Experiment 16

Energy Content of Foods

All human activity requires "burning" food for energy. In this experiment, you will determine the energy released (in kJ/g) as various foods, such as cashews, marshmallows, peanuts, and popcorn, burn. You will look for patterns in the amounts of energy released during burning of the different foods.

OBJECTIVES

In this experiment, you will

- Determine the energy released from various foods as they burn.
- Look for patterns in the quantity of energy released during the burning of different types of foods.

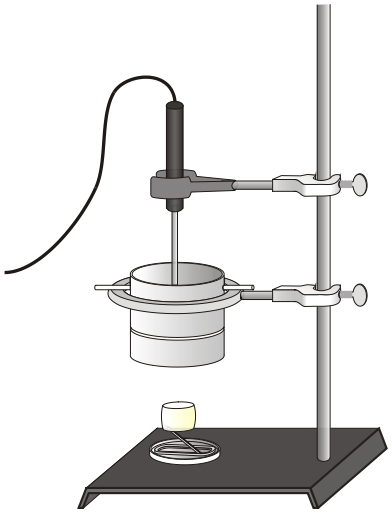

Figure 1

MATERIALS

Computer, LabPro, and Logger Pro	utility clamp
Temperature Probe	2 stirring rods
Bunsen burner	ring stand and 10 cm ring
wooden splints	100 mL graduated cylinder
two food samples	small can
food holder	cold water

PROCEDURE

1. Obtain and wear goggles.
2. Obtain a piece of one of the two foods assigned to you and a food holder like the one shown in Figure 1. Find and record the initial mass of the food sample and food holder. **CAUTION:** *Do not eat or drink in the laboratory.*
3. Determine and record the mass of an empty can. Add 50 mL of cold water to the can. Obtain the cold water from the faucet at your lab station. Determine and record the mass of the can and water.
4. Set up the apparatus as shown in Figure 1. Use a ring and stirring rod to suspend the can about 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 of the can. Remember: The Temperature Probe must be in the water for at least 30 seconds before you do Step 6.
5. Connect the probe to the computer interface. Prepare the computer for data collection by opening the file "16 Energy of Foods" from *Chemistry with Vernier* folder of Logger *Pro*.
6. Click Collect to begin measuring temperature. Record the initial temperature in your data table. 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. Allow the water to be heated until the food sample stops burning. **CAUTION:** *Keep hair and clothing away from open flames.*
7. Continue stirring the water until the temperature stops rising. Record this final temperature in your data table. Click Stop to end data collection.
8. Determine and record the final mass of the food sample and food holder. Be sure to include any particles that may have fallen off after you made the first mass measurement.
9. Examine the initial readings in the table to confirm the initial temperature, t_1. To confirm the final temperature, t_2, click the Statistics button, 

. The maximum temperature is listed in the statistics box on the graph.
10. Repeat the procedure for the second food sample. Use a new 50 mL portion of cold water.
11. When you are finished, place burned food, and partially-burned wooden splints in the container provided by the teacher.

REPORT SHEET

NAME_____

PROCESSING THE DATA

DATE_____

1. Find the mass of water heated for each sample. SHOW BELOW

2. Find the change in temperature of the water, Δt, for each sample. SHOW BELOW

3. Calculate the heat absorbed by the water, q, using the equation

   $$q = m \cdot s \cdot \Delta t$$

   where "q" is heat, "s" is the specific heat capacity, "m" is the mass of water, and "Δt" is the change in temperature. For water, s = 4.184 J/g•C°. Change your final answer to kJ. Show the calculation for BOTH trials below.

4. Find the mass (in g) of each food sample burned. SHOW BELOW

5. Use the results of Step 3 and 4 to calculate the energy content (in kJ/g) of each food sample. SHOW BELOW

6. Record your results and the results of other groups in the Class Results Table.
   - Which foods had the highest energy content?
   - Which foods had the lowest energy content?

7. Food energy is often expressed in a unit called a Calorie. Unfortunately, there is also another calorie unit known as a gram-calorie that is one thousandth of a food Calorie (large Calorie). This can be confusing. The relationship among these units is as follows:

   1 Nutritional Calorie = 1000 calories (gram-calorie) = 1 Kilocalorie = 4184 joules = 4.184 kilojoules

   According to the label on the marshmallows, 1 serving is 4 pieces or 30 grams and contains 100 Calories. Using the class average for marshmallows, compare the number of Calories on the label to the results from our lab.

   SHOW BELOW $\% \, difference = \frac{lab\ value - label\ value}{label\ value} \times 100$

8. Two of the foods in the experiment have a high fat content (peanuts and cashews) and two have a high carbohydrate content (marshmallows and popcorn). From your results, what generalization can you make about the relative energy content of fats and carbohydrates?

9. Describe the two greatest sources of error in this lab. To do this, think about the <u>*ideal situation*</u> – *removing all of the heat from all of the food and putting it completely into the water*.
   1)
   2)

DATA AND CALCULATIONS

Food type (identify by name)	_____	_____
Initial mass of food and holder	g	g
Final mass of food and holder	g	g
Mass of food burned	g	g
Mass of can and water	g	g
Mass of empty can	g	g
Final temperature, t_2	°C	°C
Initial temperature, t_1	°C	°C
Temperature change, Δt	C°	C°
Heat, q	kJ	kJ
Energy content in kJ/g	kJ/g	kJ/g

CLASS RESULTS TABLE

Marshmallows Or _____	Peanuts or Walnuts Or _____	Pecans Or _____	Popcorn Or _____
kJ/g	kJ/g	kJ/g	kJ/g
kJ/g	kJ/g	kJ/g	kJ/g
kJ/g	kJ/g	kJ/g	kJ/g
kJ/g	kJ/g	kJ/g	kJ/g
kJ/g	kJ/g	kJ/g	kJ/g

Average for each food type:

kJ/g	kJ/g	kJ/g	kJ/g