A COMPARISON OF ACTIVE DRIED YEAST PRODUCED IN DIFFERENT AREAS OF THE WORLD[1]

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ABSTRACT

Five active dried yeasts, produced in Canada, the United States, The Netherlands, and the United Kingdom, have been examined. The gas production rates and baking performance by three methods were determined, both initially and after storage at 115°F. for 4 days. Three yeasts showed a fall and two a rise in gas production rate as a result of this storage. The three yeasts that showed a fall in gas production rate after storage at 115°F. had higher initial rates and gave better loaf volumes than the remaining two. Highly significant correlations were found between rate of gas production and loaf volume for no-time dough and sponge-and-dough systems, but not for a straight-dough system. It is suggested that rate of gas production is a more sensitive index than loaf volume of the stability of the yeasts to the high-temperature storage conditions imposed.

The Prepared Bread Mix developed by the Defence Research Medical Laboratories uses active dried yeast as the leavening agent. This material is the least stable component of the mix, and in tropical areas must be packed separately and kept under refrigeration. Canadian forces in areas far from Canada might therefore obtain their supplies of yeast advantageously from the nearest source rather than from Canada. Accordingly, a survey of active dried yeasts produced in several countries was undertaken to obtain information concerning these local products.

The survey was also designed to compare different methods of evaluating yeasts, particularly gas production and performance in no-time doughs. In addition, it was decided to investigate a suggested accelerated method, i.e., storing the yeast at 115°F. for 4 days, for determining stability.

Materials and Methods

Samples of five different active dried yeasts in sealed cans were obtained directly from the manufacturers, who were requested to provide fresh material. The countries of origin were Canada, the United States, The Netherlands, and the United Kingdom. Yeasts A, B, and C were in pellet form, D was a coarse powder, and E was in the form of noodles.

Gas production rate was determined for each yeast using a pres-

[1]Manuscript received December 23, 1960. PCC Project No. D50-78-60-01. DRML Report No. 53-7. Defence Research Board, Department of National Defence, Canada.
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suremeter equipped with a Bourdon gage based on Method 34.1 of *Cereal Laboratory Methods* (1). The gages had previously been calibrated in mm. of mercury at room temperature (70°–75°F.). The total internal volume of each of the three vessels used, determined by weighing them both empty and full of water, was 256 ± 1 cc. The quantity of active dried yeast used was 0.2 g. This was added to 7.4 ml. of water at 105°F. containing 0.4 g. of sucrose and allowed 6 min. to rehydrate before the flour was added. Mixing was just sufficient to form a visually homogeneous dough. Ten minutes after the pressuremeter was replaced in the water bath at 80°F., the valve was momentarily opened and this time was taken as zero. Pressure readings were taken at 15-min. intervals. Gas production determinations were repeated on the yeasts after they had been stored in sealed cans in air at 115°F. for 4 days (96 hr.) and 8 days (192 hr.).

Three different baking methods were used to prepare bread with the yeasts as received and after storage at 115°F. for 4 days. The formulas used are given in Table I. In each method the yeast and 10 g.

TABLE I
DOUGH INGREDIENTS

	No-Time Dough	3-Hour Straight Dough	3-Hour Sponge and Dough	
			Sponge	Dough
	g.	g.	g.	g.
Hard wheat flour	1,000	1,000	600	400
Salt	20	20	10	10
Sugar	40	40	10	30
Skimmilk powder	50	50	..	50
Shortening	20	20	..	20
Lecithin	1	1	..	1
Lactic acid (85%)	2		..	..
Yeast	25	10	10	
Sugar	10	10	10	
Water	650	650	650	

of sugar were placed in 325 g. of water at 105°F. and allowed to rehydrate for 10 min. At the end of this period the remainder of the water was added at a temperature sufficient to bring the temperature of the whole to 85°F. for the doughs and 78°F. for the sponges. All doughs were mixed in a 20-qt. Hobart mixer for 5 min. at medium speed.

The no-time dough was scaled immediately after mixing, allowed 5 min. to recover, moulded, and then proofed for 50 min. at 85°F. and 90% r.h. The straight dough was fermented at 85°F. for 2.5 hr. with a punch after 1.5 hr. and again after 2.25 hr. It was then scaled, allowed 5 min. to recover, moulded, and proofed for 1 hr. at 85°F.

The sponge was allowed to ferment for 2 hr. at 85°F. and then mixed to a smooth dough with the balance of the ingredients. After another 15 min. at 85°F. it was scaled, allowed 5 min. to recover, moulded, and then proofed for 1 hr. at 85°F. and 90% r.h.

All doughs were scaled at 600 g. and baked for 35 min. at 420°F. Loaf volumes were measured after the bread was cool, by a rapeseed displacement method.

Results and Discussion

The gas production graphs for all five yeasts, each as received and after both periods of treatment at 115°F., were basically similar to each other and normal for pressuremeter results. The graphs appeared to be linear up to 300–350 mm. pressure and then continued at a reduced slope. The initial linear portion was of chief interest, since the suitability of yeast for use in a no-time dough was one of the reasons for the investigation. The pressure readings for the period from 30 to 105 min. are given in Table II, and an analysis of variance of the results, given in Table IV, confirmed that the graphs were in fact linear within a very close tolerance. The results for the individual yeasts are therefore given in Table III as the slope and intercept of the equation $P = S \times t - N$ describing this portion of the curve, where P = pressure (in mm.Hg), t = time (in min.), s = slope, N = intercept.

A comparison of the standard errors of the slopes and of the intercepts indicated that the differences among the intercepts were not significant in comparison to those among the slopes, and it is therefore justifiable to regard each yeast at each level of heat-treatment as characterized by a single parameter, namely the slope (S).

Three yeasts (A, B, and C) were substantially more active initially than the other two, and differed significantly among themselves. Storage at 115°F. reduced the activity of these yeasts and eliminated the differences among them, the major change being observed after 4 days. For the initially most active yeast (C), the decrease in activity after 8 days of storage amounted to 25% of the original value. The remaining two yeasts (D and E) exhibited increased activity after 4 days of storage at 115°F. In storage beyond this period the activity of yeast D decreased somewhat, whereas that of yeast E continued to rise. By comparison with yeasts A, B, and C, yeasts D and E were the more active after 8 days of storage.

The reason for the rise in activity of yeasts D and E is not obvious. Several authors have investigated the stability of yeasts, both compressed and active dry, stored at elevated temperatures, but all report a fall in activity (2–6). In one paper the results show an increase in

TABLE II

GAS PRODUCTION BY YEASTS: PRESSUREMETER READINGS

TIME	YEAST A			YEAST B			YEAST C			YEAST D			YEAST E		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
	No treatment														
min.															
30	59	58	52	50	53	50	61	63	59	35	29	26	31	29	30
45	105	102	92	95	92	91	112	107	106	61	54	52	54	59	53
60	145	149	142	135	136	139	159	160	157	94	90	89	85	91	91
75	194	193	185	181	182	181	208	207	208	123	122	118	118	125	126
90	237	241	233	222	223	229	255	254	255	166	151	154	147	162	156
105	275	283	278	266	260	270	301	304	303	199	192	187	181	189	188
	Treatment: 4 days at 115°F.														
30	36	43	40	38	36	31	37	41	45	38	30	34	37	38	28
45	65	74	73	75	71	72	74	74	76	71	64	63	61	67	54
60	100	115	116	114	107	111	114	112	119	110	97	96	95	102	89
75	132	157	154	152	146	152	151	152	157	146	131	140	124	137	129
90	170	195	192	178	183	188	191	191	191	186	171	175	167	173	162
105	210	225	238	225	220	229	230	233	241	222	209	215	199	210	194
	Treatment: 8 days at 115°F.														
30	34	28	27	34	31	30	34	27	25	37	33	33	39	39	40
45	61	55	51	60	61	52	59	54	51	61	64	64	77	74	71
60	90	91	90	94	94	92	92	86	89	92	96	99	115	111	108
75	125	121	119	124	126	132	124	119	123	124	130	141	151	149	150
90	165	162	156	167	156	163	165	156	157	168	171	176	189	187	184
105	195	195	188	199	199	195	200	189	193	202	205	214	222	224	226

TABLE III
VALUES OF "S" AND "N" IN EQUATIONS OF RESULTS

YEAST	TIME AT 115°F.	S[a]	N[a]
	days	*min.*	
A	0	(2.99 ± 0.02)	−33.8 ± 0.83
	4	(2.48 ± 0.04)	−37.7 ± 1.49
	8	(2.21 ± 0.06)	−40.5 ± 2.10
B	0	(2.88 ± 0.02)	−35.7 ± 0.85
	4	(2.51 ± 0.03)	−39.9 ± 1.13
	8	(2.24 ± 0.05)	−39.5 ± 1.89
C	0	(3.24 ± 0.02)	−36.4 ± 0.71
	4	(2.58 ± 0.05)	−39.2 ± 1.81
	8	(2.23 ± 0.06)	−42.5 ± 1.99
D	0	(2.19 ± 0.06)	−40.1 ± 2.09
	4	(2.43 ± 0.04)	−42.0 ± 1.41
	8	(2.34 ± 0.06)	−40.7 ± 2.50
E	0	(2.12 ± 0.04)	−36.8 ± 1.47
	4	(2.26 ± 0.05)	−37.9 ± 1.85
	8	(2.48 ± 0.01)	−36.6 ± 0.56
Variance of mean		0.1061	6.051
Mean of variances		0.001893	9.87
F =		56.05	0.613

[a] Pressure in mm. Hg = S (time in min.) — N.

the volume of bread made from yeast stored at 120°F. for 3 days, but the results were complicated by a change in baking technique between the initial and final results and the authors do not comment on this observation (6). The reality of the effect is shown by the analysis in Table IV. In all cases the differences between high-temperature storage (H_1 and H_2) were significant, as were the interactions of this effect and the linearity term (T lin. H_1 and T lin. H_2). This interaction is a measure of differences in slope between the graphs of different treatments.

Loaf volumes are given in Table V, and an analysis of variance in Table VI. The latter table gives an analysis for all five yeasts and separate analyses for group A, B, C and group D, E. Differences in loaf volume due to baking method are clearly shown in Table V, and are confirmed by the analysis, but the smaller apparent effect due to storage at 115°F. is not. For yeasts A, B, and C, however, the latter effect approaches statistical significance and the point is worthy of further investigation. The slight increases in loaf volumes shown by yeast E after treatment were not statistically significant. Differences in loaf volume among yeasts A, B, and C are not significant; loaf volumes for yeasts D and E differ between themselves and also from those of the other yeasts.

In Fig. 1 loaf volumes are plotted against the slopes (S) of the gas production graphs, each baking method being shown separately. The

TABLE IV

GAS PRODUCTION: ANALYSIS OF VARIANCE FOR INDIVIDUAL YEAST

Source of Variation	D.F.	Yeast A M.S.	Yeast C M.S.	Yeast D M.S.	Yeast D M.S.	Yeast E M.S.
Treatment (H)	(2)					
a) 4 days vs. 8 days (H_1) at 115°F.	1	4,053***	2,827***	6,561***	215***	2,336***
b) no treatment vs. 4 and 8 days, 115°F. (H_2)	1	28,616***	17,455***	44,246***	1,744***	3,246***
Vessels (V)	2	115	19	21	132.5***	122
Gas production time (T)	(5)					
a) T linear	1	232,819***	229,486***	255,089***	190,634***	185,246***
b) T residual	4	39	13.7	31.7***	93.5***	43
T lin × H_1	1	440***	430***	710***	61	269***
T lin × H_2	1	3,206***	1,999***	5,324***	303***	490***
T res × H	8	10.1	13.7	13.7	3.1	5.5
HV	4	285.5***	10	60	155.5***	83.7***
VT }	10	17.4	12.2	4.2	9.2	7.8
VTH }	20					
Total	53					

TABLE V

LOAF VOLUME

Yeast A		Yeast B		Yeast C		Yeast D		Yeast E	
0[a]	4[a]	0	4	0	4	0	4	0	4
cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*
No-time dough									
2,375	2,150	2,370	2,235	2,280	2,175	2,130	2,060	1,910	2,025
2,300	2,200	2,355	2,310	2,300	2,150	2,150	2,080	1,925	1,900
Straight dough									
2,410	2,415	2,430	2,575	2,412	2,325	2,305	2,425	2,065	2,135
2,410	2,500	2,447	2,500	2,450	2,350	2,360	2,350	2,100	2,175
Sponge and dough									
2,630	2,500	2,650	2,340	2,680	2,515	2,470	2,650	2,210	2,275
2,490	2,425	2,620	2,450	2,640	2,550	2,470	2,475	2,270	2,250

[a] Days at 115°F.

TABLE VI

LOAF VOLUMES ANALYSIS OF VARIANCE

Source	All Yeasts		Yeasts A, B, C		Yeasts D and E	
	D.F.	M.S.	D.F.	M.S.	D.F.	M.S.
Yeasts (Y)	4	220,789***	2	6,043	1	300,384*
Heat-treatment (H)	1	2,204	1	69,696	1	7,884
Baking method (M)	2	484,865***	2	229,493**	2	264,507*
Y × H	4	14,964	2	1,814	1	651
Y × M	8	9,301	4	11,304	2	5,459
H × M	2	20,908	2	25,724	2	3,585
Y × H × M (Error Term)	8	6,940	4	9,350	2	4,282
Between duplicates	30	2,237	18	1,577	12	2,624
Total	59		35		23	

points O correspond to original yeasts, points X to yeasts after 4 days at 115°F. For each baking method the correlation coefficient and the corresponding "t" value are given in Table VII, and in two cases the regression line of volume on slope has been drawn. The correlation between gas production slope and loaf volume is significant at the 1% level for the no-time dough and the sponge and dough methods, but is not significant even at the 5% level for the straight dough. This is presumably due to sugar depletion in the straight dough, so that after the final machining the rate of diffusion of sugar to the yeast cell, rather than the activity of the yeast, is the factor which controls gas production.

Since the slopes of the gas production graphs show a significant change after 4 days at 115°F., whereas the loaf volumes do not, rate of gas production affords a more sensitive index of yeast stability at

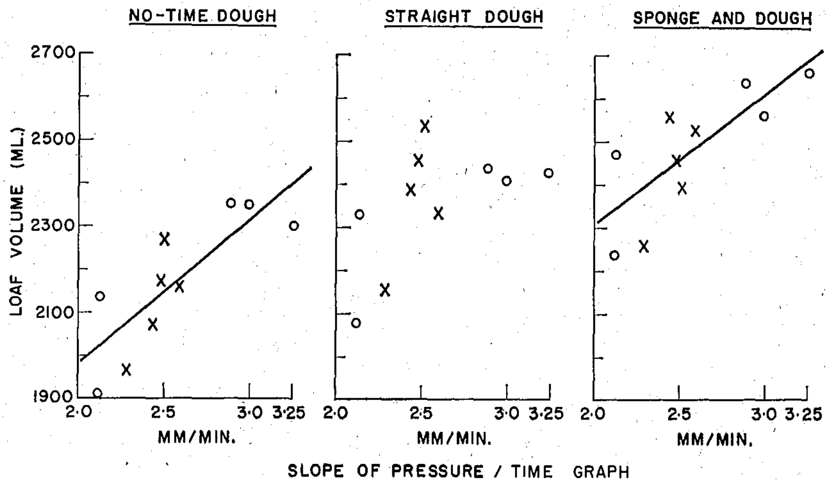

Fig. 1. Correlation of slope "S" and loaf volume. O = untreated yeasts; X = yeast-treated yeasts.

TABLE VII

Correlation of Slope "S" and Loaf Volume

Baking Method	No-Time Dough	Straight Dough	Sponge and Dough
Regression equation	V = 339S + 1300 [a]	. . .	V = 303S + 1700 [a]
Correlation coefficient	0.82	0.60	0.78
Student's "t"	4.1**	2.1	3.5**

[a] V = loaf volume; S = slope of pressure-time graph.

elevated temperature than loaf volume. Since gas production rate correlates well with yeast performance both in no-time doughs and in the sponge and dough process, it may well serve as a sorting test for yeast. Furthermore, the slope of the gas pressure/time curve can be determined in a shorter period of time than the pressure reading taken at 4 or 5 hr. or occasionally 8 hr. (7), which is the usual index for predicting yeast quality.

Acknowledgments

The author wishes to thank J. Ogilvie for statistical advice, and J. Galbraith, who carried out the baking tests.

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