Food Calorimeter

Experiment Guide
INTRODUCTION:

The food calorimeter allows students to determine the amount of energy released through the burning of food. This easy to use method involves the measuring of the change in temperature of a sample of water from the combustion of a small amount of food. The included experiment introduces concepts in thermodynamics and leads to an understanding of energy and its relation to food consumption.
GENERAL BACKGROUND:

Calorimetry is the science of measuring the change of energy involved in a chemical process. There are many different designs of calorimeters, but each is devised to measure the heat that is either released or absorbed during a chemical reaction or phase change.

The amount of heat transferred is called the calorie (symbolized $Q$) and for water is given by the thermodynamic equation:

$$Q = m_w c_w \Delta T$$

Where $m_w$ is the mass of water being heated, $c_w$ is the specific heat of water, and $\Delta T$ is the change in temperature of the water. The specific heat is the heat capacity per unit mass and for water is equivalent to 1.0 cal / g °C. Thus one calorie is the amount of heat needed to increase the temperature of one gram of water by 1 °C.

We will use the above equation in this experiment to determine the energy or caloric content of a sample of food. The stored energy inside the food sample burns and is converted into heat energy which transfers to the water in the flask above. The temperature change of the water is used to determine the amount of heat that was absorbed by the water, and thus the amount of heat released by the burning food. By dividing the amount of heat transferred by the amount of food burned, we can find the energy content per gram in the food sample, and then compare this to the food’s nutritional label.

The “calorie” used in nutrition, usually called the Calorie with a capital ‘C’ is really a kilocalorie.

Kit Contents:

- Erlenmeyer flask (200 mL capacity)
- Cylindrical metal stand
- Metal suspension plate
- Cork and nail food sample holding assembly
- Rubber stopper

Required components not included:
- Matches or a lighter
- Thermometer or temperature probe
- Digital scale with 0.1 g accuracy
- Food samples (e.g. popcorn, nuts, chips, cereal, croutons. Dry food with some fat content works best.)
Experiment

1. For safety and easy cleanup, a sheet of aluminum foil can be used as the work surface for the experiment.
2. Pour 125 mL of room temperature water into the flask. Seal with rubber stopper.
3. Set up the apparatus as shown in Figure A. Insert the top of the flask through the metal plate and turn by 90 degrees so the metal clamp on the flask rests on the plate.
4. Insert a thermometer or temperature probe into the flask through the hole in the rubber stopper. Make sure that the temperature probe is submerged in the water, but not touching the glass on the bottom of the flask.
5. Place the plate on top of the cylindrical metal sheet to suspend the flask.
6. Using a digital balance, measure and record the mass of the food sample to be used. Pin the sample to the top of the nail on the cork. In the case that the sample cannot be easily pinned, bend a paper clip and situate the ends into the cork, creating a platform for the sample.
7. Record the initial temperature of the water.
8. Using matches or a lighter, light the food sample. Quickly (and carefully) move the food sample directly under the flask. When the food ceases burning, record the maximum temperature of the water in the flask.
9. Measure and record the mass of the food sample that remains.
10. Repeat the experiment for several food samples.

<table>
<thead>
<tr>
<th>Food Sample</th>
<th>Initial Mass of Sample (g)</th>
<th>Final Mass of Sample (g)</th>
<th>Initial Water Temperature (°C)</th>
<th>Final Water Temperature (°C)</th>
</tr>
</thead>
</table>
Analysis

1. Determine the change in temperature of the water.
2. Using the equation $Q = m_w c_w \Delta T$, calculate the amount of energy in calories released by the food (i.e. the amount of heat absorbed by the water). Remember that for water 1 mL is equal to 1 gram, and the specific heat of water, $c_w$, is 1.0 cal / g °C.
3. Determine the number of kilocalories released by the food (1 kilocalorie = 1,000 calories).
4. Determine the mass of food that burned.
5. Divide the kilocalories of energy released by the amount of mass burned to find the amount of energy per gram contained in the food sample.
6. Using the information found on the food sample’s nutritional label, calculate the ‘Calories’ per gram by dividing the Calories per serving by the grams per serving (remember that a ‘Calorie’ is actually a kilocalorie).
7. Compare your calorimetry energy per gram results to that of the nutritional label.
8. Repeat the above calculation for all food samples.