

Lesson 15: Biofuels in Your Backyard

Adopted/Revised From

N/A

Grade Level

6-12

Objectives

- Construct a manual oil expeller
- Employ fire safety procedures
- Operate the manual oil expeller
- Measure mass of seeds and total oil produced
- Calculate oil percentage per gram of seeds
- Discuss, compare and contrast advantages and disadvantages of using vegetable oil from crops grown in Colorado as biofuel

Overview

Students press oil from Colorado oilseeds using a manual expeller and calculate the oil and feed content of the seed.

Materials (per group)

- One PITEBA manual seed press – this should be bolted to a 2' x 4' and then secured to a table top with clamps or otherwise secured per PITEBA instructions (CSU Extension kits for this lesson plan come with a pre-bolted press and all other materials)
- One clear 12 ounce plastic soft drink bottle
- 1 oz. of edible oil (vegetable oil)
- Lamp oil
- Two 4" C-clamps
- One large container (i.e. 4-8 cups capacity)
- One scale
- Enough oilseed to at least fill a 12 oz. soft drink bottle
- One pair of large pliers
- Paper towels
- Scale

Estimated Cost of Materials

\$120 per group

Computer Required?

No

Duration

1-2 class periods

Primer References

- 1.1 Forms of Energy
- 3.4 Biofuels

Related Articles

- [“Bridging the Biofuel Transition”](#) – Colorado State University Extension
- [“Case Study 2 – Costilla County Biodiesel Project”](#) – Western Organization of Resource Councils

Engagement

1. Students should first read the CSU Extension blog entry entitled [“Bridging the Biofuel Transition”](#).
2. What do we use for most of our transportation fuel? (petroleum)
3. Is petroleum renewable or non-renewable?
4. Do we get most of our petroleum from here in the U.S.?
5. Are there alternatives to using petroleum as fuel?

Investigation

Now we’re going to conduct an experiment to find out the challenges and opportunities behind producing our own straight vegetable oil from seeds that can be grown locally:

1. Divide the students into groups according to the number of presses you have.
2. Supply each group with listed materials. Each group should then:
3. Mount the press securely by tightly clamping the pre-bolted wood (with press) to a table using the two C-clamps so that the crank can still be rotated.
4. Weigh the seeds to be used and the large container according to the activity sheet.
5. Set up the oil press according to the instructions in the kit (highlights in blue below):
6. Unscrew the adjustment bolt and cap from the press cage.
7. Remove the expeller screw and grease the washer with edible oil.
8. Replace the washer, expeller screw, and cap.
9. Depending on the type of seed (see chart below), replace or do not replace the adjustment cap.
10. Prepare a funnel by cutting a plastic soft drink bottle approximately 15 cm from the outlet. The bottom of the bottle should be kept for later use.
11. Weigh the bottom of the bottle according to the activity sheet.
12. Fill the glass container with lamp oil. Thread the wick through the wick holder and place the wick holder into place atop the glass container.
13. Place the glass container on the foot of the expeller under the chimney. Tighten the container with an elastic band over the two projections. Always check the quality of the elastic band before use!
14. Place the bottom of the cut soft drink bottle below the oil slit.
15. Light the wick – note: all common fire safety precautions must be taken including tying hair back, not wearing loose clothing, wearing safety goggles, etc.
16. Fill the funnel with seed.
17. Wait 10 minutes to heat the press cage.

18. Right before beginning oil expulsion, place the large container below the cap/adjustment bolt to catch the press cake.
19. Start turning the crank clockwise. The press cake will appear through the 2 holes in the cap. In the beginning some seeds may appear – gently stop the seed from appearing by use of your fingers. The oil will appear through the oil slit in the press cage.
20. If using the adjustment bolt, tighten the bolt gradually after the press cake appears to obtain a good flow of oil.
21. Check regularly the flow of the seed through the funnel. If necessary, use a small wooden stick to break any bridge formation in the funnel. Coarse or broken or angular seeds may lead to bridge formation.
22. If necessary, clean the oil slit with a small knife to avoid blockage.
23. After an allotted time (i.e. 5-10 minutes), instruct the groups to stop expelling and to extinguish their burners.
24. Part of the group should then follow instructions in the kit to clean up the expeller (highlights in blue below), while the other part of the group should weigh the oil and press cake according to the activity sheet:
25. Using the large pliers, remove the cap from the press cage **as soon as possible** considering the temperature of the cap.
26. Clean the cap, adjustment bolt, and press cage thoroughly – **let the cap soak in soapy water if necessary to ensure that all hardened press cake is removed. This may need to be done multiple times over a period of days to ensure that all the press cake is removed, depending on the moisture content of the seeds used.**
27. Once the glass container and wick holder are cool enough, carefully pour the remaining lamp oil back in its original container and put the press back together just as it was found.
28. Refer to the instructions provided in the kit for troubleshooting tips.
29. The oil and press cake can be disposed of or utilized.

Seed Chart:

Seed	Use of Adjustment Bolt
Sunflower	None
Canola	Expel with bolt – at first keep 2 press cake outlets open then tighten until strings of press cake appear
Safflower	None

Class Review

1. Ask the groups to share the results of their experiments by reviewing each of the questions on the activity sheet as a class.
2. Have the students read the Related Article.
3. From the reading and based on the experiment, what are the potential implications of Rudolph Diesel's early research and engines work for our society today?
4. Graph the relationship between number of acres needed and percent of oil by weight in a seed for all types of seeds utilized by the class.
5. List or debate the advantages and disadvantages of using vegetable oil in place of petroleum fuel.

Elaboration

Now we have to figure out what energy forms are behind the production of biofuels:

1. Have students read the Primer References.
2. As a class, list or “map” the energy forms associated with the transfer of energy from its source in the oilseed crops to a vehicle moving as a result of utilizing biofuels.
3. At what point in the energy forms map is the potential energy in the oil transformed into kinetic energy?

Instructor Notes

- Always follow the instructions found in the kit (also accessible here: <http://www.piteba.com/eng/users%20manual.htm>).
- Be sure that all presses are bolted and mounted securely before expelling.
- Group members can take turns cranking (expelling) to maximize participation – sometimes the crank may be difficult to start and depending on the seed used may require considerable force throughout oil expulsion.
- The wick should be long enough to burn for 20 minutes but short enough to not form too much soot on the press cage – 1/2 inch or so should be sufficient.
- Follow all expelling instructions for specific seeds.
- Use of local seed such as canola (rapeseed) and sunflower is highly encouraged.
- The cap at the end of the press cage must be taken off and cleaned **ASAP** after use, otherwise the press cake hardens and is time-consuming to get off completely.
- If the seed is particularly dry (e.g. the oil is difficult to expel and the press cake is hard in the press cap after use), soak seeds in water for 2 days at a ratio of 0.25 cup for every 2 lbs. of seed.

Extensions and Variations

- Compare the oil content of different types of seeds.
- Use the oil to make biodiesel.

References/For More Information

PITEBA (Press Manufacturer):

<http://www.piteba.com>

Biofuels in Your Backyard

Type of seed	Mass of seeds and container (oz.)	Mass of container minus seeds used	Mass of seeds used	Mass of bottle bottom	Mass of expelled oil and bottle bottom	Mass of expelled oil	Mass of press cake container	Mass of press cake and container	Mass of press cake	Percent oil (of seeds) by mass	Percent press cake (of seeds) by mass

Type of seed	Gallons of diesel per average light truck per year	Total cost of this diesel	Gallons of SVO* needed per year in SVO-RUG blend for this light truck	Gallons of RUG needed per year in SVO-RUG blend	Total cost of this RUG	Total cost of SVO in order to equal total cost of diesel when added to total cost of RUG	Cost per gallon of this SVO (maximum "break-even" cost)	Pounds of seed to produce 1 gal. of SVO	Pounds of seed needed to produce this SVO	Acres of land needed to produce this amount of seed	Pounds of press cake from this amount of seed	Dollar value of this press cake
	655											
	655											
	655											
	655											
	655											

*SVO = straight vegetable oil

Assumptions

One gallon of vegetable oil = 8 lbs.

16 oz. = 1 lb.

SVO can be mixed with regular unleaded gasoline (RUG) at a 3:1 ratio in diesel engines

RUG costs \$3/gallon

Diesel (petroleum-based) costs \$3.30/gallon

One acre of land can produce approximately 1,500 lbs. of oilseed

Press cake is valued at approximately \$350/ton as livestock feed

Questions

1. Did the mass of the press cake plus the mass of the oil equal the mass of the seeds used? Why or why not?
2. What percent by mass was the oil content of the seed?
3. What is the maximum "break-even" cost of producing the SVO (per gallon)?
4. How many acres of land would be needed to run a light diesel truck for one year with a 3:1 SVO:RUG blend?