Sourdough For Science: Activity Overview

About the Activity

Humans have baked bread for over 10,000 years. All over the world, different cultures bake their own unique bread - and have for centuries - and yet we know almost nothing about the microbes that truly make a traditional sourdough bread. In this project, you will grow your own sourdough starter from scratch just by mixing flour and water. For two weeks, you will measure the height and pH of your starter to track the growth of your "microbial zoo" over time, and share your data with a scientist.

By **participating in a real science project**, you can help us solve the mysteries of bread. Your data will be compared with data from other participants, all over the world, who have completed the same experiment. Together we can use these data to learn how different flours affect microbial growth over time - and how those microbes affect the taste and texture of bread.

Here's What You'll Need

- ❏ Student Data Sheet (one per student)
- ❏ 6 half-pint wide-mouth jars (one per group)
- ❏ 6 tablespoon measuring spoons (one per group)
- ❏ 6 plastic spoons (to mix and scoop starter)
- ❏ 6 rulers (to measure the height of the starter)
- ❏ 6 Sharpie markers (one per group)
- ❏ pH paper (that will detect from 3.5-8.0 at the accuracy of at least one decimal place)
- ❏ 6 pH color keys (one per group)
- ❏ 6 different types of flour (one per group)
- ❏ Distilled water
- ❏ Paper towels
- ❏ Pencils for data recording
- ❏ Sourdough For Science Introduction video
- ❏ Sourdough For Science Demo video

Helpful Hints

- Organize 6 starter kits to include: one wide mouth jar, one spoon, one ruler, one sharpie, one pH paper key, pH paper (15 small strips), one type of flour, and a paper towel.
- Individual groups should focus on one type of flour.
- If you do not have access to distilled water, let water sit, uncovered, overnight in order to remove the chlorine.
- Starters should be kept in a cool area with limited access to light.
- Print out the ***Teacher Instructions*** with pictures for students who prefer visuals.

Directions

1. Warm up exercise (approx. 5 min) as students arrive to class (directions can be written on the board so that students can complete task while teacher takes roll or completes other administrative tasks):
    - Take out a blank sheet of paper and pen/pencil.
    - Make a list of all the different types of bread you can think of.
2. Watch “Sourdough for Science Introduction” video with students.
3. Divide students up into groups of 2-4, depending on how many mason jars/supplies you have on hand.
4. Assign each group one of the six types of flour: emmer, einkorn, Red Turkey wheat, rye, all-purpose and millet (millet is gluten-free if you have students with an allergy)
5. Follow ***Sourdough for Science: Teacher Instructions***

Calendar

Use the following calendar as a guide for completing all the activities.

Day 1 ● Video: Welcome ● Video: Make your starter ● Data Collection	**Day 2** ● Feed your starter ● Bread Tasting and Aroma Wheel	**Day 3** ● Feed your starter ● Guided Reading	**Day 4** ● Feed your starter ● Wonderbread Poetry Workshop	**Day 5** ● Feed your started ● Which Variable Matter
Day 6 Feed your starter Student Readiness	**Day 7** Feed your starter Who’s My’crobe	**Day 8** Feed your starter DNA ‘Recipe”	**Day 9** Feed your starter Map My Microbes	**Day 10** Feed your starter Map My Microbe
Day 11 Feed your starter Graphing Data	**Day 12** Feed your starter Graphing Data	**Day 13** Feed your starter Lab Report	**Day 14** Feed your starter Lab Report	**Day 15** Feed your starter Lab Report

Sourdough For Science: Teacher Instructions

Day 0:

Step 1: Set Up

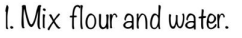
- Make sure students are with their lab group and have all their supplies.
- Hand out Sourdough Starter Lab Sheet to each group.
- Use a Sharpie to write your group name (in small type) and flour type near the top edge of your jar.

1

Step 2: Create the starter

- Measure 2 Tablespoons (Tbsp) of the flour assigned to your group, into your jar.
- Add 2 Tbsp of distilled water.
- Mix with a plastic spoon, and then use the spoon to scrape any flour-water paste back down the sides of the jar.

2



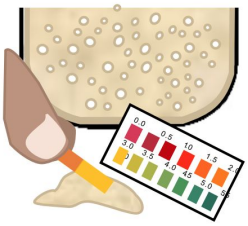
Step 3: Measure Height

- Measure and record the height of the flour-water paste (in cm) on your datasheet.

3

Step 4: pH Testing

- Scoop a small amount of your starter into a spoon, and touch one side of a strip of pH paper to the starter. (This allows the starter to soak into the pH paper, but keeps the other side of the paper clean and easy to read.) To measure the pH, match the color of the paper to the color key on the package.



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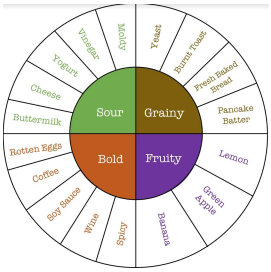
Step 5: Data Collection

- Smell your starter, and record a description on the data sheet (i.e. biscuity, fruity, floral, musty, rotten eggs, sour, no smell, etc.)
- Record any other observations or mistakes made under the correct day.



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Step 6: Clean Up

- Cover jar mouth with a paper towel and secure with lid ring or rubber band.
- Clean ALL tools.
- Place all jars and data sheets in a secure location away from direct sunlight with all clean supplies.

6

Day 1-14:

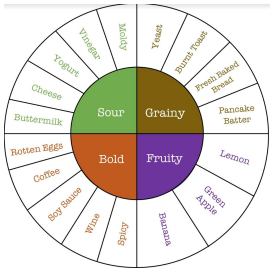
Step 1: Measure Height

- Measure and record height of each sourdough starter. (Measure to the “high tide” mark, to record the maximum growth over 24 hours.)

1

Step 2: Data Collection

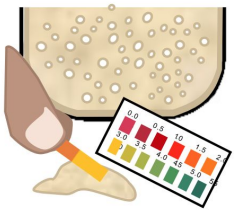
- Remove the paper towel cover.
- Record any additional observations: for example, is there a layer of liquid on top of the starter?
- Smell your starter, and record a description on the datasheet (i.e. biscuity, fruity, floral, musty, rotten eggs, sour, no smell, etc.)



2

Step 3: pH Test

- *Then* mix starter
- Scoop a small amount of your starter into a spoon, and touch one side of a strip of pH paper to the starter. (This allows the starter to soak into the pH paper, but keeps the other side of the paper clean and easy to read.) To measure the pH, match the color of the paper to the color key on the package.



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Step 4: Feeding

- Remove 1 Tbsp of the starter. (This is called backslopping.) The backslop can be discarded in the trash.
- Add 1 Tbsp of your group's flour and 1 Tbsp distilled water; mix well.
- Make sure all starter is pushed off the sides of the jar and off of the spoon.

4

Step 5: Clean

- Cover jar mouth with a paper towel and secure with lid ring or rubber band.
- Clean ALL tools.
- Place all jars and data sheets in a secure location away from direct sunlight with all clean supplies.

5

Repeat Day 1 instructions once a day, for 14 days.

- ***IMPORTANT:*** *Starters must be fed every day to keep growing.*
- *It must be fed over the weekend or put in a refrigerator to slow growth.*

Sourdough For Science: Frequently Asked Questions

Does sourdough smell as bad when baking in the oven as it does as a dough?

Sourdough in the oven tends to smell like bread baking, and even mature sourdough starters tend to smell more like bread than what you're smelling now. The reason your sourdough starter might not smell appetizing is because your sourdough starter's community is still forming. Before a starter reaches its mature climax community, it can still contain opportunistic bacteria or yeasts that produce smells and flavors that are a bit "off". When your starter reaches a stable, mature climax community, it will probably smell more like something you want to eat.

When I checked my starter this morning, there was a layer of liquid on top. What is that liquid?

Many bakers call this liquid "hooch", because it contains alcohol. When the yeasts in the starter run out of sugar and starch to eat, they get stressed and start to produce alcohol. So, hooch is a sign that your starter is hungry.

If there is some alcohol in the dough, can a person become intoxicated from consuming it?

Nope. Remember, you bake bread before you eat it – and the heat bakes off all of the alcohol.

Are there any other microorganisms in our starters besides the yeast and bacteria?

It's possible, but we haven't used DNA sequencing or microscopy to look.

If microbe reproduction slows down in the refrigerator, then why do people get sick in the winter?

There are a lot of differences between the microbes that live in sourdough starters and the microbes that make us sick; but here are a couple of reasons.

- In the winter, humans like to stay warm, so they tend to gather inside together. This means people are more likely to share germs with each other.
- Microbial reproduction slows down at low temperatures but remember that human bodies are warm — and the microbes that make people sick are only able to do that when they are growing in our bodies.

Are fungi antibacterial, or is that just mold?

Mold and yeast are actually both types of fungus, and many molds and yeasts are able to produce antibacterial compounds.

Can scientists determine the dominant bacteria or yeast in the climax community from the pH or aroma?

We know that bacteria lower the pH of your sourdough starter by creating acetic acid and lactic acid, and that yeasts are responsible for creating the aromas that contribute to the smell and flavor of bread. But we don't yet know enough to be able to identify which bacteria or yeasts are present from the pH or smell of a starter. That is actually part of our ongoing research, and the data you are collecting may help us to answer that question!

Is the relationship between the yeast and the bacteria commensalistic, mutualistic, or are they competition?

Different types of yeasts and bacteria can have different types of relationships. For the global Sourdough Project, we are measuring which different bacteria and yeasts occur in the same starters, to infer what type of relationship they might have. Two microorganisms with positive co-occurrence tend to be found in high abundance together, and we think this means that they work together in a mutualistic relationship. Other microorganisms might compete with each other for nutrients, resulting in negative co-occurrence: the "winner" would be successful and common, while the "loser" would be rare because it was outcompeted. So far, it looks like several species of *Lactobacillus* bacteria have positive co-occurrence. These bacteria may "get along well" because they are similar: they all make acid and thrive in low-pH habitats.
Yeasts, on the other hand, don't play so well with others: they tend to have negative relationships with other yeasts, as well as many types of bacteria, possibly because they are competing for the same nutrients. *Sacchromyces cerevisiae*, the same species of yeast that is used in commercial bread baking, is an exception: it has a positive relationship with a few types of *Lactobacillus* bacteria.

In a climax community is there one dominant microorganism yeast or bacteria, or are they equal and it is one of each?

The climax communities in mature sourdough starters tend to have one or two types of bacteria and yeast that are dominant.

At what temperature does the yeast and bacteria die? HOT? Does cold ever kill bacteria or yeast or are they just dormant?

Most bacteria and yeasts are killed by heating to 160F (71C), especially when the pH is low. Yeasts and bacteria can remain dormant in the refrigerator, but most will die if they are frozen unless we use a special storage technique.

What is the rate of reproduction?

When conditions are optimal (when there's a lot of food and the temperature is just right), bacteria can divide in as little as 20 to 30 minutes. Yeast take a little longer (once every 1-2 hours). But that is when conditions are perfect; we don't know the exact growth rates for sourdough starters.

Sourdough For Science: Student Activity Sheet

Name: _____ Date:_____

Objective:

Observe how your sourdough starter will grow and acidify when being fed flour and water daily.

Hypothesis:

Will a change in your sourdough starter height result from a species of bacterium or yeast? (Circle the best response.)

If the **_____ (yeast/bacteria)** grow within my starter, then the **height** of my sourdough starter will **_____ (increase/decrease)**.

Will a change in your sourdough starter pH result from a species of bacterium or yeast? Use the following template to help you.(Circle the best response.)

If the **_____ (yeast/bacteria)** grow within my starter, then the **pH** of my sourdough starter will **_____ (increase/decrease)**.

Procedure:

Day 0 (First Day):

1. Label your name and flour type near the top edge of your jar.
2. Add 2 Tablespoons (Tbsp) of the flour assigned to you, into your jar.
3. Add 2 Tbsp of distilled water to your jar.
4. Mix flour and water mixture with a spoon, and then use the spoon to scrape any flour-water paste back down the sides of the jar. **This flour-water paste is your starter.**
5. Measure and record the height of the starter (in cm) on your data table.
6. Scoop a small amount of your starter into your spoon, and touch one side of a strip of pH paper to the starter. (This allows the starter to soak into the pH paper, but keeps the other side of the pH paper clean and easy to read). Measure and record the pH on your data table.**To measure the pH, match the color of the paper to the color key on the pH package.**
7. Smell your starter, and record a description of the smell in your data table (i.e. biscuity, fruity, floral, musty, rotten eggs, sour, no smell, etc.) **See Aroma Wheel for clarification.**
8. Cover mouth of jar with one paper towel and secure paper towel with lid ring or rubber band.
9. Place jar in a warm location, out of direct sunlight.

Day 1 (Second Day):

Before feeding:

1. Measure and record the height of your sourdough starter. **Measure to the "high tide" mark (the point of highest growth), to record the maximum growth over 24 hours.**
2. Record any additional observations of your starter in your data table. For example, is there a layer of liquid on top of the starter? What color is it?

3. Remove the paper towel cover and smell the aroma of your starter. Record the smell. **See Aroma Wheel for clarification.**
4. Mix your starter and measure the pH (before feeding). Record your pH on the data table.

Feeding:

5. 1. Remove 1 Tbsp of the starter and dump into a waste container. (This is called *backslopping.*)
6. Add 1 Tbsp of flour into jar.
7. Add 1 Tbsp of distilled water into jar. Mix well with spoon.
8. Cover the mouth of the jar with the paper towel and secure with lid ring or rubber band.
9. Return jar to the location where it was stored previously.

Days 2-14:

Repeat Day 1 instructions once a day, for 2 weeks.
IMPORTANT: Starters must be fed every day to keep growing!

Data Table

Flour Type:

Day	Date	Height (cm) before mixing	Temp (℃)	Aroma	pH (after mixing, before feeding)	Other observations (i.e., color, presence of liquid, etc.)
Day 0						**N/A**
Day 1						
Day 2						
Day 3						
Day 4						
Day 5						
Day 6						

Day 7						

Questions - Checkpoint (Answer after collecting your data for Day 7):

1. Thus far, do you notice a change occurring in your sourdough starter height? If so, explain.
   _____
   _____
   _____
2. Is there a change occurring in your sourdough starter pH? If so, explain. _____
   _____
   _____
   _____
3. Are there other changes or trends you are seeing in your sourdough starter? If so, explain.
   _____
   _____
   _____

Day	Date	Height (cm) before mixing	Temp (℃)	Aroma	pH (after mixing, before feeding)	Other observations (i.e., color, presence of liquid, etc.)
Day 8						
Day 9						
Day 10						
Day 11						
Day 12						

Day 13						
Day 14						

Questions - Conclusion (Answer after collecting your data for Day 14):

1. What final observation(s) did you notice with your sourdough starter height? _____
   _____
   _____
   _____

2. What final observation(s) did you notice with your sourdough starter pH? _____
   _____
   _____
   _____

3. Are there any additional changes or trends that occurred over the last few days of your data collection? If so, explain. _____
   _____
   _____
   _____

4. Was your hypothesis supported or rejected? Why?
   _____
   _____
   _____
   _____