Experiment: Caloric Content of Foods[1]

Introduction

Food labels contain information about calories. How is this measured? Our bodies "burn" calories, but we can also burn calories (literally) by setting food on fire! It is difficult to measure the energy released directly from burning food, so this energy will be transferred to a can of water (as "heat"). The change in temperature of the water due to the heat transfer will be used to estimate the amount of heat that was released by each food item. Since the food items are different sizes and masses, a comparison will be done by measuring the heat released from each and calculating the number of Calories **per gram** of each food item, instead of total Calories.

Objectives

In this experiment, you will

- ✓ Observe and measure the amount of energy released from different food items.
- ✓ Calculate the amount of heat transferred in units of Calories
- ✓ Gain exposure to the concept of experimental error and discuss sources of error
- ✓ Practice making mass and volume measurements
- ✓ Suggest nutritional explanations for experimental results.

Hazards

Open flames can be dangerous. Make sure long hair is tied back. Be ready to extinguish a flame that gets out of control. Do not toss partially lit or glowing items in the trash. Wash your hands with soap when you are done with the experiment.

Procedure

1) Weigh each food item and record its precise mass.
(Recommendation: Cheese puffs are big… use 1 g or less.)

2) Make a stand for the food item using a paper clip. See Figure 1.

3) Measure out approximately 100 mL of distilled water using a graduated cylinder. Place this into a clean aluminum can.

4) Place the can on a clay triangle on a ring stand.
Place the food item in an empty tuna or cat food can.

Place underneath the soda can.
<u>Bring the level of the can down so it is close to the food item.</u>

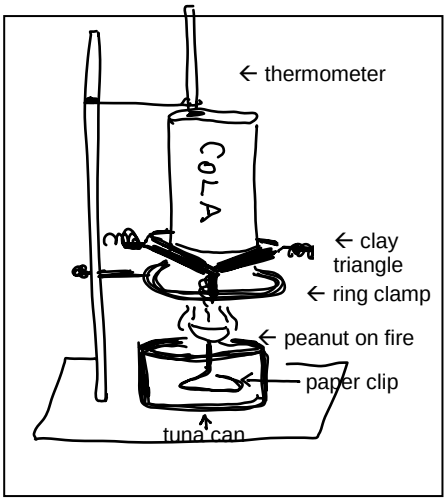

Figure 1. Setup for a burning peanut.

5) Clamp a thermometer so it is submerged in the water in the can **<u>but not touching the can</u>**.

6) Record the initial temperature of the water.

7) Use a flame to catch the food on fire. Matches, a lighter, or candles will be provided.

8) Note the highest temperature that is achieved by the energy from the burning food.

9) Examine the food item after burning. Did it burn all the way through?

10) Repeat for other food items. Feel free to add any other food items you'd like to test.

[1] Adapted from "Hands-On Chemistry Activities with Real-Life Applications" by Norman Herr and James Cunningham, 1999 (Wiley)

Report

Caloric Content of Foods

Name _____Section_____

Lab Partner _____

Prediction

I predict the _____ will have the highest number of Calories per gram.

Sample Calculations

To calculate the energy from food (transferred to water), we will use the equation

$$q = (m \times C \times \Delta T)$$

- q: heat released (calories)
- m: mass of H_2O in can (g)
- C: specific heat of H_2O (Cal/g°C)
- ΔT: change in temperature of H_2O (°C)

For the specific heat of water, use 0.001 Cal / g°C and the mass of the water in the can is approximately 100 g.

Example: If your temperature change was 8.5 °C, your heat calculation is:

q = (100g x 0.001 Cal/g°C x 8.5°C) = **0.85 Calories**

If the food item burned was 2.5 grams, then the caloric content is 0.85 Cal / 2.5 g = **0.34 Cal/g.**

Data

Food item	mass of food item (g)	initial temp (°C)	final temp (°C)	ΔT (°C)	energy released (kcal or Cal)* (see sample calculation below)	Cal per gram of food item*	% error *(Post-lab Q –see last page)*

Post-Lab Questions

1) Based on your experiment, which food item resulted in the most Calories per gram?

2) Are you surprised? Can you give a nutritional explanation for why that food item provided the most energy per gram (what is in the food that contains so many calories)?

3) Look up the calories and the grams per serving on the food label and calculate Cal/gram **<u>for each food item</u>** (see sample calculation, right).

Write the results of the calculations here, to answer the next question.

Nutrition Facts
Serving Size 1 ¼ cups (57 g)

Amount Per Serving	Cereal	Cereal with ½ cup milk
Calories	230	270
Calories from Fat	30	30

Sample Calculation for Cal/g from the food label:

$$\frac{230 \text{ calories}}{57 \text{ grams}} = 4.0 \text{ Cal/g}$$

4) Compare this value to your experimental value (obtained by this experiment) by calculating a percent error for each of your food items and enter this in the last column of your data table. The closest you are to theirs, the higher the accuracy, and the lower the % error.

% error = $\frac{(\text{your value} - \text{their value})}{\text{their value}}$ **x 100**

If you get a negative % error, why is that?

5) Your results may not be as accurate as the laboratories that compute this information for food labels. Can you give at least **TWO** reasons why your results may not be as accurate? (Do NOT say that you miscalculated or had errors in your measurements—Think about the inherent flaws in this experiment.)

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Prelab

Name _____Section_____

Caloric Content of Foods
CHEM& 121

NOTE: If it is convenient for you to do so, please bring a 12 fluid ounce aluminum soda can to lab for the experiment (one is needed for every two students). There will be some extras in case you and your lab partner do not have one.

1) Without looking at anything else, describe the term "heat" as you know it from your daily experiences in 1-2 sentences.

2) Ok, now you can look! Using a textbook or the internet, give a definition for "heat" and cite the source (give textbook title/author/edition/pg or website):

3) In this experiment, you will use various foods: a peanut, cheeto, mini-marshmallow. Make a prediction for which food item will result in the greatest number of Calories per gram of food item. Explain why you think this food item will have the highest Cal/g (1-2 sentences max).

4) One part of the procedure states that you should bring the level of the can down close to the food item.

Why is this important?

5) A peanut is much smaller than a cheese puff. This means that a cheese puff might give off ore energy simply because of its size, rather than its composition. How will you take this into account in your results so size is not a factor?