Energy in Food

Food supplies energy for all animals—without it we could not live. The quantity of energy stored in food is of great interest to humans. The energy your body needs for running, talking, and thinking comes from the foods you eat. Not all foods contain the same amount of energy, nor are all foods equally nutritious for you. An average person should consume a minimum of 2,000 kilocalories per day. That is equivalent to 8,360 kilojoules. Calories and joules are both units of energy. We will use joules in this lab since it is the accepted SI metric standard.

You can determine energy content of food by burning a portion of it and capturing the heat released to a known amount of water. This technique is called *calorimetry*. The energy content of the food is the amount of heat produced by the combustion of 1 gram of a substance. It is measured in kilojoules per gram (kJ/g).

OBJECTIVES

In this experiment, you will

- Use a computer to measure temperature changes.
- Monitor the energy given off by food as it burns.
- Determine and compare the energy content of different foods.

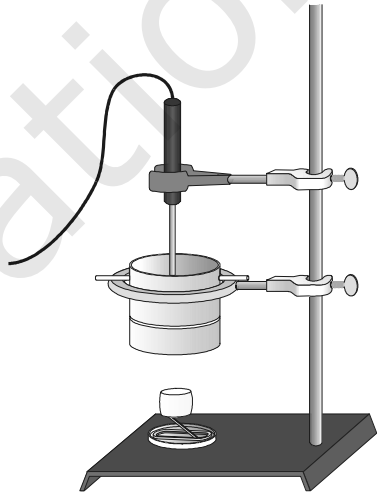

Figure 1

MATERIALS

computer
Vernier computer interface
Logger*Pro*
Temperature Probe
100 mL graduated cylinder
balance
food holder
two food samples (nut, popcorn, or marshmallow)
matches
ring stand and 10 cm ring
small can
split 1-hole stopper
two stirring rods
utility clamp
warm and cool water
wooden splint
two 1-hole rubber stoppers

PROCEDURE

1. Obtain and wear goggles.
2. Obtain a sample of food and a food holder similar to the one shown in Figure 1. Mount the food onto the food holder so that it can burn without damaging the holder. Find and record the initial mass of the food sample and food holder. **CAUTION:** *Do not eat or drink in the laboratory.*
3. Connect the Temperature Probe to the computer interface. Prepare the computer for data collection by opening the file "01 Energy in Food" from the *Biology with Vernier* folder of Logger*Pro*.
4. Set up the apparatus shown in Figure 1.
   a. Determine the mass of an empty can. Record the value in Table 1.
   b. Place about 50 mL of cold water into the can.
   c. Determine and record the mass of the can plus the water.
   d. 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.
   e. Use a utility clamp and split stopper to suspend the temperature probe in the water. The probe should not touch the bottom or side of the can.
5. Click Collect to begin data collection. Record the initial (minimum) temperature of the water in Table 1.
6. Remove the food sample from under the can and use a wooden splint to light it. Quickly place the burning food sample directly under the center of the can. Stir the water constantly. **CAUTION:** *Keep hair and clothing away from an open flame.*
7. If the temperature of the water exceeds 60°C, blow the flame out. Do not stop the computer yet.
8. After 4 minutes, if the food is still burning, blow the flame out. Record the maximum temperature of the water in Table 1.
9. Once the water temperature begins to decrease, end data collection by clicking Stop.
10. Determine the final mass of the food sample and food holder.
11. Place burned food, matches, and wooden splints in the container supplied by your instructor.
12. You can confirm your data by clicking the Statistics button, . The minimum temperature (t_2) and maximum temperature (t_1) are listed in the floating box.
13. Repeat Steps 4–12 for a second food sample. Be sure to use a new 50 mL portion of cold water.

DATA

Table 1		
Measurements	Sample 1	Sample 2
Food used		
Mass of empty can (g)		
Mass of can plus water (g)		
Minimum temperature of water (°C)		
Maximum temperature of water (°C)		
Initial mass of food (g)		
Final mass of food (g)		

Table 2		
Calculations	Sample 1	Sample 2
Mass of water (g)		
Δt of water (°C)		
Δmass of food (g)		
Energy gained by water (J)		
Energy content of food (J/g)		

PROCESSING THE DATA

Record the following calculations in Table 2. Show your work in Table 3.

1. Calculate the change in mass of water. Show your calculations.
2. Calculate the change in mass of each food sample. Show your calculations.
3. Calculate the changes in the temperature of the water, Δ*t*. Record this in Table 2. Show your calculations.
4. 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 (Δt of water) x (4.18 J/g°C)

5. Convert the energy you calculated in Step 3 to kilojoules (1 kJ = 1000 J).
6. Use your answer in Step 4 to calculate the energy content of each food sample (in kJ/g):

   Energy content of food = Energy gained by water / Δmass of food

Table 3		
Calculation	Sample 1	Sample 2
Δm		
Δt		
Energy gained		
Energy content		

7. Record your results and the results of other groups below.

Table 4			
Class Results			
Food Type	Food Type	Food Type	Food Type
Energy content (kJ/g)			
Average			

QUESTIONS

1. Which of the foods has the greatest energy content?
2. Which of the tested foods is the best energy source? Why?
3. What was the original energy source of the foods tested?
4. Why might some foods with a lower energy content be better energy sources than other foods with a higher energy content?
5. Would you expect the energy content values that you measured to be close to the value listed in dietary books? Why?

EXTENSION

1. Determine the energy content of other combustible foods.

Vernier Lab Safety Instructions Disclaimer

THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.

This copy does not include:

- **Safety information**
- **Essential instructor background information**
- **Directions for preparing solutions**
- **Important tips for successfully doing these labs**

The complete *Biology with Vernier* lab manual includes 31 labs and essential teacher information. The full lab book is available for purchase at:
http://www.vernier.com/cmat/bwv.html

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