

Food Safety Lab – Part 1

Inhibitor of Bacterial Growth - High Temperature

Purpose

To learn about the exponential growth and decay of microbial populations in relation to the organisms' temperature tolerance range. Students will observe the impact of high temperature as it inhibits microbial growth.

Overview

This investigation is a simulation in which students manipulate the temperature affecting a yeast population. Students set up water baths at several elevated temperatures to determine the high temperature range the yeast can withstand. Students will make inferences about the effect of temperature on bacteria found in kitchens and other facilities where food is prepared.

Time

2 two-hour block class periods

Key Concepts

Microorganisms have range limitations and live in an optimal niche. Microbial populations will grow exponentially as long as temperature is within the tolerance range of the bacteria (and nutrients are readily available). Cooking at high temperatures will inhibit bacteria in food.

Skills

- Making observations
- Measuring solutions
- Collecting data
- Tabulating data
- Forming hypotheses
- Testing hypotheses
- Understanding and describing interrelationships in nature
- Communicating observations and interpretations orally and in writing

Materials

- One clear bowl or large beaker
- Bakers' (or brewers') yeast packages
- Water
- Sugar
- Test tubes - 12 per student team (in test tube racks, if possible)
- 250ml beakers - 5 per team
- Thermometers - 4 per team
- Hot plates - 3 per team
- Measuring cups
- Rubber bands
- Paper towels

Facilitator Preparation

This activity has five parts and will take several class periods. The activities are as follows:

- A. Demonstration - yeast simulation of bacterial growth
- B. Preparation of a yeast/sugar solution
- C. Finding ideal temperature increments on hot plates for heating water baths
- D. Testing the effect of elevated temperatures on yeast cultures
- E. Assessment - Observing the viability of yeast cultures after applying elevated temperatures to assess the effect of different temperatures

You will be providing your learners with an observation of yeast “in action”. Since harmful bacteria are unsafe for classroom use, the yeast will be used to simulate the population growth and decay of bacteria.

Background

Can alligators live in Alaska? Can polar bears live in Florida? Perhaps they can live in places to which they are not adapted, but they will not thrive or do well. Sometimes an extreme change in temperature can cause death. Why do we refrigerate our food? What would happen if we did not refrigerate? Are the organisms still on the food in the cooler temperatures? Suppose we have a dozen tangerines in the fridge. What would happen if we take them out and leave them on the table for a week during the summer? What would they look like at the end of the week?

Procedure

This lab is divided into four parts. The activities are as follows:

- A. Simulation of bacterial growth and understanding yeast
- B. Preparation of a yeast/sugar solution
- C. Setting up water baths
- D. Testing the high temperature limits of yeast

A. Simulation of Bacterial Growth

Warm water produces the best results for this demonstration. You can use tap water or heat water using a hot plate. Place a clear bowl filled with luke warm water in view of the class. Pick up a package of yeast and pour it into the bowl. Add another package. Stir if necessary. Now add some sugar to the container along with the yeast. Add at least ten spoons of sugar or a portion of a cup. (This is food for the yeast and will bring it to life – “activating” it.) Stir the sugar until it dissolves. In a few minutes, the yeast will start to gobble up the sugar in the container and will start producing gas – carbon dioxide. It will be obvious to the students that a chemical change has taken place. Pass yeast packages out to learner teams, asking members to read the label aloud. Some students may have already identified the packages from prior knowledge (someone at home bakes). Students will watch what happens to the yeast in the bowl over the next fifteen minutes. What is the role of the sugar? What is happening in the bowl with the sugar? Have students list the changes they observe within the bowl. Compare their observations. Students should notice that they must add sugar to the culture for energy if they wish the yeast population to continue to grow.

Understanding Yeast

Students discuss what they observe during the next fifteen minutes as the yeast is “activated”. What is yeast? (Let students read the labeling on the packages if they have not already done so.) How do we use yeast?(baked goods, beer, wine) Why do you

need yeast to make bread?(helps dough rise) What actually makes the dough swell up?(carbon dioxide gas, alcohol is produced as well, evaporating during baking) What about beer – what does yeast do to hops and barley to make it beer?(eats the carbohydrates) What about wine – how does yeast turn grape juice into wine?(ferments, eats the carbohydrates, gives off alcohol and it stays in the liquid) So you have to add yeast to flour and water or grape juice or hops and barley to get what you want. It's interesting to note that yeast is not normally found in great enough numbers to ferment or act on dough in a timely manner. It has to be added so that it can outnumber the indigenous populations of organisms who would normally dine on or "rot" the fruit and flour if we left it unenhanced with the yeast culture.

B. Preparation of a Yeast/Sugar Solution

You will need approximately 300mls of this solution for each lab team. Distilled water is not necessary in these experiments. Each batch of solution should consist of: 2 liters (or quarts) of warm water, one cup of sugar, and one bakers' (or brewers') yeast package.

- 1) Combine the ingredients and stir.
- 2) Pour the combined ingredients into enough beakers for each lab team to receive one beaker of the yeast/sugar solution.
- 3) Allow each lab team to observe the activity in the solution. They should record the approximate time that activity in the solution is visible. How do they know the yeast is activated? Have students list their observations. (movement of water, bubbling, smell, foaming)

C. Setting Up Water Baths

Instruct students to do the following:

- 1) Fill four beakers to about half full with water ONLY. One beaker will be the control and will not be heated.
- 2) Place a thermometer in each beaker and place three beakers on separate hot plates. Choose temperatures so that the differences are at least ten degrees apart (for example, 30 degrees, 50 degrees, and 70 degrees)
- 3) Choose Low, Medium, and High settings on each hot plate to correspond with the team's chosen test temperatures. (Students may not be able to achieve the exact temperatures with the hot plates.) Wait ten minutes for the temperatures to stabilize.
- 4) Take temperature readings and adjust hot plate settings accordingly. Ask students if they need to raise the temperature? If so, they need to wait ten minutes for the beaker of water to respond to the change.
- 5) Have students take a new reading. Record if satisfactory. Record the dial reading that corresponds to this temperature.

D. Testing the High Temperature Limits of Yeast

Instruct students to do the following:

- 1) Divide the test tubes into 4 sets (3 test tubes in each set). Label one set as CONTROL. Label each of the remaining sets to reflect the final temperatures of the 3 water baths (one set at the lower temp., another set at the medium temp., and the other set at the higher temp.).
- 2) Place 10mls of activated yeast solution in each of the 12 test tubes.
- 3) Place each temperature set of test tubes in the corresponding water bath and record the start time.
- 4) After ten minutes, remove the test tubes and beakers from the hot plates. Turn off the hot plates.
- 5) Place the test tubes in a beaker of water at room temperature and cover each with a piece of paper towel.
- 6) Observe the sets of test tubes after 24 hours, 48 hours, and 72 hours for activity as evidence of viability.

Student Assessment

1. Yeast Growth Demonstration
Have students describe what they see happening in the clear bowl containing the yeast. Students should sketch the container and write a brief description of what's going on within the container.
2. Observing the Yeast Solution
How do they know the yeast is activated? Have students list their observations. (Movement of water, bubbling, smell, foaming). Ask students why they think the test tubes were covered after the experiment. (To prevent contamination)
3. Observing the Viability of Yeast Cultures After Applying Elevated Temperatures
Ask students if they saw any activity in the heated sets of tubes. Why are they heating the test tubes at different temperatures?(to determine the highest temperature range that the yeast can withstand and still remain viable) Did they find out the high temperature limit for yeast after doing the trials during this lab, or is more experimentation necessary? How would they set up a follow-up experiment to find a more specific temperature?
4. Observing the Yeast Cultures Over 72 Hours
Ask students why the test tubes containing the yeast cultures are placed at room temperature and why are the cultures observed for two days. (We want to know what temperature was the highest the yeast could withstand and still remain viable. We are not looking for a sustained high temperature that will kill the yeast - this is the reason for putting the yeast at room temperature after the initial 10 minutes trial at the recorded temperatures. The cultures are observed for two days to see if they are truly viable and not just surviving in a weakened state immediately after the trials in the lab.) How could they make sure that the yeast in the test tubes without any signs of activity are not still viable?(Place the yeast in a small amount of warm sugar solution and observe the solution for 24 hours for signs of activity. If activity can be observed, the yeast in the test tube was still viable - they just needed more nutrients to get them going again.) If they are still viable, what would you need to do? (another run at more discreet temperatures)
5. Temperature Tolerance Lab
Assign points for the following components of the student lab:
Rubric for the Lab:
 - ❖ Did all participate as a team?
 - ❖ Was behavior conducive to safety?
 - ❖ Were team members careful with equipment?
 - ❖ Was clean up appropriate?