

Activity 5.3.1 Energy in Feed

Purpose

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 palatable to animals. Animals consume a wide variety of feedstuffs that provide varying levels of energy.

You can measure the amount of energy in feedstuffs using calories or joules. The United States commonly measures food energy in calories. One calorie is the amount of heat required to raise the temperature of 1 gram of water by 1 degree centigrade. Nutrition labels use calories as the unit of measurement, but food calories are actually kilocalories (kcal). In reality, every food calorie on a nutrition label is 1,000 calories.

Feedstuffs higher in carbohydrates and fat contain more energy. You can determine the energy content of feed by burning a portion of the feed 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?

Materials

Per class:

- Electronic balances
- Feed samples
- Cold water

Per pair of students:

- LabQuest2
- Temperature sensor
- 100ml graduated cylinder
- Ring stand
- 2 10cm rings
- Utility clamp
- Iron wire

Per student:

- Safety goggles
- Pencil
- Agriscience Notebook

- Small plastic cup
- Aluminum foil
- Burner
- Juice can
- Stirring rod
- 2 single hole stoppers
- 3g of two feed samples

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 – Predictions

Your teacher will supply your class with samples of feed. You and a partner will select two feeds to test. In *Activity 5.3.1 Student Worksheet*, write one to two sentences predicting which feedstuff will be the best energy source.

Part Two – Data Collection

- Put on your safety goggles and tie long hair back.
- Prepare the LabQuest2.
 - Connect the temperature sensor to the LabQuest2.
 - Turn on the LabQuest2.
 - 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.
- Obtain a sample of feed. Use the plastic cup to transport your sample.
- Place the iron wire on the electronic balance and carefully add 3g of the feed sample on the iron wire.
- Determine and record the initial mass of the feed sample and iron wire in Table 1 of *Activity 5.3.1 Student Worksheet*.
- 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 50ml 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 2.5cm (~1 inch) above the feed sample.
 - Use a utility clamp to suspend the temperature sensor in the water. The sensor should not touch the bottom or side of the can.
- You are ready to begin collecting data.
 - Select the collect data button on your LabQuest2.
 - 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 LabQuest2 screen during data collection.
 - Temperature readings (in °C) can also be monitored to the right of the graph.
- 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.
- Store the data from the first run by selecting the File Cabinet icon.
- Remove the iron wire and determine the final mass of the feed and iron wire. Record the mass in Table 1.
- 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.

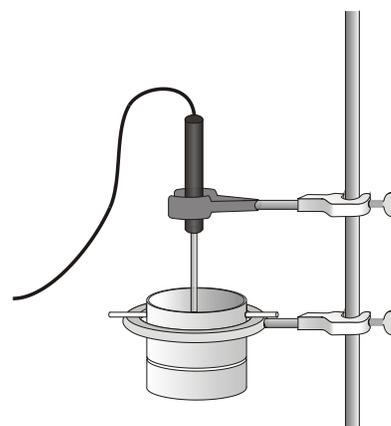


Figure 1. Apparatus.

12. Clean off the wire and empty the can of water.
13. Repeat Steps 3–12 for the second feed sample.
14. Compare the two samples by viewing 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 Three – 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.

$$\Delta \text{ mass} = \text{initial mass} - \text{final mass}$$

2. Calculate the changes in the temperature of the water, Δt .

$$\Delta t = \text{initial temperature} - \text{final temperature}$$

3. Calculate the energy gained by the heated water. Show your calculations. To do this, use the following equation.

$$\text{Energy gained by water} = (\text{mass of water}) \times (\Delta t \text{ of water})$$

4. Use your answer in Step 3 to calculate the energy content of each food sample (in cal/g).

$$\text{Energy content of food} = \frac{\text{Energy gained by water}}{\Delta \text{mass of food}}$$

Conclusion

1. Which feed sample has the greatest energy content?
2. Which of the tested feeds is the best energy source? Why?
3. How did the results compare to the predictions you made in Part One?
4. Why might some foods with a lower energy content be better energy sources than other foods with a higher energy content?
5. What are two sources of heat loss that may have occurred in this experiment?
6. Would you expect the energy content values that you measured to be close to the value listed in feed analysis books? Why?

Name: _____

Activity 5.3.1 Student Worksheet

Predictions:

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 feed and holder (g)		
Final mass of feed 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		

Table 3. Results

Calculations	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:		

Source: Redding, K., & Masterman, D. (2007). *Biology with Vernier*. Beaverton, OR: Vernier Software & Technology.