

Experiment of calcium carbonate composition of eggshells



**ASSIGN
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INTRODUCTION

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 2 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, 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 calcium is spread over a larger surface area during egg formation. A brown eggshell's increased

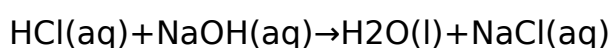
tendency to break, when compared to white, is often attributed to this “thinning out” of calcium during deposition.

To avoid the breakage of eggs before reaching market, the eggshells needs to be as strong as possible. The strength of eggshells is mainly determined by the percentage of calcium carbonate in it. In order to monitor the quality of eggshells, the following experiment has to be done to determine the percentage of calcium carbonate in eggshells.

In this experiment, back titration is used. First, excess acid is reacted with the calcium carbonate in eggshells.



Later, if we can find out the number of mole of unreacted acid, number of mole of calcium carbonate can then be found out. The number of mole of unreacted acid can be found by titration with the following reaction.



Percentage by mass of calcium carbonate in eggshell can then be calculated by the following formula:

4. 2AIMS AND OBJECTIVES

The purpose of this experiment is to determine the percentage by mass of calcium carbonate in eggshells.

design an experiment that quantifies the amount of calcium carbonate present in a natural

substance.

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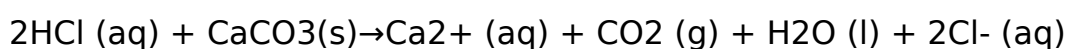
- relate the amount of a reactant or product of a chemical reaction to another reactant or product.
- work collaboratively with their peers to solve a given problem in the laboratory in a way that models the scientific method.
- apply a common acid reaction between hydrochloric acid and the carbonate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

Chapter 2

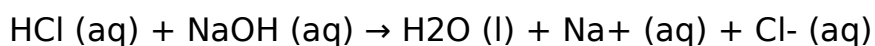
THEORY & METHODOLOGY

PRINCIPLE OF THE EXPERIMENT

During this experiment, the percentage of CaCO₃ in an eggshell is determined by reacting the eggshell with hydrochloric acid. The equation for this reaction is:



This reaction cannot be used directly to titrate with the CaCO₃. Instead, an excess of hydrochloric acid is added to dissolve the eggshell, and the remaining acid is titrated with NaOH solution to determine the amount of acid that did not react with the eggshell. The equation used to determine the amount of leftover acid is:



APPARATUS AND EQUIPMENTS

- Beaker
- Pipette Filler
- Electronic balance
- Volumetric flask
- Burette
- Wash bottle

- Mortar and pestle Conical flasks
- White tile
- Filter funnel
- Filter paper 25.00 cm
- 3 pipette

CHEMICALS USED

- 2 M HCl Phenolphthalein
- 2 M NaOH

PROCEDURE

- White and Red colour eggshells have taken and the protein membrane was removed on the inside of the eggshells.
- The eggshell was washed with distilled water
- Dried in an oven for few minutes.
- The eggshell was then grounded into fine powder by mortar and pestle.
- 2g of eggshell powder is weighted accurately by using an electronic balance and it was transferred to a conical flask.
- 25.00 cm³ of HCl was pipetted to dissolve the eggshell powder.
- Distilled water was added to the flask until it reached about 100cm³. The flask was swirled gently.
- Put the solution into cubed for two days.
- Filtered the solution using filter papers.
- Pipet out 25.00 cm³ from each solutions to titration flasks.
- The solution was then titrated with standardized NaOH.
- Repeat another two samples from each solution.
- Collect the correct burette readings at the end point.

Chapter 3**EXPERIMENTAL RESULTS****THE COLOR CHANGE OF THE SOLUTION**

- White egg Brown egg
- Colourless pink Colourless pink

THE TITRATION RESULT OF BROWN EGG

	1	2	3
Volume of eggshells	25.	25.	25.
solution/cm ³	00	00	00
Volume of NaOH used/cm ³	20.	19.	20.
	10	90	10

- Average volume of NaOH used: $(20.10 + 19.90 + 20.10) = 20.03 \text{ cm}^3$

THE TITRATION RESULT OF WHITE EGG

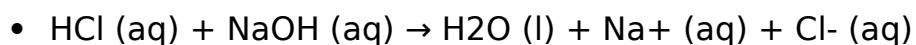
	1	2	3
Volume of eggshells	25.	25.	25.
solution/cm ³	00	00	00
Volume of NaOH used/cm ³	20.	20.	20.
	40	35	00

- *Average volume of NaOH used: $(20.40 + 20.35 + 20.00) = 20.25 \text{ cm}^3$

Chapter 4**CALCULATIONS****CALCULATIONS**

- $2\text{HCl (aq)} + \text{CaCO}_3\text{(s)} \rightarrow \text{Ca}^{2+}\text{(aq)} + \text{CO}_2\text{(g)} + \text{H}_2\text{O (l)} + 2\text{Cl}^-\text{(aq)}$

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**FOR BROWN EGG**

Number of moles of NaOH used to react with HCl

$$= 20.03 \text{ cm}^3 / 1000) \times 2 \text{ M} = 40.06 \times 10^{-3} \text{ mol}$$

Since number of moles of NaOH = number of moles of HCl in 25 cm³

$$= 40.06 \times 10^{-3} \text{ mol}$$

$$\text{HCl mols in } 100 \text{ cm}^3 = 40.06 \times 10^{-3} \times 4 \text{ mol}$$

The initial no of moles of HCl: volume X molarity

$$= 100/1000 \times 2 \text{ M} = 200 \times 10^{-3} \text{ mol}$$

Number of moles of HCl used to react with CaCO₃ =

$$(200 \times 10^{-3} - 160.24 \times 10^{-3}) \text{ mol} = 39.76 \times 10^{-3} \text{ mol}$$

According to the equation, one mole of HCl required to react with 2 moles of CaCO₃,

$$\text{Number of moles of CaCO}_3 \text{ reacted} = 39.76 \times 10^{-3} / 2$$

$$= 19.88 \times 10^{-3} \text{ mol}$$

$$\text{The weight of CaCO}_3 = 19.88 \times 10^{-3} \text{ g} \times 100 \text{ g}$$

$$\text{The \% of CaCO}_3 \text{ in eggshell (brown)} = (1.988/2) \times 100\%$$

$$= 99.4\%$$

FOR WHITE EGG

Number of moles of NaOH used to react with HCl:

$$(20.25 \text{ cm}^3 / 1000) \times 2 = 40.50 \times 10^{-3} \text{ mol}$$

Since number of moles of NaOH = number of moles of HCl in 25 cm³

$$= 40.50 \times 10^{-3} \text{ mol}$$

HCl Volume in 100 cm³ = $40.50 \times 10^{-3} \times 4$ mol

The initial moles of HCl: volume \times molarity

$$= 100 / 1000 \times 2 \text{ M} = 200 \times 10^{-3} \text{ mol}$$

Number of moles of HCl used to react with CaCO₃ :

$$(200 \times 10^{-3} - 162 \times 10^{-3}) \text{ mol} = 38 \times 10^{-3} \text{ mol}$$

Number of moles of CaCO₃ reacted = $38 \times 10^{-3} / 2$

$$= 19 \times 10^{-3} \text{ mol}$$

The weight of CaCO₃ = $19 \times 10^{-3} \text{ g} \times 100$

The % of CaCO₃ in eggshell (white) = $(1.9 / 2) \times 100\%$

$$= 95.0\%$$

Chapter 5**DISCUSSION AND CONCLUSION****CONCLUSION**

- Percentage of CaCO₃ in red eggshells = 99.4%

- Percentage of CaCO_3 in white eggshells= 95. 0%

Therefore red eggshells has the higher percentage of CaCO_3 .

DISCUSSION

Source of errors

- The eggshell powder did not dissolve completely
- Variation in visual judgment at the end point
- Instrumental errors of the electronic balance
- The eggshell was not fully dried
- Some droplets of solution may still adhere on the beaker and the glass rod which lead to the reduction in number of moles of excess HCl

In this Experiment we can also do the EDTA titration.

REFERENCES

- <http://www.google.lk/search?hl=en&source=hp&q=caco3+percentage+in+eggshell&btnG=Google+Search&meta=&aq=f&oq=>
- <http://wwwchem.csustan.edu/chem1102/Egg.htm>
- <http://www.oppapers.com/essays/Determine-Percentage-Mass-Calcium-Carbonate-Eggshells/165593>
- <http://ag.ansc.purdue.edu/poultry/multistate/koelkebeck1.htm>