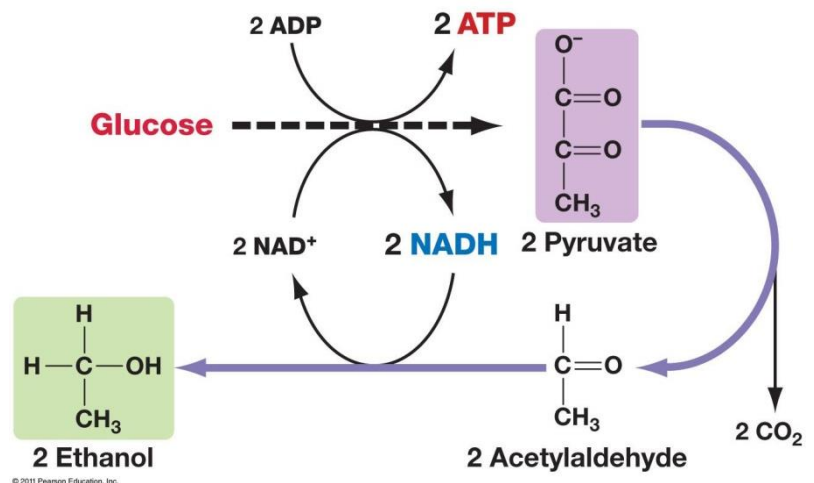


LAB: Fermentation and Root Beer

HONORS BIOLOGY: UNIT 3

ACTIVITY OBJECTIVE: This experiment will illustrate that the fermentation processes, as in yeast fermentation, is used to produce a naturally carbonated beverage.

BACKGROUND INFORMATION: There are two types of respiration; **aerobic** (requiring oxygen) and **anaerobic** (without oxygen). Yeast cells (a type of fungus) obtain energy from glucose (sugar) by a specific anaerobic process called **fermentation**. There are two types of fermentation, **lactic acid fermentation** (which occurs in muscle cells when they are oxygen deprived), and **alcoholic fermentation**, which is involved in the making of food products. Alcoholic fermentation begins after glucose diffuses into the yeast cell. The glucose is broken down into 2, 3 carbon molecules called pyruvic acid. The pyruvic acid is then converted to CO₂, ethanol and energy for the yeast cell. Don't get excited, students, there is very little ethanol in this root beer. Fermentation is used to make a variety of food products, including the making of beer, wine, bread, cheese, sauerkraut, and baked goods. It is the carbon dioxide produced by the yeast that give root beer it "fizz." This fizz is produced in store bought root beer by a carbonation machine that forces carbon dioxide into the root beer mixture, without the aid of our little yeast friends. Here is the chemical equation for alcoholic fermentation:



MATERIALS REQUIRED

- 4-liter (1-gallon) plastic container for food
- 1 package of brewing yeast (not bread yeast)
- Root beer flavoring extract, 15-20 mL
- Sugar
- Warm tap water (37°C)
- 6-8 plastic, 2-L soft drink bottles with caps
- 5% bleach rinse to clean bottles
- Stirring spoons
- Balance
- Permanent marker

EXPERIMENTAL PROCEDURE

1. Dissolve 0.12 g (1/4 tsp) of yeast in 250 mL of warm water (37°C). Let this mixture stand for 5 minutes or longer.
2. With the permanent marker, mark the plastic container at the level where 4 L of liquid would be.
3. In the plastic container, combine root beer extract and 45 g of sugar with sufficient warm water (37°C) to dissolve the sugar (approximately 2 cups). Use 15-30 mL of extract, depending on your personal taste preference for root beer flavor. Refrigerate the leftover extract.
4. Taste for overall flavor. Add more sugar or root beer extract to suit your taste.
5. Add the yeast mixture. Make sure that the yeast is suspended completely before adding it. Mix thoroughly.
6. Add additional warm water to bring the level to within 8 cm of the top of the container.
7. Wash the soft drink bottles well with detergent and hot water. Rinse with a 5% bleach solution to sanitize. Finally, rinse several times with warm water.
8. Fill bottles with the root beer formula, up to 2.5-5 cm from the top. Tightly secure the caps on the bottles. Lay bottles on their side to check for leaks. Reseal bottles that show signs of leakage. Bottles now sealed properly may become flat or sour.
9. Age bottles 3-4 days at room temperature (approximately 24°C). Keep them in a cardboard box, with corrugated cardboard between each bottle. If one should explode because of increased gas pressures, the box will contain the spill and the pieces of plastic.
10. After 3-4 days, move the bottles to a cooler (15-18°C), dark place. The total aging process should take at least one week, with 2 weeks improving the flavor. **Refrigerate the bottles before opening them.**
11. As natural carbonation takes place, a slight yeast deposit will form on the bottom of the bottle. When serving the root beer, pour carefully to leave most of the yeast deposit undisturbed. This deposit is not harmful in any way, but it sometimes gives the drink an off-flavor.
12. Taste the products initially, after 5 days, and at the end of the fermentation (10 days). Compare the experimental sample to a commercial root beer for flavor intensity, sweetness, and degree of carbonation, using the following scale: 1 = more, 2 = same, and 3 = less. Enter the data in the table provided.

DATA TABLE- Comparison of Experimental Sample to a Commercial Root Beer

Scale: 1= more, 2 = same, 3 = less

TIME	ROOT BEER FLAVOR INTENSITY	SWEETNESS	DEGREE OF CARBONATION
0 DAYS			
5 DAYS			
10 DAYS			

QUESTIONS

1. Why should brewing yeast be used rather than the yeast used to make bread?
2. When suspending the yeast, you were to use warm water (37°C). What would happen if hotter or colder water is used?
3. What is the purpose of sugar in the formula?
4. Is it possible to produce a low-calorie root beer using this method? Why?
5. What is the natural carbonation process?

6. What is the purpose of fermentation (both lactic acid and alcoholic fermentation)?

7. How are lactic acid and alcoholic fermentation different?

8. How is lactic acid and alcoholic fermentation related to the process of glycolysis?

9. How are the molecules NAD⁺ and NADH important in allowing glycolysis to continue during alcoholic fermentation?

10. How many molecules of ATP are produced in fermentation compared with cellular respiration?