**Cool Bread**

**DESCRIPTION & OBJECTIVES:**

Microbial fermentation during bread-making is a complex process that help define the sensory properties of the finished bread, including texture, flavor, and aroma. In this activity, we will experiment with how yeast fermentation of wheat flour dough and explore how microbial activities are affected by environmental conditions.

**GRADE LEVELS:**

Elementary School, Middle School, and High School

**NEXT GENERATION SCIENCE STANDARDS:**

Disciplinary Core Idea:

2/5-PS1.A Structure and Properties of Matter, MS/HS-PS1 Matter and Its Interactions

Performance Expectations:

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Practices: Developing / using models, Planning / carrying out investigations

Crosscutting Concepts: Cause and effect: Mechanism / explanation

**OUTCOMES:**

To gain a general understanding of:

* The components of wheat flour.
* Effect of yeast proofing on fermentation activity.
* Effect of fermentation temperature on leavening.

**CONTACT:**

Dr. Glen Li, Department of Food Science and Technology, Oregon State University, <https://foodsci.oregonstate.edu>

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**MATERIALS:**

* All-purpose wheat flour (bleached or unbleached. Whole grain flour delivers lackluster results)
* Active dry yeast (instant yeast could work too, although the effect of proofing would be limited)
* Sugar
* Salt
* Measuring cup, tablespoon, and teaspoon
* Flat-shaped cooking ware or container (e.g. mason Jar)
* Wooden stir bar
* Ruler or measuring tape
* Timer (or timer mobile app)
* (optional) food coloring for differentiating dough samples

**DIRECTIONS:**

**Preparation of flour dough for leavening:**

1. Prepare ingredient mixtures in **three bowls** (#1, #2, #3), each containing:
	1. 1 cup of warm water (about 100 °F; no higher than 110 °F) for #1 and #2, tap/cold water for #3
	2. 2 teaspoons of active dry yeast
	3. 1 teaspoon of salt
	4. 2 teaspoons of sugar for #1, no sugar for #2 or #3
	5. Food coloring for differentiating samples, if applicable
2. Let mixture stand still till yeast is dissolved
3. Gradually add 3 cups of flour, over 5-6 additions. After each addition, mix thoroughly.
4. Knead repeatedly to achieve homogeneity. A video tutorial on how to knead: <https://www.youtube.com/watch?v=ySOj0fFWo1U>
5. Break each dough into 2 smaller pieces of equal size (one for room temperature leavening, one for cool leavening in fridge). Place them in a container with a flat bottom (e.g.a mason jar) and measure their diameters. Cover containers with cling wrap.
6. Dough leavening under room temperature would take 1 hour. For dough leavened in fridge (40 °F) the process takes 48 hours.
7. (optional for HS) keep track of dough diameter over time, and plot the data
8. After leavening finishes, measure the diameter of dough samples and record the data

**Baking**

1. Slash the top of dough samples (2-3 times) at about 2 mm depth
2. Bake the dough samples at 400 °F for 25-30 minutes, until the loaves are golden brown and sounds hollow when tapped.
3. Let the bread cool, and taste the bread

**HELPFUL HINTS:**

* You may put more than one dough sample in a container for leavening but it is discouraged, as it may complicates diameter measurement
* A deep container can help prevent dough getting compressed by the cling wrap

**EXPECTED RESULTS:**

* Dough containing sugar rise faster and reaches a larger size
* Proofing with warm water helps with leavening
* Cold fermentation results in a richer aroma profile

**EXPERIMENT QUESTIONS**

**Basic Level**

Which dough rises the fastest (as measured by diameter increase)?

Teacher’s notes: Sugar fermentation and the subsequent CO2 release causes dough to leaven and increase in size. Proofing yeast with warm water gives the fermentation process a kick-start. Providing yeast with additional sugar results in increased gas generation.

**Advanced Level**

What is the impact of fermentation time?

Teacher’s notes: Under lower temperature and prolonged fermentation time, yeast enzymes have more time to generate aroma compounds (alcohols, esters, nitrogen-containing compounds) from flour components. Cold temperature also help preserve low-boiling point aroma compounds.

**REFERENCES**

“The Bread Baker's Apprentice: Mastering the Art of Extraordinary Bread” by Peter Reinhart

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**WORKSHEET QUESTIONS:**

* What causes the dough to rise?
* Which dough rises faster? Why?
* Does the cold-fermented dough taste any different?