

Brewing Rootbeer

Target Grade Level: 5th

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UNIVERSITY OF MONTANA GK-12 PROGRAM

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2. NAME OF INQUIRY: BREWING ROOTBEER

3. GOALS AND OBJECTIVES:

a. Inquiry Questions:

1. What is your hypothesis for each of the treatments?
2. What is the purpose of the yeast?
3. What would happen if we placed a lot of yeast in the bottles?
4. What if no yeast was used?

b. Ecological Theme(s):

1. Yeast are able to fill several niches due to their different respiration systems
2. Anaerobic conditions select for only certain types of microorganisms.

c. General Goal:

1. Demonstrate beneficial uses of microorganisms.
2. Introduce different respiration pathways of microorganisms.
3. Compare modern brewing (via CO₂ injection) verses how yeast were once used to carbonate soda.

d. Specific Objectives:

- ❖ Academic: Students learn that not all organisms use oxygen as a part of their respiration process. Byproducts (waste) from one organism can be utilized by others.
- ❖ Experimental: Different types of yeast and amounts of sugar will affect the taste of the rootbeer; these can be divided into treatments and analyzed by the students.
- ❖ Procedural: Students learn about the solubility of compounds (i.e. sugar).

e. Grade Level: 5th

f. Duration/Time Required:

- Prep time: 3-4 hours entails gathering supplies and equipment and sanitizing materials to be used in experiment.
- Implementing Exercise During Class: approximately 1 hour
- Assessment: approximately 30 minutes.

4. ECOLOGICAL AND SCIENCE CONTEXT:

a. Background (for Teachers): This exercise helps students understand that microorganisms can be beneficial. Depending on the grade level most students will have the preconception that all microorganisms cause disease (i.e. germs). However, this is not the case microorganisms are used to make yogurt, cheese, antibiotics, as well as ethanol which could one day be a renewable fuel source. This inquiry will enable the student to understand that not all microorganisms are agents of disease. Also the student will gain a greater understanding that not all organisms use oxygen to breath, and that their ability to do so enable them to live in extreme and diverse environments.

b. Background (to present to Students): The teacher can introduce the idea of microorganisms, by asking their students " what do you know about microorganisms?" Most, if not all, will discuss how microorganisms cause disease. Here the teacher can explain the benefits some microorganisms provide. Furthermore the teacher can ask

“do all organisms breath oxygen?” Here the teacher can explain how other compounds can be used in the respiration process.

5. MOTIVATION AND INCENTIVE FOR LEARNING: This is a fun hands on activity that will enable the student to learn about the positive uses of microorganisms. At the end of the experiment/assessment you can have a taste test comparing brewed rootbeer to store bought rootbeer or a rootbeer float social works as well.

6. VOCABULARY:

Respiration

- breathing: the bodily process of inhalation and exhalation; the process of taking in oxygen from inhaled air and releasing carbon dioxide by exhalation
- the metabolic processes whereby certain organisms obtain energy from organic molecules; processes that take place in the cells and tissues during which energy is released and carbon dioxide is produced and absorbed by the blood to be transported to the lungs

Fermentation

- a process in which an agent causes an organic substance to break down into simpler substances; especially, the anaerobic breakdown of sugar into alcohol

Yeast

- Yeast is a single celled life form of fungus. Yeast exists on plants, in the air, in soil, and in and on humans and animals. Yeast metabolize simple sugars and produce alcohol and carbon dioxide through the process of fermentation. Different strains of yeast are used for different processes, such as brewing and bread making.

Anaerobic

- Anaerobic refers to an environment or a condition which is free of oxygen or describes a microorganism which can grow in the absence of oxygen.

Aerobic

- Characterizing organisms able to live only in the presence of air or free oxygen, and conditions that exist only in the presence of air or free oxygen. Contrast with anaerobic.

Carbon dioxide

- (CO₂). A heavy, colorless gas that does not support combustion, dissolves in water to form carbonic acid, is formed especially in animal respiration and in the decay or combustion of animal and vegetable matter, is absorbed from the air by plants in photosynthesis

Ethanol

- (CH₃CH₂OH) A colorless, flammable liquid produced by fermentation of sugars. Ethanol is used as a fuel oxygenate. Ethanol is the alcohol found in alcoholic beverages.

7. SAFETY INFORMATION: Culturing microorganisms can lead to the isolation of pathogenic organisms. All materials used in this experiment should be cleaned with detergent and hot water as well as a 5% bleach solution. All water used should be brought to a rapid boil for at least 5 minutes. Upon the completion of the brewing process, bottles should maintain a yeasty smell. If the bottles smell like sulfur (rotten eggs) dispose of bottle. Also, the amount of alcohol produced in this process is 0.03%.

8. MATERIALS LIST (including any handouts or transparency masters):

1. Plastic 2-liter bottle
2. 20 oz plastic soda bottles
3. Sugar
4. Rootbeer extract (Schilling)
5. Yeast (bread or champagne will work)

Recipe

1. Add 150 grams sugar/Liter water.
2. Add 3ml of Rootbeer extract/Liter water.
3. In separate container add 30ml of warm water (80° F) to 1/4 gram yeast, mix and allow solution to sit for five minutes. (This activates the yeast).
4. Pour yeast solution into one liter container.
5. Once the solution is mixed it can be dispersed into smaller bottles (~500ml).
6. Place bottles on their side at room temperature (65-75 F) for at least one week.
7. 24 hours prior to opening bottles place in refrigerator standing on end (this deactivates the yeast and allows it to settle to bottom of container).

9. METHODS/PROCEDURE FOR STUDENTS:

a. Pre-investigation work: This exercise is a portion of a larger curriculum piece intended to introduce students to microorganisms. Basic knowledge of microorganisms should already be established with the students before beginning this research project. Before the experiment the instructor leads a discussion on respiration and what it means to breathe. The students are asked if all organisms “breathe oxygen”. The instructor then explains how some microorganisms use other compounds to carry out the cellular processes of respiration. The instructor then discusses how yeast are able to use oxygen as well as sugar to “breathe”. Now the instructor can ask their students if they know of any positive benefits derived from microorganisms. The instructor can now give a brief history of how Egyptians were the first to domesticate yeast, and how it is used in bread making today.

b. Investigation work: Students are divided into pairs or groups of no more than 5 individuals. 4th and 5th grade students are given a “brewing packet” that contains all of the necessary ingredients pre measured. Older students can be given the recipe and allowed to measure their own materials. The instructor has the option of adding additional treatments such as no yeast, double yeast treatment, or no sugar. The instructor can assign these treatments; however, we found it more useful if the instructors made these additional treatments. This way everyone who participates in the experiment will have their own bottle of brewed rootbeer.

Once the initial setup is complete the students are asked to write out their predictions for each of the treatments. During the fermentation process the students can watch their bottles begin to expand and they should be able to see the colonies of yeast become larger. At the end of the experiment the students should realize that the soda was carbonated by the yeast breaking sugar into CO₂.

10. ASSESSMENT:

Younger students (3rd-5th) can draw pictures of yeast cells metabolizing sugar and respiring CO₂. Advanced students could possibly setup formulas of what is occurring in the brewing process (i.e. Sugar + Water → Carbon dioxide +

Ethanol). If students have good chemistry background they could draw this out using chemical formulas of the reaction.

11. EXTENSION IDEAS:

This experiment could be repeated using different types of flavoring (grape, cherry) as well as types of yeast. Furthermore, students could develop their own recipe for brewing soda by adjusting sugar and yeast concentrations.

12. SCALABILITY

This experiment could be scaled up by plating yeast onto agar plates as rootbeer brews. Students would be able to see the density of yeast colonies increase as time passes.

13. REFERENCES:

- www.greydragon.org/library/brewing_root_beer.html
- www.leeners.com/rootbeer.html
- www.alpharubicon.com/kids/makesoda.html
- mipwww.life.uiuc.edu (search database: yeast)
- www.prenhall.com/brock (online guide to microorganisms)

14. LIST OF EXPERTS AND CONSULTANTS

None

15. EVALUATION/REFLECTION BY FELLOWS AND TEACHERS OF HOW IT WENT:

This experiment went very well. The students were quite excited by the idea of creating their own rootbeer and being able to consume it.