A Laboratory Method for Saltine Crackers[1]

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ABSTRACT

Results of a test baking procedure for saltine crackers showed that fermentation time of the sponge plays an important role in conditioning cracker doughs. Cracker doughs prepared from sponges fermented longer were found to machine better and to have more uniform oven spring and a better texture with fewer blisters and compact areas than did doughs fermented for short times. Replacing up to 30% soft wheat flour with hard wheat flour (HWF) improved machinability by mellowing the dough. Oven spring was improved by adding HWF, and the crackers' texture was also improved. In general, the weight of baked crackers decreased as HWF was increased up to 30%. Crackers obtained from straight HWF were of good quality, with an excellent oven spring but were heavier than crackers made from straight soft wheat flour. Crackers made from doughts in which the sponges were mellowed by addition of lactic acid had no oven spring at all and were completely different in texture and taste from normal crackers. These results clearly showed yeast to be a fundamental ingredient in crackers. Yeast not only adjusts pH to allow enzymatic conditioning of the dough but also improves both texture and flavor of the finished crackers.

Crackers are an exceptional baked product with a unique texture. Conventionally, crackers are prepared by a sponge and dough process that takes approximately 24 hr. A prolonged sponge fermentation is thought to be required to bring about the many changes that give saltine crackers their unique textural properties. The cracker sponge fermentation is important, but it is also a very long process, requiring about 18 hr, or approximately 75% of cracker production time. Although the saltine cracker formula has not been standardized, Matz (1968) has summarized six published formulas for soda crackers and presented an average and range for each ingredient used in the formulation. In reviewing the basic principles of salting cracker production, Pieper (1971) outlined a typical formula for cracker production. Additional information has been reported by Heppner (1959) and others (Bohn 1957, Johnson and Bailey 1924).

Attempts to develop a procedure for production of satisfactory experimental crackers have led some to conclude that they cannot be produced (Dunn 1933). However, the purpose of the present investigation was to establish such a procedure to produce saltine crackers under laboratory conditions.

MATERIALS AND METHODS

Two types of flour were used throughout the experiments: soft wheat flour (SWF) from Acme-Evans Co. (division of General Grain, Inc., Indianapolis, IN 46204) and hard wheat flour (HWF) milled on the Kansas State University pilot mill. SWF-A contained 9.2% protein and 0.44% ash; SWF-B contained 9.3% protein and 0.42% ash. HWF-A contained 11.6% protein, 0.40% ash, and HWF-B 10.5% protein, 0.41% ash. Compressed fresh "Budweiser yeast" produced by Anheuser-Busch, Inc. (St. Louis, MO 63118) was used. The shortening was Swift's "Silverleaf" lard made from lard and partially hydrogenated lard with butylated hydroxyanisole and butylated hydroxytoluene added. Other chemicals were reagent grade.

Measurement equipment was a vernier height gauge with vernier reading of 1/50 mm (1/1000 in.) and range of 250 mm (10 in.), made in Japan by Mitutoyo Manufacturing Co., Ltd., and a specially constructed ruler graduated in 1-mm lengths to measure the length of 10 crackers. The baking surface was a specially designed 8½ × 17 in. rectangular shaped ¼-in. flattened expanded metal plate (gauge 20–22) weighing 444.06 g and 1-mm (0.040 in.) thick with adjustable legs. Normally, it was used at a 3-in. leg height.

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Cracker Formula

The cracker formula (Table I) used in this study was based on that of Faridi and Johnson (1978).

Mixing Procedure

Crackers were made on a laboratory scale, using a sponge and dough procedure previously described (Pizzinatto and Hoseney 1980). The sponge was fermented for 18 hr at 86° F (23° C), and the dough, hand packed tightly into a 2,000-ml beaker, was fermented for 6 hr at 30° C and 90% rh.

Sheeting and Cutting

After fermentation, the dough was flattened by hand into a rectangular-shaped frame to give a uniform piece of dough 3½ × 11 × 1 in. in width, length, and thickness, respectively. This procedure

TABLE I
Cracker Formula[a]

Ingredients	Sponge (%)	Dough (%)
Flour	65	35
Water	25	···
Yeast	0.4	···
Shortening	···	11
Salt	···	1.8
Soda	···	0.45

[a]Ingredients based on flour weight. Flour weighed on a 14% moisture basis.

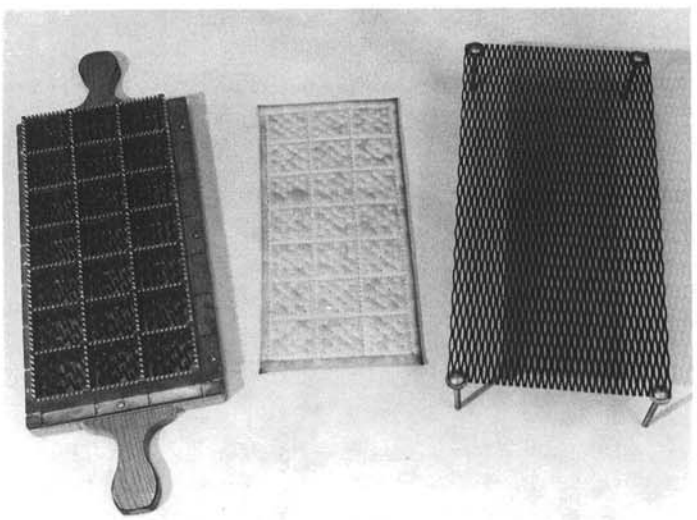

Fig. 1. Cutter-docker, plate of baked crackers, and baking rack.

allowed us to control the width and have a more uniform edge on the sheeted dough, besides facilitating the first passage through the sheeter. Dough was sheeted (Anets pie-crust roller, model MDR-45) in steps by passing it 12 times through the sheeter and going from an initial thickness of 1 in. to the final thickenss of 0.023 in. (0.58 mm). During the first six passages, dough was gradually reduced from 1 to 0.050 in. by passing it through the following sheeter openings: 16.12, 12.30, 9.50, 5.65, 2.88, and 1.25 mm. The next three passages were with a 0.050-in. gap. After each of these passages, dough was folded on itself once; consequently, after three passages it had 2^3 or eight layers. This dough was sheeted three more times through the following openings: 0.035, 0.025, and 0.023 in. (0.89, 0.64, 0.589 mm, respectively). The final reduction, 0.023 in. (0.58 mm), was selected because it gave crackers with weight and thickness close to those of commercial crackers. Crackers with better texture and more uniform oven spring were obtained when the first eight sheetings were in one direction and the last four at a right angle to the first direction. When dough had been sheeted, it was cut with a specially designed hand-cutter-docker (Fig. 1). The cutter-docker (21 cells, 7 × 3, of 2 × 2 3/16 in.) indents and partially seals the edges of cracker dough without cutting through. Cutting-docking was accomplished by placing the dough sheet on a belting cloth laid on a heavy board (Fig. 2). This arrangement forms a bed for the dough sheet that is neither too soft (causing distortion) nor too hard (causing inefficient cutting). After it had been cut, the dough sheet (Fig. 3) was protected from moisture loss by a covering of wax paper until immediately before baking.

Baking

An electrically heated reel-type laboratory oven was used with the reel stopped and set in such a way that, of four shelves, two were at the same level and exactly in the middle of the other two shelves. Crackers were baked for 4 min and 20 sec at 510°F (265°C) on a rectangular-shaped rack. A protective edge of about ½ in. of dough around the cut cracker plate was necessary to protect cracker edges from overbaking. Without this precaution, the edges of the cracker bloomed faster than did the middle area and became darker in color than did the body of the cracker. The oven door was opened during the last 20 sec of the baking period. This procedure gave crackers with a better developed color.

The baking surface was one of the most important factors in the production of experimental crackers. Four different types of racks were tested. All of them had the same overall size, 8½ × 17 in. Two were made with a 3/32 in. diameter wire spaced at ¼ and 3/32-in. intervals, respectively. The other two were made of ¼ and ½-in. flattened, expanded metal. The best results were obtained with the ¼-in. flattened, expanded metal (Fig. 1), but although this surface was the best one found and gave satisfactory results, it was not ideal.

The major problem with the baking surfaces appeared to be heat transfer. Because the rack is at room temperature before going into the oven, part of the oven heat is absorbed by the rack, and the bottom of the dough sheet receives less heat for a time. Preheating the racks created more problems than it solved. Racks with more mass required more oven heat, and the bottom of the cracker stayed

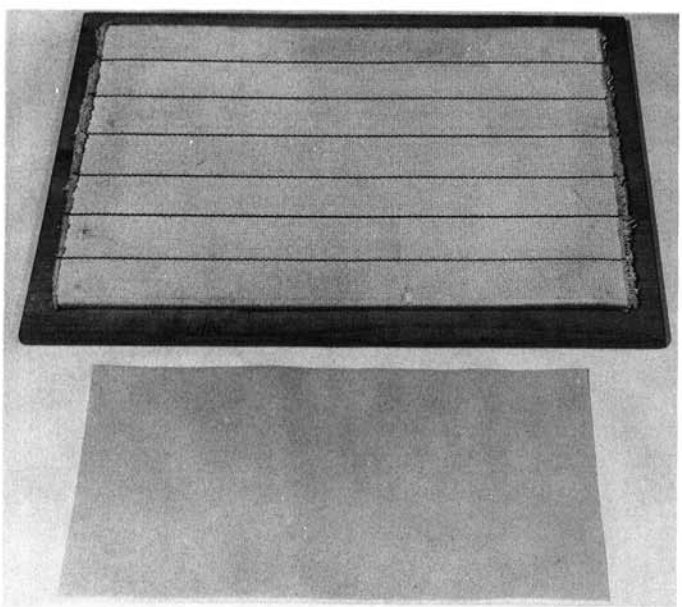

Fig. 2. Sheeted dough and cutting bed formed by a heavy board and a belting cloth.

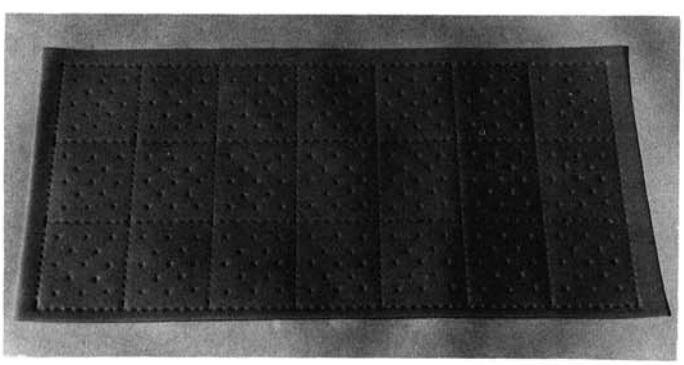

Fig. 3. Plate of sheeted dough after cutting-docking.

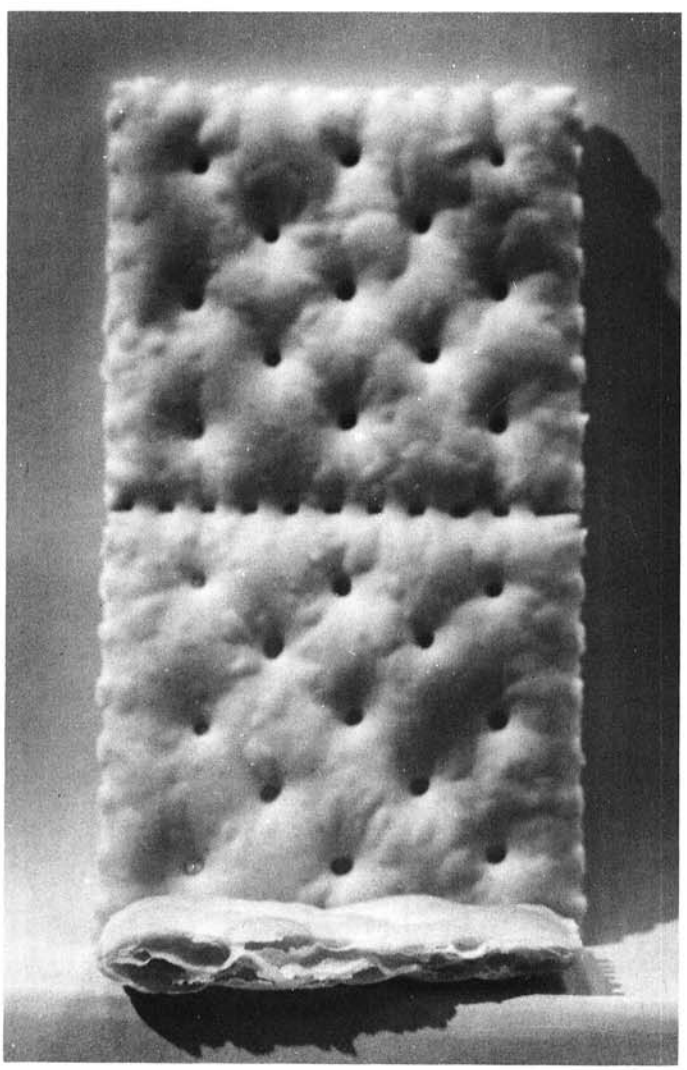

Fig. 4. Close-up of baked crackers and a cracker cross-section showing the internal structure.

cool longer. Thus, the heat transfer problem was worse with heavier racks. The mass of the baking surface apparently had to be balanced with the weight of the cracker piece in order to obtain the desired baked product.

After baking, the crackers were placed on a rack (½-in. expanded metal) at room temperature and allowed to cool for approximately 30 min. The baked cracker plate was then broken into individual crackers. After those with obvious flaws had been removed, 10 of the 21 pieces were chosen at random and were placed in pressure-sealed plastic bags to be stored for later measurements. Approximately 24 hr after baking, the weight, height, and length (in two directions) were measured for each 10-piece sample. Each sample was measured twice for each attribute, and each 500-g dough generated three samples.

pH Determination

The pH of cracker sponges was determined as described previously (Pizzinatto and Hoseney 1980).

RESULTS AND DISCUSSION

Baking Results

Baking tests were performed using 100% SWF as the control. The reported data is the average of at least three replications and generally more. Besides the usual measurements, a height/weight (H/W) ratio was used as a measure of oven spring. A picture of a baked cracker is shown in Fig. 4.

Data in Table II show that the characteristics of baked crackers were affected considerably by fermentation time. In general, the H/W ratio and shrinkage of both sides decreased as fermentation time decreased. Doughs fermented longer were more pliable and had better machinability. Doughs with less fermentation time were more elastic and thus required more pressure to be sheeted. The elasticity caused the dough to contract after sheeting and before cutting and the cracker was thicker. This result explains the increased weight and height of crackers with reduced fermentation time. Because contraction occurs rapidly (before cutting), it probably also explains the reduced shrinkage. The increased height obtained with less fermentation was mainly caused by blisters and does not represent better oven spring. Oven spring was more uniform as fermentation time increased. Increased fermentation time also gave crackers with better texture (more like that of commercial crackers) and with fewer blisters and compact areas.

Table III shows that when part or all of the SWF was replaced with HWF, shrinkage of side A (the direction of the last sheeting) tended to decrease as the amount of HWF increased. Side B shrinkage was inconsistent; it increased with 10 and 20% replacement and decreased with 30 and 100%. The weight of baked crackers decreased as HWF was substituted. This gave lighter crackers than were obtained with straight SWF—except for crackers baked from 100% HWF, which were slightly heavier than the control. A general tendency toward increasing height and H/W ratio was seen as the amount of HWF was increased. HWF had a mellowing effect, making the dough more pliable and less elastic, which improved its machinability. Oven spring was also improved by addition of HWF, and this resulted in crackers with better texture.

A comparison of characteristics of crackers prepared with SWF and with HWF is given in Table IV. The crackers from the SWF were lighter in weight and had more shrinkage than did those prepared from HWF. However, the lower shrinkage obtained with HWF was probably because of a fast contraction of the sheeted dough before cutting, which decreased the amount of shrinkage in the baked crackers. No consistent relation was found between H/W ratio and flour type. Oven spring of crackers prepared with HWF was considerably higher than that of crackers with SWF. This is reflected by the height values. In general, the HWF gave good crackers.

With the yeast used in this study, the sponges had a pH of 4.15 after 18 hr of fermentation. Lactic acid added to nonyeasted cracker sponges (pH 4.15) produced a mellowing effect; extensigrams showed low extensibility and low resistance to extension (Pizzinatto and Hoseney 1980). Cracker doughs prepared without yeast but with lactic acid added to adjust the sponge pH to 4.15 were very soft. This softness increased with "fermentation" time. In general, the doughs were excellent for machining, with the exception of dough "fermented" for 6 hr. However, crackers prepared with those doughs had no oven spring at all. The difference in height values (Table V) was the result of blisters. The number of blisters increased as "fermentation" time decreased. Also, as "fermentation" time decreased, shrinkage generally decreased. On the other hand, weight, height, and H/W ratio increased as "fermentation" time decreased, and these crackers were quite different in texture and taste from normal crackers. These results clearly show that yeast is a fundamental ingredient in crackers; besides its role in adjusting pH to allow enzymatic conditioning of the dough, yeast has an important effect on both texture and flavor.

SUMMARY

Data in Table VI show means and standard deviations for the different attributes measured. From the baking results we concluded that fermentation time is important in conditioning

TABLE II
Effect of Cracker Sponge Fermentation on Physical Characteristics of Baked Crackers[a]

Sponge Fermentation (hr)	Shrinkage[b] (cm) of Side A	Shrinkage[b] (cm) of Side B	Weight (g)	Height (cm)	Height/Weight Ratio
18 (control)	3.385	4.037	29.729	6.983	0.235
15	3.167	3.866	31.157	6.864	0.220
12	2.900	3.550	33.337	7.326	0.220
9	2.767	3.375	34.457	7.508	0.218
6	3.000	3.375	34.483	7.459	0.216

[a] Data for 10 crackers.
[b] Size of cutter × 10 minus size of 10 crackers after baking.

TABLE III
Effect of Replacement of SWF by HWF[a] on Physical Characteristics of Baked Crackers[b]

Percent in Sample SWF	Percent in Sample HWF	Shrinkage[c] (cm) of Side A	Shrinkage[c] (cm) of Side B	Weight (g)	Height (cm)	Height/Weight Ratio
100 (control)		3.385	4.037	29.729	6.983	0.235
90	10	3.275	4.175	28.940	7.172	0.248
80	20	3.208	4.241	27.813	7.080	0.255
70	30	3.125	3.775	28.067	7.161	0.255
	100	2.542	3.525	30.283	8.205	0.271

[a] Percentage was calculated on the basis of all flour (both sponge and dough) although HWF was used only in the sponge except at 100%.
[b] Data for 10 crackers.
[c] Size of cutter × 10 minus size of 10 crackers after baking.

TABLE IV
Physical Characteristics of Baked Crackers Prepared with SWF or with HWF[a]

Flour Type	Shrinkage[b] (cm) of Side A	Shrinkage[b] (cm) of Side B	Weight (g)	Height (cm)	Height/Weight Ratio
SWF-A (control)	3.385	4.037	29.729	6.983	0.235
SWF-B	3.217	4.183	27.660	6.884	0.249
HWF-A	2.542	3.525	30.283	8.205	0.271
HWF-B	2.392	3.450	33.083	7.696	0.233

[a] Data for 10 crackers.
[b] Size of cutter × 10 minus size of 10 crackers after baking.

TABLE V
Effect of "Fermentation" Time on Physical Characteristics of Baked Crackers in Presence of Lactic Acid[a]

"Fermentation" Time (hr)	Shrinkage[b] (cm) of Side		Weight (g)	Height (cm)	Height/Weight Ratio
	A	B			
Dough with yeast (control)[c]					
18	3.385	4.037	29.729	6.983	0.235
Dough with lactic acid					
18	2.608	3.066	27.657	5.387	0.195
15	2.408	2.925	28.573	5.802	0.203
12	2.358	2.908	29.090	5.942	0.204
9	2.325	2.933	30.073	6.156	0.205
6	2.283	2.550	33.393	7.012	0.210

[a] Data for 10 crackers.
[b] Size of cutter × 10 minus size of 10 crackers after baking.

TABLE VI
Means and Standard Deviations for Control Crackers[a]

	Shrinkage[b] (cm) of Side		Weight (g)	Height (cm)	Height/Weight Ratio
	A	B			
Mean	3.385	4.037	29.729	6.983	0.235
Standard deviation	0.313	0.260	0.676	0.182	0.007

[a] Data from 12 fermentation batches prepared on four different days.
[b] Size of cutter × 10 minus size of 10 crackers after baking.

cracker sponges. Cracker doughs prepared from sponges fermented longer were more pliable and easier to machine. Crackers obtained from those doughs had more uniform oven spring, better texture, and fewer blisters and compact areas. Replacement of SWF by HWF up to certain limits (30%) had a beneficial effect. Oven spring was also improved by addition of HWF, resulting in crackers with better texture. Normally, the weight of baked crackers decreased as HWF increased up to 30%. In general, crackers obtained from straight HWF had good quality, giving an excellent oven spring. However, they were heavier than crackers obtained with straight SWF. Crackers obtained from doughs mellowed by addition of lactic acid had no oven spring at all and were quite different in texture and taste from normal crackers. These results point to the fundamental role of yeast not only in adjusting the pH to allow enzymatic conditioning of the dough but also in improving texture and flavor of the finished crackers.

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