KINGSBOROUGH COMMUNITY COLLEGE

The Science of Nutrition Laboratory
Science 70

THE DETERMINATION OF THE CALORIC CONTENT OF A CASHEW NUT

Purpose: In this Activity, students determine how many calories are released per gram when cashews burn and then compare the quantity of energy available from carbohydrates versus fats. Students burn the food items attached to a cork and pin then heating a test tube containing water and measure the resulting change in temperature of the water.

Calories – Who's Counting?

People must consume food to survive. Living cells use potential energy stored in food molecules and oxygen molecules to carry out the chemical processes that support life. Energy is sometimes measured in *calories* (cal). One calorie is defined as 4.184 Joules, approximately the quantity of energy required to increase the temperature of 1 mL of pure water by 1°C. This calorie is not the same as the "food calorie" on nutritional labels. This unit, a Calorie, is equivalent to 1,000 calories or 1 *kilocalorie* (kcal). Not all types of food release the same quantity of energy in calories when they burn or are metabolized. Whether the food is fat, protein, or carbohydrates makes a difference in calorie counting.

Background

For every 14 kcal per day that an individual reduces food intake, that person's weight is reduced by one lb; for a majority of the population, each pound lost increases life expectancy by 37 days. Thus, each kcal/day of reduced food intake extends life expectancy by about 2.5 days (1). More energy is available from fats than carbohydrates because carbon in carbohydrates is already partially oxidized. The carbon in fats is largely unoxidized. Oxidation takes place as fats and carbohydrates are converted to carbon dioxide and water. A fat also contains more carbon atoms per gram; therefore combustion of a gram of fat releases more than twice as much energy as a gram of carbohydrates. Generally fats provide about 9 Calories (9 kcal) per gram, while carbohydrates provide 4 Calories (4 kcal) per gram.

Equipment:

Test tube with insulation; cold water; 100-mL graduate cylinder; ring stand with clamp extension and clamp holder; cashews; wooden splint or lighter; nonflammable holder to hold the burning food; ruler; balance; and thermometer.

Procedure:

1. Using the data table to record the mass of water, initial and final water temperatures, change in water, mass of holder, and initial and final mass of the sample and holder combined.

2. Using a test tube, measure 20 mL of cold water. Pour the water into an empty, clean test tube.

3. Set up the apparatus shown in the drawings. Measure and record the initial temperature of water. The thermometer should not touch the bottom of the test tube.

4. Measure and record the mass of a nonflammable holder to hold the food samples. Place a cashew onto the holder. Measure and record the initial mass of the sample and holder combined.

5. Place the sample with its holder under the test tube. Adjust the height of the clamp on the ring stand so the sample is less than 2 cm from the bottom of the suspended test tube.

6. Remove the sample and holder from the underneath the test tube. Light the sample with a burning wooden splint or lighter. Once it begins to burn, push the sample and holder underneath the test tube. (This prevents the water from being heated by the splint or lighter flame.)

7. Use a thermometer to stir the water gently as the food burns. Record the highest temperature reached by the water. The thermometer should not touch the bottom of the test tube.

8. After the sample is nearly or completely burned, measure and record the final mass of the sample and holder. Empty the water from the test tube, and wash and dry the outside. Repeat steps 2-8 for the next sample. Conduct two trials for the cashew.

Analyzing Data:

1. Calculate the energy transferred to the water using: $q = Cpm\Delta T$
where q is energy (cal), Cp is the specific heat capacity of water (1 cal/g °C), m is the mass of the water (g), and ΔT *is change in water temperature (° C)*. Record q for each trail. Assume that all of the energy released by the burning food goes into heating the water.

2. Calculate the quantity of energy released in cal/g, keeping in mind the amount of sample that was actually burned. Compare the values for cashews. Compare the values to those on the food package.

Questions:

1. Why did the mass of the food samples decrease? Where did this mass go?

2. Why did the temperature of the water increase? How was energy transferred from the food to the water?

3. Explain one way to alter the setup to assure that most of the energy from the burning food heats the water.

4. Why is it important to keep the thermometer from touching the tube while measuring the temperature? Why should the water be stirred while measuring the temperature?

Data Table

	Trial I	**Trial II**
Analytical balance, weigh the cashew to 0.0000g	--------------------	------------------
Mass of cashew after burning	--------------------	------------------
Change in mass of cashew	--------------------	-----------------
Mass of 20 mL of water (g)	--------------------	------------------
Specific heat of water (*Cp*)	1.00 cal/g °C	1.00 cal/g°C
Final water temperature	--------------------	------------------
Initial water temperature	--------------------	------------------
Change in temperature (ΔT)	--------------------	------------------

Calculate the number of **calories gained by the water**:

q=Cp x m x ΔT =__________________________ = (cal)

Show working:
Calculate the number of calories per gram of cashew:

$$\frac{calories\ gained\ by\ water\ \ (cal)}{change\ in\ mass\ of\ cashew\ (g)} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = \quad (cal/g)$$

Class average for calorie content: ___________________.