Energy in Feed

Modified CASE Activity 5.3.1

These modified lessons are from the Curriculum for Agricultural Science Education (CASE). Each lesson has been modified to showcase how soybeans can be used for the applications/activities. The Nebraska Soybean Board supports the CASE model for Nebraska Agricultural Education and the majority of this lesson is copyrighted by CASE and its partnering affiliates.

Objectives:
- Determine the energy content of a feedstuff.
- Explain the effects of heat energy on consumables.
- Explore various energy sources that feeds could provide for. (biofuel, etc.)

Anticipated Length:
3 – 50 minute class periods

Lab Materials:

Per class:
- Electronic balances
- Cold water

Per student:
- Safety goggles
- Pencil
- Agriscience Notebook

Per group of four students:
- LabQuest®
- Temperature sensor
- 100 ml graduated cylinder
- Ring stand
- 2 10 cm rings
- Utility clamp
- Iron wire
- Small plastic cup
- Aluminum foil
- Burner
- Juice can
- Stirring rod
- 2 single hole stoppers
- 3 g of two feed samples
  (1 of soybeans, 1 of alfalfa grass hay)

Teacher Notes:
Make sure all lab material are available

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Background

All living organisms require energy to grow and survive. Plants can produce energy through the process of photosynthesis. Animals produce energy by consuming feed from plant or other animal sources. Determining the best sources of energy is important to animal producers to ensure animal health and production. Not all feeds contain the same amount of energy nor are all feeds high in energy palatable to animals. There are a wide variety of feedstuffs available for animals that provide varying levels of energy.

The energy in feeds is measured in either calories or joules. In the United States, food energy is commonly measured in calories. One calorie is the amount of heat required to raise the temperature of 1 gram of water by 1 degree centigrade. On food labels, calories are listed as the unit of measurement, but food calories are actually kilocalories (kcal). In reality, every calorie on a food label is 1,000 calories.

You can determine the energy content of feed by burning a portion of it and capturing the heat released in a known amount of water. This technique is called calorimetry. How can you use calorimetry to determine the energy content of common feedstuffs?

Procedure

In this activity, you will work with a partner to compare the amount of energy different feeds produce. Divide the following tasks with your partner.

CAUTION: *Do not eat or drink in the laboratory.*

Part One – Data Collection

1. Put on your safety goggles and tie long hair back.
2. Prepare the LabQuest.
   - Connect the Temperature Probe to the LabQuest.
   - Turn the LabQuest on.
   - Choose New from the File menu.
   - On the Meter screen, select Rate on the touch screen.
   - Change the data-collection rate to 0.2 samples/second.
   - Set the data collection length to 180 seconds.
3. Obtain a sample of feed. Use the plastic cup to transport your sample.
4. Place the iron wire on the balance and carefully place 3 g of the feed sample on the iron wire.
5. Determine and record the initial mass of the feed sample and iron wire in Table 1 of Activity 5.3.1 Student Worksheet.

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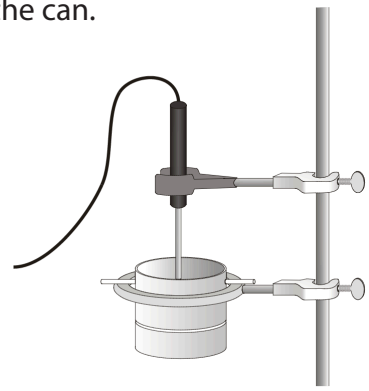
6. Set up the apparatus as demonstrated by your teacher. (See Figure 1.)
   - Determine the mass of the empty can. Record the value in Table 1.
   - Place 50 ml of cold water into the can.
   - Determine and record the mass of the can plus the water.
   - Insert a stirring rod through the holes in the top of the can and hold it in place with two one-hole stoppers. Position the can 2.5 cm (~1 inch) above the food sample.
   - Use a utility clamp to suspend the temperature probe in the water. The probe should not touch the bottom or side of the can.



7. You are now ready to begin collecting data.
   - Select the collect data button on your LabQuest.
   - Use the burner to light the food sample. Position the burning food sample directly below the center of the water-filled can. Quickly relight the food sample if it stops burning during data collection. **CAUTION:** *Always keep hair and clothing away from open flames.*
   - A real-time graph of temperature vs. time will be displayed on the LabQuest screen during data collection.
   - Temperature readings (in °C) can also be monitored to the right of the graph.
8. After data collection has stopped, analyze the graph to determine the maximum and minimum temperatures of the water.
   - Choose Statistics from the Analyze menu.
   - Record the Maximum (final) and Minimum (starting) temperature values recorded during data collection in your data table.
   - Select OK.
9. Store the data from the first run by selecting the File Cabinet icon.
10. Remove the iron wire and determine the final mass of the feed and iron wire. Record the mass in Table 1.
11. Determine the final mass of the water and record in Table 1. Be cautious, as there will be soot on the bottom of the can.
12. Clean off the wire and empty the can of water.

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13. Repeat Steps 3–12 for the second feed sample.
14. A good way to compare the two samples is to view both sets of data on one graph.
    - To do this, select Run 2 on the touch screen and select All Runs. Both runs will now be displayed on the same graph.
    - Examine the data points along the displayed curve. To examine the data pairs on the displayed graph, select any data point. As you move the examine line right or left, the temperature values of each data point are displayed to the right of the graph.
    - Use the displayed graph to fill in the tables and answer the questions below.
    - Print a copy of your graph according to your teacher's instructions.
15. When finished, discard all burnt materials in the container as directed by your teacher and clean up your lab area.

Part Two – Processing the Data

Complete the following calculations and show your work in Table 2. Record your results in Table 3. The Delta symbol (Δ) stands for change and the *t* represents temperature.

1. Calculate the change in mass of each food sample. Show your calculations in Table 2.
   – Δ mass = initial mass – final mass

2. Calculate the changes in the temperature of the water, Δ*t*.
   – Δ*t* = initial temperature – final temperature

3. Calculate the energy gained by the heated water. Show your calculations. To do this, use the following equation:
   – Energy gained by water = (mass of water) x (Δ*t* of water)

4. Use your answer in Step 3 to calculate the energy content of each food sample (in cal/g):
   – Energy content of food = Energy gained by water / Δmass of food

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1. **Which feed sample has the greatest energy content?**

2. **Which of the tested feeds is the best energy source? Why?**

3. **Why might some foods with a lower energy content be better energy sources than other foods with a higher energy content?**

4. **What are two sources of heat loss that may have occurred in this experiment?**

5. **Focusing on the soybean meal and its energy content, what are some ways we could use soybeans besides for feed?**

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Table 1. Data		
Measurements	**Sample 1**	**Sample 2**
Feed used		
Mass of empty can (g)		
Mass of can plus water (g)		
Initial temperature of water (°C)		
Final temperature of water (°C)		
Initial mass of soybean meal and holder (g)		
Final mass of soybean meal and holder (g)		
Final mass of can plus water (g)		

Table 2. Calculations		
Calculation	**Sample 1**	**Sample 2**
Δ mass of feed (g)		
Δ*t* of water (°C)		
Energy gained		
Energy content		

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Table 3. Group Results		
Calculation	**Sample 1**	**Sample 2**
Mass of water (g)		
Δ*t* of water (°C)		
Δ mass of feed (g)		
Energy gained by water (cal)		
Energy content of feed (cal/g)		

Table 4. Class results		
Group	**Feed type** _____	**Feed type** _____
Energy content (cal/g)		
Avg.		