

Elemental Analysis of Metal Contents in Snail Shell Powders: Ashed and Unashed Comparisons

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ABSTRACT

This work was aimed at investigating the metal contents of ashed and unashed shell powders of snail (*Achatina fulica*). The snails were collected and treated according to the American Society for Testing and Material (ASTM D482-91). Potassium (K), Sodium (Na), Calcium (Ca), Magnesium (Mg), Zinc (Zn) and Iron (Fe) in the ashed and unashed snail shell powder was determined. The result showed that the concentration of the metals in the unashed snail shell powder was higher than that of the ashed powder. The differences in the concentration of the metals was linked to the effect of ashing on the formation of silicates of the metals at high temperature (800 °C). At very high temperature, Ca (in the form of calcium carbonate) had very high concentration in both the ashed and unashed snail shell powder. This indicates that snail shell powder can be used as filler in paper industry to improve the paper opacity, or in the cosmetic industry as face powder.

Keywords: *Achatina fulica*, Ashing, Metal contents, Snail shell powder

1. INTRODUCTION

Snail live among wet vegetation. They are most abundant in rainy seasons and are most active at night (Egbon, Jatto, Asia and Ize, 2006). Snail has any useful applications, the edible part of it is used as food whereas its slime is used traditionally as medicine cosmetics, etc. Snail shell on the other hand also has several uses resulting from its hard nature and chemical properties. The shells are known as rich source of calcium and has been used as fillers in the ceramic industry, paint, animal feed, construction and paper industry.

Snail shell is brownish in colour with dark brown markings. Snail shell is usually very hard and protects the snail from predators, dehydration and physical damage. Locally, snail shell is used in the manufacture of jewels, buttons and collections for arts (Jatto, Asia and Medjor, 2010).

Shell powder is an important filler in the paper industry. Because of its calcium carbonate and chitin contents, shell powder can be used to increase the mechanical properties of paper. Such properties include: moisture resistance, smoothness, abrasion, machine flowability, brightness, strength and opacity. Shells in powdery form has also been used in the ceramic industry in the manufacture of breakable plates, pipes and kitchen utensils. The shell is known to increase the hardness of the product, resistance to weathering and strength of the material. The use of snail shell powder in treatment of water has been reported (Jatto, Asia and Egharevba, 2013; Botkin and Edward, 1988; Jatto, Asio and Egharevba, 2013). This research is aimed at determining the concentration of metals (K, Na, Ca, Mg, Zn and Fe) present in the ashed and unashed snail shell powders.

2. MATERIALS AND METHOD Sample collection and preparation

The snail shells was collected from snail meat sellers at Calabar Itu Highway, Akwa Ibom State. The empty shells were washed, dried and ground to powdery form with mortar and pistle. The powder samples were then sieved using a sieve of 63 μ m pore size to obtain a fine powder. The powders were divided into two portions: one portion was subjected to ashing in a muffle furnace at 800 °C for 30 minutes. The second portion was not ashed.

Sample digestion

The ashed snail shell powder (0.002 kg) was weighed into a 50ml standard flask containing hydrochloric acid and water in the ration of 1:1. The flask was made up to 50ml mark with distilled water. The resulting solution was used as a stock solution for the determination. The same procedure was repeated for the unashed snail shell powder.

Analysis of metal contents in the samples

A solar 969 AAS model Flame Atomic Absorption Spectrophotometer was used for the analysis. The lower to upper limit of the instrument was set at 190-900 nm wavelength range and fitted with correct hollow cathode tube. Deionized water was aspirated into air-acetylene flame for zero absorbance at flow rate of 5 cm³ and a current of 3.0 A was passed through the hollow cathode lamb. This was followed by aspiration of blank (aqueous solution of HNO₃), standard solutions and finally, the stock solutions. The corresponding concentrations for the metals detected was recorded from the spectrograph.

3. RESULTS AND DISCUSSION

The concentration of metals in the ashed and unashed snail shell powders is presented in Table 1. In the ashed powder, concentration of Ca was the highest (1685.00 mg/kg), followed by K (596.99 mg/kg). similarly, in the unashed powder, concentration of Ca was equally the highest (1920.00 mg/kg), followed by K (1226.16 mg/kg) respectively. The result revealed that the concentrations of Ca and K were the highest in both the ashed and unashed snail shell powder.

Table 1. Concentration of metals contents in ashed and unashed snail shell powder.

Metal	Concentration in Ashed powder (mg/kg)	Concentration in unashed powder (mg/kg)
K	596.99	1226.16
Na	544.62	671.54
Ca	1685.00	1920.00

Mg	177.95	300.39
Zn	22.45	14.19
Fe	65.12	129.69

Calcium is an important mineral needed in the body. Its main function includes the provision of structure and strength to the skeleton. In the earliest forms of exoskeleton and in shells, the structural rigidity is generally provided by calcium carbonate. In vertebrates such as reptiles, fish, mammals and humans, the structure of the skeleton is mainly provided by a form of calcium phosphate called hydroxyapatite crystals, which are found in collagen. Calcium ions on bone surfaces interact with those present in the bodily fluids, therefore enabling ion exchange, which is essential in maintaining the balance of calcium in the blood and bone. Calcium circulating in the blood is involved in several vital processes including coagulation, nerve signal transmission, hormone signalling and muscle contraction. In this study, calcium content was higher than every other metal investigated. The unashed powder had the highest amount (1920.00 g/kg) compared to the ashed powder which only yielded 1685.00 mg/kg.

Calcium may be used as a reducing agent in the process of metal extraction. Because of the high amount of calcium content in snail shell powder (both ashed and unashed), extraction of the mineral is possible provided it is modified with suitable chemicals that can aid the extraction process. As a result, the powder can find useful applications in the following industrial processes:

- Production of some metals, as an alloying agent.
- The powder can be used as an additive in the production of toothpaste, mineral supplement as well as cement, mortar, glass, plastics, acetylene gas, insecticide, rodenticide, animal feed, fertilizers, blackboard chalk, food additive, wax crayons, cosmetics, plastics and paints, etc.

Various researchers have discovered different industrial applications of snail shell powders. For instance, studies by Andrade *et al.* (2015) revealed that snail shell powder can be applied to wounds to enhance wound healing. Research has shown that snail shell powders when used as a filler, enhances the mechanical properties of plastics such as polypropylene (Onuegbu and Igwe, 2011). The production of chitosan from snail shells as an adsorbent for the removal of Lead (II) Ion and Nickel (II) Ion from aqueous solution as well as its Adsorption Isotherm Model has been studied by Akinyeye, Ibigbami and Odeja (2016).

Similarly, Activated Carbon has been produced from snail shell powder (Gumus and Okpeku, 2015). The study evaluated the use of snail shell powder as a raw material for the preparation of activated carbon using $ZnCl_2$ and $CaCl_2$ with the temperature ranging from 500 °C to 800 °C. The activated carbon prepared was characterized, showing effect of temperature on ash content, pore volume and porosity. The adsorption isotherm for methylene blue was carried out on the activated carbon in a batch study. The adsorbent exhibited excellent adsorption for methylene blue. The experimental data were used for both Langmuir and Freundlich models. The adsorption coefficients of Langmuir isotherm were found to be 0.996 and 0.957 for $CaCl_2$ and $ZnCl_2$ while 0.969 and 0.962 were obtained for the Freundlich isotherm

respectively. The study concluded that activated carbon (produced from snail shell powders), impregnated with CaCl_2 and ZnCl_2 is favourable for adsorption of methylene blue under favourable conditions.

Iron is a very important metal and has been used in several ways. Iron (III) chloride is used in coagulating heavy metals and other unwanted particles from water during treatment. Hence, the use of snail shell powder in the treatment of waste water is justified. The concentration of Fe in the unashed powder was 129.69, this was higher than the concentration of Fe in the ashed powder and lower than 251.23 reported by Jatto *et al.* (2010).

4. CONCLUSIONS

It was observed that the concentrations of the metals were in decreasing order: $\text{Ca} > \text{K} > \text{Na} > \text{Mg} > \text{Fe} > \text{Zn}$ in both the ashed and unashed snail shell powder. The concentrations of the metals also differed in the ashed and unashed powder respectively. Such differences may be due to the effect of ashing at high temperature (800 °C) which must have converted all organic content including chitin and protein into inorganic substances such as carbon compounds in the form of salts and oxides. Calcium for instance, in the form of calcium carbonate must have been changed to calcium oxide. The lower values of the metals in the ashed snail shell powder must have been caused by the formation of silicates of the metals at high ashing temperature. This work has identified some useful metals present in snail shell powder, therefore snail shell powder (ashed and unashed) can be used in industries as fillers, sizing, coagulating and coating agents.

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