

Ethanol in a Bag

Grade Level(s)

4th and 5th grade

Estimated Time

30 minutes

Purpose

Students will explore how ethanol is made from corn through fermentation.

Materials

▪Links:

Website with virtual resources: www.linncoag.com -2020/21 virtual learning drop down tab- January

Book: My Family's Corn Farm

<https://www.yumpu.com/en/document/read/63054656/my-family-s-corn-farm>

Instructional video <https://www.youtube.com/watch?v=iDTHHfUo6U>

Process of ethanol video: <https://intotheoutdoors.org/topics/ethanol-primer/#video>

▪Worksheets:

Prediction worksheet

Sequencing cards

Experiment labels

▪Other:

Ziplock bags

Corn starch

Corn oil?

Corn meal

Sugar

Active dry yeast

Hot water (not included in kit)

Measuring spoon

Tape (not included in kit)

Vocabulary

Ethanol: Ethanol fuel is a renewable fuel that is commonly domestically produced or fermented from agricultural waste, grain or corn.

Dent or Field Corn: has a high soft starch content and is used to feed livestock, make ethanol and used to create 4000 different products.

Fermentation: the chemical breakdown of a substance by bacteria, yeasts, or other microorganisms.

Interest Approach – Engagement

1. Show field corn ear and ask the students to name what kind of corn it is.
2. The corn being displayed is dent corn. Did you know 98% of corn fields in Iowa grow dent corn and only 2% grow sweet corn?
3. Dent corn is used to feed livestock, make ethanol- a fuel for our cars, and can be found 4000 products.

Background - Agricultural Connections

This activity is a basic experiment that allows students to observe the process of fermentation and the challenge of producing ethanol from cellulosic sources. Students combine yeast and warm water with a feedstock in a snack size resealable bag and observe as the yeast “eats” the feedstock such as sugar, cornmeal, or corn starch and produces carbon dioxide and ethanol. Ethanol is simply the chemical name for ethyl alcohol. Essentially, this is grain alcohol, not unlike moonshine. However, when made for fuel purposes, it must be blended with gasoline before leaving the plant, so it cannot be sold as a food-grade product. The percentage that the pure ethanol gets mixed with the gasoline is called the blend. This is where we get names like E-85 and E-15. The most common here in Iowa is E-15. This is made from the starches in the corn kernel. There are byproducts from ethanol, including DDGs, or dried distiller’s grains. These can also be used as a nutritional, cheaper feedstuff for livestock.

Cellulosic ethanol is also ethanol, but it is instead made from the cellulose of the plant. This means that all of the plant material, including stems, stalks, and leaves, can be used to create fuel. This process has not yet become very popular, but it holds promise. Where there are cellulosic ethanol plants, farmers may bale the leftover corn stover in their field after harvest to sell to these plants. There has also been research into a variety of other crops, including giant miscanthus, that create a large amount of plant matter with very little inputs. As of January 2016, there are 4 cellulosic plants in Iowa (Nevada, Blairstown, Liberty, and Galva). Three use corn “leftovers” including cobs, stover, and fiber, while one uses municipal solid waste (MSW).

- Iowa leads the nation in ethanol production, with 47 percent (1.3 billion bushels) of the corn grown in Iowa going to create nearly 30 percent of all American ethanol.
- Iowa’s 42 ethanol plants are expected to use approximately 1.3 billion bushels of corn, which will produce well over 3.9 billion gallons of renewable ethanol fuel and 9.37 million U.S. tons of the livestock feed, distillers dried grains (DDGs).

- Production has increased from about 25 million gallons in the early 2000s to about 2.1 billion gallons advanced biofuel in 2015.

Procedures

1. Watch the instructional video- link provided above
2. Read My Family's Corn Farm- virtual link above
 - How did the farmers grow the corn? What kind of corn did they grow? What was the corn used for?
3. Watch the process of ethanol video: <https://intotheoutdoors.org/topics/ethanol-primer/#video>
 - Ethanol is a renewable fuel, meaning we can grow corn year after year. Traditional fuels come from a non-renewable source.
4. Today we will be exploring the fermentation process.
5. Ask the students to predict what they think will happen when we mix a feed source with yeast and warm water. Which feed source (feed stock) do they think will have the most reaction?
6. Pass out the following materials:
 - 1 resealable bag per student
 - 1 tsp of yeast
 - 1 tsp of feed source (sugar, corn starch or corn meal) alternating around the room.
 - Add ¼ cup of warm water, seal the bag while removing most of the air and mix (knead like bread).
 - Tape a label to the bag. Be sure to record your food source.
 - Lay bag flat on a surface and wait 15 minutes.

** Warning- as the yeast produce carbon dioxide, the bag will expand and may even pop. Be sure to monitor the bag and release the gas if becomes too inflated.
7. While you are waiting for the experiment, pass out the sequencing cards and ask students to place them in order from seed to ethanol.
Correct sequence: Farmer, planter, the corn, harvest, transportation, elevator, ethanol plant, grinder, cooker, fermentation, molecular sieve, delivery, and retail.
8. Questions to discuss:
 - If the bag is inflating, what is filling it up? *Carbon Dioxide- the yeast begins to eat the food source while releasing CO₂.*
 - Are you observing fermentation? How do you know? *The bag will begin to fill with gas.*
 - How did the yeast respond to the different feedstocks? Why do you think there was a difference?
 - If sugar is yeast's favorite "feed," why might we want to use a cellulosic plant material instead of sugar for making ethanol? *Corn grows well in the Midwest, we have a market for corn, and corn is an annual plant.*

Organization Affiliation

Great Lakes Bioenergy Research Center and Iowa Agriculture Literacy Foundation

Agriculture Literacy Outcomes

T2.3-5.b. Distinguish between renewable and nonrenewable resources used in the production of food, feed, fuel, fiber and shelter.

T5.3-5.d. Explain the value of agriculture and how it is important in daily life.

Iowa/ Common Core Standards

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sounds, light, heat, and electrical currents.

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

SS.4.17. Create geographic representation to illustrate how the natural resources in an area affect the decisions people make.