Functional (Bread-Making) Properties of a New Dry Yeast

B. L. BRUINSMA[1] and K. F. FINNEY[1]

Cereal Chem. 58(5):477–480

ABSTRACT

Eight vacuum-packed and two nonvacuum-packed dry yeasts had excellent viability when opened 4–22 months after being manufactured. Fermipan dry yeast, when properly sealed and stored, maintained good viability after being opened 48 times over a period of 18 weeks. Some methods of adding Fermipan yeast should be avoided. Gas production of Fermipan dry yeast decreased with increasing time of contact with wheat flour at room temperature; the decrease was more than 22% in 18 hr. Rehydration of dry yeast in distilled water decreased yeast viability more than did rehydration in 3% sucrose solution. However, addition of dry yeast to wheat flour during the mixing phase of breadmaking maintained maximum yeast viability. Fermipan dry yeast would be especially useful in industry and research in many areas of the world (and in the military services during peacetime and war) where the regular receipt of fresh supplies of good compressed yeast is not feasible.

Dry yeasts have been an important commodity since the discovery after World War II of yeast strains that were able to withstand drying (Pyler 1973). Some dry yeasts have unacceptable gassing power and produce unacceptable loaf volume and crumb grain of bread, compared to those produced with compressed yeasts.

Crane et al (1952) reported that storage time, temperature, moisture, and oxygen were important factors that influenced the stability of dry yeast. Felsher et al (1955) found that dry yeast stored at 4.4 or −29° C was useful in breadmaking after two years, the duration of the experiment. When the same yeast was stored at 49° C, it was graded unacceptable after eight days. Stacey (1964) stored five different dry yeasts for four and eight days at 46° C and found that the activity of two of the yeasts increased and that of three decreased nearly 25% during storage. Dry yeast decreased mixing time and increased oxidation requirement during breadmaking (Ponte 1971). Ponte points out that those properties may be desirable with mellow strong flours but undesirable with weak flours. Glutathione leached from damaged cells during the rehydration of dry yeast appears to be responsible for the decrease in mixing time (Ponte et al 1960).

Fermipan, a relatively new dry yeast (Langejan 1974), is reputed to be essentially equal in quality to good compressed yeast. In many places in the United States and other parts of the world, and in the military services during peacetime and war, regularly obtaining fresh supplies of good compressed yeast is not feasible.

Thus, we examined Fermipan yeast to determine 1) its fermentability and loaf volume potential compared to those of compressed yeast, 2) its effect on mixing time and other dough properties during breadmaking, 3) the effect of time and storage temperature on its stability after the vacuum seal is broken, 4) its stability for different methods of addition to formula, and 5) its viability and uniformity from one batch to another over long periods of time.

MATERIALS AND METHODS

Materials

Ten different 1-lb samples of Fermipan yeast were obtained from GB Fermentation Industries Inc., Des Plaines, IL. The yeasts had been manufactured about 4–22 months before our studies began.

BCS-78, a straight grade flour, was milled from a composite of many hard winter wheat varieties harvested at several locations throughout the Great Plains in 1978. BCS-78 flour contained 12.4% moisture and 12.2% protein (14% mb). It had an excellent loaf volume potential and a medium-long mixing time (4⅝ min with compressed yeast).

Methods

Protein and moisture were determined by AACC approved methods 46-11 and 44-15A, respectively (AACC 1976).

The bread-making method included mixing to minimum mobility (optimum) and using 60.5 ml of water (optimum), 50 ppm ascorbic acid (an excess in the absence of nonfat dry milk), 100 g of flour (14% mb), 6.0 g of sugar, 1.5 g of salt, 3.0 g of shortening, 5.3 ± 0.2 g of compressed yeast or about 2.0 g of Fermipan dry yeast (which gave gas production equal to that of 5.3 g of compressed yeast), and 0.25 g of barley malt (52 dextrinizing units per gram). Compressed yeast was a 50:50 blend of weekly shipments from Anheuser-Busch, Inc., and Standard Brands, Inc. Ascorbic acid is its own buffer against over-oxidation (Shogren and Finney 1974). Unless stated otherwise, straight doughs were fermented 52 min to first punch, 77 min to second punch, and 90 min to pan and were proofed 32 ± 1 min (the time required to proof controls to 7.8 cm) at 30° C. Baking time was 24 min at 215° C. Loaf volume was determined immediately after baking by dwarf rapeseed displacement. Loaf volumes that differed by 27 cc were statistically significant at $P = 0.05$. In studies where the viability of Fermipan yeast was adversely affected, either the proof time was increased to maintain constant proof height of 7.8 cm for 2% yeast or the yeast concentration was increased enough to maintain 59.5 gasograph units (GU) of gas production in 135 min and give an approximately constant time to proof to 7.8 cm. Additional related details are given by Finney (1945), Finney and Barmore (1943, 1945a, 1945b), and by Finney et al (1976).

In gas-production and bread-making tests, except for the studies on liquid suspensions, dry yeast was added to the flour 15 min or less before the mixing stage of breadmaking.

After a bag of Fermipan dry yeast was opened for sampling and after each reopening, the top was folded tightly against the contents to eliminate air and taped to prevent unfolding. Then the container of yeast was sealed in a close-fitting polyethylene bag and stored at either 3 or 25° C.

In stability studies, Fermipan yeast stored at 3 and 25° C was reopened about 48 times over a period of 18 weeks. During each weekly interval, each of two samples was reopened on two successive days, twice on the first day to sample for gas production tests made in both the morning and afternoon and once for a period of about 1 hr on the second day to take samples for bread-making tests.

Gasograph gas production was determined on a dough instead of the slurry described by Rubenthaler et al (1980). The dough included 1/10 the amount of each ingredient used in breadmaking and was mixed to minimum mobility (Finney and Shogren 1972) and fermented 135 min. Gas production in 135 min was expressed in gasograph units.

A gas production test for 135 min is approximately equivalent in breadmaking to 5 min + 90 min + 32 min + 8 min, where 5 min is the

[1]Research chemist, U.S. Grain Marketing Research Laboratory, Agricultural Research, Science and Education Administration, U.S. Department of Agriculture, Manhattan, KS 66502.

Mention of firm names or trade products does not constitute endorsement by the USDA over others not mentioned.

time that all ingredients are together before completion of optimum mixing, 90 min is the fermentation time from completion of mixing to panning of dough, 32 min is the proof time, and 8 min is the oven time before maximum spring of dough. For a bread-making fermentation time of 120 min instead of 90, and an accompanying proof of 47 min instead of 32, the comparable gas production test would be run for 5 + 120 + 47 + 8 = 180 min (Finney et al 1976).

RESULTS AND DISCUSSION

Adding Fermipan Dry Yeast to Wheat Flour

Adding dry yeast to flour at the mixing stage of breadmaking was an additional task during an already busy schedule; but when we added dry yeast to flour 0–18 hr before mixing, gas production of yeast decreased with increasing time of contact with flour at room temperature (Fig. 1). Gas production of the dry yeast decreased more than 22% in 18 hr. The dry yeast cells (4.4% moisture) may have been ruptured by the absorption of water from the relatively high-moisture flour. The increasingly adverse effect with time also may have been compounded by room temperature and air. Thus, adding Fermipan dry yeast to flour the day before or even one hour before breadmaking was undesirable.

Liquid Suspensions of Fermipan Yeast

When dry yeast was rehydrated in distilled water at either 25 or 40°C (Table I), gas production was drastically decreased about 17 GU, bread grain was questionable to unsatisfactory, and time to proof to 7.8 cm had to be increased 13–14 min to obtain bread volume that still was about 60 cc less than that when dry yeast was added to flour at the mixing stage. Adding dry yeast in 3% sucrose solution rather than in water improved gas production, shortened proof time, and gave loaf volume and crumb grain equal to those when dry yeast was added to flour at the mixing stage of breadmaking. Addition of the dry yeast to the wheat flour maintained maximum yeast viability.

TABLE I
Effect of Method of Rehydrating Fermipan Dry Yeast

Yeast[a]	Added	Gas Production (GU)[b]	Time to Proof to 7.8 cm (min)	Loaf Volume (cc)	Crumb Grain[a]
Compressed	In H_2O at 25°C	56.8	31	983	S
Fermipan	To flour	57.0	33	967	S
	In H_2O at 25°C	41.3	46	907	Q-U
	In 3% sucrose at 25°C	48.6	41	965	S
	In H_2O at 40°C	40.8	47	900	Q-U
	In 3% sucrose at 40°C	48.4	40	973	S

[a] 5.3 ± 0.2% compressed and 2.0% Fermipan (22 months old).
[b] Gasograph units.
[c] S = satisfactory, Q = questionable, U = unsatisfactory.

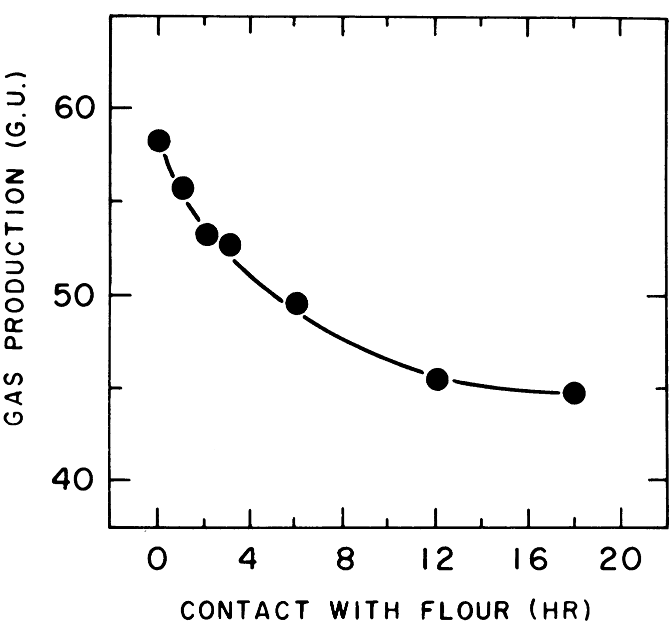

Fig. 1. Effect on gas production of the contact time of 2% Fermipan dry yeast 3 and wheat flour at 25°C. G.U. = gasograph units.

Viability of Nine Fermipan Yeasts 4 to 22 Months Old

When the dry yeasts were added to wheat flour at the mixing stage of breadmaking and their concentrations were adjusted to give the gassing value of the compressed yeast (59.5 ± 0.5 GU), bread volumes (Table II) were within experimental error of that for compressed yeast. Crumb grains of loaves were not significantly different (data not given). A small increase in the dry matter of some of the dry yeasts probably would have produced loaf volumes essentially identical to that for compressed yeast.

Adding dry yeasts as solids at the mixing stage decreased mixing time from 4⅝ for compressed yeast to 3⅞ min, a decrease of 16%. Fermentation was 90 min and yeast was 2%. A long fermentation of 180 min and accompanying yeast of only 0.75% would decrease mixing time only about 0.25 min.

Stability of Fermipan Yeast

Gas production of 2% concentrations of two freshly opened, vacuum-packed, 1-lb samples of yeast 10 was 59.5 GU. The two identical samples of yeast were responsible for proof times of 33 min (to 7.8 cm) and bread volumes of 970 and 969 cc (Table III); those values are the controls. Thereafter, one sample was stored at 3°C and the other at 25°C.

In subsequent tests of the yeast stored at 3°C, proof time for 2% yeast was essentially constant at about 33 min throughout 10 weeks and loaf volumes were essentially equal to that of the control. From 13 to 18 weeks, proof time generally increased only 1–2 min and loaf volumes were essentially equal to that of the control. From the third week through the 18th week, the concentration of yeast needed to maintain a gas production of 59.5 GU increased somewhat from 2.07 to 2.18%. Corresponding proof times and loaf volumes, however, were essentially constant and equal to those for 2% yeast.

For 2% yeast stored at 25°C, however, dough proof time increased with storage time from 33 at first opening to 50 min after 18 weeks. Although yeast concentration to maintain a gas production of 59.5 GU in 135 min increased with increasing storage

TABLE II
Yeast Concentrations of Compressed and Fermipan (FP) Dry Yeasts Needed to Produce 59.5 ± 0.5 Gasograph Units in 135 Min and Optimum Loaf Volume of Bread

Yeast[a]	Approximate Age (months)	Yeast Needed, %[b] As Received	Dry Basis	Dry Yeast as Percent of Compressed Yeast (db)	Loaf Volume[c] (cc)
Compressed	···	5.47	1.64	···	981
Fermipan					
1	16	1.86	1.78	109	951
2	16	1.91	1.83	112	964
3	22	2.01	1.92	117	971
4[d]	22	2.11	2.02	123	976
5	22	1.91	1.83	112	975
6	12	1.88	1.80	110	968
7[d]	12	1.99	1.90	116	967
8	6	1.87	1.79	109	955
9	4	1.99	1.90	116	983
10	8	2.00	1.91	116	970

[a] Compressed yeast contained 70.0% moisture; FP yeast contained 4.4 ± 0.3% moisture.
[b] Percent of flour.
[c] Average of six loaves.
[d] Not vacuum packed.

time, proof times were essentially constant through 10 weeks and increased only 1–2 min in the 13–18 week period. After 18 weeks, yeast concentration had to be increased to 3.2% (an increase of 60%). All bread volumes, except for the somewhat low ones for 2% yeast after 13 weeks, were equal to that of the control as a result either of increasing proof time to maintain a constant proof height of 7.8 cm for 2% yeast or of increasing yeast concentration to maintain 59.5 GU of gas production and an approximately constant time to proof to 7.8 cm.

Gas production of 2% yeast stored at 3°C and reopened three times weekly had decreased only about 5 GU (8%) after 18 weeks (Fig. 2). Gas production of 2% yeast stored at 25°C, however, had decreased about 20 GU (33%) after 18 weeks. Thus, yeast stored at 25°C deteriorated much more rapidly than that stored at 3°C.

Baking tests showed that 2% of the dry yeast stored at 25°C for 18 weeks required 50 min to proof the dough to 7.8 cm (Table III), whereas 2% of the same yeast stored at 3°C required only 35 min. When the yeast stored at 25°C was proofed for only 35 min, loaf volume was only 833 cc and proof height was only 6.7 cm (data not shown in Table III). All values indicated that the yeast held for 18 weeks at 25°C was less viable than that held at 3°C: 2% of the former gave a loaf volume of 833 cc rather than of 983 cc, a proof height of 6.7 cm rather than of 7.8 cm, and gas production in 135 min of 40.5 GU rather than of 59.5 GU; in addition, 3.2% of the former and 2% of the latter were needed for gas production of 59.5 GU in 135 min.

Dispensing Instead of Weighing Fermipan Dry Yeast

In most of the bread-making and gas-production studies reported here, quantities of yeasts were weighed during the dough-mixing stage. In future 100-g bread-making studies with Fermipan-type dry yeasts, we shall dispense the desired quantities with appropriate cylindrical spoons with diameter-length ratios of 1:2–1:4. When a heaping cylinder of the desired volume of Fermipan dry yeast was scraped level with the straight edge of a spatula, weights of 0.200 ± 0.004 g, 0.760 ± 0.010 g, and 2.740 ± 0.030 g of dry yeast were quickly dispensed. The weights of yeast dispensed were about ±1.1–2% of the desired weight and were within acceptable precision. Weights of 0.76 and 2.74 g of dry yeast correspond to 2.0 and 7.2 g of fresh compressed yeast and to bread fermentation times before panning of 180 and 70 min, respectively; 0.200 g corresponds to 0.53 g of compressed yeast per 10 g of flour.

CONCLUSIONS

1. Ten vacuum-packed samples of Fermipan yeast had excellent viability when opened 4–22 months after being manufactured.
2. A freshly-opened, vacuum-packed Fermipan dry yeast should be sealed and stored at about 3°C.
3. Fermipan yeast should be added to wheat flour at the mixing stage of breadmaking. Viability decreases with increasing time

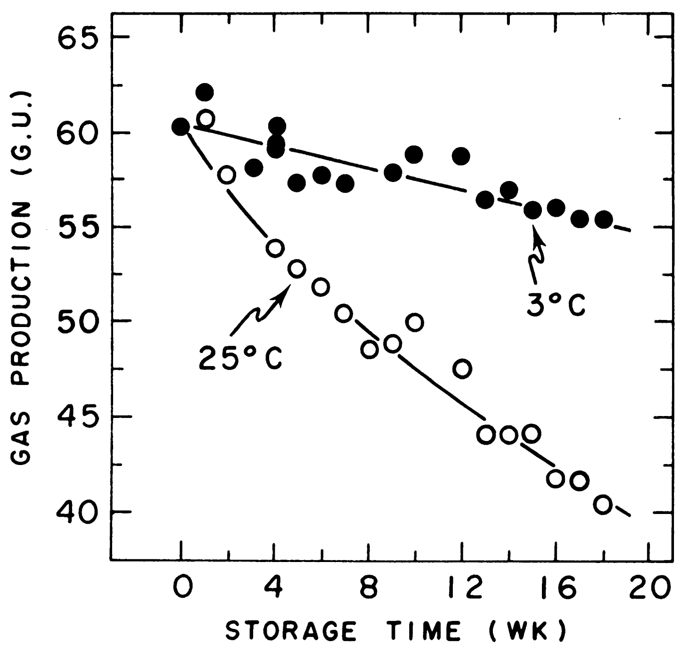

Fig. 2. Gas production in gasograph units (G.U.) of 2% Fermipan dry yeast 10 stored at 3 and 25°C and reopened about 48 times over a period of 18 weeks.

TABLE III
Effect on Proof Time and Loaf Volume of Reopening[a] Fermipan Yeast[b] Stored at 3 and 25°C

	Stored at 3°					Stored at 25°C				
	For 2% Yeast Concentration		For Yeast Concentration Needed to Match Gas Production of Control			For 2% Yeast Concentration		For Yeast Concentration Needed to Match Gas Production of Control		
Yeast Reopened After (weeks)	Proof[c] Time to 7.8 cm (min)	Loaf[d] Volume (cc)	Yeast[e] Concentration (%)	Proof Time to 7.8 cm (min)	Loaf Volume (cc)	Proof[c] Time to 7.8 cm (min)	Loaf[d] Volume (cc)	Yeast[e] Concentration (%)	Proof Time to 7.8 cm (min)	Loaf Volume (cc)
Opened	33.0	970	(Control)	···	···	33.0	969	(Control)	···	···
1	32.5	960	1.93	33.0	953	32.5	960	1.96	33.5	953
3	33.5	970	2.07	33.0	950	33.5	953	2.13	32.5	950
4	32.0	953	2.00	32.5	968	34.0	970	2.25	31.0	978
5	33.0	975	2.09	33.5	975	33.5	965	2.27	31.0	985
6	33.5	940	2.08	33.0	960	34.5	938	2.31	31.0	960
7	35.0	978	2.09	34.0	980	37.0	968	2.42	31.0	960
8	33.5	970	2.13	32.5	968	37.5	973	2.47	32.0	993
9	33.0	975	2.07	32.5	960	37.5	960	2.51	31.5	973
10	33.5	955	2.10	33.0	963	40.0	980	2.48	33.5	960
13	35.5	960	2.12	33.0	952	44.0	945	2.72	35.5	960
14	33.5	955	2.10	32.5	968	43.0	932	2.82	33.5	957
15	34.0	970	2.15	32.5	955	45.0	943[f]	2.90	33.5	947[f]
17	35.5	965	2.17	32.5	972	48.5	940[f]	3.10	34.5	965[f]
18	35.0	983	2.18	33.0	982	50.0	950[f]	3.20	34.0	968[f]

[a] Reopened 48 times at weekly intervals over a period of 18 weeks.
[b] Fermipan yeast 10.
[c] Time to proof to 7.8 cm was 32 min for compressed yeast (fresh each week).
[d] Loaf volume was 977 ± 16 cc for compressed yeast (fresh each week).
[e] Gas production of control = 59.5 ± 0.5 gasograph units in 135 min.
[f] Crumb grains not satisfactory.

in contact with wheat flour.

4. When properly sealed and stored, Fermipan dry yeast maintained good viability after being reopened about 48 times over a period of 18 weeks, the duration of the experiment.
5. Desired quantities of Fermipan-type dry yeasts can be quickly and precisely dispensed with adjustable and calibrated cylindrical spoons.
6. Fermipan dry yeast would be especially useful in industry and research in many areas of the world, and in the military services during peacetime and war, in situations where regularly receiving a fresh supply of good compressed yeast is not feasible.

ACKNOWLEDGMENTS

We thank Tresa D. Jones and Margo S. Caley for their expert technical assistance in conducting the gasogram and bread-making tests.

LITERATURE CITED

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 1976. Approved Methods of the AACC. Method 46-11, approved October 1976; Method 44-15A, approved April 1967. The Association: St. Paul, MN.

CRANE, J. C., STEELE, H. K., and REDFERN, S. 1952. Techniques for estimating the stability of food products: Active dry yeast. Food Technol. 6:220.

FELSHER, A. R., KOCH, R. B., and LARSON, R. A. 1955. The storage stability of vacuum-packed active dry yeast. Cereal Chem. 32:117.

FINNEY, K. F. 1945. Methods of estimating and the effect of variety and protein level on the baking absorption of flour. Cereal Chem. 22:149.

FINNEY, K. F., and BARMORE, M. A. 1943. Yeast variability in wheat variety test baking. Cereal Chem. 20:194.

FINNEY, K. F., and BARMORE, M. A. 1945a. Varietal responses to certain baking ingredients essential in evaluating the protein quality of hard winter wheats. Cereal Chem. 22:225.

FINNEY, K. F., and BARMORE, M. A. 1945b. Optimum vs. fixed mixing time at various potassium bromate levels in experimental bread baking. Cereal Chem. 22:244.

FINNEY, K. F., and SHOGREN, M. D. 1972. A ten-gram mixograph for determining and predicting functional properties of wheat flours. Bakers Dig. 46(2):32.

FINNEY, P. L., MAGOFFIN, C. D., HOSENEY, R. C., and FINNEY, K. F. 1976. Short-time baking systems. I. Interdependence of yeast concentration, fermentation time, proof time, and oxidation requirement. Cereal Chem. 53:126.

LANGEJAN, A. 1974. Preparation of active dry baker's yeast. United States Patent Office. No. 3,843,800, Oct. 22.

PONTE, J. G., Jr. 1971. Bread. Page 711 in: Pomeranz, Y., ed. Wheat Chemistry and Technology. Am. Assoc. Cereal Chem.: St. Paul, MN.

PONTE, J. G., Jr., GLASS, R. L., and GEDDES, W. F. 1960. Studies on the behavior of active dry yeast in breadmaking. Cereal Chem. 37:263.

PYLER, E. J., ed. 1973. Baking Science and Technology. Siebel Publishing Co.: Chicago, IL.

RUBENTHALER, G. L., FINNEY, P. L., DEMARAY, D. E., and FINNEY, K. F. 1980. Gasograph: Design, construction, and reproducibility of a sensitive 12-channel gas recording instrument. Cereal Chem. 57:212.

SHOGREN, M. D., and FINNEY, K. F. 1974. A mixture of ascorbic acid and potassium bromate quickly optimize loaf volume (Abstr.). Cereal Sci. Today 19:397.

STACEY, N. E. 1964. A comparison of active dried yeast produced in different areas of the world. Cereal Chem. 41:149.

[Received March 16, 1981. Accepted May 18, 1981]