



Alternative Transportation and Technology
Fermenting Sucrose—Making Root Beer
Adopted from Kim B. Foglia---<http://bio.kimunity.com>
DRAFT

Title: Fermentation of Sucrose—Making Root Beer
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Objective:

Through experimentation students will produce carbonated root beer by the fermentation of sugar.

Standards:

Chemistry –Grades 9-12

- **1O.a.** Students know large molecules (polymers), such as proteins, nucleic acids, and starch, are repetitive combinations of simple subunits.

Materials:

1 Empty Two Liter Plastic Bottle
2 Bottles (.5 liter) Spring Water
Brewer's Yeast
Sucrose
Root Beer Extract
Large Beaker
Funnel, Cups
10 ml Graduated Cylinder

Manpower Resources:

- 1 Teacher

Big Question?

How is the process of fermentation important to making ethanol fuel?

Background

All organisms need energy to live. Cellular respiration is the process they use to convert the energy stored in sugars into the quick energy of ATP. If oxygen is available, the mitochondria can perform their "energy generator" job and make a lot of ATP energy. This version of respiration is called aerobic respiration and it produces enough ATP energy to support large active, multicellular animals like you.

If oxygen is not available, large organisms cannot produce enough energy to survive. That's why animals die if they cannot breathe. But even though there is no oxygen, some one-celled

organisms can still digest sugars and make enough ATP energy to live and grow. This version of respiration is called **anaerobic respiration**. It is used by bacteria and fungi and is also referred to as fermentation. There are two types of **fermentation**:

- ❑ **lactic acid fermentation** which is used by bacteria (and how we make yogurt) and also occurs in muscle cells when they are oxygen deprived like during a sprint race; and
- ❑ **alcoholic fermentation**, which is used by yeast (a one-celled fungus) and how we make beer, wine, bread, and many other foods.

This lab is to explore alcoholic fermentation. When yeast break down sucrose ($C_{12}H_{24}O_{12}$) to make ATP energy they also make two waste products: alcohol and CO_2 . Unfortunately for the yeast, the alcohol eventually builds up and kills them. But unlike the yeast, humans see the alcohol as a desirable product. In addition, the CO_2 collects in the fermenting liquid and makes it fizzy, hence the term "carbonation" or "carbonated beverage". This is the old-fashioned way that soda was made, like root beer, birch beer, and sarsaparilla.

HISTORY OF ROOT BEER:

Root beer was made by our ancestors by soaking Sassafras (a type of tree) root in water, and adding sugar and yeast (for carbonation). In the early 1900s however, scientists discovered that safrole, a chemical found in Sassafras root, was a carcinogen (cancer-causing agent) and human consumption has been banned. Now, a mixture of other herbs and spices makes up "root beer extract" which is what is now used to make homemade root beer.

Procedure:

Pick up a bottle of spring water. In teams of two people, mix root beer in an empty 2 liter bottle and then after it is mixed, pour it back into the spring water bottle.

The procedures listed below are measurements for **one lab team of 2 people**.

1. Empty one of the bottles of spring water into a clean beaker and heat in a microwave to about body temperature ($37^{\circ}C$).
2. While this water is heating, measure 0.25g of yeast in a small beaker or cup. Once the water is heated, add 50mL of the warm water to the yeast so it dissolves. Let stand for at least 5 minutes.
3. While the yeast is dissolving, measure 4 milliliters of root beer extract.
4. While the yeast is dissolving, measure 110 grams of glucose.
5. Get clean, empty 2-liter bottle. This will be the mixing bottle. Pour the sucrose into the

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- 2-liter bottle using a funnel. Next pour the root beer extract into the same 2-liter bottle. Use some of the heated spring water to rinse out the root beer extract from the graduated cylinder and add it to the 2-liter bottle. Add the rest of the warmed spring water into the 2-liter bottle to dissolve the sugar.
6. Now heat up the second spring water bottle in a microwave to about body temperature.
 7. While this water is heating, add the dissolved yeast mixture to the 2-liter bottle.
 8. Now add the second bottle of warmed spring water to the 2-liter bottle. Gently swirl the bottle to mix well.
 9. Pour the root beer mixture into empty spring water bottles. **Do not fill the bottle all the way.** Only fill to the point the straight sides of the bottle start to curve in to the neck. Give excess root beer mixture to the teacher to make some "Tester" bottles.
 10. Close the cap on bottle **tightly** and hold it upside down for a minute to check for leaks. Put name on the cap.
 11. Observe and describe the appearance of the root beer.
 12. Age the root beer for 2–3 weeks at room temperature in a dark place, after that refrigerate for 1 week.
 13. Refrigeration will stop the fermentation process and kill the yeast — and stop from producing alcohol (Sorry!). Be sure to check bottles every day for tightness, if the bottle gets too pressurized, they will burst.
 14. After chilling, get the bottle, open carefully, pour a sample into a cup, and observe and record the appearance of the root beer. Taste.

Post – Lesson:

Students answer the following questions:

SUMMARY QUESTIONS

1. Describe the appearance of the root beer before the fermentation process.
2. Why was it necessary to use yeast in this experiment?
3. Why was the glucose necessary in this experiment?
4. What is the yeast doing to the sugar?
5. What are the biproducts of the reaction?
6. What process is yeast using to make ethanol?
7. Write the equation for alcohol fermentation using glucose ($C_6H_{12}O_6$).
8. Describe how the process of fermentation is important to making ethanol fuel?

Vocabulary to Know:

Cellular respiration, aerobic respiration, anaerobic respiration, lactic acid fermentation, alcoholic fermentation

Link to lesson:

<http://bio.kimunity.com/documents/Lab20RootBeerFermentation2006.pdf>