# Energy content of Food

Driving Question

Which type of foods contain the most energy per gram?

Materials and Equipment

|  |  |
| --- | --- |
| * Marking pen | * Plastic straw |
| * Aluminum pie pan (4) | * Food sample (4) |
| * Fast-response temperature sensor with interface | * Wooden matches or starter wand |
| * Electronic balance | * Paperclip, large (5) |
| * Large base and support rod, rod and clamp | * Aluminum soda can (4) |
| * Graduated cylinder, 100 mL | * Water, 200 mL |
| * One-hole rubber stopper (4), ~1 1/2" top diameter | * Tape |
|  | * Cardboard box, large |

Background

Nutrients can be divided into 2 categories: macronutrients, and micronutrients. Macronutrients are those nutrients that the body needs in large amounts. Micronutrients are those nutrients that the body needs in smaller amounts. The amount of energy stored in food is measured in terms of calories. One calorie is equal to the amount of heat energy required to increase 1 gram (g) of water by 1 degree Celsius (°C). One calorie equals 4.186 joules (J), another unit used to measure energy.

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. Connect the temperature sensors.

2. Open the Energy Content of Food lab file.

3. Display data on the graph to show Temperature versus Time.

4. Label each of four aluminum soda cans with one of the following: marshmallow, popcorn, peanut, and cashew.

5. Open a large paper clip, and bend the top half so it is perpendicular to the bottom half. Bend the paper clip over the side of a piece of cardboard or cover of a hard-cover book. The paper clip should form a flat platform to hold the food piece.

6. Insert one end of the paper clip into a one-hole rubber stopper.

7. Use the balance to determine mass, and use Table 1 in the Data Analysis section when instructed to record data.

8. Determine the mass of each empty aluminum can, and record the data in Table 1.

9. Pour 50 mL of water into each can. Determine the mass of each can plus water, and record the data in Table 1.

10. Determine the mass of each sample of food, and record the data in Table 1.

11. For each food sample, put a paper clip, rubber stopper and the sample of food into a pie pan. Determine the mass for each set of a paper clip, a rubber stopper, a sample of food, and a pie pan, and record the data in Table 1.

12. Make a hanger for the soda can by bending open another paper clip. Tape a plastic straw to the cord just above the bulb of the quick-response temperature probe. The straw taped to the sensor cord helps prevent the sensor from touching the can. This helps assure accurate measurements.

13. Take the setup to a ventilated hood inside or, alternatively, use a cardboard box outside as a wind break.

14. Hang a soda can to the rod with the paper clip, and adjust the height of the rod stand so the bottom of the can is about one centimeter above the food sample on the paper clip platform in the pie pan.

15. Hang the soda can labeled “marshmallow” on the rod with a paper clip. Insert the straw taped to the sensor cord into the water, and tape the cord to the can so that the end of the probe does not touch the bottom or sides of the can. Put the paper clip and rubber stopper in a pie pan close to the aluminum can, but not directly under it, and place the marshmallow on the paper clip platform.

16. Start data recording.

17. Using the wooden match or starter wand, begin burning the food sample.

18. Adjust the rod with the hanging soda can so the bottom of the soda can be directly over the burning food sample on the paper clip above the pie pan as shown in the equipment setup graphic.

19. Immediately after the food sample stops burning, gently twirl the can to stir the water with the probe still in it. Name the data run “Marshmallow”.

20. Stop recording data when the temperature stops rising, which may be about 30 seconds after the food sample stops burning. Name the data run “Marshmallow”.

21. Repeat previous steps for the other food items you are testing.

22. For each food trial, determine the following and record the values in Table 1:

* mass of the water
* change in mass of the food sample after burning
* change in temperature of the water
* heat Q (in joules) transferred to the water (Q = m c ∆T)
* the energy content (calories) of the burned food sample in terms of calories, that is, the portion of the heat that was transferred to the water, which is equal to
* energy (Calories) per gram of food burned
* total energy (Calories) contained in the food piece

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | Marsh-mallow | Popcorn | Peanut | Cashew |
| Mass of empty can (g) |  |  |  |  |
| Mass of can + water (g) |  |  |  |  |
| Mass of water (g) |  |  |  |  |
| Mass of food sample (g) |  |  |  |  |
| Before burning, mass of food sample + clip + rubber stopper + pie pan (g) |  |  |  |  |
| After burning, mass of food sample + clip + rubber stopper + pie pan (g) |  |  |  |  |
| Change in mass of food sample (g) |  |  |  |  |
| Water temperature before burning (°C) |  |  |  |  |
| Water temperature after burning (°C) |  |  |  |  |
| Change in temperature, ∆T (°C) |  |  |  |  |
| Heat Q transferred to the water (joule) |  |  |  |  |
| Energy content of burned food (calorie), Q/(4.186 calories/joule) |  |  |  |  |
| (Large) Calories/gram of food sample |  |  |  |  |
| Total Calories in food sample (Calorie) |  |  |  |  |

Analysis & Questions

1. According to the United States Department of Agriculture (USDA), there are about 5.9 Calories in 1 gram of peanuts. What percentage of this accepted value was measured in your calorimeter?
2. Assume you had similar percentage for the other food items. What would be the accepted value for the other food samples?
3. Carbohydrates and proteins contain 4 Calories/gram, whereas fats contain 9 Calories/gram. From this information, what can you say about the composition of the 4 food items you tested?
4. Discuss the role of plants in the energy cycle of living organisms. Why is the productivity of plants of concern to other organisms?