EGG SHELL: AN IMPROVISED CALCIUM TRIOXOCARBONATE (IV), ($CACO3_)$ FOR IN TEACHING AND LEARNING OF QUALITATIVE ANALYSIS IN CHEMISTRY

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Abstract
This paper determined the content of calcium trioxocarbonate (IV) (CaCO3) in egg shell as an improvised material in teaching the concept of qualitative analysis in chemistry among senior secondary school students in Enugu state. The importance of CaCO3 was discussed. The concept of improvisation in chemistry teaching using egg shell and their implications were discussed. The study also articulated the procedures used for the determination of the gram content of calcium trioxocarbonate (IV) (CaCO3) in the egg shell and was found to be 4.16g. The percentage content of CaCO3 in the egg shell was found to be 83.2%. The implications for improvisation in teaching and learning of chemistry were also highlighted.

Keywords: Qualitative Analysis, Egg Shell, Trioxocarbonate (IV), (CaCO3), Improvisation

Introduction

Science curriculum these days has emphasized that science should be taught in such a way that it will enable students to gain access to new knowledge which will make them to behave rationally towards the problems created by the environment in which they live and the society at large. This means that discovering new avenues to achieve a better result is of paramount importance (Usoro, 2008). For progress in science to be meaningful and reasonable, the science teachers must be innovative in their daily teaching activities. For instance, chemistry is, and needs to be taught as a creative discipline since it stands a chance of solving global challenges such as food security, health problems and others.

Chemistry is the study of properties of matter and the changes it undergoes (Chang & Overby, 2008). The life process of all organisms involves chemical changes and many activities centres on the study of chemistry (Ababio, 2013; Emendu, 2014) Chemistry is a pre-requisite subject to all science and science related disciplines.. Practicals in secondary school chemistry is done under quantitative and qualitative analysis Qualitative analysis aspect of chemistry plays vital role in the development of drugs, which helps to prevent, cure and alleviate diseases and prolong lifespan (Tunde, 2014).Qualitative analysis is a process of identification of a substance, which includes determining what chemical elements that are present in the sample tested, what ions, functional groups or molecules are in its composition. Qualitative analysis

exposes students on how to identify substances like gases, anions and functional groups (Tunde, 2014). Despite the importance of chemistry in the economic development of any country,, students' performances in the subject in external examinations have not been satisfactory (WAEC chief Examiner's report 2015-2018, Umate, Eya & Okebannama, 2019). Olubu (2015) observed that the students' performance in Chemistry practical is generally poor at the Senior School Certificate

Previous studies revealed that there are many factors that could be attributed to the students' poor performance in chemistry. These among others include: Poor teaching approaches (Umate & Ahmad, 2018; Muhammad, 2014; Attah, 2014), abstract nature of chemistry concepts (Njoku & Ezeodurukwe, 2014) and lack of resources for conducting practical (Achimugu, 2016; Otieno, 2012). Among these factors, Achimugu, (2016) reported that lack of resource materials for conducting practical is the major contributory factors to the students' failure in chemistry for practical in schools. The implication is that there is need to explore alternative sources of laboratory facilities such as local materials for conducting practical to improve students' performance in chemistry. This will in turn, give the students the opportunity to link chemistry practical with local materials available in the environment. This study thus, intends to use eggshell as an improvised source of calcium trioxocarbonate (IV) which can be used in performing qualitative analysis in chemistry

The teaching and learning of chemistry should be directed towards the use of local materials which should be from the learner's environment (Ezeudu, 2000). Some chemistry teachers feel that the use of local materials in teaching chemistry wastes time whereas others feel that the collection and preparation of these local materials are hard to be accomplished (Udofia, 2014). The authors advocated for the use of local materials in teaching and learning of chemistry as this will help in developing the wasted resources within the environment. Effective teaching and learning of chemistry at the secondary school level is a precursor to making individuals creative and productive (Udofia, 2014).

Improvisation is known to improve the performance of students in chemistry this is because when chemistry students are taught with local materials within their environment, it boosts their interest and then achievement in the subject. Using $CaCO_3$ from egg shell to teach identification of cations and anions in qualitative analysis will boost the students interest and then academic achievement in the concept.

Chemistry teaching requires standard equipment, chemicals and concrete resources for meaningful teaching and learning. However, insufficiency of all these (equipment, chemicals and concrete resources) coupled with poor funding and increased population of students makes it difficult to get adequate resources for practical teaching(Udo and Eshiet ,2007). The use of local materials in science teaching and learning hinges on the concept of improvisation (Udofia, 2014). Ekong (2003)

defined improvisation as the creation, development, derivation, selection and building up of relevant and needed materials from the resources of the environment for demonstrative instructions. Improvisation as a concept can be seen as a technique of originating a totally new tool, instrument, material, devise or modifying existing ones for serving a particular function. For the teacher to be able to improvise, he/she must be innovative, resourceful and creative in both thinking and manipulative skills (John, 2009). Improvisation is applicable to almost all the facets of knowledge like arts, science, education, medical sciences, engineering and non academic spheres. Okpara{2002}, Udofia (2005), and Udo and Eshiet (2007) have differently used improvised materials from learner's environment and discovered that it enhances learning processes in chemistry. Udofia (2007) found out that students' involvement in collecting, extracting, preparing and using improvised indicators in titrimetric analysis in chemistry significantly enhanced creativity among secondary school students. The process of teaching and learning require a good deal of improvisation since it touches the cognitive, affective and psychomotor domains of the learners. This is exemplified by improvising calcium trioxocarbonate (iv) used in teaching qualitative analysis from egg shell

Calcium trioxocarbonate (IV), $CaCO3$: is the principal constituent of limestone. It is a chemical compound which has several uses or applications in different areas of life. When calcium carbonate is heated to drive off water and carbon (IV) oxide, CO_2, they could produce a substance called quick lime (calcium oxide),which has binding and cementing qualities (Ababio, 2013). Today, Portland cement uses processed limestone, which can harden under water and is great for bridge construction. Apart from being used as a construction material, CaCO3has the following uses,

Manufacturing industries – an ingredient utilized as filter in paper, paint, sealants an coatings.

Agriculture and the food industry: Animal feed and agricultural lime for soil. It is also used in many food and cooking products such as baking powder, dough and dry mixes. It is also an ingredient in toothpaste.

Medicine- supplement to treat calcium deficiencies and antacid for heartburn and indigestion, etc (John, 2016).

Based on these, there is the need therefore to look for strategies for promoting the extraction of calcium trioxocarbonate {iv} from local materials within the environment of the leaner which is the intent of this research

Statement of Problem

Report from WAEC Chief Examiner (2015-2018) practical revealed that the students' performance in practical chemistry is low. Some of the students' weakness as a result of their inability to record observation and logical inference; assigning wrong charges to ion (WAEC, 2017). Also is the inability of the students to write correct formula of cations and anions and inability to deduce inferences from what is

observed. The chief examiner recommended that the candidates should be exposed to practical skills early in their formative years and they should also improve on their qualitative analysis skills. To achieve this goal, qualitative analysis should be taught to students consistently from their early years in senior secondary schools. The use of local materials like $CaCO_3$ from eggshells in teaching identifications of cations and anions in qualitative analysis will help to make this dream achievable as it will be cheaper and more easily affordable than the standard $CaCO_3$boughtin the market. Moreover, it will help to capture the interest of the students in qualitative analysis thus leading to improved performance. The problem of this study therefore is to determine the mass content as well as the percentage content of $CaCO_3$ in eggshells

Purpose of the Study

The purpose of this study was to determine, the calcium trioxocarbonate (IV) (CaCO3) content in egg shell which can be used to teach qualitative analysis in chemistry in senior secondary schools.

Research Questions

1. What is the content in gram of calcium trioxocarbonate (IV) (CaCO3) in egg shell?
2. What is the percentage content of calcium trioxocarbonate (iv), CaCO3 in egg shell?

Methodology

The research was a true experimental study. The study was conducted in Saint Teresa's College (STC) Nsukka, Enugu State

Name of the local material	-	Egg
Botanical Name	-	Macrogamete
Local (Igbo) Name	-	Ákwá
Part used	-	Shell

Title: **Determination of the calcium trioxocarbonate (IV) (CaCO3) content of egg shell using back titration.**

Apparatus: Weighing balance, beaker, conical flask, funnel, glass rod, filter paper, measuring cylinder, retort stand, burette, pipette, spatula, indicator bottle (Attah, 2013).

Procedure:

Students were engaged in collecting, grinding and weighing of the eggshells during the experiment in the laboratory. The experiment was centrally done in the school laboratory of St Teresa"s college Nsukka. All the sixty SS 3 chemistry students in the school watched the extraction of the $CaCO_3$from the eggshells after which was

used in teaching them qualitative analysis specifically identification of calcium ionCa^{2+} and trioxocarbonate IV ion CO_3^{2-} by their chemistry teacher. This was to motivate them and show them the creativity in chemistry teaching and learning and also to convince them that those reagents that are normally bought can be made locally from our environment.

Since CaCO3 is insoluble in water, it cannot be titrated against standard acid instead excess acid of known concentration is added to the CaCO3 material (egg shell) to bring about the reaction:

$CaCO3_{(s)} + 2H^+_{(aq)} \rightarrow Ca^{2+}_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

The excess acid is determined by back titration with a standard solution of an alkali NaOH. The number of moles of the acid that reacted with CaCO3 in the egg shell can be found from the knowledge of the number of moles of the acid originally added and the number of moles of the excess acid found by back titration

Solution A: 5g of crushed egg shell was weighed, and added to 100cm^3 of 2 $moldm^{-3}HCl_{(aq)}$, measured with a measuring cylinder, to dissolve the CaCO3 in the egg shell. The solution was transferred to a one dm^3 volumetric flask and made up to the mark with water. This solution contains excess $HCl_{(aq)}$ as well as other impurities not likely to react with NaOH.

Solution B: 0.2 mold dm^{-3} NaOH $(_{aq})$.
Indicator used:the indicator used was methyl orange

Titration Procedure: 25cm^3 of solution B was titrated against solution A contained in the burette using methyl orange as indicator and the following burette readings were obtained.

Burette Readings in cm^3	**Trial/Rough**	**1st**	**2nd**	**3rd**
Final Reading	2.10	2.00	2.10	2.20
Initial Reading	0.00	0.00	0.00	0.00
Difference	2.10	2.00	2.10	2.20

To obtain the average volume of the acid used, the following calculations were used;

Average of the 1st, 2nd and 3rd readings $\frac{(2.00+2.10+2.20)cm^3}{3} = \frac{6.00}{3} = 2.10cm^3$

$= 2.10cm^3$

To calculate the number of moles of NaOH in 25$cm^3$0.02mol dm^3solution

The number of moles of NaOH in 25cm^3

$= \text{VB x M NaOH} = \frac{2.10cm^3 \times 0.02moldm^{-3}}{1000}$

$= 0.00042mol/dm^3$

This is also the number of excess HCl present in 25cm3 of A that reacted with 1Mole of NaOH, then, 1000cm3 of A contains

$$0.00042 \times \frac{1000}{25} = 0.0168\text{mol of excess A}$$

Solution A was prepared by dissolving the egg in 100cm3 of 1Mole HCl, hence the number of mole of HCl initially presents in 1dm3 of solution A is

$$100 \times \frac{1}{1000} = 0.1\text{ of HCl}$$

Then, the number of moles of HCl which reacted with CaCO3 in the eggshell
= 0.1-0.0168= 0.0832
Since 2moles of HCl which reacted with 1mole of CaCO3, then 0.0832 mole of HCl reaction with $100 \times 0.0832 = \frac{4.16}{2} =$

4.16g of CaCO3 which is the mass of CaCO3 presents in the 5g of the eggshell used then the percentage is

$$\frac{4.16\text{g}}{5\text{g}} \times \frac{100\%}{1} = 83.2\%$$

Findings and Discussions

To answer research one from the calculation above, it is discovered that egg shell contains 4.16g of CaCO3out of the 5g used.
To answer research question two, the percentage equivalent is 83.2%

From the analysis, it was discovered that the 5g of the egg shell used contains 4.16g of calcium trioxocarbonate (IV) which is equivalent to 83.2% CaCO3 with some minor impurities, this finding falls in line with the reason advanced by Udemeobong (2004) who also extracted hydrogen trioxonitrate (v) $HNO_3$from yellow cocoyam (Xanthosomaantiquorium). It is also in support of the findings of Iwuoha and Kalu (1995) who also found oxalate crystals ($H_2C_2O_4$), from some plants.

Conclusion

Improvisation in chemistry for effective instructions and improved students learning becomes imperative. This study has established the practicability of using egg shell for teaching and learning quantitative analysis in chemistry. Chemistry teachers are therefore encouraged to integrate the principles and practice of improvisation from local resources into their teaching and students learning processes. This will help

to inculcate creativity skills among chemistry students as well as help to realize the articulated objectives of chemistry curriculum in the school system. It will also reduce the cost and time of the chemistry teachers moving about searching for qualitative reagents used in chemistry classes. The study has also revealed that most of the chemical reagents bought in the market could also be gotten from our locality. In conclusion, since eggshell gives high yield of CaCO3 (83.2%) it should be used as a major source of cations and anions for qualitative analysis.

Recommendations

From the findings of this study, the following recommendations are made to achieve desired and better results in learning outcomes at the secondary a nd post secondary levels in chemistry.

1. Chemistry curriculum planners and chemistry textbook writers should include the use of egg shell as a source of calcium trioxocarbonate (IV) in qualitative analysis.
2. Chemistry teachers should also be encouraged to try to extract CaCO3 for their qualitative analysis from eggshell. This will motivate the students to learn chemistry. It will also push teachers and students to explore for other local materials that have chemical contents for chemistry teaching and learning.
3. Creative skills should be introduced in the teacher Education programmes while preparing those teachers to be at the undergraduate level of our Educational system.
4. Conferences, seminars and workshops should be organized to assist and foster positive teachers' attitude towards making the development of creativity an integral part of chemistry classroom learning.

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