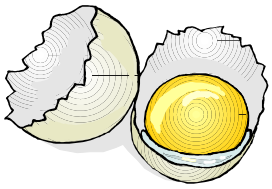
Inquiry Lab Activity:



Calcium Carbonate Content of Eggshells

Adapted from: Lechtanski, V. L. *Inquiry-Based Experiments in Chemistry;* Oxford: New York, 2000; pp 159-165.

Objectives

Students will be able to:

- design an experiment that quantifies the amount of calcium carbonate present in a natural substance.
- relate the amount of a reactant or product of a chemical reaction to another reactant or product.
- work collaboratively with their peers to solve a given problem in the laboratory in a way that models the scientific method.
- apply a common acid reaction between hydrochloric acid and the carbonate ion.

Safety

This lab uses a 3 M HCl solution. Goggles and aprons are required for the duration of this lab. Students must be reminded that excess hydrochloric acid may be present at the end of the reaction. Students may NOT heat solutions containing hydrochloric acid. All students must have their procedures approved by the teacher prior to beginning work.

Background

Calcium carbonate, $CaCO_3$, is found in nature giving hardness and strength to things such as seashells, rocks, and eggshells. As hard as this substance is, it will react readily with hydrochloric acid to yield carbon dioxide gas (and two **other** products). In this experiment students will design an experiment by reacting eggshells with 3 M HCl to compare the calcium carbonate composition of white (chicken) eggshells to brown eggshells.

A good quality eggshell will contain, on average, 2.2 grams of calcium in the form of calcium carbonate. Approximately 94% of a dry eggshell is calcium carbonate and has a typical mass of 5.5 grams,[1] although these values can differ depending on sources. Amounts as low as 78% have been published. The remaining mass is composed largely of phosphorus and magnesium, and trace amounts of sodium, potassium, zinc, manganese, iron, and copper. In the case of brown versus white eggs, a definitive difference in calcium carbonate amounts may be hard to uncover. However, consider this. The color of the eggs is nothing more than a result of a different breed. The quality, nutritional value, and taste are identical between white and brown eggs, though two notable differences are size and price. Brown eggs are usually larger and slightly more expensive. The reason for the price increase is because brown eggs come from larger hens, which need to be fed more food daily. With a larger intake of calcium each day, one might expect the produced egg to have a higher calcium carbonate content. However, since the eggs are larger, it must be kept in mind that the

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[1] Butcher, G. D. & Miles, R. D. *Concepts of Eggshell Quality*, URL http://www.afn.org/~poultry/flkman4.htm

calcium is spread over a larger surface area during egg formation. A brown eggshell's increased tendency to break, when compared to white, is often attributed to this "thinning out" of calcium during deposition.

Procedure

Using the available lab equipment, design an experiment to determine what percentage of an eggshell's mass is calcium carbonate. Find the percent mass of calcium carbonate in white and brown eggshells. Keep in mind that there are several ways to execute this lab. You may not need all of the apparatus that has been provided. When preparing the eggshell, remove the membrane as it will interfere with the reaction. Assume that anything that doesn't react with the acid remains solid. PRIOR TO BEGINNING WORK, SUBMIT IN WRITING TO THE TEACHER:

1. A balanced equation for the reaction between calcium carbonate and hydrochloric acid.
2. An outline of the procedure that you intend to use. (A significant portion of your grade will be determined by how close you are to the accepted value.)

Materials

Consumables (per group)

- 2 different eggs (i.e. 1-white & 1-brown)
- 50 mL of 3 M HCl
- Filter paper

Lab equipment

- Mortar & pestle
- Standard vacuum filter apparatus (side arm flask, rubber hose, funnel…)
- Gas collection apparatus (one-holed stoppers with glass tubes & compatible flasks, rubber tubing, gas collection tubes/bottles, pneumatic troughs…)
- Standard lab balances
- Beakers (250 mL)
- Graduated cylinders
- Hot plates
- Thermometers

Questions

1. Calcium carbonate decomposes upon heating. Write a balanced equation for this reaction.
2. How were you sure that you added sufficient acid to completely react with all of the calcium carbonate? If you failed to add sufficient HCl, how would this affect your data?
3. If you had the opportunity to repeat this experiment, what would you do differently?
4. Based on your collected data, calculate the percent composition of calcium carbonate of both the white and brown eggshells.