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Cooperative Extension

Biofuel Education

Note to Educators:

This introductory bioenergy activity was created with funding from a USDA-NIFA Capacity Building Grant and is made available for anyone to use in their classroom, 4-H program, or other youth activity to maximize its impact. As such, if you do use one or more of the activities, I only ask that you also have your students fill out the survey at the end of the activity packet and forward the results to me at jdekoff@tnstate.edu along with the number of youth involved and the amount of time it was used. This way I can track and evaluate the overall impact.

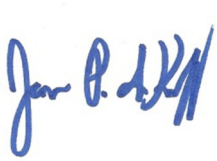
On the following pages you will find:

- Instructor's copy
    1. Bioenergy background
    2. Laboratory activity with answer key
    3. Biodiesel bingo activity
    4. Biodiesel bingo feedstock guide
    5. Biodiesel bingo boards (20 unique boards)
- Student's copy
    1. Bioenergy background
    2. Laboratory activity
    3. Biodiesel bingo activity
    4. Biodiesel bingo feedstock guide
    5. Student survey

In my use of these activities, I have found it helpful to do both activities at the same time as there is some downtime once the first activity (ethanol production with yeast) is initiated.

If you have any questions, please let me know!

Thanks!



Jason P. de Koff, Ph.D.
Assistant Professor
Tennessee State University

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Cooperative Extension

What is Bioenergy?

Dr. Jason de Koff, Tennessee State University

Bioenergy involves the use of different types of organic matter (material that was once living or can break down naturally in the soil), to produce energy. This energy can be heat, electricity (biopower) or fuel (biofuel). There are a number of different kinds of organic matter, called feedstocks, that can be used to produce bioenergy. A list of some of these include:

- Trees
- Grass
- Soybeans
- Sunflower seeds
- Waste cooking oil
- Manure
- Garbage

Seeds that contain oil like canola (above), sunflower and soybean can be used to produce biodiesel.

Generating heat energy from organic matter is an easy process that simply requires the combustion (burning) of the material to produce heat. In generating electricity, the heat energy produced from burning organic matter turns water into steam which turns a special kind of windmill called a turbine. This turbine turns a magnet surrounded by copper wire which generates electricity.

Coal and gas power plants (above) produce electricity from heat energy. Biopower can also be produced in this way using things like wood chips.

To produce biofuel, sugars from plants can be turned into a biofuel called ethanol or oils from seeds like canola, soybean and sunflower can be turned into a biofuel called biodiesel. In the next activities, we will learn a little more about these types of fuels.

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Biofuel Education

Do yeast prefer Corn Pops™ or Corn Meal?: Producing ethanol from multiple feedstocks

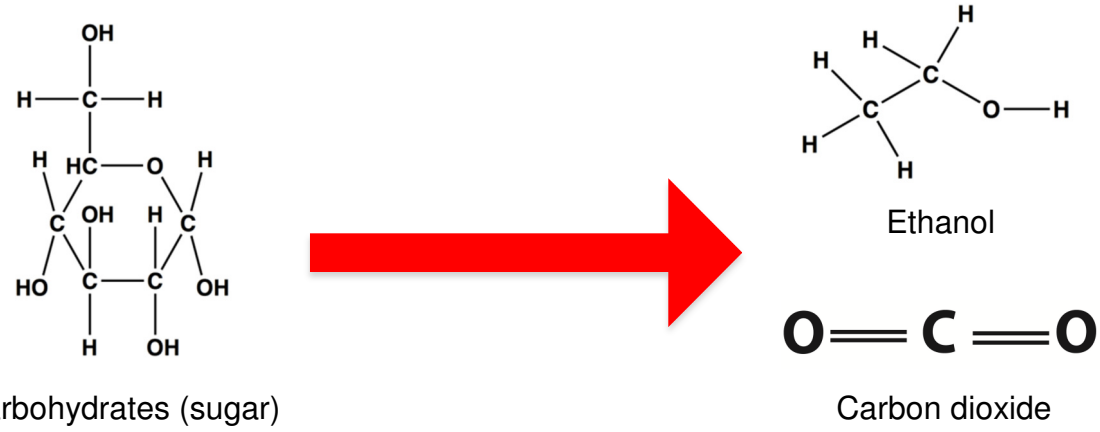
created by Dr. Jason de Koff (adapted from "Fermentation in a Bag" by Dr. Ken Newberry)

Objective:

The objective of this laboratory is to determine which feedstocks yeast prefer for the production of ethanol and why they choose certain types.

Background:

Yeast are microorganisms that are used in baking things like bread but they can also be used to produce the biofuel, ethanol. Below is the process that takes place:



Today, we will be determining how much ethanol is produced by different feedstocks by capturing the carbon dioxide produced using a balloon. As an example, about 9 drops of ethanol production will cause a balloon to expand to about three inches in diameter with carbon dioxide.

Materials needed:

Cereal (variety pack), Corn meal
Yeast
Plastic bags
Scoopulas
Weighing boats
Balance
Graduated cylinders
250 mL Erlenmeyer flasks
Balloons

Procedure:

1. Select one of your favorite cereals and place a handful in a plastic bag.

2. Close the bag and using your hand or the bottom of your plastic Erlenmeyer flask proceed to crush the cereal into a powder-like substance.

3. Once crushed, use a scoopula to weigh out about 8 grams of your cereal into a tared weighing boat on a balance. Also, you or your partner can weigh out about 8 grams of corn meal into a separate weighing boat and complete each of the next steps for each of your cereal and corn meal samples separately. At the end, you will compare the size of the balloon from the cereal sample with the balloon from the corn meal sample.

4. Select one 7 gram packet of yeast and carefully pour it into your 250 mL Erlenmeyer flask.

6. Using your graduated cylinder, measure 100 mL of warm water and pour it into your Erlenmeyer flask.

7. Quickly place your balloon over the mouth of the flask and gently swirl the material until it all dissolves.

8. After about 15 minutes check on your flask and balloon and identify any changes that you see.

Pre-lab Questions:

1. Why do we crush the cereal before adding it to the flask?
The greater surface area allows for the reaction to take place at a faster rate.

2. According to the reaction equation, what is causing the balloons to inflate? What other product is being produced by the reaction?
Production of CO_2 gas
Ethanol

3. What are some ways that we could compare which feedstocks produce the most ethanol?
Measure how quickly each balloon inflates, measure the size of each balloon.

Thought Questions:

1. In this laboratory exercise, which feedstocks do you think produced the most?
The cereals with the most sugar.

2. What other feedstocks are used to make ethanol?
Wood, grasses, anything with starch, cellulose

3. What is this process called?
Fermentation

4. What is your conclusion, do yeast prefer Corn Pops™ or Corn meal? Why?
Corn Pops™ because they have more readily-available sugars

Biodiesel Bingo

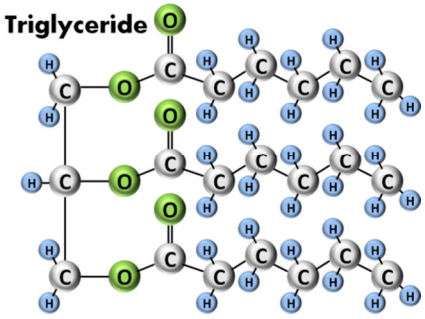
Created by Dr. Jason de Koff, Tennessee State University

Objective:

The objective of this activity is to understand how biodiesel fuel is produced and the different types of feedstocks that can be used to produce biodiesel.

Background:

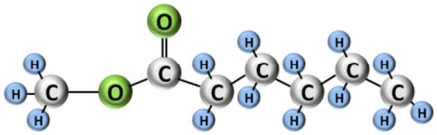
Biodiesel is a fuel that can be used in diesel engines and can be produced from the same oils that are used for cooking. These oils contain triglycerides that are too thick to be used directly in a diesel engine so they have to be mixed with other chemicals (an alcohol and a base) to form biodiesel. The biodiesel is thinner so it can be used in a diesel engine. Another material called glycerin is produced which can be used in making things like soaps, paints and resins.



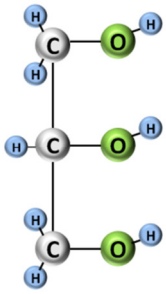
Cooking Oil

Chemicals (Alcohol and base)

Biodiesel



Glycerol



Activity:

The following activity will help you to identify different plants that can be used for producing biodiesel. Use the feedstock guide to identify the relevant feedstocks on your game board.

For instructors:

Preparation:

Print a unique bingo board and a feedstock guide for each student. Print an extra feedstock guide and cut out each individual feedstock to use for randomly selecting them during the game. They can be held in your hand or placed in a hat or other container for selection. Instructors will need to provide some type of marker (penny, bingo chip) to students to play this game.

Procedure:

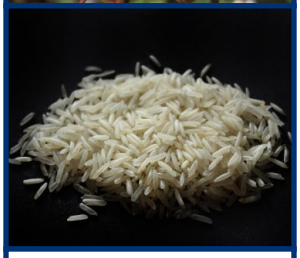
1. Review background information on biodiesel production with students.
2. Hand out a bingo board and feedstock guide to each student, along with markers for students to mark their selections.
3. Explain how the bingo game works for those that are unsure. Just like with regular bingo, students can start out by placing a marker on the "Free Space". The first one to get five marked feedstocks in a row wins (prizes can be awarded).
4. Select a feedstock at random and give the name to the students. The students will use their guide to identify the correct picture to place their marker.
5. When one or more students get bingo, check their selections with the feedstocks that have been called.

Biodiesel Feedstock Bingo

Feedstock Guide


Mustard plant


Cotton


Rice


Peanut


Vegetable oil


Castor bean pod


Rice plant


Soybean seed


Canola seed


Safflower seed


Camelina seed


Soybean seed pod


Sunflower plant


Cotton plant

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Biodiesel Feedstock Bingo

Feedstock Guide

Palm tree

Algae

Safflower plant

Mustard seed

Sunflower seed

Corn seed

Camelina plant

Peanut plant

Canola plant

Castor bean

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Biodiesel Feedstock Bingo

There are many different kinds of materials, called feedstocks, that can be used to produce biodiesel. By using the accompanying guide and playing this game, you will learn what these feedstocks are and what they look like.

created by Dr. Jason de Koff

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College of Agriculture, Human and Natural Sciences

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Student Copy

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What is Bioenergy?

Dr. Jason de Koff, Tennessee State University

Bioenergy involves the use of different types of organic matter (material that was once living or can break down naturally in the soil), to produce energy. This energy can be heat, electricity (biopower) or fuel (biofuel). There are a number of different kinds of organic matter, called feedstocks, that can be used to produce bioenergy. A list of some of these include:

- Trees
- Grass
- Soybeans
- Sunflower seeds
- Waste cooking oil
- Manure
- Garbage

Seeds that contain oil like canola (above), sunflower and soybean can be used to produce biodiesel.

Generating heat energy from organic matter is an easy process that simply requires the combustion (burning) of the material to produce heat. In generating electricity, the heat energy produced from burning organic matter turns water into steam which turns a special kind of windmill called a turbine. This turbine turns a magnet surrounded by copper wire which generates electricity.

Coal and gas power plants (above) produce electricity from heat energy. Biopower can also be produced in this way using things like wood chips.

To produce biofuel, sugars from plants can be turned into a biofuel called ethanol or oils from seeds like canola, soybean and sunflower can be turned into a biofuel called biodiesel. In the next activities, we will learn a little more about these types of fuels.

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Do yeast prefer Corn Pops™ or Corn Meal?: Producing ethanol from multiple feedstocks

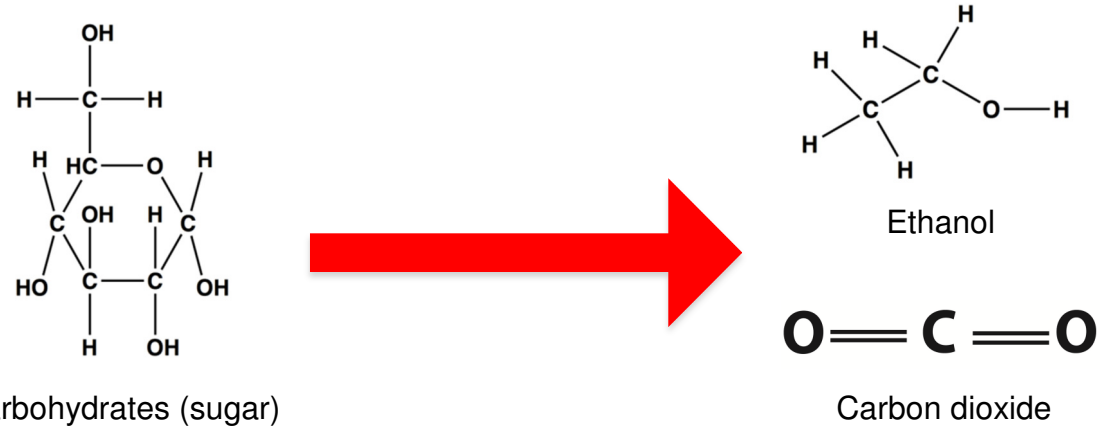
created by Dr. Jason de Koff (adapted from "Fermentation in a Bag" by Dr. Ken Newberry)

Objective:

The objective of this laboratory is to determine which feedstocks yeast prefer for the production of ethanol and why they choose certain types.

Background:

Yeast are microorganisms that are used in baking things like bread but they can also be used to produce the biofuel, ethanol. Below is the process that takes place:



Today, we will be determining how much ethanol is produced by different feedstocks by capturing the carbon dioxide produced using a balloon. As an example, about 9 drops of ethanol production will cause a balloon to expand to about three inches in diameter with carbon dioxide.

Materials needed:

Cereal, Corn meal
Yeast
Plastic bags
Scoopulas
Weighing boats
Balance
Graduated cylinders
250 mL Erlenmeyer flasks
Balloons

Procedure:

1. Select one of your favorite cereals and place a handful in a plastic bag.

2. Close the bag and using your hand or the bottom of your plastic Erlenmeyer flask proceed to crush the cereal into a powder-like substance.

3. Once crushed, use a scoopula to weigh out about 8 grams of your cereal into a tared weighing boat on a balance. Also, you or your partner can weigh out about 8 grams of corn meal into a separate weighing boat and complete each of the next steps for each of your cereal and corn meal samples separately. At the end, you will compare the size of the balloon from the cereal sample with the balloon from the corn meal sample.

4. Select one 7 gram packet of yeast and carefully pour it into your 250 mL Erlenmeyer flask.

6. Using your graduated cylinder, measure 100 mL of warm water and pour it into your Erlenmeyer flask.

7. Quickly place your balloon over the mouth of the flask and gently swirl the material until it all dissolves.

8. After about 15 minutes check on your flask and balloon and identify any changes that you see.

Pre-lab Questions:

1. Why do we crush the cereal before adding it to the flask?

2. According to the reaction equation, what is causing the balloons to inflate? What other product is being produced by the reaction?

3. What are some ways that we could compare which feedstocks produce the most ethanol?

Post-lab Questions:

1. In this laboratory exercise, which feedstocks do you think produced the most?

2. What other feedstocks are used to make ethanol?

3. What is this process called?

4. What is your conclusion, do yeast prefer Corn Pops™ or Corn meal? Why?

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Biodiesel Bingo

Created by Dr. Jason de Koff, Tennessee State University

Objective:

The objective of this activity is to understand how biodiesel fuel is produced and the different types of feedstocks that can be used to produce biodiesel.

Background:

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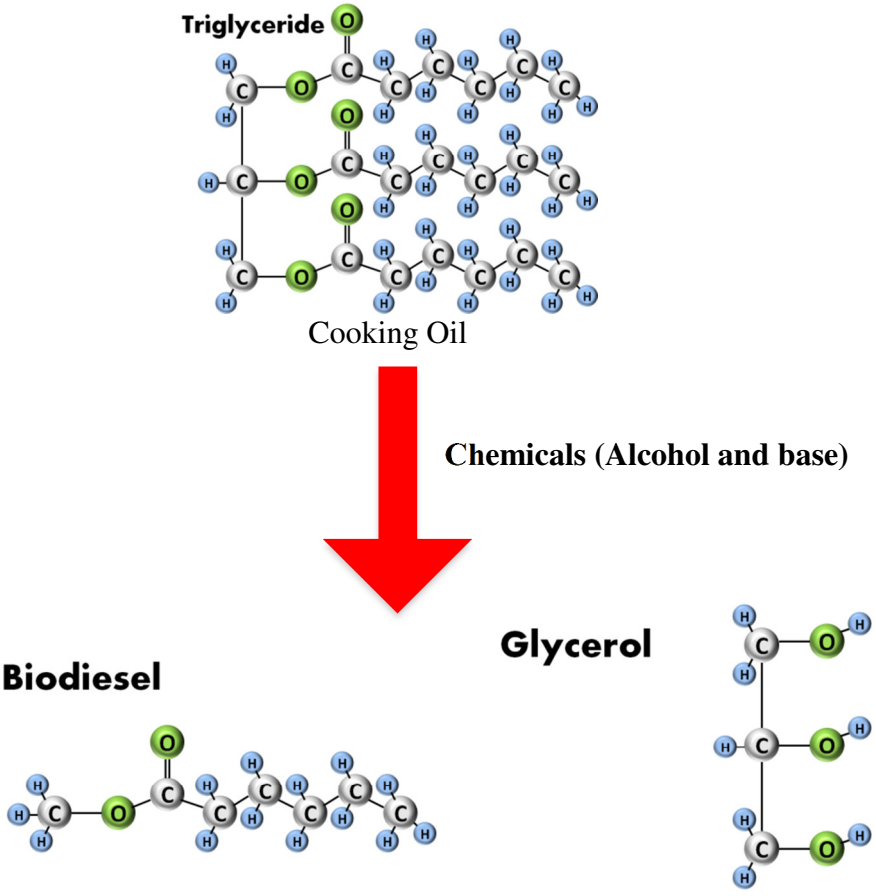


Activity:

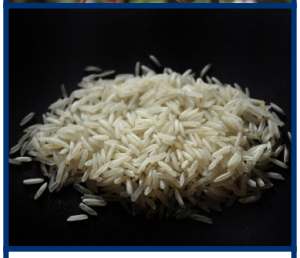
The following activity will help you to identify different plants that can be used for producing biodiesel. Use the feedstock guide to identify the relevant feedstocks on your game board. Your instructor will provide you with your own game board.

Biodiesel Feedstock Bingo

Feedstock Guide


Mustard plant


Cotton


Rice


Peanut


Vegetable oil


Castor bean pod


Rice plant


Soybean seed


Canola seed


Safflower seed


Camelina seed


Soybean seed pod


Sunflower plant


Cotton plant

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Biodiesel Feedstock Bingo

Feedstock Guide

Palm tree

Algae

Safflower plant

Mustard seed

Sunflower seed

Corn seed

Camelina plant

Peanut plant

Canola plant

Castor bean

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Survey – What did you learn?

After having completed one or more of the bioenergy activities, circle the answer that fits best with your level of agreement with each statement below.

1. Now that I have completed some or all of these bioenergy activities I feel that I know more about bioenergy (circle one below).

Strongly agree Agree Disagree Strongly disagree

2. I feel that my knowledge of bioenergy has (circle one below):

Not changed Increased slightly Increased significantly

3. After completing the activities, I feel more likely to try to find out more about bioenergy (circle one below).

Strongly agree Agree Disagree Strongly disagree

4. This activity has increased my interest in having a job in bioenergy (circle one below).

Strongly agree Agree Disagree Strongly disagree

5. Now that I have participated in this activity, I am more likely to talk to my parents about bioenergy (circle one below).

Strongly agree Agree Disagree Strongly disagree