Energy content of food

Teacher Notes

CHEMISTRY
Thermo-chemistry

Driving Question:
How much energy is there in food?

Applied Technology: Data-logging

Student Level: Middle School Level (11-14)

Duration: 1 lesson period

Recommended Settings: Student Investigations

Learning Objectives

- To measure the rise in temperature of water heated by a burnt item of food.
- To calculate the amount of heat given out by the burnt food.
- To determine the energy content of the item of food.

Didactical Approach

A sample of a food of known mass is burned, heating a calorimeter. Students record the temperature of water heated in the colorimeter, calculate the energy transferred to the water, and hence estimate the energy present per unit mass of food.

This is an activity in which different student groups can investigate different items of food. If each group investigates two food items, one in common with the rest of class to provide a common baseline, and the other a different item from the rest, a comparative table of energy in different foods can be drawn up from the class results. This should be possible to achieve in 45 - 60 minutes. Avoid foods to which students might have allergies.

Metal containers, such as copper calorimeters or tin cans of similar dimensions that can be held in a clamp, provide more effective heat transfer to the water. Note that this benefit is lost if the can is stood on a tripod, as the latter will also be heated.

Some food items can be burned safely and easily using a mounted needle. Others may melt and drop off the needle. Take care with mounted needles.

One food item needs to be selected as suitable for the standard experiment used by each student group. Enough samples of approximately the same mass of this food item need to be provided for the class. A trial run before the lesson is advised to establish:

1. that this food item will burn readily, sustain combustion and leave little unburnt residue, and
2. the mass of this food item will cause a temperature rise in the water around 20-30 °C.

Concepts learnt in this activity:

- Energy, heat, energy transformation, energy content of food per mass unit.

Materials

- Data-logger e.g. CMA €Lab,
- Temperature sensor,
- Metal calorimeter or metal can,
- Measuring cylinder (50 mL),
- Heat resistant mat,
- Stand and clamp,
- Mounted needle or another food holder,
- Measuring scale
- Bunsen burner,
- Lab coat and safety goggles
- Variety of dry food items like potato crisps, mini-marshmallows, popped popcorn, peanuts (do not use and eat an item of food when you allergic to it!).

Procedure

- Connect the temperature sensor to input 1 of your data-logger.
- Open the Coach Activity 'Energy content of food'.
- Let the students perform experiment in small groups.
- Let the students perform the measurements and investigate different food items.

Questions and Assignments

- Determine the mass of water heated in the calorimeter.
- Find the change in temperature of the water.
- Calculate the heat absorbed by the water.
- Determine the amount of heat produced during burning of an item of food.
- Determine the energy content of the item of food per gram.
- Which item of food produces the most energy?
- Compare the experimental results with the official values of energy content given for the food on its packet.
- Are your results close to the official numbers?
- Are they higher or lower? If they are lower, you must be under-estimating the energy released from the food. How can you improve the experiment?
- Which foods give the most energy per gram?

Data Analysis

Students measure the temperature change of water in a calorimeter heated by burning an item of food. Based on the temperature they calculate the energy (in J) absorbed by the water. For this calculation the following equation should be used:

$$Q = m * c * \Delta T, \text{ where}$$

Q is the absorbed energy, m the mass of water heated (in g),
c the specific heat of water (4.2 J g^{-1} deg^{-1}) and ΔT the temperature rise.

Finally knowing the mass (in g) of the burnt item (the final mass – the initial mass) the energy content per gram (J/g) can be calculated.

Resources

Coach Activity: Energy content of food.cma7

Coach Result: Energy content of food.cmr7

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