NOTE

Accelerated Breadmaking Process at Two Fermentation Temperatures

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Bread may be produced by methods generally categorized as straight dough, sponge and dough, continuous mix, and continuously mixed and moulded doughs (Pyler 1982). From the 1950s into the 1970s, the trend was towards the continuous mixing systems to reduce the overall process time and cost, but the bread flavor and crumb texture differed somewhat from those made by traditional methods. In the past decade there has been a return to the sponge and straight dough methods (Kamman 1979), but efforts are still being made to reduce the total process time.

Hileman (1976) prepared a dough additive which reduces the mixing time by 30%. Wollermann et al (1980) described a process for the preparation of yeast-leavened doughs reducing the mixing times with an additive containing sorbic acid and its sodium, potassium, or calcium salts. Rusanova et al (1976) used ultrasonic treatment on sponges, resulting in a 25–30% reduction in fermentation time and an improvement in bread quality. Auerman et al (1977) used ultrasound for 1–3 min on fluid yeast under pressure, and for 8–12 min on semifinished dough, reporting a reduction in process time as well as improved bread quality. Kudryasheva (1979) exposed baker's yeast to Co(60) radiation at 300–750 rad/sec, and found that the ionizing radiation resulted in a shortening of the breadmaking process by 20–50 min.

The quest of scientists has often been to explore yeast species less well known than the traditional *Saccharomyces cerevisiae.* Williams and Luksas (1981) described bread production with *Candida lusitaniae* and *S. delbruckii.* Sankyo Co. Ltd. (1979) developed a process for high sugar content bread using *S. rosei.* Derkanosov et al (1978) used distiller's yeast in breadmaking, and Kusachi (1981) developed a lactic yeast preparation of *Kluyvermyces lactis* and *K. fragilis* to use cheese whey. Adding 2.5% of their lactic yeast preparation reduced bread volume, as well as bench time, of pie and snack doughs by over 80%.

Trivedi et al (1984) developed a new quick-rising yeast using protoplast fusion to combine two strains of yeast. Oszlayi (1983) developed an instant yeast, which eliminated the normal rehydration step before breadmaking.

Fermentation and proofing are the most time-consuming steps in automated bread baking, but they might be shortened at higher fermentation temperatures as, within limits, microbial enzymatic reaction rates increase with increasing temperature.

The objectives of this study were to compare the effect of temperature on the performance of a commercial baker's yeast at 30 and 41° C, and to isolate a thermophilic yeast that could ferment at a higher temperature.

MATERIALS AND METHODS

Wheat Flour

Seventy-two percent extraction wheat flour was obtained through Ms Wallace flour mills, Bombay, having 13.8% moisture and 9.3% protein (14% mb, N × 5.7), determined by approved methods (AACC 1976).

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Yeast Isolation and Identification

Pasteurized fruit juices and roller-dried yeasts were screened to isolate yeasts that could ferment at high temperature. Standard media were made selective with 0.025% calcium propionate, and a yeast with biochemical and morphological characteristics identical to *S. cerevisiae* was successfully isolated from commercial roller-dried yeast and identified as described by Lodder (1970).

Growth Temperature Determination

Flasks containing standard broth (Lodder 1970) were inoculated, and growth was observed at 30 to 50°C (Table I). Growth was recorded as positive if the absorbance at 640 nm increased by a factor of 10 in four successive determinations (Vidal-Leiria et al 1979).

Heat Resistance of Isolated Yeast

Cells grown in standard broth at 41°C were harvested by centrifugation at 10,000 rpm, stored at 4°C, and used within seven days. Heat resistance was determined by suspending freshly harvested yeast solids in sterile phosphate buffer (pH 7.0). Test tubes containing 1% inoculum were incubated at 65 or 70° C for 250 min, removed from the water bath, immediately chilled, and subsequently plated on standard plate count agar.

Dough-Raising Capacity

Four grams of compressed yeast (65% solids) were suspended in 30 ml of water containing 1.5 g of sucrose, and set aside for 20 min at 40° C. To the above suspension, 100 g of wheat flour was added, along with an additional 25.2 ml of water (optimum absorption as determined by the Brabender farinograph). The dough was mixed in a planetary mixer, transferred to a 500-ml graduated cylinder, and pressed to occupy 130–140 ml. The cylinders were then placed in water baths at 30 or 41° C, and their volume increase observed for 1 hr.

Yeast Activity

Tower brand commercial compressed baker's yeast was obtained from Indian Yeast Company, Uran, Maharashtra. Its yeast activity was measured as follows: A yeast suspension was prepared from 8 g of yeast cake (65% solids) and 30 ml of distilled water. After 15 min at 30° C, 20 g of wheat flour was added and mixed with a glass rod. Forty milliliters of this mixture was poured into 250-ml graduated cylinders, placed in water baths at 30 or 41° C, and the increase in volume observed for 3 hr.

Bread Making

Doughs were prepared using both baker's yeast (control method) and isolated yeast (higher temperature method). Equal amounts of

TABLE I
Growth of Isolated Yeast Strain and Baker's Yeast at Various Temperatures

Temperature (° C)	Yeast Growth at the End of 24 hr	
	Thermophilic	Baker's Yeast
30	+	+
37	+	+
41	+	+
45	+	−
50	+	−
52	−	...

dry yeast solids were added, adjustment being made in the quantity of water added. The experimental straight-dough breadmaking formula, based on 100 g of flour was: yeast (compressed) 2.5 g, sucrose 4.0 g, sodium chloride 2.0 g, hydrogenated shortening 3.0 g, water (distilled) 52.2 ml (Fernandes 1983). The dry ingredients were mixed for 2 min at low speed, the water added and kneaded at intermediate speed for 2.5 min, and at high speed for 2 min. Water absorption and optimum mixing times had first been determined with the Brabender farinograph. The doughs were fermented and proofed for a control and an accelerated process (Table II).

Following fermentation, doughs were divided into 150 g pieces, moulded by hand, and placed into lightly greased baking pans (8 × 2 × 2½ in.) and proofed. After baking at 220° C for 30 min, breads were allowed to cool for 1 hr before volumes were measured by mustard seed displacement.

Sensory Evaluation

Breads were evaluated 3 hr after baking by untrained taste panels of 10 to 12 graduate students. A ranking difference was used to compare breads for crust appearance, crumb texture, odor, and flavor. Hedonic scores were determined using a 9-point scale; expressions used ranged from "excellent" to "inedible." All results are the averages of two determinations.

Statistical Tests

The *F*-test for analysis of variance was used to test for significant differences at the 5% level.

RESULTS AND DISCUSSION

Isolated Yeast Strain

The yeast strain *S. cerevisiae* IS 3, isolated from roller-dried yeast, exhibited growth up to 50° C (Table I). Its maximum growth temperature was higher than that for mesophilic yeasts, as defined by Vidal-Leiria et al (1979). All four tubes of the thermophilic yeast strain exhibited positive growth up to 180 min at 65° C, and up to 150 min at 70° C. Vidal-Leiria et al (1979) classified yeast on maximum growth temperature as <24° C for psychrophiles and 24–48° C for mesophiles. The isolated yeast grew well at 50° C and had reasonably good heat stability at 65 and 70° C, so it may be considered a thermophile.

Comparison of Activities for the Two Yeasts

The increase in volume for the thermophilic yeast was 71 ml at 30° C and 108 ml at 41° C, whereas the corresponding values for commercial baker's yeast were 130 and 180 ml (Fig. 1). Thus, the commercial baker's yeast apparently has a higher yeast activity, but the relative increase (41/30 × 100) was greater for thermophilic yeast (Fig. 2). The commercial baker's yeast had a better dough-raising capacity than thermophilic yeast IS 3 (Fig. 1). However, the thermophilic yeast exhibited a greater relative increase in dough-raising capacity, at 41° C as compared to 30° C, than the increase with temperature exhibited by the commercial yeast (Fig. 3).

The peak in the commercial yeast curve may be caused by the transient phase that the yeast passes through. As the temperature rises, the dough-raising capacity increases, but a further increase in temperature reduces the fermentation power of the yeast. A similar effect did not occur for yeast activity, as the conductivity of batter is greater than that of dough, and it takes more time for the dough to warm up to 41° C. As soon as the dough temperature exceeds the temperature for optimum activity, the rate of increase of dough volume is reduced.

The percent increase in yeast activity and dough-raising capacity increases with rise in temperature for the two yeasts. The major increases in volume at 41° C should result from increased activity, and only slightly from the expansion of gases at higher temperature. The increase in yeast activity and dough-raising capacity was continuous over the entire observation period; there was no conspicuous reduction in activity with time. Our findings

TABLE II
Fermentation Time and Temperature for the Two Processes

Process	Control Conditions	Elevated Temperature
First fermentation	60 min, 30° C	45 min, 41° C
Second fermentation	30 min, 30° C	25 min, 41° C
Proof	60 min, 41° C	45 min, 45° C
Baking	30 min, 220° C	30 min, 220° C

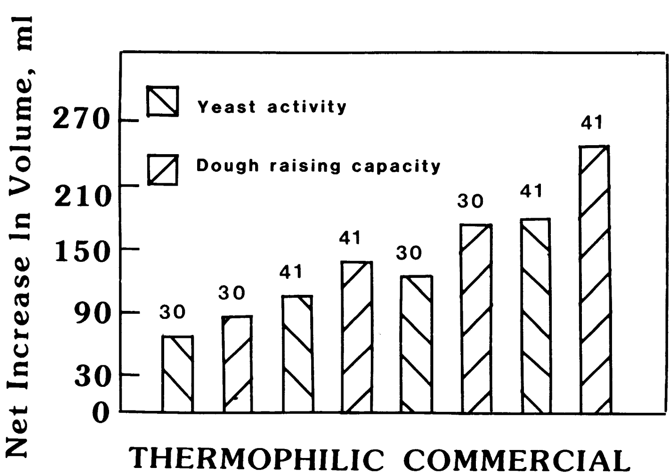

Fig. 1. One-hour yeast activity (slurry) and dough-raising capacity of a thermophilic and a commercial strain of *Saccharomyces cerevisiae* measured at 30 and 41° C.

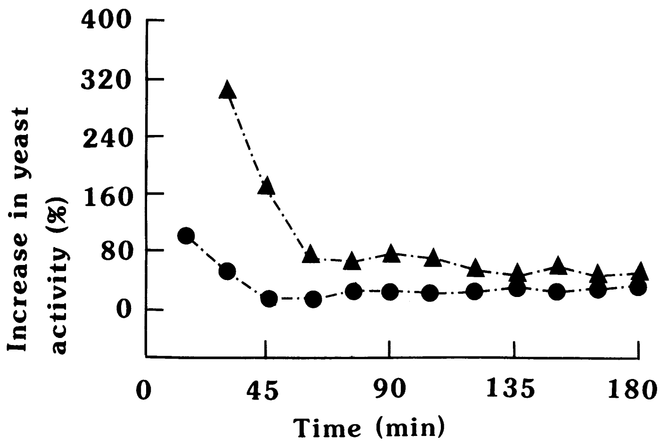

Fig. 2. Relation in yeast activity, measured as 41/30 × 100, for the thermophilic (▲) and commercial yeasts (●).

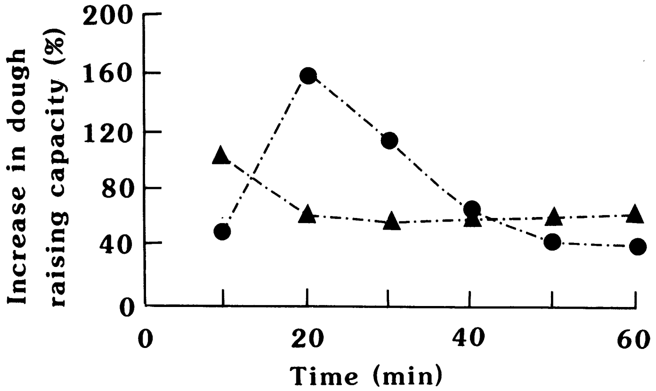

Fig. 3. Relative increase in dough-raising capacity, measured as 41/30 × 100, for the thermophilic (▲) and commercial yeasts (●).

TABLE III
Loaf Characteristics of Bread
Made by Two Different Processes

Yeast and Temperature	Volume (cc)[a]	Specific Volume (cc/g)
Commercial yeast control, 30°C	570	4.36
	565	4.56
Commercial yeast, 41°C	645	5.06
	650	5.36
Thermophilic yeast, 41°C	525	4.48
	545	4.22

[a] Average of two determinations.

agree with those of Cooper and Reed (1968), who showed that yeast gassing power is subject to wide variation and observed that higher temperatures, up to about 100°F (38°C), accelerate the fermentation rate; above that level the gassing rate begins to decrease.

Comparison of Breads Baked with the Two Yeasts

Table III compares loaf volume and specific volume of the baker's yeast bread doughs fermented at 30 and 41°C. The loaf volumes differed significantly ($P < 0.001$). At 41°C, the average loaf volume was 647.5 cc as compared to 567.5 cc for the 30°C control, a 14% increase. The large loaves were described by the panelists as the most acceptable.

Taste panel results suggested that there were no significant differences between loaves, in crust appearance, odor, flavor, or crumb texture. Some of the panelists gave a lower crumb texture score for the bread fermented at a higher temperature and described the texture as being more open.

Breads made with commercial baker's yeast were rated better in crumb texture and flavor, but the thermophilic yeast produced better crust and odor. The differences were not statistically significant.

CONCLUSIONS

The most important result of the present study was the apparently successful dough fermentation at higher temperature by the commercial baker's yeast now used in India, without a change in ingredients. There was a desirable increase in specific volume, but no change in flavor.

A thermophilic strain of the yeast *S. cerevisiae* was isolated. Doughs fermented with thermophilic yeast at the higher temperature (41°C) and shorter times produced breads comparable to those fermented with baker's yeast at the lower temperature. The breads could not be distinguished by the panelists during subjective evaluation.

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