Test to Determine the Optimum Water Absorption for Saltine Cracker Doughs[1]

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ABSTRACT

Twelve commercial cracker flours and two flours milled from soft wheats were baked into crackers using a laboratory-scale baking procedure. Water absorption was varied and the optimum absorption was selected for each flour. A modified mixograph procedure was developed that enabled optimum baking absorption to be predicted before mixing a cracker sponge. Correlation of the mixograph procedure with the baking test was $r = 0.95$.

Finney (1945) defined optimum baking absorption in bread systems as

> the greatest amount of water that can be added and still produce a dough of such consistency that it can be conveniently and efficiently handled in the bake shop and will yield satisfactory bread.

Such a critical approach could well be used to study the influence of water in cracker production. The absorption for a cracker flour generally is considered to be the minimum, rather than the maximum, amount of water that can be added to produce a dough of desired consistency. The dough should be wet enough to sheet, yet dry enough to avoid the formation of an elastic dough. Any excessive water that is added must be evaporated in the oven to produce crackers with 2–4% final moisture, which results in longer bake times.

A review of the literature did not reveal any methodology for determining optimum absorption for crackers. Most workers used a constant water level within a given study, regardless of the flours being used (Johnson and Bailey 1924; Reiman 1938; Brown 1939; Simmons 1940, 1941; Vaupel and Hanks 1944; Faridi-Araghi 1975; Pizzinatto and Hoseney 1980; Doescher and Hoseney 1985). If, as assumed, cracker doughs do have an optimum absorption level, a rapid and practical method of predicting that absorption needs to be developed.

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MATERIALS AND METHODS

Ingredients

Twelve commercial cracker flours provided by Nabisco Brands Inc., Conagra Inc., Lance Inc., or Dixie-Portland Flour Mills Inc., and two flours that were milled from soft wheats at Kansas State University were used in the study. Flour protein ranged from 7.8 to 10.1% and flour ash ranged from 0.37 to 0.52%, on a 14% moisture basis (Tables I and II).

Cracker Baking

Crackers were baked using a slightly modified procedure developed at Kansas State University (Pizzinatto and Hoseney 1980, Doescher and Hoseney 1985). The formula (Table III) was based on 500 g of flour (14% mb) with water being optimized for each flour. A brew of 100:200:3:0.6 flour, water, sucrose, and yeast, respectively, described by Doescher and Hoseney (1985) was used as the starter.

The yeast and starter were blended for 1 min in an Oster mini-jar with approximately 75 g of water. The jar was rinsed with the remaining water, and this was added to the sponge. A pin mixer TMCO-National Manufacturing, Lincoln, NE; 1-lb size) modified to turn at 32 rpm, was used for all the mixing steps. Sponges were mixed for 3 min, with the bowl being scraped down after each minute. Sponges were fermented in covered mixing bowls for 18 hr at 27°C and 80% rh.

Total titratable acidity was determined for each sponge before the dough stage. A sample of sponge (10.0 g) and 100 g of water were blended in an Oster mini-jar for 2 min. Four drops of octanol were added to reduce foaming, and pH was measured directly in the Oster mini-jar using a Corning 125 pH meter. This slurry of the sponge was then titrated with 0.1N NaOH to pH 7.0. The appropriate quantity of $NaHCO_3$ to be used in the dough stage was determined by the following formula: g $NaHCO_3 = 1.6968 + (0.5216 \times$ ml 0.1N NaOH).

After fermenting the sponge, the remainder of the flour, salt, and soda were sprinkled over the surface of the sponge and mixed with the modified National pin mixer for 20 sec. Lard or shortening, melted to 60° C, was added to the dough ingredients and mixed for 10 sec. After scraping, the dough was mixed an additional 1 min and then allowed to ferment at 27° C and 80% rh for another 4 hr.

Sheeting and baking were as reported by Doescher and Hoseney (1985), except that the expanded metal baking surface was preheated 75 sec at the oven temperature of 288° C. The cracker dough was sheeted through 8.89 mm diameter smooth rolls for a total of 10 passes, with the roll gap being gradually reduced from 25 to 0.3 mm. The dough piece was folded three times and turned 90° once during sheeting, and then immediately cut and docked (21 cracker cells per sheeting). A narrow strip of dough was left intact around the cells to eliminate any edge effect during baking. The dough was then transferred onto a piece of pressboard, slid onto the preheated baking surface, and baked approximately 3.75 min. After cooling on wire racks, crackers were stored in plastic bags overnight before cutting and measuring. All height and weight measurements were made on stacks of 10 crackers.

RESULTS AND DISCUSSION

In the production of crackers, sheeting converts the semidry mass into a coherent, smooth, homogeneous-appearing dough. It is our contention that optimum crackers cannot be produced if the dough is not sheeted (developed) to the proper point. Little flexibility is available on the production line for making changes in the sheeting process, thereby increasing the need to have a consistent, controlled dough coming to the sheeting line. Optimum water absorption is essential for the optimum development of a bread dough (Hoseney and Finney 1974). It is logical that water is just as critical in cracker dough development. Therefore, when comparing the quality of crackers made from different flours within one production system, each flour should be used at an optimum water level.

People in the cracker-baking industry generally determine optimum absorption for cracker flours by setting a series of sponges, varying the water level used in each sponge between 22 and 30%, based on total flour. This procedure requires large numbers of samples and much time, because selection of the optimum absorption cannot be made until after the 18-hr sponge fermentation, or perhaps after the additional 4-hr dough fermentation. If such a series were not run in advance of switching to a new flour supply, considerable quantities of poor quality product could have been produced during the testing period.

For our study, four flours, two of which were milled from soft wheats at Kansas State University, were initially baked into crackers, using several water absorption levels for each flour. The optimum absorption level (Table I) was selected for each flour based on the resultant crackers' stack height, stack weight, and cell structure. When the water used in baking was 1% less than the level judged to be optimum, the doughs were crumbly and it was difficult to form a continuous dough sheet. When 2% more than the optimum water was used in baking, the doughs were elastic after sheeting. This gave crackers with lowered stack heights. With standard baking times and the higher baking absorptions, cracker moisture was generally higher than the 2–4% moisture desired for good quality crackers. Stack weights, calculated on dry basis, were lowered with increasing absorption levels (Table IV).

Our results were in agreement with those of Micka (1934), who noted that crackers baked from high-absorption doughs gave solid, tough products, rather than the desired light, dry, crisp products. Vaupel and Hanks (1944) reported that increasing water levels in cracker sponges led to a faster wetting of the sponge flour and usually to a more rapid drop in pH during the sponge fermentation. Fields et al (1982) also reported more rapid pH drops with increasing water levels in sponges and slurries. Although we did not note large drops in pH with increasing water levels, this phenomenon may account at least partially for the decrease in cracker stack height with increasing absorption.

An additional 10 flours were made into crackers, and the optimum baking absorption was selected for each flour (Table II) based on the same criteria used for the original four samples. The same trends were observed regarding the influences of inadequate and excessive water levels. It became increasingly apparent that an optimum absorption level did exist for each cracker flour.

The mixograph is used widely to measure mixing properties of bread flours. It requires only 10 g of flour, can produce a mixogram in only 8 min, and can be used to determine bread-baking absorption (Finney and Shogren 1972). Oh and co-workers (1986)

TABLE I
Flours for Initial Absorption Series

Sample	Protein[a] (%)	Ash[a] (%)	Baking Absorption Range (%)	Baking Absorption Optimum (%)	Mixograph Absorption (%)
1	9.6	0.51	23–28	25.0	36.0
2	9.5	0.45	25–28	26.5	37.5
3	9.4	0.45	25–29	27.0	37.5
4	9.0	0.49	24–27	25.0	36.0

[a] 14% mb.

TABLE II
Flours for Conformational Absorption Series

Sample	Protein[a] (%)	Ash[a] (%)	Baking Absorption Range (%)	Baking Absorption Optimum (%)	Mixograph (%)
5	9.6	0.52	27–30	28.0	39.0
6	7.8	0.42	25–27	27.0	37.0
7	10.1	0.48	26–29	27.0	38.0
8	10.1	0.49	24–27.5	25.5	36.5
9	9.1	0.45	25–28	27.0	37.5
10	9.1	0.46	25–29	26.0	37.5
11	7.8	0.37	25–28	26.5	37.0
12	8.5	0.45	25–28	26.0	37.0
13	9.1	0.46	25–28	26.0	37.0
14	9.5	0.44	24.5–29	26.0	37.0

[a] 14% mb.

TABLE III
Cracker Formula[a]

Ingredient	Sponge (%)	Dough (%)
Flour	65.00	35.00
Water	optimum	...
Yeast	0.36	...
Starter (brew)	4.50	...
Salt	...	1.19
Soda	...	optimum
Shortening	...	7.84

[a] Based on flour weight.

TABLE IV
Effect of Varying Absorption

Absorption (%)	Sponge pH	Stack Ht (mm)	Stack Wt[a] (g)	Ht/Wt
Flour 10				
25	3.66	...	...	...
26	3.61	68.33	34.34	1.99
27	3.59	67.45	34.37	1.96
29	3.50	63.72	31.94	1.99
Flour 12				
25	3.78	...	...	...
26	3.45	67.35	34.57	1.95
27	3.50	67.04	34.24	1.96
28	3.58	61.79	31.27	1.98

[a] Dry basis.

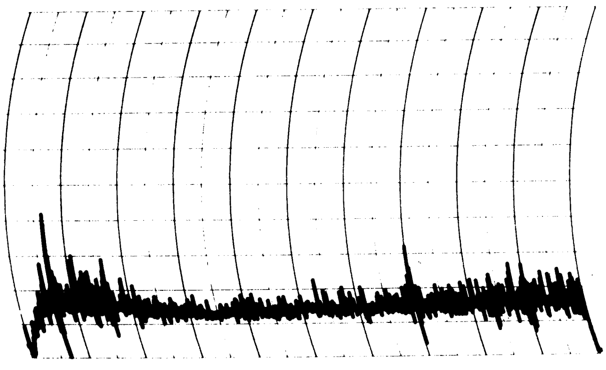

Fig. 1. Mixogram of cracker flour having too little water.

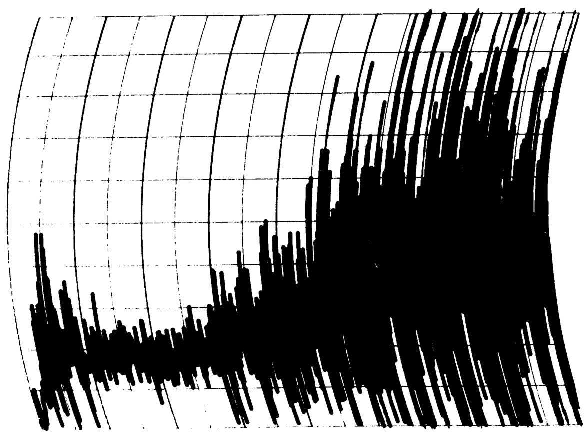

Fig. 2. Mixogram of cracker flour having too much water.

developed a modified mixograph method to determine the optimum water absorption of flours to prepare oriental noodles. Aliquots of NaCl solution and distilled water were added to the flour at 1-min intervals until an abrupt change occurred in the mixogram. The absorption levels used in cracker baking (22–30%) are much too low to produce a mixing curve with the standard mixograph procedure. Therefore, a modified procedure was developed.

The initial four flours were tested on a mixograph (TMCO-National), using a 10-g sample (14% mb). The water level was varied initially in 1% increments and finally in 0.5% increments from a starting absorption of 37%. If a mixograph curve did not show any dough development, but simply remained near the baseline (Fig. 1), more water was needed. If dough development occurred before 7 min of mixing (Fig. 2), less water was needed. The optimum absorption produced a narrow mixing curve with very little resistance for 7 min, after which dough development occurred (Fig. 3). The absorption determined by the mixograph procedure was 11% (flour basis) higher than the optimum baking absorption for the four flours used in the initial trial (Table I).

This mixograph procedure was then used to determine the absorption level for each of the 10 additional flours (Table II). The mixograph absorption levels, minus 11% water, were all within 1% of the baking absorptions selected for the flours tested. The correlation between the predicted mixograph value and the baking absorption was $r = 0.95$.

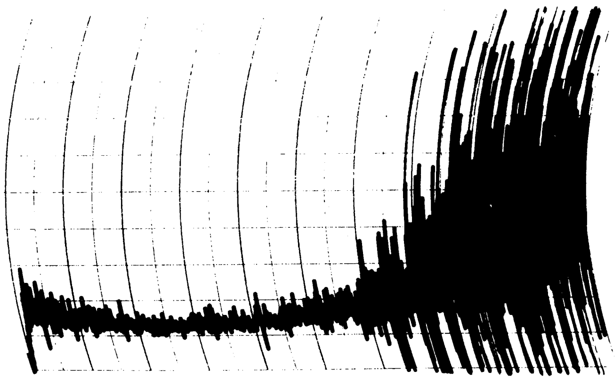

Fig. 3. Mixogram of cracker flour having the desired water.

The mixograph technique described above appears to be a good predictive tool for determining optimum cracker flour absorptions. The level of water selected with this quick method permits acceptable crackers to be baked without a trial bake to determine absorption, and it apparently could be applied to either research or industry cracker production.

ACKNOWLEDGMENT

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