Nature of the San Francisco Sour Dough French Bread Process

I. Mechanics of the Process

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San Francisco sour dough French bread has been made more or less continuously in the San Francisco bay area for over 100 years. Its popularity and virtually universal acceptance are well established for the local market (estimated at 15 to 20 per cent of the bread consumed), with visitors, and for export to other areas of the U.S. and foreign countries. In view of this long standing success it is not surprising to find that a certain mystique surrounds the process in view of the absence of easy answers to the following questions:

1. What actually are the mechanics of the process?
2. How has the process managed to survive for such a long period without foundering, i.e., what are the perpetuating and protective mechanisms involved?
3. Why hasn't the process been transported successfully to other areas despite many abortive attempts to do so, i.e., is there any substance to the rumored necessity for local San Francisco climate, or unique alleged contribution of "properly" contaminated walls, canvas, etc.?
4. What are the one or more microorganisms involved in the leavening and souring actions in this unique dough and why has there been nothing reported on their nature in the technical literature in all this time?

Our attempts to date to throw some light on these questions and provide information useful for further development of this process and possible application to other areas are reported in this and the following paper.

Starter Sponge

The heart of the process is the starter, or mother sponge, for not only is it the source of both the leavening and souring powers, but it also provides the mechanism for perpetuating the process. In commercial practice, the starter sponge is rebuilt about every eight hours or at least two to three times a day, seven days a week. Presumably it has been carried in this fashion for 100 years, although we can only guess how it got started originally. We prepare and develop it as described in **Table I.** The very high proportion of previous starter sponge used in preparing a new one (generally 25 to 40 per cent) serves two functions: (a) it provides a massive inoculum of whatever microorganisms may be involved and, of equal importance, (b) it insures a very acidic environment **(Table I)** which we have found contains a substantial amount of acetic acid. Very few known microorganisms are able to initiate growth in, or survive constant exposure to, this particular environment since acetic acid under these conditions is fairly lethal—somewhat similar to the resistance mayonnaise shows to microbial action. Accordingly, this not only suggests a clue to one of the questions raised, namely the self-protective nature of this sour dough system, but also alerts us to the probability that any microorganisms we may find involved in this process may be expected to have rather unusual properties.

As indicated in **Table I,** in addition to using a high proportion of previous starter sponge, the new starter sponge is made up with a high gluten flour (Montana Spring, approx. 14 per cent protein, as is basis) and using a relatively low water absorption of about 50 per cent. This formulation serves to keep the starter sponge manageable, preventing it from becoming excessively slack and sticky during its de-

Figure 1: *Hearth oven with steam injection system for baking sour dough French bread.*

Table I

Sour Dough Starter Sponge

100 parts previous sponge 100 parts flour (Hi-gluten) 46-52 parts water
Make up and hold 7-8 hrs. at 80°F. Starting pH = 4.4 to 4.5 Final pH = 3.8 to 3.9

velopment period of about seven to eight hours at 75 to 80°F.

In the final bread formulation (**Table II**), the starter sponge, even though it contributes only about 11 per cent of the total flour in the bread dough, serves an additional vital function in imparting strength to the bread dough which otherwise would be quite slack after the limited floor time (approximately one hour) provided between make-up and molding.

Preparation and Handling

The bread dough, as shown in **Table II**, is made up simply with the fully developed starter sponge, flour, water and salt. None of the other usual ingredients of white pan bread, such as yeast, sugar, shortening, nonfat dry milk, monoglycerides, dough conditioners, oxidants, mold inhibitors, etc. are needed or used, although, as will be discussed below, low levels of baker's yeast may be added on occasion. The starter sponge is used at a level of approximately 9 to 15 per cent of the final bread dough which, after make-up, is allowed to relax for at least 30 minutes. Then it is scaled (divided), rounded and given an overhead proof of about 20 minutes at 90°F., after which it is molded, placed on canvas dusted with rice flour and/or corn meal and allowed to proof about six to eight hours at 85 to 90°F. This long proof time may be reduced somewhat by increasing the proportion of starter sponge or by lengthening the floor time before molding, but is generally essential for development of the acidity and coarse grain typical of this bread as well as for volume.

The pH of the bread dough on make-up is about 5.3 and drops to about 3.9 when the long proof is completed, or roughly to the same point reached by the starter sponge itself.

Baking

Baking is carried out in a hearth (generally carborundum) oven for a relatively long time (45 to 55 minutes) at a relatively low temperature (375 – 390°F.). It is quite essential to slash or make cuts on the surface of the fully-proofed dough just before it is placed in the oven, otherwise the crust character will be wrinkled and generally unsatisfactory and the eating quality of the crust is probably the most essential part of this bread. Also an absolute requisite to achieving the desired crust character is the use of a very wet oven, particularly the first part of the baking cycle and continued until the crust attains a light tan color. Generally this is achieved by saturating the oven with low pressure steam. Our small hearth oven with the insulated steam injection system evident on the right is illustrated in **Figure 1.** We saturate the oven with low pressure steam before inserting the bread and then continue the steam injection for the first half of the baking cycle or for 22½ minutes in our case. Although the dough may be placed directly on the hearth by means of a wooden peel as illustrated (**Figure 1**), we generally confine it in a perforated Vienna loaf pan which allows a convenient method (**Figure 2**) of measuring the height increase during proofing.

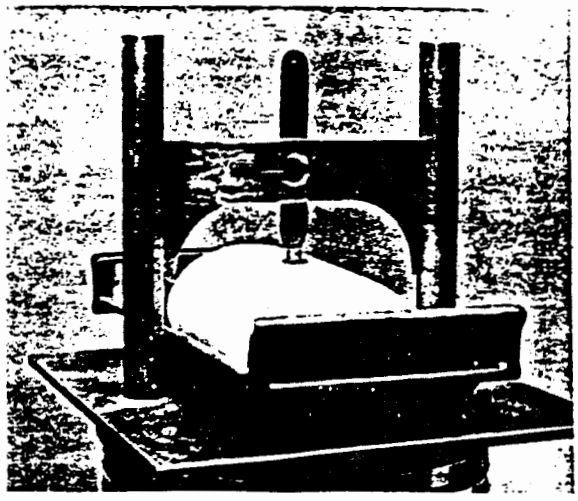

Figure 2: *Device for measuring height increases during proofing for sour dough confined in perforated Vienna loaf pan.*

Table II

Sour Bread Dough Formulation

20 parts starter sponge (11% of final mix) 100 parts flour (regular patent) 60 parts water 2 parts salt
Make up — approx. 1 hr. floor time — then proof 8 hr. 86°F. Starting pH = 5.2 to 5.3 Final pH = 3.9 to 4.0

The pH of the bread (20 g. cross-sectional slice + 80 ml. distilled water) is approximately the same as the fully-proofed dough, or about 3.9 to 4.0, suggesting there is little or no loss of acids during baking. This is also in agreement with measurements of the extractable titratable acidity described below.

Nature of the Acidity

As determined by our co-workers Irving Hunter and Mayo Walden, the total acidity of sour dough bread or dough, not surprisingly, is about eight to 10 times that of conventional straight dough bread or dough (as prepared by us). Surprisingly, however, about 50 per cent of the readily extractable (acetone) acidity of these sour dough materials was found by these workers to be acetic (**Table III**). No other volatile acids as, e.g., formic, propionic or butyric, were detected in the sour dough materials by the gas chromatographic method employed. Work still in progress indicates the presence of substantial amounts of lactic acid in sour dough and also that the exact proportion of acetic acid may vary somewhat with the extraction procedure used. It seems fairly certain, however, that the levels of acetic acid found are sufficient, in the pH range encountered, to inhibit the growth of most microorganisms. The

Table III

Acidity of Sour French and Conventional Breads and Doughs

	Méq. acidity/g*		% of Total acidity as acetic
	Total	Acetic	
Sour starter sponge	0.049	0.024	50
Sour bread dough	0.039	0.022	56
Baked sour bread	0.047	0.024	51
Conventional dough	0.008	0.005	57
Conventional bread	0.005	0.004	76

* Per gram of product, as is basis.

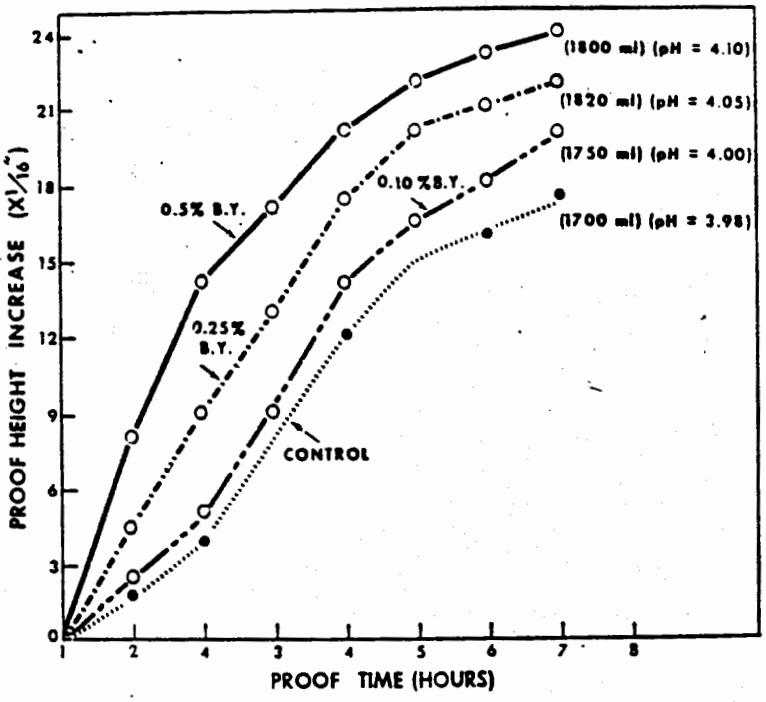

Figure 3: ***Effect of commercial compressed baker's yeast on proof height in sour dough. Volume and pH figures shown are for the baked bread.***

pH, of course, affects the fraction of the acetic acid which is undissociated. It is the undissociated form that is considered to be most inhibitory and which increases as the acidity develops.

Allowing for loss of moisture during baking it is noted **(Table III)** that there is little or no net loss of either total acidity or acetic acid during baking which is in agreement with the virtual lack of pH change.

Variations in Procedure

Many deviations from the procedure described above may be used to advantage for special situations. For example, the number of rebuilds of the starter sponge may be greatly reduced, particularly if it is not going to be used immediately, by maintaining it at 50 – 55°F. between builds. This device is most useful if combined with controlled time of development at 80°F. before placing it at 50 to 55°F. For overnight holding, or up to 24 hours, we have found a slightly abbreviated time of development of about six hours at 80°F. desirable before placing it at 50 – 55°F. For longer holding periods of two to three days, a sharply reduced development time of three to four hours is desirable. By these means we have reduced the necessity of rebuilding the starter sponge to about four times a week instead of three times a day with only slight reduction in bread performance. If maximum performance is essential it can be quickly obtained by successive rebuilds at 80°F. Holding at 35°F. for more than a day or two or at 80 – 85°F. for over 12 hours will sharply curtail leavening power particularly and extensive rebuilding may be necessary to recover it. Freezing the starter sponge is out of the question as the leavening power is virtually completely lost in a day or two although the souring power may persist for some time. The explanation for this phenomenon will be forthcoming in the following paper.

Another device that may be used to advantage, with caution, is addition of low levels of compressed baker's yeast to improve the leavening action. As noted in **Figure 3** the benefits in proofing power are immediate and carry through also to slightly improved bread volumes. Our studies indicate, however, that the level of compressed yeast used should be limited to between 0.10 and 0.20 per cent of the flour, or roughly 1/10 to 1/5 that used in conventional bread dough, otherwise there may be lessening of the souring action, interference with crust browning and introduction of atypical flavors.

As noted in **Figure 4,** addition of sugar to the formulation (either glucose or sucrose) has little or no effect on proof height for the first four hours or so but yields a definite increment in height during the last two or three hours. This improvement in proof height, however, does not appear to carry through significantly into the bread. Thus the addition of sugars to the formulation may not have much merit except possibly where unusually long proof times are feasible. Rate of souring and final pH were not significantly affected by addition of either glucose or sucrose at levels up to 2 per cent of the flour.

Finally, although we have generally used about 2 per cent salt (based on the flour) in the bread dough formulation, limited studies have shown that it might be profitable to reduce this somewhat. Slightly increased volumes were obtained at 1.50 to 1.75 per cent salt without noticeably affecting the rate of souring or flavor. Higher salt levels (2.5 per cent) were markedly inhibitory to proof height, bread volume, and rate of souring.

THE END

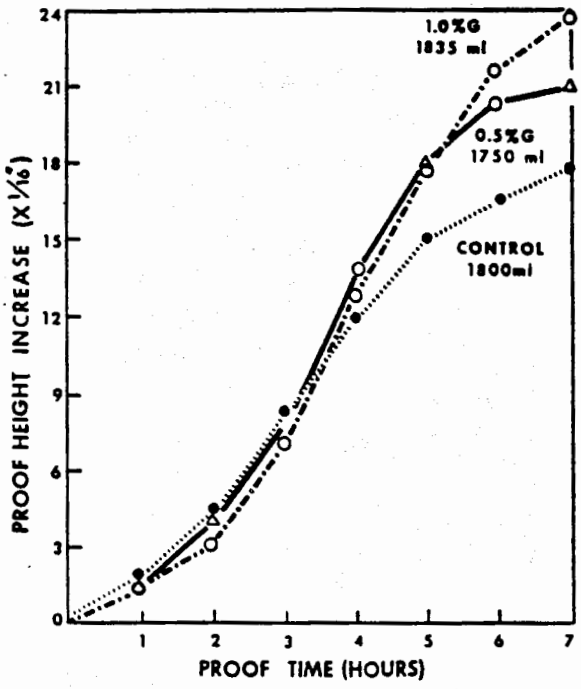

Figure 4: ***Effect of added glucose on proof height in sour dough. Volume of baked loaves also indicated.***