Lab 32 Energy Content of Food

Name: _____ Lab Partner(s): _____

Driving Question

Which type of foods contain the most energy per gram?

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 reactions. Respiration occurs more slowly than combustion because it is controlled by enzymes, but the reactions are essentially the same.

$$\text{carbon based fuel} + O_2 \rightarrow CO_2 + H_2O + \text{energy}$$

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.

Materials

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

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. Open *SPARKvue* and build a page with one graph.
3. Connect the temperature sensor.
4. Display Temperature on the y-axis of the graph.
5. Set the Sampling Rate to 1 Hz.
6. Use a paperclip, cardboard, and tape to construct a food stand similar to the diagram. Cover the cardboard with foil.
7. Tape the wooden splint to the sensor so the stick extends 1 cm past the metal shaft.
8. Rinse a can with water. Fill it with 100 mL of water. Place the temperature sensor in the can. Ensure the sensor tip contacts only water for greater accuracy.
9. Place the nut in the foil stand as illustrated and record the combined mass of the nut and stand.
10. Use a paper clip to suspend the can so that it hangs above the food stand.
11. Place the foil stand under the can. Adjust the can height so that, once the food is lit, the flame will be 2-3 cm below the bottom of the can.
12. Start collecting data.
13. Ignite the food. Use a wooden splint to light the nut from the bottom, and move the foil stand slightly if needed to center the flame beneath the can.
14. Stop collecting data when the nut completely loses its flame.
15. Remove the temperature sensor from the can and dry it.
16. Record the combined mass of the nut and stand after burning, then dispose of the nut remains.
17. What changes are visible on the can after burning the nut?
18. Discard the can.
19. Repeat the experiment with a new can and a marshmallow.
20. 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 the table.
2. Repeat with the marshmallow run.
3. Calculate the change in temperature ΔT of the water for each food.
4. Calculate the change in mass Δm of each food.
5. Calculate the energy content per gram of food using the following formula

$$e = \frac{m_w c_w \Delta T}{\Delta m},$$

where $m_w = 100$ g is the mass of the water and $c_w = 1$ cal·g$^\circ$ is the specific heat of water. (Using these values, the energy content per gram has units of calories/gram.)

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

Food	Initial Mass (g)	Final Mass (g)	Δm (g)	ΔT (°C)	e (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. 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.

8. Explain why the energy content per gram that you calculated might be higher or lower than the true energy content of the food.

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.