Sourdough and Wild Yeast Fundamentals

Introduction

Many of the breads in my books require a natural starter, sometimes known as sourdough starter. In most of the formulas you will find both commercial yeast and sourdough, as the acidity in the starter is important for both flavor development and control of the enzymatic activity. By sourdough I mean wild yeast or naturally leavened dough, as opposed to dough leavened with commercially produced yeast. Wild yeast breads have a number of appealing qualities that draw us to them. Some are flavor qualities and some are romance qualities. There's something compelling about capturing wild yeast and bacteria and then putting them to work to raise dough, something very craft-like, closer to the bone. The flavor of such breads is often superior to commercially yeasted breads because, from the get-go, they require the use of a preferment (the starter, which can go by any number of names such as the *levain*, the chef, the mother or *madre*, *barm*, sour sponge, etc.). Since it has to be fermented in advance, wild yeast starter functions very much like a *poolish, biga*, or other types of prefermented dough as a flavor enhancer while also carrying all, or the bulk, of the leavening responsibility, unlike the commercially yeasted preferments, which are mainly flavor enhancers with a minimal leavening role (more like a booster).

There are many ways to make a starter, some more effective than others. There are numerous systems and loads of information, misinformation, and folklore available on-line. Many people obsess over their starters, coddling them like newly born infants, keeping them on regular feeding cycles, and fretting when they don't bubble up they way we think they should. In three previous books I gave three different methods for establishing a starter and, after perfecting what I thought was the simplest foolproof method for *The Bread Baker's Apprentice,* discovered that it didn't always work. A team of amateur sleuths and passionate home bakers, led by Debra Wink of Columbia, Missouri, tackled the problem on the King Arthur Flour website in a discussion group called The Baking Circle. This discussion is preserved on their archives for those who want to read it in full, but the short version is that the first stages of the starter, the seed culture, was not performing for a number of readers as I had said it would (I never had this problem with my test batches, but based on e-mails I received and am still receiving, the problem is, apparently, pretty widespread. Debbie, who is a chemist, put the starter under a microscope and came up with the theory that the problem was the presence of a genus of lactic bacteria called leuconostoc that generate a lot of carbon dioxide (like yeast) but also interfere with yeast growth and development. It's a long story so, with Debbie's permission, I'm printing excerpts from our e-mail exchanges to bring all of you into our obsessive world of yeast freaks.

There are a number of classic versions of sourdough, under various names, that can be modified into whole grain versions. *Pain au levain*, for instance, which is the name of classic French-style naturally-leavened (wild yeast) bread, usually made with a small percentage of whole wheat flour, can also be made, in our version, out of 100%

whole wheat flour. The country-style two-kilo *pain Poilane miche* made famous by Max and Lionel Poilane in Paris, and also made by many other bakers, is made by the Poilane's with high extraction flour, that is, sifted whole wheat flour. Sifting removes some of the germ and bran but not all so that the bread is hearty but not overwhelmingly so (the term, high extraction, refers to the amount of flour extracted from the milled wheat kernels; it is not 100% whole wheat, but a very high percentage of the wheat is salvaged, about 85%, as compared to 72%-75% in white flour)**.** In my version we use full extraction whole wheat flour rather than sifted flour. Traditional rye breads are often made with wild yeast starter to acidify the dough for a better tasting and more digestible rye. But it is rare to find a 100% rye bread, though it can be done in some traditional breads like *volkornbrodt*. Rye, which is low in gluten, usually requires high gluten white flour as a partner to compensate for the lack of gluten. You can also make mixed method breads that incorporate both wild yeast starters and commercial yeast.

The Starter

But to make wild yeast bread we must first have a wild yeast starter. Because there are many ways to create a starter, we should first focus on what it is and how it works.

The most common misperception about wild yeast or sourdough starters is that the wild yeast is what causes the sour flavor. As I learned in my correspondence with Debbie Wink, there is an interesting microbial drama taking place. Wild yeast is living, side by side, with various strains of bacteria. It is the bacteria that causes the sour flavor tones as they metabolize available sugars and convert them into lactic or acetic acid. Amazingly, different strains of bacteria cause different flavors and aromas. This explains why breads made in various parts of the world may have different flavors even if made by the same formula. From a functional standpoint, the role of the yeast is to leaven and slightly acidify the bread via the production carbon dioxide and ethyl alcohol, while the function of the bacteria is to acidify and flavor the dough and, to a lesser degree, create some carbon dioxide. This can be called a symbiotic relationship, as the organisms harmoniously share the same environment and food source, and supplement the work of the other.

In a best case scenario, the acidifying work of the bacteria lowers the ph level of the dough to the ideal environment for the growth of the desired strains of wild yeast (I use *strains*, the plural form, because wild yeast is not just a specific strain, such as the *saccaromyces cerevisiae* of commercial yeast, but an indeterminate variety of strains under the general name *saccaromyces exiguous*, which means wild). This symbiotic relationship, perhaps of all the mysteries of bread making, is the most fascinating. As the ph lowers to more acidic levels commercial does not survive while the wild yeast does, and even certain bacterial strains no longer survive, such as the leuconotocs, that were responsible for creating some of the acid in the first place. It all gets very complex but, fortunately, this complexity manifests itself, as it also does in great cheese or wine, in the final flavor.

The starter is merely a medium in which the microorganisms can live and grow, and create their important by-products, alcohol, carbon dioxide, and acid. The baker then builds the starter to a size that it is capable of raising the dough. Typically, the amount of the starter can be anywhere from 15% up to, in some instances, 100% of the flour weight. In most bakeries it is usually in the 20%-33% range. Since commercial yeast usually only represents, with a few exceptions, 1%-3% of the flour weight, there is obviously a much smaller concentration of functioning yeast cells in a starter than in commercial yeast. But, then, a starter has other functions as well, one of which is that it provides the flavor values of pre-fermented dough such as a sponge, *poolish* or *biga*. With the whole grain, delayed fermentation method, added to the complexity that a wild yeast starter brings to the dough, we should have an extremely multi-layered, flavorful dough or, as one of my students calls it, "Bread to the max!"

Making the Starter

First Stage: Making a Seed Culture

There are many ways to make a seed culture. The simplest is with just flour and water and, frankly, this works but not always on a predictable schedule. I've seen methods on the internet calling for onion skins, wine grapes, plums, potatoes, milk, buttermilk, and yogurt. These can all serve as fuel for the microorganisms and they do work to make a seed culture. But, in the end, a starter (and bread itself) is really about fermented flour. So our goal is to create the conditions in which the appropriate organisms can grow and function to create great tasting bread.

The following method produces a versatile starter that can be used to make 100% sourdough breads as well as mixed method breads (that is, leavened by a combination of wild yeast starter and commercial yeast). However, if you already have a starter or a method of making a starter that is different than this, feel free to use it. The starter can be made from either whole wheat flour or whole rye flour (rye bread fanatics tend to keep a rye-only starter, though I have found that the wheat starter works just as well in rye breads). If you already have a finished starter that you've been nurturing, even if made with white flour, it can be converted to a whole grain starter and used in the formulas that follow. After a few feedings, only traces of the white flour will remain.

At this first stage, what we will call "the seed culture," we are not making the starter that goes into your dough but, rather, a starter (the "seed") that makes another starter (the "mother" or "barm"), from which you will make your final dough. In most bakeries the mother is used to build yet another starter, the "levain" or "chef", that goes into the final dough, but in this book the formulas have been developed around a 75% hydrated "mother" starter, that is, 75% water to 100% flour. This is firmer than wet sponge starters that many bakers prefer to keep, but the hydration is very close to the final dough hydration, which makes it easier to use in calculations. Keeping one starter that is ready to use also saves a step. During the development of these formulas many of the testers complained that the steps were too complex: mashes, starters built into other starters, multiple mixing cycles. So, during the year of testing, we refined the process to make the dough less complicated to make, without sacrificing flavor. The process is still challenging enough, but most of the complexity is in the flavor, not the process. We want the complexity to manifests in the final flavor, to create, as my students call it, "Bread to the max!"

The Pineapple Juice Solution

To avoid the problems described above in *The Bread Baker's Apprentice*, and in honor of the work of Debbie Wink and her many cohorts on the King Arthur Baking Circle, I now call this method "the pineapple juice solution." Pineapple juice, as you can see from Debbie's detailed explanation, is not the only acid that neutralizes the dastardly leuconostoc bacteria but it has proven itself to be reliable, so why tamper with success. However, if you are the mad scientist type, as so many bread baking enthusiasts are, feel free to experiment with ascorbic acid or citric acid as found in other juices. And remember, too, that if the seed culture does not respond in exactly the way described, on the exact schedule predicted, just give it more time. In the end, in most instances, the good microbial guys prevail and the seed will survive to fulfill its mission and destiny.

Notes:

-- If making a rye starter substitute whole rye flour, such as pumpernickel or coarse rye flour. If making both a wheat and rye starter be sure to label them as they will be hard to tell apart.

--Though the instructions give a time range, this can only be, at best, an estimate. Ambient temperature, weather conditions, the type or brand of flour—all of these are factors that determine how long each stage will take. Ultimately, the fermentation activity will dictate when a stage has been fulfilled.

--There is divided opinion as to whether the pineapple juice is really necessary after Day One. It probably is not, but it will not hurt to use it on Day Two and may, in some instances, serve as insurance against the leunconostoc. If you decided to drink the remaining pineapple juice after Day One, it's okay to substitute spring or filtered water.

--If you do not have pineapple juice and would prefer to use water, use filtered or spring water. The starter may or may not stay on the predicted feeding schedule, depending on the presence or absence of the leuconostoc bacteria in your flour. However, if you aerate the starter a few times each day it will eventually overcome the leuconostoc as it acidifies, the wild yeast will grow, and it will come to life.

--Aeration is very helpful in stimulating the growth of the wild yeast, as yeast buds more rapidly in the presence of oxygen (yeast factories pump air into the vats of yeast-inoculated liquid nutrients to rapidly stimulate yeast growth). Our testers discovered that slow moving starters came to life much faster when they were stirred a few times each day.

--The sprouted wheat flour (wheat malt) or diastatic barley malt is optional, and serves as a catalyst to release sugar from the flour starches for the yeast and bacteria to feed upon. Use it if you have it—it serves as a kind of insurance policy or vitamin pill -- but the starter will work with or without it.

--All tools and bowls should be sanitized, either in boiling water or in the dishwasher.

--The timing of the various phases is approximate, and is greatly affected by the time of year, the ambient temperature, and the number of times you aerate the sponge. In the winter it may take twice as long for the seed culture to activate; in the summer it may happen very quickly. If the seed seems to be taking longer than predicted, do not abandon it but continue on. If necessary, you can repeat the Phase Four step, or simply extend the waiting period between phases by a day or two. If you aerate the sponge as directed it will minimize the possibility of contamination by unwanted spores or molds.

Phase One (Day One):

<measure>	**<ounces>**	**<grams>**	**<ingredient>**	**<%>**
###	(### ounces)	(### grams)	xxx	###
4 tablespoons (approx.)	1	28.35	Whole wheat or whole rye flour	100
1/4 cup	2	56.5 grams	Unsweetened pineapple juice (or filtered or spring water)	200
1/4 teaspoon			Sprouted wheat flour (wheat malt), or diastatic barley malt (optional)	
	3		Total	

Use a small bowl or 2 cup glass measuring cup. Stir the flour and juice together with a spoon or whisk to make a pancake batter-like paste, or sponge. (Note: After mixing, remove the remaining juice from the can and transfer it into a clean jar or container and refrigerate -- or go ahead and drink it.) Be sure all the flour is hydrated. Cover the top of the bowl or measuring cup with plastic wrap or a loosely tightened lid and leave at room temperature for 48 hours, stirring for one minute with a wet spoon or whisk two or three times each day, to aerate it. There will be little or no signs of fermentation activity, no bubbles, during the first 24 hours; bubbles should begin to appear, however, within 48 hours.

Phase Two (Day Three):

<measure>	**<ounces>**	**<grams>**	**<ingredient>**	**<%>**
###	(### ounces)	(### grams)	xxx	###
2 tablespoons (approx.)	1/2	14	Whole wheat or whole rye flour	100
2 tablespoons	1	28.35	Unsweetened pineapple juice or filtered or spring water	200
	3		All of the Day One sponge	
	4 1/2		Total	

Add the new ingredients to the Phase One sponge and mix or whisk to distribute and fully hydrate the new flour (the liquid can be cold or room temperature—it does not matter). Again, cover with plastic wrap and leave at room temperature for 24 to 48 hours. Stir to aerate two or three times each day, as before. There should be signs of fermentation (bubbling and growth), during this period. When the dough becomes very bubbly or foamy, or at the end of 48 hours, continue to Phase Three, whichever comes first.

Phase Three (Day Four or Five):

<measure>	**<ounces>**	**<grams>**	**<ingredient>**	**<%>**
###	(### ounces)	(### grams)	xxx	###
5 to 6 tablespoons	1 1/2	42.5	Whole wheat or whole rye flour	100
3 tablespoons	1 1/2	42.5	Filtered or spring water	100
	4 1/2		All of the Phase Two dough	

	7 1/2		Total	

Add the new ingredients to the Phase Two sponge and stir or whisk as before. The sponge will be thicker as we reduce the percentage of water, but it will still be very wet and sticky. Again cover with plastic wrap and leave out at room temperature for 24 to 48 hours, stirring with a wet spoon or whisk to aerate at least twice each day, as on the previous days. Within 48 hours it should be very bubbly and expanded. If not, wait another day or two, aerating as before, until it becomes active. (Note: if the sponge was active bubbly prior to this phase, it could become active and bubbly in less than 24 hours. If so, proceed to the next phase).

Phase Four (Day 5 or later)

<measure>	**<ounces>**	**<grams>**	**<ingredient>**	**<%>**
###	(### ounces)	(### grams)	xxx	###
7 tablespoons (approx.)	2	56.5	Whole wheat or whole rye flour	100
3 tablespoons	1 1/2	42.5	Filtered or spring water	75
	3 3/4		Half of the Phase Three sponge	

	7 1/4		Total	

Discard or give away half of the Phase Three sponge. Add the new ingredients to the Phase Three sponge and mix as before. Cover the bowl and leave out at room temperature until the sponge becomes bubbly and foamy. It should swell and nearly double in size, but it will fall when jostled due to the high hydration. This can take anywhere from 4 to 24 hours. If, after 24 hours, there is little sign of fermentation, continue to aerate it as before, and leave it at room temperature until it becomes very active. The seed culture should register between 3.5 and 4.0 if tested with ph paper (see page 00 for how to use ph paper). You can now proceed to the next step or you can place the seed culture in the refrigerator for up to two days.

Second Stage: The Mother Starter

Once you have established a seed culture you will need to convert it into a mother starter. This is the starter you will keep perpetually in your refrigerator and is the permanent starter from which you will build your doughs. (Note: In previous books I also referred to this starter as a *barm*, but as I learned through the ongoing research of Monica Spiller, the term *barm* is more properly used for starters made using mashed (scalded) grain as the growth medium.)

To convert a seed culture into a mother starter, you will use the seed culture to inoculate a larger batch of flour and water to make a firm piece of dough. The seed culture is full of wild yeast and bacteria but its structure has also been weakened by the acidic buildup and ongoing enzyme action of both starch and protein enzymes. To make the mother starter strong enough to function in the final dough, we will build it with three times the amount of flour as weight of the seed. We will also hydrate it at 75% the weight of the new flour. After a couple of feedings, also called “refreshing,” the starter will have approximately the same feel as the final dough.

Notes:

--Should you prefer to keep a wetter or drier mother starter, you can do so, but must also adjust the water in the final dough accordingly. Also, the fermentation time and the degree of sourness may vary; some bakers say the firm starter gets more sour than the wet sponge starter, and some say the opposite, but my experience has been that both versions, over time, produce similar flavors.

--A little starter goes a long way, so the following instructions call for you to discard or give away half of your seed culture. If you would prefer to keep a larger mother starter on hand, especially if you are baking often or are increasing the size of you batches, you can convert the entire seed culture into a mother starter by doubling the weight of the new flour and water. This will give you over 3 pounds of starter. Most home bakers seem to prefer keeping a smaller batch, such as the one below.

The Mother Starter

<measure>	**<ounces>**	**<grams>**	**<ingredient>**	**<%>**
###	(### ounces)	(### grams)	xxx	###
	11 1/2		Whole wheat or whole rye flour	
	8 1/2		Filtered or spring water	
	4		Half of the seed culture	
	24 (#1 1/2)		Total	

1. Combine all the ingredients together in a bowl or in the bowl of an electric mixer. Mix on slow speed about 2 minutes with the dough hook, or use a large spoon or your hands, until the ingredients form a coarse ball of dough,. It will be slightly sticky. Let the dough rest for 5 minutes, then resume mixing or kneading for another two minutes, or until the dough is fairly smooth and all the ingredients are evenly distributed.
2. Place the dough in a clean bowl or container large enough to contain the dough after it doubles in size. Cover the bowl with plastic wrap or with a lid (do not tighten the lid, as the carbon dioxide gas will need to escape). Leave out at room temperature for 4 to 8 hours, or until the dough doubles in size. It should register 4.0 or less if tested with ph paper (see page 00).
3. When the dough is fermented, degas it by kneading it for a few seconds, form it back into a ball, cover, and refrigerate. After a few hours, vent any carbon dioxide build-up by opening the lid briefly. The mother starter is now ready to use and will be good for up to 5 days. To use after 5 days, you must refresh all or part of the mother starter.

Refreshing the Mother Starter

Whenever the starter gets low, rebuild it (also called feeding or refreshing it) by discarding all but 4 ounces and repeat the instructions above. You can have as little as 1 ounce of starter and still rebuild it in increments over a number of feedings. This is a good thing to do when you haven't used it for a while and want to start baking again.

For example, 1 ounce of mother starter can be added to 3 ounces of whole wheat or rye flour, plus 2 1/4 ounces of water. This will produce 6 1/4 ounces of starter. You can then build all or part of that into a larger piece by using the same ratios: 100% flour, 33.3% starter, 75% water. In the example above, 6 1/4 ounces of starter will require 18 3/4 ounces flour (6 1/4 multiplied by 3) and 14 ounces water (18 3/4 multiplied by 75% or .75 (or 3/4). You can build a small piece of starter into a large piece very quickly.

If I am planning to make one loaf of bread and need a refreshed starter because I have not used the mother starter for awhile, I will often take a small piece, say 1 ounce, from the mother starter, add 3 ounces of flour and 2 ¼ ounces of water. After fermenting this new piece of starter I will have more than enough for the final dough.

If I have not refreshed the mother starter for awhile, and it appears to have broken down and lost all its structure (due to acid and enzyme activity eating up the dough), I will take a small piece of the starter, perhaps one ounce, build it up to about 6 ounces, then build that piece into a new mother starter. I rarely keep more than one pound of mother starter on hand unless I am doing a lot of baking or recipe testing.

After a few weeks in the refrigerator the protein and starches will break down and give it the structural strength of potato soup. This is okay, as the microorganisms are still viable, though fairly dormant (maybe even a little drunk). Discard all but one ounce of this and build it back in stages using the 3 to 1 process described above. In a day or two you will have a refreshed, strong, rebuilt mother starter.

Final Notes:

--The acidity of a starter should be between 3.5 and 4 on the ph scale. If you can test a small piece of starter with ph paper you will know if it is ready or not. However, acidity is caused by bacteria, and that is only one of the functions of a starter. Many of the recipes in my books use a combination of both natural starter and commercial yeast. But some of the recipes are leavened totally by natural starter. This is why you must also see growth in your starter (that is, leavening), to indicate that the yeast population has also replenished itself. Typically, in a healthy starter, the yeast and bacteria have learned to cohabitate, and the mix of various strains of bacteria and yeasts is largely determined during the seed culture stage. However, temperature variations and long dormancy periods can adversely affect the yeast (more than the bacteria), so it may be necessary to refresh an old starter with a few feedings to build back the yeast population.