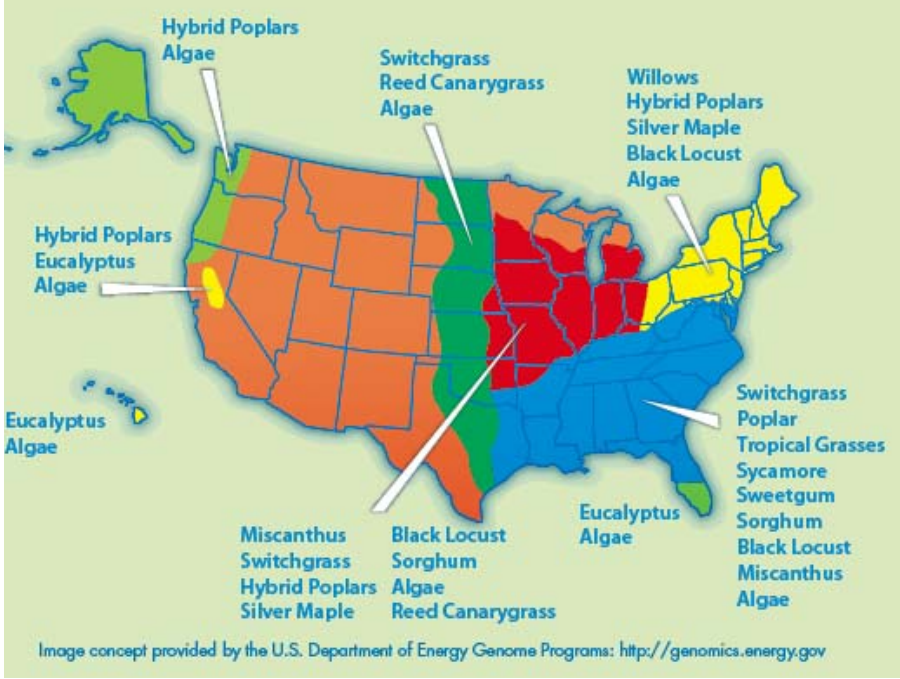
# Pop Bottle Biofuel

You know that before baking a loaf of bread you must let the dough rise. During the rising process, or fermentation in this case, yeast breaks down sugars to get energy, just like when you eat sugars to give your body energy. In this process, the yeast releases two waste products: carbon dioxide (the same gas you exhale) and ethanol (a liquid that can be used as a biofuel). Because the ethanol is mixed with water in the experiment, you can not see it directly.

Ethanol is a type of biofuel- a source of energy obtained from recently harvested plant materials. On the other hand, fossil fuels like coal or oil are sources of energy from plants and animals that died a very long time ago. The sugar inside corn kernels can be broken down by yeast to make carbon dioxide and ethanol in the same process. In a chemical plant, the ethanol is removed from the mixture to make a fuel that is mixed with gasoline and sold as some gas stations. You may have noticed this where a sign says “E10”, which means 10% ethanol, 90% gasoline.

In the Unites States, most ethanol is made form corn. In this experiment, we are going to observe how yeast can break down processed corn sugars- like those found in corn syrup- through fermentation. We will also see if other plant products can be used by the yeast to make biofuels.




*The map above lists types of crops that farmers could grow in different parts of the county to use for biofuel production. Some suggestions are using wood chips or sawdust, dried corn husks, ordered grasses like switchgrass.*

- Although there are a lot of sugars inside of the dried leaves and wood chips, the yeast cannot digest the leaves and wood directly to get energy and release carbon dioxide and biofuels. The cellulose first needs to be broken down into tinier parts before the yeast is able to eat it. However, unlike the process in which the starches inside of corn kernels are made into corn syrup, it is currently much harder and more expensive to break up the cellulose in crops like wood chips or dried grass. Scientists are working on ways to make it easier to break up the cellulose so that all the other crops you saw on the U.S. map can be used to make biofuels for our cars.

**Materials Per Group:**

- (3) empty and rinsed out 20 oz plastic water or pop bottles with their caps.
- Warm tap water
- (3) packets of either active dry yeast or dry quick rise yeast *(equal to 3 tablespoons if measuring from bulk)*
- (3) 9" latex balloons
- Light-colored corn syrup
- Dried, ground-up plant based material- at least 6 tablespoons, some for extra.
- Scissors
- String or construction paper *(for balloon measurement)*
- Small plastic funnel or paper cup for pouring
- Masking tape and markers *(to label your bottles)*

**Time Requirement:**

- 20 minutes for preparation
- 10 minutes (or longer if desired) to observe your bottles

**Procedure:**

1. Gather the 3 bottles and add 1 packet or one tablespoon of yeast to each bottle.
2. In the 1st bottle you will not add any carbon source. This is your negative control- you use it as reference to see what happens when no food is added to the bottle.
3. In the 2nd bottle, add 3-4 tablespoons of corn syrup- the sugars which are inside of corn. In the factory, the starches inside corn kernels are broken down into sugars to make corn syrup.
4. In the 3rd bottle add your found dried ground-up plant based material. Add about 4 tablespoons.
5. Scientist are studying how other plants and parts of plant, not just corn, can be used as a source of bio-fuel.
6. Fill your bottles half-full with warm tap water that is very warm to the touch, but not so hot that it is painful or scalding. Replace the cap and shake to mix contents.
7. Remove the cap and place a balloon over the mouth of each bottle and watching the time for approximately 10 minutes see what happens. Measure the size of each balloon to compare which balloon has the most carbon dioxide in them. Do this by wrapping the string around the largest part of the balloon and then measuring the length. This is called measuring the circumference.

**Questions:**

Individually create a google doc titled, **BIOFUEL LAB- FIRST NAME LAST NAME** and type out and answer the questions below from your group's lab. Share your questions with me giving me permission to edit.

1. What was dried ground-up plant based material your group used in this experiment?

2. Record the size (circumference) of each of your balloons after 10 minutes and at the end of the hour.

| | **Bottle #1**<br>Negative Control | **Bottle #2**<br>Corn Syrup | **Bottle #3**<br>????? |
|---|---|---|---|
| 10 minutes | | | |
| ___ minutes | | | |

3. Can the yeast use the sugars inside corn syrup as food? How can you tell from your experiment? Do you think you made biofuel from the corn syrup?

4. Can the yeast use the sugars inside the cellulose in the dried leaves (or other plant material) for food? How can you tell from your experiment? Do you think you made biofuel from the plant material?

5. Do you see any evidence of carbon dioxide inside the bottles (in addition to the fact that the balloons get inflated?)

6. What do you think could have caused some variation in results between your group and another group in the class for the same test of corn syrup in bottle #2?

7. Let the experiment sit overnight. The next day note any changes in the size of the balloon, if any at all. Remove your balloons from the top of each bottle and compare the smell from each bottle. You might be able to smell a difference between the negative control (bottle #1) and the corn syrup (bottle #2). In the corn syrup bottle, the yeast is breaking down sugars to make ethanol, which has an odor. Smell bottle #3 why do you think it smells (or doesn't) the way it does?

8. Global warming occurs when carbon dioxide (and other greenhouse gases) from the fuels we burn accumulate in the atmosphere. What do you think the impact of biofuels on global warming would be?

9. What are some advantages and disadvantages of using biofuels?

10. What sources of biofuels do you think would be best suited for Michigan?

**Terms:**

**BIOFUEL**
A fuel (or material that can be burned as a source of energy) that comes from recently harvested material, like corn kernels, as opposed to fossil fuels like oil and gas, which come from material that died a long, long time ago.

**CARBON DIOXIDE**
A gas that is released when you exhale; is a product of fermentation of sugars by yeast in this experiment; and is implicated in global warming when present in high levels in our atmosphere.

**CELLULOSE**
A major component of plant material; it is not digestible by humans and is part of dietary fiber. It is the most common organic compound on Earth!

**CIRCUMFERENCE**
A measure of the distance around a circle.

**ETHANOL**
A liquid produced by the fermentation of sugars by yeast; it can be mixed in a refinery with gasoline to use as a fuel in car engines.

**FERMENTATION**
Generally, the process by which organisms like yeast break down substances for energy without using oxygen. In our experiment, the fermentation of sugars by yeast produces energy for the yeast and releases carbon dioxide and ethanol as waste products.

**FOSSIL FUELS**
Sources of energy, like coal and oil, which come from plants and animals that died a very long time ago.

**NEGATIVE CONTROL**
A part of a scientific experiment that is expected to have no result; used here as a test to make sure that the balloon did not inflate without the addition of sugars.

**RENEWABLE ENERGY**
Energy from sources like the sun or wind that can be replenished.

**VARIABLE**
Something that can vary, or differ, in a scientific experiment.

**YEAST**
A type of fungus that is made up of only one cell per organism (as opposed to a mushroom, for example, which is a fungus that is made up of lots of cells per organism).

*Lab copied from www.4H.org/NYSD*