**Energy and the Caloric Density of Food**

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**ABSTRACT**

Food is humans source of energy. It is how the body powers itself and how we get the necessary nutrition we need to survive. In this lab the energy found in food was studied. The purpose was to see how energy is stored in food, and how that energy may be released. More so, the lab was done to see just how much energy is in food. The food items being investigated in this experiment were a potato chip, peanut, walnut, Cheeto and marshmallow. To conduct the experiment, a calorimeter was built using a can of water, a thermometer, a Bunsen burner and clamps. The food items were each immersed in the flame of the Bunsen burner and then placed under the calorimeter. To find the caloric density of each food item a specific heat formula utilized change in temperature to then determine the calories in each food item. The results showed that the potato chip and marshmallow had the same change in temperature and, therefore, the same calorie amount (0.6 C). The Cheeto and peanut had the same change in temperature and calorie amount as well. The results yielded were lower than expected. There is much uncertainty when looking at the results of the experiment.

**INTRODUCTION**

This lab explored energy, more specifically the energy found in food. The energy found in food is usually defined by calories. A calorie is the amount of heat required to heat a gram of water by one degree Celsius. A joule is the amount of energy arranged over a meter when one newton is applied to it. Both the joule and the Calorie are measurements of energy, but the joule is defined by the metric system. By applying heat to foods, the energy stored in the foods can be released as heat. This lab utilized a calorimeter to find the energy stored in each food subject tested. The purpose of a calorimeter is to measure the heat of chemical reactions. The most basic design of a calorimeter was used in our lab. It consisted of a suspended thermometer placed in a can of water, and held up.

The labs purpose was to see how energy relates to and is stored in food. The lab aimed to discover the calories found in each food sample by using stoichiometry. The lab was done to see how energy is stored in food, and how it is released, particularly, how much energy is stored in food. The hypothesis was that the results of the lab will show varying caloric densities around ten calories per food item. This is based off the calories found in one serving of each of the food items, and then calculated to see what the caloric density of one of each food item should be.

**MATERIALS**

* Cheeto
* Marshmallow
* Potato Chip
* Walnut
* Peanut
* Aluminum Soda Can
* Bunsen Burner
* Thermometer
* Two Clamps
* 300 ml of Water
* Extra water in container to cool burnt foods

**METHODS**

In this experiment the caloric density of different foods were measured. Marshmallows, Cheetos, potato chips, walnuts, and peanuts were gathered for the experiment. In the lab, a calorimeter was constructed. To assemble the calorimeter an aluminum soda can was filled with 300 ml of water. From here, the can full of water was clamped a foot into the air. A thermometer was clamped above the can. The thermometer was placed so it was not touching any part of the can, only the water inside the can. The starting temperature of the water was then recorded. A Bunsen burner was placed next to the can. The Bunsen burner was placed away from the can, so the water would not be directly impacted by the flame of the Bunsen burner.

The marshmallow was the first food to be tested. The marshmallow was immersed in the Bunsen burner flame until it caught fire. The marshmallow was then placed an inch under the can and held there until it had completely burnt away. After the marshmallow was obliterated, the temperature of the water was taken again and the change in temperature calculated. This procedure was repeated for the Cheetos, potato chips, walnuts, and peanuts.

**Figure 1:** Diagram of Calorimeter



**HAZARDS**

Students were dealing with Bunsen burners and open flames. Students were careful while using the Bunsen burner and always kept flaming materials inside the fume hood. To be cautious, the hot ashes and remains of the burnt foods were submerged in cold water before being disposed. The gas for the Bunsen burner was turned off in between trials for safety. The can was also exposed to large amounts

**RESULTS**

**Calculations:** Finding Caloric Energy

c (j/g/degreeC) = q (calories) / m (grams) x change in temperature (Celsius)

c (j/g/degreeC) x (( m (grams) x change in temperature (Celsius)) = q (calories)

calories = specific heat (j/g/degreeC) (( mass (grams) x change in temperature (Celsius))

calories/1000 = Food Calories (kilocalories)

Cheeto: 1 j/g/degreeC ( 300 g x 4 Celsius) = 1,200 c = 1.2 C

Marshmallow: 1 j/g/degreeC (300 g x 2 Celsius) = 600 c = .6 C

Potato Chip: 1 j/g/degreeC (300 g x 2 Celsius) = 600 c = .6 C

Peanut: 1 j/g/degreeC (300 g x 4 Celsius) = 1,200 c = 1.2 C

Walnut: 1 j/g/degreeC (300 g x 7 Celsius) = 2,100 c = 2.1 C

To find the calories, or energy, per food item the equation c = q/m(change in temperature) had to be used. The equation is used to find specific heat, however the equation can be manipulated to find the amount of calories in a food item. The original equation divides calories by the mass multiplied by the change in temperature, which yields the specific heat. The equation we used multiplies specific heat, mass and change in temperature to find calories. By using this equation it was found that a Cheeto has 1,200 calories, a marshmallow has 600 calories, a potato chip has 600 calories, a peanut has 1,200 calories and a walnut has 2,100 calories. Food calories are measured in kilocalories. To find the kilocalories in each food the amount of calories for each food item was divided by 1,000. This means a Cheeto has 1.2 food calories, a marshmallow has .6 food calories, a potato chip has .6 food calories, a peanut has 1.2 food calories and a walnut has 2.1 food calories.

**Table 1:** Temperature Change and Caloric Energy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Food** | **Starting Temperature** (Celsius) | **End Temperature** (Celsius) | **Temperature Change** (Celsius) | **Calories in Food** (C) |
| Potato Chip | 18 | 20 | 2 | 0.6 |
| Cheeto | 20 | 24 | 4 | 1.2 |
| Walnut | 23 | 30 | 7 | 2.1 |
| Peanut | 30 | 34 | 4 | 1.2 |
| Marshmallow | 34 | 36 | 2 | 0.6 |

The table indicates that the marshmallow and potato chip had the same change in temperature (2 degrees Celsius) and the same calorie amount (0.6 C). The Cheeto and peanut had the same change in temperature and calorie amount as well. The change in temperature for the peanut and Cheeto being 4 degrees Celsius, containing 1.2 calories (C). The walnut stood out in the way that it was the only item that did not match any other item in change in temperature or calorie amount. The walnut had a 7 degree change in temperature and 2.1 calories (C). The walnut also had the highest change in temperature and calorie count.

**DISCUSSION**

The results show that the marshmallow and potato chip have the same calorie amount. The results also show that the peanut and Cheeto have the same calorie amount. When beginning this study, these were not the expected results. The calorie amount for each food item was estimated to be much higher than what the results indicated. Beyond that, it is surprising that the calorie amount for the foods were so similar, and even the same in the cases of the peanut and the Cheeto, and the marshmallow and potato chip. The nutrition facts for each food are very different than the results we obtained. A Cheeto is stated to have 7.2 calories, a potato chip 10.7 calories, a walnut 14 calories, a peanut 11 calories and a marshmallow 22.5 calories.

Our results differ greatly from the stated calorie amount for each food item. This means there is room for error and uncertainty. When studying the results, each starting temperature was different. This muddles the validity of the results. If the water in the can was already hot, the burning of the foods would not change the water temperature as much as if the water was at room temperature. Therefore, the foods that were tested last most likely had a smaller change in temperature than they would have if the water was not already hot. If the experiment were done again, the water temperature would be more controlled. For every trial a new can with fresh water would be used. It would be made sure that the same amount of water was used each time, as well as making sure that the water was the same starting temperature for each trial. This would yield more accurate results.

Another source of uncertainty is that while burning the foods, all the energy was not directly applied to the can - energy was released that the water did not capture. This is a fault in the construction of the calorimeter, however there is no way to make sure that all the energy from the food is completely applied to the water. In any scenario and any construction of the calorimeter we could’ve made, energy would have escaped. This means that our measurements and results portray less energy than is actually contained in the food items.

A final source of uncertainty was that the experiment was based off of number of food item, one of each food item was burnt. While doing the experiment, the mass of each food item was not measured. This means that while calculating the caloric energy of each food the mass of the food item was not taken into consideration. The mass of each food is important when determining the caloric energy, and without this the results were not accurate. If the experiment were to be repeated, the mass of each food item would be taken before each trial to ensure the calculations could be as accurate as possible. As the experiment was done, there is a lot of room for both error and uncertainty and the results are not precise, nor accurate.