Demo: What Causes Yeast to Ferment?

FOR THE TEACHER

Summary
In this lesson, students will observe and verify molasses sugar content as a result of its ability to ferment yeast. They will compare how molasses allows yeast to ferment with other sugar solutions as well as a sugar-free solution.

Grade Level
Middle School, High School

NGSS Alignment
This activity will help prepare your students to meet the following science and engineering practices:

- Analyzing and Interpreting Data
- Planning and Carrying Out Investigations
- Engaging in Argument from Evidence

Objectives
By the end of this lesson, students should be able to

- Understand variables and control
- Understand that yeast requires sugar to ferment
- Recognize that when yeast ferments, the gas carbon dioxide is a product

Chemistry Topics
This lesson supports students’ understanding of

- Variables
- Controls
- Chemical reactions
- Fermentation

Time
Teacher Preparation: 20 minutes – if you do the limewater test, it should be prepared the day before
Lesson: 20 minutes

Materials

- Yeast (1 tsp per test solution)
- Test solution 1: 1 tablespoon of molasses dissolved in 50 mL of warm water
- Test solution 2: 12 g (1 tablespoon) of sugar dissolved in 50 mL of warm water
- Test solution 3: 50 mL of warm water
- Additional test solutions (see teacher notes for suggestions)
- Balloons (one per test solution)
- Erlenmeyer flasks (one per test solution)

Safety
Food used in the lab is not to be consumed.

Teacher Notes

- Procedure:
  - Prepare three test solutions: molasses, sugar, and water. (See materials section for test solution preparation.) Make sure the water is about 90-100 °F so the yeast activates quickly, but don’t let it get too much hotter than that, as it will kill the yeast.
Add yeast to each test solution, place a balloon over the opening of the flask, and ask students to make observations. Allow between 5 and 10 minutes for gas collection.

Results: The molasses and sugar balloons should inflate, but the water should not. Yeast requires sugar to ferment.

- You could ask for volunteers to add the yeast and place the balloon on the flasks to involve students.
- Analysis question 1 asks students to identify variables: the independent (manipulated) variable is the type of solution, the dependent (responding) variable is how much the balloon inflates (how much CO₂ is produced), and the control is the water with nothing added to it except yeast.
- Analysis question 4 asks students to identify the gas inside the balloon. If they need a push in the right direction, you could provide students with the equation for the fermentation of sucrose: C₁₂H₂₂O₁₁ + H₂O → 4 C₂H₅OH + 4 CO₂. They could identify that CO₂ is a gas, which would expand to fill the balloon. If you have equipment, you could bubble some of the collected CO₂ from a balloon into limewater to show a ppt forms: Ca(OH)₂(aq) + CO₂(g) → CaCO₃(s) + H₂O(l)
  - Preparation of limewater: add 1 tsp of Ca(OH)₂ to 1 gallon of water; after vigorous shaking, allow the solution to sit overnight. Filter out any undissolved Ca(OH)₂. The solution should be clear and colorless.
- Additional sugar sources that you can test:
  - 50 mL of milk (lactose)
  - 1 tablespoon of corn syrup in 50 mL of water (fructose)
  - 1 tablespoon of various sweetener in 50 mL of water
    - Splenda (sucralose)
    - Equal (aspartame)
    - Sweet N Low (saccharin)
    - Truvia (rebaudioside A and erythritol)
    - Some artificial sweeteners have a small amount of dextrose in them, which can be metabolized by yeast, so you may see some balloon inflation with some of the artificial sweeteners, even if the main component is not “real” sugar.
  - You could also try some sugar-free materials, such as salt, starch (ex: cornmeal), or cellulose (ex: woodchips/plant material) to reinforce that yeast needs sugar to metabolize.

FOR THE STUDENT

Lesson

What causes yeast to ferment?

Background
Have you ever baked a fresh loaf of bread? Why is it so light and fluffy when it comes out of the oven? In this investigation, you will learn a little more about this chemical reaction that is facilitated by a living organism: yeast.

Safety
Food used in a lab is not to be consumed.

Procedure
Your teacher will show you a number of test solutions in Erlenmeyer flasks. You will add yeast to the solutions, place a balloon over the opening of the flask, and observe. Identify the variables and the control in this investigation.

Results/Data/Observations
Create a data table in the space below that allows you to record observations of each test solution.

**Analysis**
1. What is the independent variable in this experiment? The dependent variable? The control?
2. Which test solution produced the most inflated balloon? Why?
3. If you used twice as much test solution, how do you think the balloon would compare?
4. What caused the balloon to inflate? How can you test this?
5. Which solution produced the least inflated balloon? Why?
6. What are two other materials you could put in the flask that might cause the balloon to inflate if yeast were added? Use evidence from this experiment to justify your choices.

**Conclusion**
What did you learn from this investigation?