SUSTAINABLE BIOECONOMY
FOR ARID REGIONS

SBAR

EXPLORING OIL EXTRACTION

OVERVIEW

In this lesson, students will engage in the process of extracting oil from a plant resource such as peanuts or similar tree nut. Students will practice measuring mass and calculating the percentage of the extract and byproducts of the extraction process. Through this process, students will deepen their understanding of how valuable commodities like fuel and rubber can be extracted from plants

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EXPLORING OIL EXTRACTION LESSON PLAN

STUDENT LEARNING OBJECTIVES:

After completing these activities:

1. Students will accurately weigh and record mass of starting material, oil, and meal.
2. Students will calculate the percentage mass of oil and meal from an original plant source (peanuts or similar tree nut) using their measurements taken during the experiment
3. Students will be able to correctly demonstrate a basic oil extraction technique.

TIME REQUIRED:

80 to 120 minutes
20 minutes teacher preparation

RESOURCES:

1. Exploring Oil Extraction Lesson Plan
2. Exploring Oil Extraction PowerPoint Presentation
3. Exploring Oil Extraction Lesson Plan Worksheet

EQUIPMENT AND SUPPLIES NEEDED FOR ONE SETUP:

1. Plastic soda hopper (use the cut off top of a plastic 2 liter soda bottle)
2. Dixie cups (2)
3. Votive candle or alcohol burner
4. Crank press: Piteba Oil and Seed Expeller is the model used in the lesson
5. 500 mL or larger glass beaker
6. 10 oz. peanuts or other tree nut
7. Paper towels
8. Scale to obtain mass
9. Coffee filter
10. Small plastic beaker
11. Exploring Oil Extraction Worksheet
12. Optional coffee grinder to grind larger nuts before adding to press
13. Thermometer (one) to measure air temperature in classroom
14. Safety goggles for all participants
15. One lighter per instructor (if using candle/burner)

THIS ACTIVITY PLAN WOULD WORK WELL AS PART OF:

- Chemistry curriculum
- Plant biology curriculum
- Environmental science curriculum

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THIS LESSON IS ALIGNED TO AFNR, FFA and NGSS STANDARDS. Expanded standards listed on page 8.

LESSON PLAN:

1. Bell Ringer: (5 minutes)

Discuss the following questions with your students:

- What is extraction? (*A way to separate a desired substance from another substance*.)
- What is a byproduct? How might byproducts be useful? (*Exmples of byproducts: straw from a grain processing operation, salt from a desalination plant, ethanol is a byproduct of the sugar industry*.)

2. Introduction for students:

In this lesson you will extract oil from a peanut or similar tree nut and calculate the percentage of oil and meal of the original substance. You will learn about how oil extraction is part of the process used to create biofuels. Biofuels are different from fossil fuels, like the gasoline most people use in their cars, because they come from plants. You will also learn about the term "bioeconomy" and how the bioeconomy and biofuels are connected.

3. Setup: (15 to 20 minutes)

Press Setup (10 to 15 minutes)

This activity can be done as a demonstration if one setup is available, or groups of students can work together if there are enough materials. For each press, you need a hopper cut from a 2- or 3-Liter plastic soda bottle. A 50 mL glass beaker or dixie cup can be used to collect the oil at position 3 in the diagram below. An upside down dixie cup with a candle or alcohol burner on it will be at position 2 to heat up the grinder to allow more oil extraction. Finally, a cup or glass beaker will be placed at the end of the press, under the silver expeller, to collect the meal from the grinding process. A coffee grinder can be used to grind larger nuts like peanuts before adding to press so that the press does not take as long to extract oil. Be careful not to use the coffee grinder for more than a second or two because you will quickly have nut butter.

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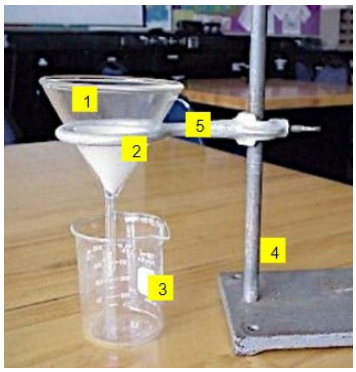
Filter Setup (3-5 minutes)

Set up the stand upright and screw the ring onto the stand around halfway up the stand. The ring and stand hold the funnel. Put a coffee filter inside the funnel. Under the filter, put a beaker to collect refined oil.



1. Funnel
2. Filter
3. Beaker
4. Ring stand
5. Ring

4. Exploring Oil Extraction Powerpoint Presentation & Extraction Activity: (80 to 120 minutes)
    1. **Slide 2 (3-5 minutes):** Begin by asking students the three questions on the slide:
        - What are the three main types of fossil fuels? (*Oil, natural gas and coal*)
        - What are fossil fuels made of? (*The remains of living things (mostly plants) buried under pressure millions of years ago*)
        - Are fossil fuels renewable? (*No, they took millions of years to form*)

    2. **Slides 3 and 4 (3-5 minutes):** Biofuel & biodiesel
        - What is the difference between biofuel and biodiesel? (*Biofuel is energy made from living matter, usually plants. Biodiesel is vegetable oil that can be converted to fuel in a diesel engine*)
        - What is biodiesel made from? (*vegetable oil or animal fats)*
        - Are biofuels renewable? (*They are potentially renewable, which means it depends on the plant material and the way it is grown*) You can also show the video embedded in the slide to give students answers to these questions.
            https://www.youtube.com/watch?v=ZGmwtDffc74

    3. **Slides 5-7 (3-5 minutes):** Use the chart to ask students about the pros and cons of fossil fuels and biofuels. You will then go over the general list on slides 5 and 6 or can add student ideas to a T chart on a whiteboard.

    4. **Slide 8 (2 minutes):** Ask students what a "bioeconomy" is. It may help to ask what an economy is first, and then add the bio part. The answer to the question and a little background on SBAR will be found when you click on the slide again.

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5. **Slide 10 (1 minute) :** Go over the purpose of the experiment, you may also want to refer back to slide 8 and reiterate the idea of a bioeconomy.

6. **Slide 11 (1 minute):** Show the common types of nuts and seeds where oil can be extracted. Ask students if they know of any other examples. (*olives, jojoba*)

7. **Slide 12 (5-7 minutes):** Have students write the answers to the following questions: What is a mixture? How do we get olive oil from olives? Is the process the same for other oils like canola oil or avocado oil? Ask students for their answers.

8. **Slide 13 (1 minutes):** Go over the list of supplies and ensure that students have all they need for the activity.

9. **Slide 14 (5-7 minutes):** Review the set up for the press. The diagram will help with student understanding as well as a set-up at the front of the room as described in the section above.

10. **Slide 15 (5-7 minutes):** Show the set-up for the filtering. Explain that the filter set-up is to further refine the oil and remove any particles different from the oil. The ring and stand hold the funnel. Put a coffee filter inside the funnel. Under the filter, put a beaker to collect the refined oil. If students are setting the filter up themselves, monitor their progress to ensure that they have completed the steps.

11. **Slide 16 (10 minutes):** Go over the first three steps with students.
    1. Weigh and record the mass of the smaller plastic container on Exploring Oil Extraction question 1 (Press Setup). Fill with the nuts, weigh, and record the combined mass in the second column.
    2. Weigh and record the mass of the larger glass beaker on Worksheet # 1 question 1, and place the beaker at end of the press.
    3. Make sure the press setup looks like the figure in your procedures and the picture on slide 14. The plastic hopper should be put on top, small plastic container underneath the oil outlet, and an upside-down Dixie cup with a candle on top next to the small container.

    As students complete these steps, roam and monitor to ensure they are recording the mass properly and have a correct press set-up.

12. **Slide 17 (10-15 minutes):** When students are ready, go over the next four steps and help students complete this step. Use a lighter to light votives or alcohol burners if temperature is less than 77 degrees in the lab space.
    1. Pour seeds or nuts into hopper and start cranking on the press. If it is below 77^{o}F in your classroom, have your instructor light the candle or alcohol burner.
    2. Collect the meal in the large beaker. Collect the oil in the Dixie cup.
    3. Continue to pour nuts into the hopper and crank on the press until all the nuts have been processed.
    4. Weigh and record the mass of the large beaker with meal.

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13. **Slide 18 (10-15 minutes):** Instruct students to take their oil from the small beaker and carefully move it to the filter apparatus. Demonstrate the procedure for the filtering as described in the steps below.
    1. Weigh and record the mass your small plastic beaker in Worksheet # 1 part 2 (filter setup), and coffee filter.
    2. Pour oil on the filter and wait for all the oil to pass through. Collect clean oil in small plastic beaker. Collect leftover meal on the filter.
    3. After filtering, weigh and record the mass of small plastic beaker with oil, and filter with meal.

    Experiment is done, data has been collected, and now it is time for the calculations. This step can be a great place to clean up and end the session if you are low on time.

14. **Slide 19-20 (15-20 minutes):** Have students calculate three values: the percentage of oil, the percent meal, and the percent error using their measurements from the activity. First tell students to record the mass of the meal in their worksheet under calculations. You can tell students that they have already measured this; you are just writing in table three to make your calculations easier. Make sure the mass of the oil and the mass of the nuts is also transferred to this section. Make sure to explain to students what each abbreviation means as described. Here are the abbreviations used in the equation:

    M_m = Mass of meal

    M_o = Mass of oil

    M_t = Total mass (meal and oil)

    Calculate the percentage of meal, the percentage of oil and the percent error using the equations listed in row two of the calculations section. You can help comprehension by using a whiteboard to do an example with made up values for each variable. Students can also refer to the equation in the third data table for assistance.

15. **Slide 21 (5-10 minutes):** Clean up procedures may vary. Make sure students dispose of oil and meal properly. Also make sure students wash out beakers and put all materials back as directed.

16. **Slide 22 (2-5 minutes):** As an informal discussion, you can ask students to pick whether meal or oil was more valuable and what they had more of. You can make a connection back to biofuels by asking students if they think that biofuels also have byproducts. How could byproducts be used? What if they are not used?

17. **Slide 23 (5-10 minutes):** You can ask one or both the closing questions. The exit ticket question can be a good way to assess if students understood the percentage error in the process of extraction. Collect exit tickets after students have finished writing their answers down. Answers are in parenthesis after the question.

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5. Follow-up:

Would this procedure be any different if you had larger or smaller nuts?
What could you do with the meal besides throw it away? (*Answers will vary but include use as compost, have more or less waste, burn it, make it into something else*)

6. Leveling Up:

What are some ways to further purify or refine the oil you extracted? If you were use this fuel in a car, what would you have to consider? (*You may want to make a connection with fossil fuel refining, in which higher heat leads to different types of fuel*).

7. Exit Ticket:

Compare the percentage of oil to the total mass of the original plant material. Do you think this percentage is the same or different for distinct types of nuts? Why? (*Depending on the nut, there could be more or less waste due to the density of the seed and the amount of oil in that species*).
Remind students of the first questions asked about byproducts. Ask them what other byproducts would they like to learn more about.

DEFINITIONS:

Bioeconomy: An economic system based on using renewable biological resources from land and sea.
Biofuel: A fuel that is produced from organic matter like plants.
Byproduct: A secondary product that occurs during the process of making something else.
Extraction: The process of separating one substance from a mixture.
Fossil fuel: Coal, oil or natural gas made from the decay of organic material over geologic time. Fossil fuels take millions of years to form from dead plant and animal material.
Hopper: a container for a bulk material such as grain, that tapers downward and can discharge its contents at the bottom.
Press: a device for applying pressure to something in order to extract juice or oil.
Mass: A measure of the amount of matter in a physical object.
Meal: the edible part of any grain or pulse ground to powder, any powdery substance made by grinding.
Renewable resource: A resource from the environment that is naturally replaced and so can be used repeatedly.

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STANDARDS DETAIL:

NGSS

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost benefit ratios.
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

AFNR Career Ready Practices

CRP.02: Apply appropriate academic and technical skills. Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive.
CRP.04: Communicate clearly, effectively, and with reason. Career-ready individuals communicate thoughts, ideas and action plans with clarity, whether using written, verbal and/or visual methods.
CRP.07: Employ valid and reliable research strategies. Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies.
CRP.08: Utilize critical thinking to make sense of problems and persevere in solving them. Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem.

FFA Precept

FFA.PL-A. Action: Assume responsibility and take the necessary steps to achieve the desired results, no matter what the goal or task at hand. -
FFA.PL-E. Awareness: Understand personal vision, mission and goals.
FFA.PL-F. Continuous Improvement: Accept responsibility for learning and personal growth.
FFA.PG-J. Mental Growth: Embrace cognitive and intellectual development relative to reasoning, thinking, and coping.
FFA.CS-M. Communication: Effectively interact with others in personal and professional settings.
FFA.CS-N. Decision Making: Analyze a situation and execute an appropriate course of action.
FFA.CS-O. Flexibility/Adaptability: Be flexible in various situations and adapt to change.

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Author Biography:

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