PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
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Pakistan Journal of Nutrition 8 (7): 965-969, 2009
ISSN 1680-5194

Analysis of *Egeria radiata* and *Thais coronata* Shells as Alternative Source of Calcium for Food Industry in Nigeria

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Abstract: *Egeria radiata* and *Thais coronata* locally called Nkop and Nko nko respectively by the Efik, are widely eaten by Niger Delta Region of Nigeria. After consuming their soft-flesh, the empty shells are constantly thrown away as waste. This research therefore is to analyzed and ascertains the suitability of these shell wastes as raw materials for calcium supplements. Results of analysis show that these shell contain a high percentage (95.54%) of Calcium Oxide (CaO), 2.52% of Magnesium Oxide (MgO) and trace amount of other oxides. Calcium oxide has been a major source of calcium; it concluded that *Egeria radiata* and *Thais coronata* shells are suitable source raw materials for the production of calcium supplements by our indigenous food industry.

Key words: *Egeria radiata*, *Thais coronata*, calcium supplement, shell wastes

INTRODUCTION

Nigeria is endowed with abundant enormous quantities of seashells. Seashells are hard coated coverings of small to medium size soft-bodied, sea animals found mostly on shores of the world's coastal regions. In West Africa, 2 of the dominant benthic organisms found along its coastal lagoons and mangrove swamp are *Egeria radiata* and *Thais coronata*. In Nigeria, Shellfish seashells are widely eaten for their proteinous and nutritious mineral content (Oyekan, 1984; Avril and Ross, 1999; Ogogo, 2004), by the people of the Niger Delta region of Nigeria. However, after the soft flesh is consumed, their empty shells are constantly thrown away as waste or discarded around settlements as refuse, in spite of their ostensible economic value (Sidney and Young, 1981; Chang, 1991; Claude, 2002). Available evidence shows that these seashells contain a high proportion of Calcium Carbonate ($CaCO_3$) and trace amount of metals oxides which can be exploited and processed as a source of calcium supplement for our indigenous food industry (Bames, 1980; Bajah, 1986; Chapman, 1997; Ogri, 2002; Malu and Bassey, 2003; Kohl and Martin, 2005).

Seashells are known to be useful natural calcium source for food as well as animal feed application. Although, there are other sources of extracting/ processing calcium (i.e., limestone rock, dolomite, gypsum, calcium fluoride, apatite, marble, aragonite, chalk and calcite), because these deposits are extracted in combination with magnesia, silica, iron, alumina and clay minerals as impurities, the cost of extracting/ processing is enormous. In the united state for example, it cost approximately about $60 to $70 to extract and processed one ton of Calcium Carbonate ($CaCO_3$) deposit as compare to that of processing seashells (Lefond, 1983; Slatopolsky, 1986; Miller, 1995; Malu and Bassey, 2003).

In our local communities in Nigeria across the Niger Delta region along the coast, large heaps of shells of consumable selfish are seen dotting around beaches and local markets areas where they can be contracted out at a costless rate for any established food or pharmaceutical company around the region. Flesh of these consumable shellfish are extracted by local fishermen and markets women and deposited at specific areas where, they can be easily source for by our local food and pharmaceutical companies.

The extraction/processing of seashells are quite environmentally friendly than that of quarrying/mining of limestone deposit which comes with pollution of environment and soil erosion (Donatelle, 2005; Meyer, 2006; Barefoot *et al*., 2002). Another source of obtaining calcium carbonate is through the bubbling (electrolysis) of carbon dioxide into calcium hydroxide solution in which calcium carbonate is precipitate out. This process however is expensive (Gerrior and Zizza, 1994; Browne, 1993; Frank and Greer, 2006).

In our Nigeria society of today, there is wide spread concern that inadequate calcium intake has been attributed to several pathological condition and has been identified as a great health problem. Dairy products such as milk, yogurt and cheese, which are the major source of calcium in the typical diet (Subar *et al*., 1998) are expensive and beyond the reach of the common man due to poverty (Nwankwere, 2005). Calcium is a vital mineral in the human body, about 99% of it is stored in our bones and teeth where it functions to support their structure (Shils, 1999). The remaining 1% is found throughout the body in blood, muscle and the fluid between cells. Calcium is needed for muscle contraction, blood vessel contraction and expansion, the secretion of hormones and enzymes and sending messages through the nervous system (Zemel *et al*., 2005). A constant level of calcium is therefore needed to maintained body fluid and tissues so that these vital body processes function efficiently.

In the United State of America for example, according to their continuing survey of Food Intake of Individuals 9CSFII 1994-96), the percentage of their citizens not meeting their dairy recommended intake for calcium (U.S. Department of Agriculture, 1994-96), shows that 44% boys and 58% girls ages 6-11, 64% boys and 87% girls ages 12-19 and 55% boys and 78% girls ages 20+ are not meeting their dairy calcium intake needs. However, this is not the case in a less developed country like Nigeria there are no available data showing level of dietary deficiency on its peoples.

Lack or decreased in calcium level in the body can lead to osteoporosis (a disease associated with sudden bone fracture due to calcium deficiency), numbness and tingling in fingers (Shils, 1999). Others include convulsion, muscle cramps, poor appetite and mental confusion, abnormal heart rhythms and even death to mention just a few. Considering, the large quantities of shell thrown away as waste on a daily basis, especially in the Niger Delta regions of Nigeria alone, despite the growing need to exploit non-oil alternatives to reduce the pressure on oil (Apeh, 2004; Onyibe, 2005). In view of the fact that sustainability has become the unavoidable trend in today's global natural resource exploitation, it is clear that over-dependence on oil and reckless disposal of seashells are likely to have cumulative and negative environmental impacts (Sell, 1981).

Because of the aforementioned problems coupled with high cost of obtaining calcium supplements by the Nigeria teeming population, there is a high level of concern that Nigerians are not meeting the recommended intake of calcium supplements (Table 1) in their daily dietary foods due to widespread poverty among it's population (Nwankwere, 2005). It is therefore, desirable to not only investigate other ways of generating revenue, but also to explore more sustainable and beneficial ways of obtaining cheaper calcium supplements by determining the amount of calcium carbonate present in *Egeria radiata (Nkop-Efik)* and *Thais coronata (Nko nko-Efik)* seashells with the view of utilizing them by our indigenous Food industry.

Table 1: Shows the recommended daily calcium intake for infants, children and adults

Male and female age	Calcium (mg/day)
0-6 months	210
7-12 months	270
1-3 years	500
4-8 years	800
9-13 years	1300
14-18 years	1300
19-50 years	1000
51 + years	1200

mg = milligrams, source: Subar *et al*. (1998)

MATERIALS AND METHODS

Collection and preparation of samples: *Egeria radiata* and *Thais coronata* shells were randomly collected from the Great Kwa River estuary and its environs of Cross River State, South Eastern Nigeria (Osuala, 1990). The sampling was carried out between the months of September and December to reflect the late dry season periods when the influence of tidal waves on the estuary is at low level (Asuquo *et al*., 1999). The collected seashell samples were sorted-out according to their species, put into sample bags (calico bags) and labelled "A" and "B" to distinguish them from each other as shown in Table 1 and Plate 1 and 2.

Treatment of the seashell samples: The seashell samples (80 g) were pre-treated by bonification (to concentrate materials to be analyzed) prior to analyses. The shells of the samples were used while their fleshy parts were discarded. To purify them, the samples were thoroughly washed with warm water, rinsed in distilled water, air-dried for one week and further dried in an oven at 110°C for 6 h, according to pre-treatment recommendations of the Association of Official Analytical Chemists (Harries, 1975). After drying, the samples were each homogenized by crushing them into fine grains using a crusher (Megan Model BB200). The crushed particles were then sieved using a 120 mm mesh. From the pre-treated samples, 10 g each of the pulverized particles labelled "A" and "B" were taken and carefully placed in a clean crucible and weighed, using a Mettler analytical balance. The weighed samples were then placed in an electric muffle furnace and heated for 1 h at 950°C to determine the loss on ignition. The ignited samples were allowed to cool to room temperature in a desiccator and then carefully poured into clean-dried, properly sealed and labelled sample bottles.

Analysis of percentage concentration of oxides in the samples: For each of the representative pre-treated samples, 0.2 g was carefully weighed and placed in a clean, dried crucible. Ten cm^3 of Concentrated Hydrochloric Acid (HCl) was then added to release the metal oxide contents into the solution (Rantala and Loring, 1992). The acid used was of analytical grade. The mixture was placed on a hot plate in a fume cupboard and heated slowly to about 50-60°C for 2 h. Two cm^3 of concentrated HCl acid was added once more and the heating continued until a clear digest solution was obtained.

Plate 1: Egeria radiate seashells

Plate 2: Thais coronata seashells

The clear digest solution was cooled to room temperature, carefully filtered into a plastic volumetric flask and made up to 100 cm^3 with de-ionized water. All glassware and specimen bottles used were initially thoroughly washed with HNO_3 and rinsed with de-ionized water (Sinex *et al.*, 1980). The solution was allowed to stay for 3 days before analysis using atomic absorption spectrophotometer (AAS, Unicam Model 969) equipped with absorption and flame emission modes. The absorption mode was used to determine Fe_2O_3, CaO, MgO, MnO, TiO_2, NiO, CuO ZnO, SrO, ZrO, P_2O_5 and PbO, while the emission mode was used for the determination of K_2O and Na_2O. Working-standard solutions of the elements were prepared for each oxides. The standard solutions and aliquots of the diluted clear digest were used for the determination. Also, standard curves were used to establish the relationship between absorption and concentration (Underwood and Day, 1988). To overcome matrix interferences, all reagents used to treat the samples were added to the working standard in the same proportion (Bilos *et al.*, 1998), while the detection limit of the AAS was <0.001mg/L.

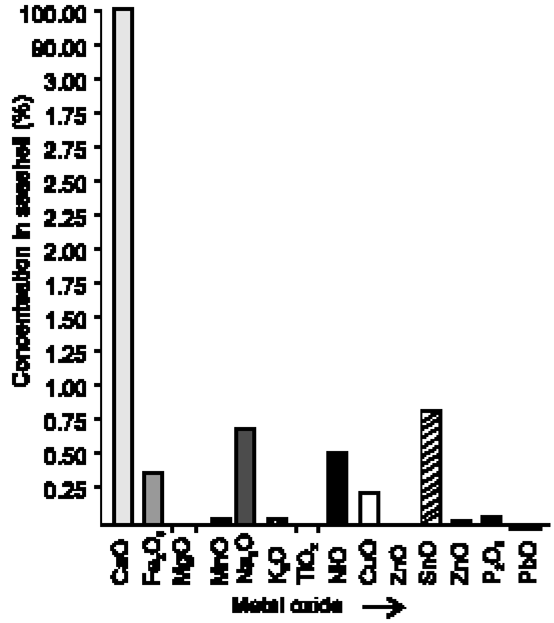

Fig. 1: Bar Chart showing concentration of various metals oxides in seashell sample A (Egeria radiata)

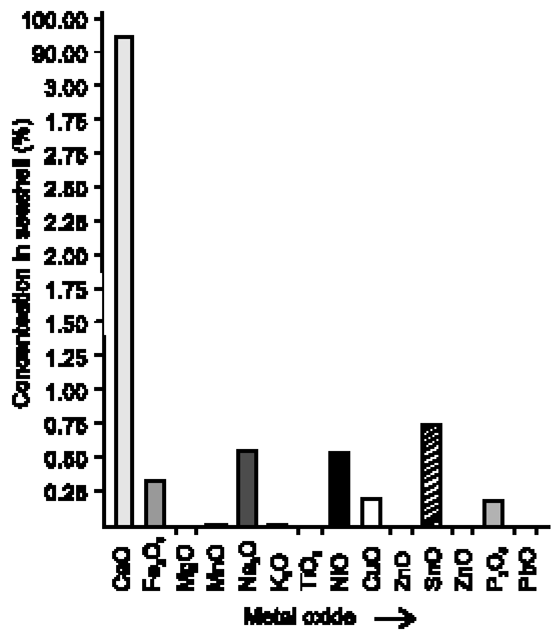

Fig. 2: Bar Chart showing concentration of various metals oxides in seashell sample B (Thais coronata)

Table 2: Seashell samples obtained from the Great Kwa River estuary of Cross River state

Sample code	Biological/Common name	Local name
A	Egeria radiata (common galatea clam)	*Nkop*
B	*Thais coronata* (rock shell)	*Nko nko*

RESULTS

Figure 1 and 2 shows the percentage mean concentrations of the various oxides present in the seashell samples. The result reveals that Calcium Oxide (CaO) is the predominant metal oxide, with 95.54±0.05% in samples "A" and "B". Magnesium oxide is the next dominant oxide with 2.52±0.02%. The percentage mean concentrations of the other oxides were found to be below one percent and therefore, of no commercial significance.

DISCUSSION

Calcium, a predominantly extra cellular cation that helps regulate and promote neuromuscular and enzyme activity, skeletal development and blood coagulation (Zemel *et al*., 2005). The body absorbs calcium from the gastrointestinal tract, provided sufficient vitamin D is present and excretes it in the urine and faeces (Subar, 1998). Over 99% of the body calcium is found in the bones and teeth (Shils, 1999). However, calcium can shift in and out of the bone structures, i.e. when calcium concentrations in the blood falls below normal, calcium ions can move out of the bones and teeth to help restore blood vessels. Parathyroid hormones, vitamin D and to a lesser extent, calcinations and adrenal steroids control calcium blood levels. Calcium and phosphorous are closely related, usually reacting together to form insoluble calcium phosphate. To prevent formation of a precipitate in the blood, calcium levels vary inversely with phosphorous serum calcium level rise, phosphorous levels decrease and it is excreted through renal excretion. Since the body excretes calcium daily, regular ingestion of calcium in food (at least 1g/day) is necessary for normal calcium balance.

Conclusion: In conclusion, this study reveals that calcium oxide a major source of calcium supplements (Sidney and Young, 1981; Donatelle, 2005; Bisi, 2007) exist in commercial quantities in *Egeria radiata and Thais coronata* shells. Most ores or solid minerals do not contain such high concentrations before exploitation is embarked upon (Sell, 1981). Also, analysis conducted on the same region of the Great Kwa River revealed a significant low acceptable level of heavy metal contamination in biota around the region (Ogri, 2002). Furthermore, analysis indicates that, as raw material, *Egeria radiata and Thais coronata* shells generally fulfil the basic requirements of being abundant and cheapness in our local environment for the production of calcium supplements.

From the foregoing discussion, it is conclusive that *Egeria radiata and Thais coronata* shells thrown away as waste in the Niger Delta Region contain enough calcium oxide to make them exploitable as raw material in the compounding and production of calcium supplements/calcium base drugs for our indigenous food industries The proper harnessing of these shells can not only provide employment opportunities for the unemployed, but also serves as a source of non-oil foreign exchange and accelerate our national natural resource and technological development but also as a means of providing cheaper calcium supplements for the Nigerian teeming population leading to a healthy Nat

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