The Caloric Content of Food

Reading:
The Caloric Content of Food and its Application to Mitochondrial Respiration Science Literacy Skills

Key Questions:
What is a calorie?
How is the caloric content of an item measured?
How do the calorie contents of macronutrients differ?

SAFETY:
- Follow the directions of your teacher at all times.
- Be very careful to not touch anything that is hot. Hold the back of your hand near a potentially hot item before touching it to determine if it is emitting heat.
- Be very careful to not bump the calorimeter while food is burning.
- Safety goggles or safety glasses must be worn at all times.

Materials and Equipment:

Large can with top and bottom removed
Soda can
3 Corks
2 Foil pie pans
Thermometer
Tongs
3 Dissection pins
Glass stir rod
Ring stand (with ring and clamps)
Graduated cylinder
1 small marshmallow (mini)
1 peanut or walnut
1 piece of dry cat food

PREDICTIONS:
In this activity, you will be evaluating the calorie content of a marshmallow, a nut, and dry cat food. A marshmallow is mostly carbohydrate. A nut is high in fat. The dry cat food is high in protein. Based on your reading, predict which food item will have the most calories per gram.

→Food item with the most calories per gram:

I think ____

because____

____

____

Procedure:

1. Push one dissection pin through each cork so that the pinhead is flush to the cork. You may either push it directly through the middle of the cork, or you can push it through the side, see the picture below:

2. Measure 50 ml of water with the graduated cylinder and then slowly pour the water into the soda can.
3. Place the thermometer into the can and wait until the temperature on the thermometer stabilizes and record the temperature ($T_{initial}$) on the table. Remove the thermometer and put in a safe location.
4. Set up the ring on the ring stand in the **middle of your lab bench**.
5. Put the glass rod through the soda tab so that it balances across the top of the can.
6. Use an electronic balance to measure the mass the cork and the pin. Record this value on your data table.
7. Measure the mass a small piece of the first food item to be burned. The mass should be between 0.5 and 1.5 grams. Record the mass (mass $food_{intial}$) on table below.
8. Push your first food item onto the pin so that it stands above but not touching the cork.
9. Place the pie pan under/beside the stand. Position the food item roughly in the center of the pie pan.
10. Place the large can over the food item so that the food item is in the middle of the can.
11. Attach the ring clamp to the stand and lower the soda can with water into the middle of the ring until it is suspended from the glass rod.
12. Lower the ring and soda can apparatus into the large can until it is suspended approximately 5-10 cm above the food item.
13. **Put on your safety goggles**. **The goggles must now be worn until the end of the experiment**. You will not be allowed to complete the lab without safety goggles
14. Raise your hand and wait for your teacher to come to your table to light the food item. When he/she comes to your bench, lift the outer can up until it just touches the ring stand. Your teacher will light the food item on fire. Immediately lower and release the large can.
15. Listen closely and check often for active burning. When the food item stops burning or **is completely black or burns away** then combustion is complete.
16. Immediately place the thermometer in the soda can. **Do not let the thermometer touch the sides of the can.** Wait until the temperature on the thermometer stabilizes and record the temperature (T_{final}) on the table.
17. Remove the thermometer and put in a safe location.
18. Lift the large can and let the food item sit until it is no longer hot (approximately 1 minute).
19. Use an electronic balance to measure the mass the cork, pin, and food combination. Record this value (mass of cork, pin, & $food_{final}$) on your data table. Remove any remaining food from the pin and place on a non-flammable surface out of the way.
20. Pour out the water from the soda can.
21. Keep your goggles on. Switch roles and repeat steps 2 through 20 for the next two food items. Each person in the group should perform a different role for the next food item.
22. **Place any leftover food items in the trashcan. Make sure they are not smoking or still hot.**

Food item	Mass cork & pin (g)	Mass $food_{initial}$ (g)	$Temp_{initial}$ (°C)	$Temp_{final}$ (°C)	Mass cork, pin, & $food_{final}$ (g)	Mass $food_{final}$ (g)
Cat food						
Nut						
Marshmallow						

Calculate Results

1. Calculate change in temperature for each food item: $T_{final} - T_{initial} = \triangle T$.

2. Calculate the heat gained (Q) by the water using the equation below. Where, m equals the mass of your water = 50 g for 50 ml of water, C is the specific heat of the water or 1.0 cal/g °C (a constant), T is the change in temperature of your water.

   $$Q = mC\triangle T \quad \text{or} \quad Q = 50\text{ g} * 1.0\text{ cal/g °C} * \triangle \mathbf{T}$$

   Because 50 * 1 = 50, you can reduce your equation to $Q = 50 * \triangle \mathbf{T}$

3. Convert the heat gained (cal) to food Calories (i.e kilocalories) by dividing Q by 1000.

4. Determine how much of the food item burned: $m_{initial} - m_{final}$ = mass burned.

5. Calculate the energy content per gram of food: Calories / mass burned

Food item	$\triangle$T (°C)	Q (cal) (=$\triangle$T * 50)	Calories (=$\triangle$T * 50) /1000	Mass burned (g)	Cal / g
Cat food					
Nut					
Marshmallow					

6. Obtain the data for the calorie content of each of the food items from each group in the class. Calculate the mean and standard deviation for each.

Food item	Mean	Standard deviation
Cat food		
Nut		
Marshmallow		

Questions:

1. Which food item had the highest calorie content? Which had the lowest calorie content?

2. Why did we use a similar mass of each food item?

3. Based on your observations, what is the relationship between burn time and relative calorie content?

4. What can you learn from the calorie information listed on the nutrition labels of food items?

5. If you tried to burn a food item in a room without oxygen, it will not burn. Likewise, if mitochondria don't have adequate oxygen, they will not produce ATP. Why won't food or mitochondria produce energy without oxygen?