ENERGY CONTENT OF FOOD

Driving Question

Which type of foods contain the most energy per gram?

Materials and Equipment

- Temperature sensor
- Aluminum Foil
- Graduated cylinder, 100-mL
- Rod or other attachment
- Cardboard Square (10cm x 10cm)
- Large marshmallow (1)
- Tape
- Aluminum cans (2)
- Centigram Balance
- Ring stand
- Large paper clips (2)
- Whole cashew or peanut (1)
- Matches
- Wooden Splint (3)

Background

Plants use photosynthesis to convert the sun's energy into chemical bond energy stored in carbohydrates, proteins, and fats. Energy from chemical bonds is released during respiration, which is very similar to combustion or burning reaction. Respiration occurs more slowly than combustion because it is controlled by enzymes, but the reactions are essentially the same.

$$carbon\ based\ fuel + O_2 \rightarrow CO_2 + H_2O + Energy$$

Calorimetry is a method used to calculate energy released based on heat exchange during a chemical reaction. You will burn different kinds of food and calculate the amount of energy released based on temperature change in water. Energy released by the burning food is equal to the energy absorbed by the water and the surrounding environment.

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Use appropriate caution with burning and hot materials, such as matches, starter wands, and foods.
- Conduct the lab in a well-ventilated area, preferably outside or under a ventilated hood.

Procedure

1. Put on your safety goggles.
2. Connect the temperature sensor.
3. Open the *AGR 10 Energy Content of Food* lab file.
    - If the configuration file is not available, create a graph display of temperature versus time. Set the sample rate to 1hz.

4. Use a paperclip, cardboard, and tape to construct a food stand similar to the diagram. Cover the cardboard with foil.

5. Tape the wooden splint to the sensor so the stick extends ~1/2 inch (~1 cm) past the metal shaft.

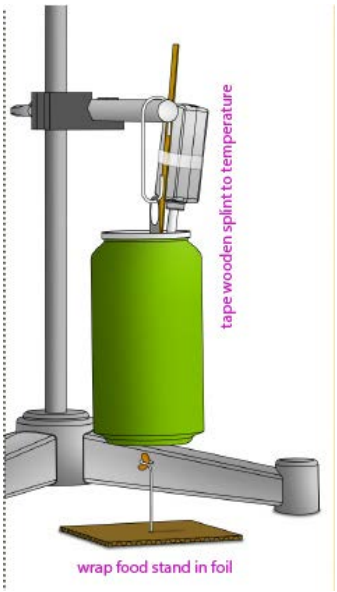
6. Rinse a can with water. Fill it with 100 ml of water. Place the temperature sensor in the can. The wooden splint should help the sensor contact only water for greater accuracy.

7. Record the mass of the nut on a piece of paper. Use the same paper to record data throughout the experiment.

6. Place the nut in the foil stand as illustrated and record the mass of both items together.

7. Use a paper clip to suspend the can from a ring stand attachment.

8. Place the foil stand under the can. Adjust the can height so the nut is 1 inch (2.5 cm) or less below the bottom of the can.



9. Start collecting data.

10. When the temperature stabilizes, use a wooden splint to ignite the nut from the bottom. Move the foil stand to center the flame beneath the can.

11. Stop collecting data when the nut completely loses its flame.

12. Remove the temperature sensor from the can and dry it.

13. Record the combined mass of the nut and stand after burning, then dispose of the nut remains.

? 14. What changes are visible on the can after burning the nut?

15. Discard the can.

16. Repeat steps 4 through 14 with a new can and a marshmallow.

? 17. What changes are visible on the can after burning the marshmallow?

Analysis

1. Use Show Statistics to get the minimum and maximum temperatures. Record these values in table 1.

2. Repeat with marshmallow run.

3. Calculate change in temperature for each food by subtracting minimum temperature from maximum temperature. Your answer should be a positive number. Record the answers in Table 1.

4. Calculate change in mass for each food (initial mass of food+holder minus final mass of food+holder). Record your in Table 1.

5. Calculate the change in mass using the following formula

$$EnergyPerGram = (100 \times \frac{\Delta T}{\Delta M})$$

Table 1: Mass, temperature and energy data for food samples

Food	Initial Mass (g)	Final Mass (g)	**ΔMass** (g)	**ΔTemp** (°C)	Energy per Gram (cal/g)
Peanut					
Marshmallow					

6. What happens to the mass that appears to be lost during burning? Use observations from your experiment to support this claim.

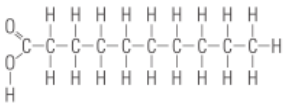
7. Using only temperature change to compare energy released for each food is an unfair comparison. Why?

8. Which type of food contains more energy per gram: a fat (nut) or carbohydrate (marshmallow)? Use multiple lines of evidence from your experiment to support your answer.

9. Do the structural differences between fat and carbohydrate molecules support your answer to the pervious question? Why or why not?

10. Summarize the flow of energy from the sun to the energy in your body.

FAT



CARBOHYDRATE