40 sec at 200 rpm. A tinned sheet steel pan 180 mm in diameter and 40 mm deep was greased with commercial pan grease. The bottom was lined with a parchment paper. Batter (320 g) was transferred into the pan and baked at 170° C for 23 min.

Viscosities of batters immediately after mixing were measured three times at 1-min intervals with a Brookfield viscometer. Estimation of cake volume, grain, cell uniformity, and color of cakes was performed according to AACC method 10-90 (1962). Softness and springiness were measured by the Rheometer (RUD-J2, San Co., Japan) by the following method. Cake was cut horizontally at heights of 20 and 40 mm from the bottom of the pan. The center areas of the bottom and middle pieces were vertically punched into disks 52 mm in diameter. The disk was placed between the plunger of a 10-mm diameter disk and the flat table. The table was elevated at 1.5 mm/sec to compress the test piece, and stress was recorded. The compression test was repeated three times. Softness was expressed as the mean value of stress at 10-mm compression. Springiness was measured as the difference between the point of contact of the test piece with the plunger on the first compression to the point of contact on the second compression, compared to the distance measured on clay as standard. All tests were performed in duplicate; averages of duplicates are reported.

RESULTS AND DISCUSSION

Bread-Baking Test

Properties of the treated flour (exposed to gaseous ammonia for 48 hr) are shown in Table I. No significant differences were observed in ash, crude protein, and wet gluten contents. The pH of the ammonia-treated flours was 6.3–6.5, slightly higher than that of untreated flours.

Farinograph and extensigraph data (Tables II and III, respectively) indicate that ammonia treatment of flours resulted in a considerable increase in farinograph development time and valorimeter value. Extensigraph area and resistance to extension also increased, and weakness and extensibility decreased. These changes suggest that ammonia treatment may improve flours for bread-baking purposes.

Characteristics of bread baked from ammonia-treated flours are shown in Table IV. Increase in loaf volume was the same, regardless of ammonia-treatment time (24–76 hr). Crumb color of bread from ammonia-treated flours was white but less lustrous. Casual inspection indicated that ammonia treatment caused no visible changes in crust color and crumb grain and no apparent unacceptable flavors.

Cake-Baking Test

Properties of the treated flour (exposed to gaseous ammonia for 76 hr) are shown in Table I. No remarkable changes in ash, crude protein, and maltose value were observed. The farinograph data (Table II) reveal that ammonia treatment increased development time, stability, and valorimeter values while it increased strength. The extensigraph data (Table III) also indicate that ammonia treatment resulted in a higher value of resistance to extension and larger areas with lower extensibility compared with measurements on untreated flour. The amylograph viscosity (Table V) of the ammonia-treated flour was higher than that of untreated flour after the beginning of pasting. This difference increased as pasting continued, with maximum difference observed at maximum viscosity. The temperature at maximum viscosity of the ammonia-treated flour was slightly lower than that of the untreated flour. Viscosities of cake batters of ammonia-treated flour were higher than viscosities of batters from untreated flour (Table VI), and specific gravities of batters of ammonia-treated flour were slightly

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TABLE I
Analyses of Ammonia-Treated Flours[a]

Flour	Ammonia Treatment (hr)	Moisture (%)	Ash (%)	Crude Protein (%)	Wet Gluten (%)	pH	Maltose Value (mg/g flour)
Semihard patent	0	15.2	0.51	14.2	41.2	5.99	···
	48	12.4	0.51	14.4	40.6	6.42	···
Hard clear	0	15.5	0.72	16.6	49.7	6.08	···
	48	11.5	0.71	16.9	50.2	6.30	···
Soft patent	0	13.9	0.39	9.7	28.8	5.80	13.6
	76	14.3	0.38	10.1	28.4	6.60	13.3

[a] Dry weight basis.

TABLE II
Values of Farinographs of Doughs from Ammonia-Treated Flours

Flour	Ammonia Treatment (hr)	Water Absorption (%)	Development Time (min)	Stability (min)	Weakness (BU)[a]	Valorimeter Value	Mechanical Tolerance Index (BU)[a]
Semihard patent	0	63.4	8.0	12.7	30	72	20
	48	67.1	15.0	12.5	20	89	20
Hard clear	0	64.7	8.0	9.0	40	71	27
	48	71.3	14.0	8.5	30	87	30
Soft patent	0	53.2	1.2	3.0	70	40	92
	76	51.2	1.5	6.5	40	54	20

[a] Brabender units.

TABLE III
Extensigraph Data at Three Rest Times (45, 90, and 135 min) of Doughs from Ammonia-Treated Flours

Flour	Ammonia Treatment (hr)	Area (cm^2)			Resistance to Extension (BU)[a]			Extensibility (cm)		
		45	90	135	45	90	135	45	90	135
Semihard patent	0	113	122	96	455	505	460	19.0	18.4	15.9
	48	157	183	128	735	920	970	15.8	15.3	10.1
Hard clear	0	110	116	133	400	475	510	21.1	18.4	19.4
	48	160	>116	>133	840	>1,000	>1,000	14.8	11.8	9.6
Soft patent	0	52	70	66	230	330	350	16.3	15.2	13.4
	76	78	79	89	395	610	705	13.8	10.3	9.7

[a] Brabender units.

TABLE IV
Characteristics of Breads Made from Ammonia-Treated Flours

Flour	Ammonia Treatment (hr)	Water Absorption (%)	Mixing Time (min)	Proofing Time (min)	Loaf Volume[a] (L)	pH
Semihard patent	0	65	5.2	47	1.65± 0.05	5.53
	48	67	9.0	43	1.90± 0.10	5.56
Hard clear	0	67	9.0	43	1.65± 0.10	5.80
	48	67	9.0	40	1.90± 0.01	5.81

[a] Averages of duplicates.

TABLE V
Amylograph Data at Various Temperatures (50-93° C) of Ammonia-Treated Flours Used for Cake-Baking Test

Ammonia Treatment (hr)	Viscosity (BU)[a]							Maximum Viscosity (BU)[a] and Corresponding Temperatures (°C)	
	50	60	67.5	75	82.5	90	93		
0	0	5	20	55	165	550	595	610	92.0
76	0	5	30	60	205	710	620	710	90.0

[a] Brabender units.

TABLE VI
Characteristics of Batter and Cake Made from Ammonia-Treated Flour

	Untreated	Treated for 76 hr
Batter		
Viscosity, poise (min after preparing)		
1	57	70
2	55	68
3	55	65
Specific gravity	0.47	0.43
Feature	···	Less fluidity than control
Cake		
Cake volume, ml[a]	741 ± 7.0	753± 7.5
Softness, g/cm²[a]		
Upper part	54.1± 0.00	57.8± 0.95
Bottom part	135.9± 3.21	99.2± 2.17
Springiness, cm[a]		
Upper part	2.05± 0.10	1.55± 0.10
Bottom part	1.95± 0.23	1.35± 0.25
Uniformity	Even	Even, good
Moistness	Moist	Moist, good
Grain	Silky	Silky, better than control
Color	White	Slightly creamy

[a]Averages of duplicates.

lower than specific gravities of batters from untreated flour. The volumes of cakes from ammonia-treated flour were not increased. There was less difference in softness between the upper and bottom parts of the treated cakes, which suggests that ammonia treatment results in cakes of more uniform texture. The uniformity, moistness, grain, and color of cakes from treated flour were also improved, although a decrease in springiness was observed. Further studies will be necessary to determine the usefulness of ammonia treatments for improvement of flours for sponge cakes.

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