Live sourdough cultures for bread with taste
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Mankind has used the sourdough method of breadmaking fur at least 3000 years. It is not clear how the method originated, although speculations include the accidental inclusion of a piece of old dough in a mix, the use of wild honey to sweeten an unpalatable flat bread and the ancient Greeks using sour wine as the liquor in a bread recipe. The techniques of sourdough processing have been refined and optimised, particularly following the work of Louis Pasteur. His researches into the science of fermentation led to the cultivation of specific strains for use in the brewing and baking industries, and later on during the 19th and 20th centuries, the biological processes involved in the production of sourdough became better understood. In this way, empirical practices have now become a controlled biotechnological process aimed at achieving maximal quality in the final product.

Basic methods of sourdough bread production

There are three basic methods of sourdough breadmaking commonly in use today:

- Traditional rye sourdough, for the production of dark rye breads particularly associated with Central and Eastern Europe, Russia and parts of Germany

- Levain Levure used in the production of *pain an levain* and *pain de campagne* style bread in France, and rustic breads in Spain, Portugal and Greece

- San Francisco Sours, which are used in California to make a characteristically chewy, sour bread that is exclusive to the region.

Although these methods vary slightly from each other, the principle is the same:

to create a spontaneously fermented dough that acts as a leavening agent in a breadmaking process.

Back in ancient times, leavening was the principle function of a sourdough and

the flavours created within the sour were of secondary importance. In modern times, we have access to plentiful supplies of commercially produced live yeasts that are manufactured to high standards of consistency and reliability. So, for us, the leavening action is less important

than the flavouring capacity of the sourdough. Furthermore, the addition of a sour has an improving effect on the rheology of the main breadmaking dough - but more of this later.

Traditional rye sour

'The traditional method of sourdough production follows a three-stage process:

Rye flour and water are mixed together to form a dough which is allowed to ferment spontaneously

2 Additional flour and water are mixed with stage one, and the dough is allowed to ferment further

3 A second addition of flour and water is mixed with stage *2,* and the dough is allowed to ferment fur a third time.

Two-thirds of this final dough is used in the bread production while the remaining sour is used to seed the next sour dough, beginning at stage 2. The bread production method will typically incorporate 18-25% of sourdough, have a short bulk fermentation of about 30 minutes, and a fairly long proof, generally 1to 1.5 hours. Baking may take anything up to two hours, depending on the type of rye bread being made.

The characteristics of (he flavour conferred on the bread by using this method are determined by the temperature of the sour, the type of flour used in the production of the sour and the length of time thee sour is allowed to ferment. These parameters need to be determined and controlled in order to produce loaves with the same flavour profile time after time.

The whole process relies on the presence of native bacteria and wild yeast in the flour and the atmosphere. This means that the process is very susceptible to changes in flour type and origin, temperature, ambient conditions and also to contamination by spores from commercially produced yeast that are generally more vigorous than their wild counterparts.

The process needs to be managed and controlled in order to maintain the consistency and integrity of the sourdough. If it should become contaminated, this will detrimentally affect the flavour and acidity of the final product. The only method of curing the problem is to begin the whole process again from scratch, thereby losing three days of production.

However, a well controlled process, using a clean thermostatically controlled fermenting room (or water jacketed tanks) and an efficient hygiene regime has allowed this method to be used successfully in plant bakeries in Central and Eastern Europe, Russia and Germany.

Levain Levure

This method of sourdough dough production is mainly used in France but is also found in Spain, Portugal and Greece. Biotechnologists in large ingredients manufacturing companies

have developed live starter cultures that are specifically designed to overcome a number of the problems associated with traditional sourdough production.

Specific strains of bacteria and yeasts have been identified and produced in **a** prepacked form that is used as a starter culture in the production of sourdoughs. The combination of the microflora in these cultures is rigorously controlled so that each sourdough receives the same inoculation to ensure consistency of flavour in the bread. Since each sourdough is inoculated with a fresh culture, the fermentation time of the sour is shortened and consequently the risk of accidental contamination by unwanted yeasts and bacteria is greatly reduced.

The method involves the production of a sourdough that is made from flour, water and the starter culture. This dough is fermented only once, for 16-20 hours at 28-30^{0}C. A bread dough is then made as normal, incorporating up to 30% of the sourdough. Normal processing follows, but it is usual for a bulk fermentation and 1-2 hours of proofing time to be used in order to fully develop the desirable flavour. Baking takes around 35-40 minutes at around 230^{0}C, depending on the size of the dough piece and the colour required.

There are two types of live starter culture available, one that contains only bacteria, and one that is combination of bacteria and yeast. Bacterial starters develop only acidity in the bread, either lactic or acetic or both, depending on the selection of the bacteria used in the culture. Little alcohol and carbon dioxide are formed unless yeast is also added at this stage$_1$ so there is no formation of the complex aromatic compounds that are the precursors to bread flavour. Additionally, the rate of acidification is such that proteolysis of the gluten occurs, giving a slack final dough that is prone to collapse during further processing.

The starters that contain bacteria and yeast together develop both acidity and aromatic compounds in the sourdough, to give an extra dimension to the flavour in the final product. Furthermore, the rate of acidification is controlled so that the gluten network within the sour is preserved during the main dough making stage. This increased stability of the dough reduces the risk of the bread collapsing during the later stages of the bread making process.

San Francisco Sourdough

This type of bread was introduced to the Bay area of San Francisco in the mid 19th century during the Gold Rush, although whether the French, Spanish or Basque immigrants were the originators of me method is open to conjecture. Speculation holds that the climate, humidity and proximity of the ocean were all factors in establishing a specific strain of Lactobacillus that is used to produce this uniquely flavoured bread.

During the late 1960s and early 1970s Dr Leo Kline of the American Society of Bakery Engineers undertook extensive research into the identification and isolation of the microflora responsible for the leavening and acidification of San Francisco sourdough, and discovered

that two specific organisms were present.

The first was a souring bacterium that he subsequently named *lactobacillus sanfrancisco.* This bacillus exhibits the unusual characteristic of only being able to use maltose as its carbohydrate source. The second micro-organism that Dr Kline identified was the yeast strain *Saccromyces exiguus*, which, as well as being acid resistant, can only metabolise sucrose and/or dextrose Thus the two organisms happily co-exist without competing for food sources.

The production method for San Francisco sourdough bread is slightly different from those mentioned above. Traditionally, no cultivated yeast is used in its production so that, in addition to about three hours of bulk fermentation, it employs a proof time of 5-6 hours at 30~C, or 3-12 hours at 23-25~C. This extended proof time allows the flavours in the dough to develop further and can extend the length of the entire process to as much as 20-24 hours from start to finish. Baking generally takes around one hour depending on the size of the dough piece.

Comparative flavours

A taste comparison of the breads produced from these different methods shows that the traditional rye has a fairly powerful acetic flavour, with a sticky. resilient crumb texture that is chewy in the mouth. The aftertaste depends on the type of rye flour used, but may be sour and nutty or merely acidic.

The levain levure has a more mellow flavour with undertones of soured cream. The crumb is less abrasive but still chewy. The aftertaste is sweeter than the traditional rye, but finishes with a hint of sourness. The crust should he fairly thick, but crisp and crunchy rather than chewy. Typically the crust is covered with tiny blisters that give it a rustic appearance.

The San Francisco sourdough bread should have a creamy flavour with an acidic bite. The crumb is chewy but not tough, and a characteristic crust should be thick and chewy, but not leathery.

Advantages and disadvantages of using a sourdough process

Type of Sourdough	Advantages	Disadvantages
Traditional Rye	Long shelf life Intense Flavour Improved crumb resilience and stability	Long inflexible process High risk of contamination Skilled personnel required Special machinery to handle soft dough required
Levain Levure	More consistent final product	Still a long process

	Lower risk of contamination	Some skills required
	Slightly more flexible process	Temperature control of fermenting sour
	Enhanced bread flavour	
	Improved dough/crumb stability	
	Good shelf life	
San Francisco Sour Dough	Unique flavour and texture Culture unavailable elsewhere	Very long process Skilled personnel required for dough handling Temperature control is very important

Cost implications of adopting a sourdough method of bread making

As with any manufacturing process, the investment needed in adopting a sourdough method may be in machinery, manpower or both. To take the process logically from start to finish, the investment areas may he summarised thus:

Mixing: Spiral mixers are best, due to their gentle mixing action and the fact that they incorporate air into the mix, although planetary mixers may also be used. I ugh speed mixers are unsuitable for this process as the high shear action reduces the flavour and destroys the fragile gluten network in the sourdough. Even when spiral mixers are used, it is advisable to delay the addition of the sourdough until the final two minutes of mixing in order to preserve the rheological properties of the sour as far as possible

Fermentation; The temperature of the fermenting sourdough must be carefully

monitored and maintained. Cooler fermentation (between 23-25^{0}C) tends to promote the formation of lactic acid, whereas temperatures between 26-28^{0}C tend to promote me formation of the sharper acetic acid. Either flavour may be desirable, but once the required conditions have been established they need to be controlled in order to maintain consistent flavour front sour to sour. Thus the investment at this stage would be in a temperature-controlled room, or water jacketed tanks for the sourdough.

Dividing/rounding: At this stage of the process (after bulk fermentation) the dough is relatively fragile, so a divider with a gentle felling action is best, coupled with a rounder that has a low shear action, such as a V belt.

Moulding: The type of moulders will depend on the shape and texture characteristics required in the final bread, as well as the dough rheology at this point. Dough containing a reasonably high proportion of rye flour will withstand a relatively intense moulding, whereas levain levure dough requires gentler handling in order to preserve the desired texture.

Proving: There must be sufficient capacity for the provers to be set at the correct temperature and humidity for the appropriate length of time. It is tempting to raise the prover temperature to speed up this section of the process but; although this will increase the throughput, it will also have a detrimental effect on the development of the flavour in the crumb. 'this is particularly true of the San Francisco process, which relies on the long slow proof for the development of its unique flavour.

Cutting: Due to the relative fragility of the dough, the personnel employed to cut the bread prior to baking must be sufficiently skilled to ascertain the correct degree of proof before attempting the cut. If the dough is green, the cut will burst excessively and if it is over ripe it will collapse on cutting. Furthermore, the type and position of the cut is important to ensure an even spring in the oven; and this in itself is an area of skill

Baking: Sourdough bread performs best as a 'hearth' or oven bottom product. The instant heat provided by the hot sole promotes an open texture with fine cell walls, a good oven spring and a thick crisp crust.

In summary, live sourdough cultures confer a distinctive flavour to bread due to the presence of lactic and acetic acids caused by the metabolism of lactic acid bacteria.

of the three methods described, each method has its advantages and disadvantages, particularly with regard to investment in time and equipment. However, I firmly believe that any method that adds value to bread by enhancing its flayour, eating qualities and keeping properties must be worth the trouble!