Calorie (energy) Content of Food

1. Introduction

If you were to eat an apple as a snack you would probably think no more of it other than as a way to appease your hunger. Yet, an apple is so much more than that. It contains complex organic compounds, atoms held together as molecules that are rich in stored energy. Food can be thought of as potential energy for the body. You need to consume food in order to gain energy, which you use to keep your body strong and healthy. Not all foods contain the same amount of energy. Food is made of hydrocarbons, which our bodies use as fuel, just like a car uses gasoline.

2. Background

In this experiment, you will use the technique of calorimetry, which means to measure the heat of a reaction, to determine the energy content of a small sample of food. This is the sort of measurement that is made by food manufacturers, so that they can properly label the food that they sell. When this technique is used, the food is burned in a pure oxygen atmosphere, so that combustion will be as complete as possible. The heat is captured by the water of the calorimeter, and the temperature rise of the water indicates how much heat was released by combustion of the food.

To measure temperature changes, you will use a Temperature probe in Figure 1. The Stainless steel temperature probe is an accurate, durable, and inexpensive sensor. The temperature range for this sensor is from -40 to 135°C.

Figure1. Stainless Steel Temperature probe

3. Objective

- Use computer analysis in measuring temperature changes.
- Learn how energy is given off by a food as it burns.
- Determine and compare the energy contents of different foods.

4. Equipment

Computer
Vernier computer interface
Logger Pro Software
Temperature probe
100 mL graduated cylinder
Balance
Food holder
Food samples (nuts, popcorn, gummy bear, etc)
Matches
Ring stand and 10 cm ring
Small can
Two stirring rods
Split 1-hole stopper
Two 1-hole rubber stoppers
Utility clamp
Wooden splint
Bunsen burner

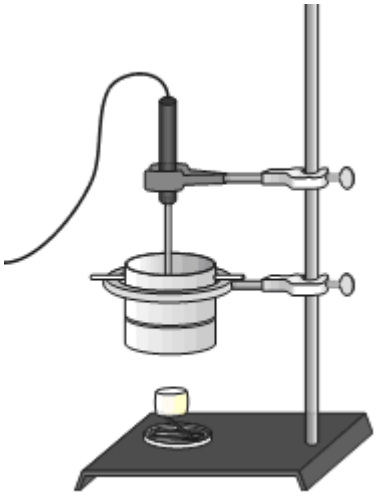

Figure 2.

5. Experimental Procedure

1. Plug the Temperature Probe into Channel 1 of the LabPro or CBL 2 interface. Use the link cable to connect the TI Graphing Calculator to the interface. Press in the cable ends in firmly.

2. Turn on the calculator and follow these steps to start the DATAMATE program.

   TI-83 Calculators:

   Press [PRGM], then press the calculator key for the *number* that precedes the DATAMATE program (usually [1]). Press [ENTER], then press [CLEAR] when you reach the Main screen.

   TI-83+ Calculators:

   Press [APPS], then press the calculator key for the *number* that precedes the DATAMATE program. Press [CLEAR] when you reach the Main screen.

3. Set up the calculator and interface for the correct Temperature Probe.

   a. Select SETUP from the main screen.
   b. If the calculator displays the correct Temperature Probe in CH 1, proceed directly to Step 5. If it does not, continue with these steps to set up your sensor manually.
   c. Press [ENTER] to select CH 1.
   d. Select TEMPERATURE from the SELECT SENSOR menu.
   e. Select the correct Temperature Probe (in °C) from the Temperature menu.

4. Set up the data-collection mode.

   a. To select MODE, press [▲] (the up arrow key) once and press [ENTER].
   b. Select TIME GRAPH from the SELECT MODE menu.
   c. Select CHANGE TIME SETTINGS from the TIME GRAPH SETTINGS menu.
   d. Enter "5" as the time between samples in seconds.
   e. Enter "96" as the number of samples (data will be collected for 8 minutes).
   f. Select OK to return to the setup screen.
   g. Select OK to return to the main screen.

5. 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. Determine and record the initial mass of the food sample and food holder in Table 1.

6. 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 to suspend the temperature probe in the water as shown in Figure 1. The probe should not touch the bottom or side of the can.

7. You are now ready to begin collecting data.

   a. Select START on the main screen.

b. Use a match to light the food sample. Position the burning food sample directly below the center of the water-filled can. Quickly light the food sample again if it stops burning during data collection. **CAUTION:** *Always keep hair and clothing away from open flames.*
c. A real-time graph of temperature *vs.* time will be displayed on the calculator screen during data collection.
d. Temperature readings (in °C) can also be monitored in the upper-right corner of the graph.
e. Data collection will stop after 8 minutes, and a graph of temperature *vs.* time will be displayed.

8. Stir the water slowly and continuously using the stirring rod until data collection stops.

9. Analyze the graph to determine the maximum and minimum temperatures of the water. To do this:

a. Press ENTER to return to the main screen, then select ANALYZE.
b. Select STATISTICS from the ANALYZE OPTIONS menu.
c. Press ENTER to set your left boundary at the beginning of the curve.
d. Use ▶ to move the cursor to the end of the curve, and press ENTER to set your right boundary. The program will now calculate and display the statistics for the data between the two boundaries.
e. Record the MIN and MAX values as the initial and final water temperatures in your data table.
f. Press ENTER to return to the ANALYZE OPTIONS menu, then select RETURN TO MAIN SCREEN.

10. Remove the food holder (ceramic pot) and determine the final mass of the food and holder. Record the final mass in Table 1. **CAUTION**: *food sample and holder may still be hot.*

11. Clean off the food holder and empty the can of water.

12. Store the data from the first run so that it can be used later. To do this:

a. Select TOOLS from the main screen.
b. Select STORE LATEST RUN from the TOOLS MENU.

13. Repeat Steps 6 – 12 for the second food sample. Remember to use a fresh sample of cold water.

14. When finished, discard all burnt matches and food samples as directed by your teacher.

6. Results

Table 1			
Calculations	Measurements	Sample 1	Sample 2
	1. Food used		
	2. Mass of empty can (g)		
	3. Mass of can plus water (g)		
Step 3 – Step 2	4. Mass of water (g)		
mass of both food holder and food	5. Initial mass of food (g)		
mass of both food holder and food	6. Final mass of food (g)		
	7. Initial temperature of water (°C)		
	8. Final temperature of water (°C)		
ΔT = Step 8 – Step 7	9. ΔT of water (°C)		
Δm = Step 6 – Step 5	10. Δmass of food (g)		
See the Section 7 (Calculations)	11. Energy gained by water (Cal)		
Energy Food= Step11/ Step 10	12. Energy content of food (Cal/g)		

7. Calculations

You may need the following calculations in Table 1.

- Calculate the mass of sample food burned. Mass(initial)-Mass(final) = Δm(burned)
- Calculate rise in temperature of the water T(final) –T(initial) = ΔT.
- Convert the mass of the water in the can into kilograms
- Calculate the energy gained by the heated water. To do this, use the following equation:

Calories (Cal) = (mass of water (kg))x(temperature change (°C))x(specific heat of water)

Specific heat of water = 1.0 Cal/(kg, °C)
One **Cal** = 1000 calories.

- Calculate the energy content of each food sample (in Cal/g). To do this, use the following equation:

Energy content of food = Energy gained by water (Step11) / mass of food (Step10)

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

Table 2			
Class Results			
Group Number	Food Type _____	Food Type _____	Food Type _____
	Energy content (Cal/g)		
1			
2			
3			
4			
5			
6			
Average			

8. Analysis

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? (On the nutrition facts label)

4. Would you expect the energy content values that you measured to be close to what is written on the label in the nutrition facts? Why?

Food (Serving size is 2 tsp)	Calories
Average all types jelly, jams	35
Average all types, sugar-free	8
Average Pure Fruit Spreads	68
Fruit Spreads (Weight Watchers)	16
Marmalade, orange	65
Marmalade, reduced sugar	17

Peanuts (1oz)	Calories	Fat
Peanuts	165	15g
Dry roasted peanuts	165	15g
Dry roasted peanuts (light)	130	9g
Honey roasted peanuts	175	12g
Oil roasted peanuts	175	15g
Planters peanuts	160	14g
Plain salted peanuts	160	14g
Weight Watchers roasted peanuts	140	8g
Chocolate coated peanuts	152	10g