ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue III March 2025

Assessment of Some Mineral and Heavy Metal Contents of Samples of Edible Chalk (*NZU*) Produced in Mbaise, Imo State, Nigeria

Olubiyi, Elizabeth O., Ukozor Alphonsus UC, Okwulehie Felicia C.

Alvan Ikoku Federal University of Education, Owerri,Imo State, Nigeria

DOI: https://doi.org/10.51244/IJRSI.2025.12030059

Received: 20 February 2025; Accepted: 03 March 2025; Published: 11 April 2025

ABSTRACT

The incidence of consumption of food materials with high doze of heavy metals is common. The main purpose of this work was a comparative analysis of mineral and heavy metal of four samples of edible chalk (nzu) produced and in Mbaise, Imo State, Nigeria. Four different samples of edible chalk—ike nzu, ogbake nzu, akuru aku,apiri nzu or apiriaka and oru (pink edible chalk) were selected and purchased from the market of area of study. Calcium and potassium contents were determined by flame photometry, while heavy metals—chromium, lead, nickel and cobalt; magnesium and phosphorus contents were determined by spectrophotometry. Results indicated that calcium contents ranged from 2.52-6.30mg 100^{-1}g, each significantly different ($p<0.05$) from each other; potassium was 0.016-0.02 mg 100^{-1}g, magnesium, 0.22-0.37 mg 100^{-1}g,with a significant difference, and phosphorus,10.74-98.48 mg 100^{-1}g, each significantly different from each other. Heavy metal contents revealed 14.50-25.0 mg 100^{-1}g for chromium, with a significant difference; lead, 5.25-17.50 mg 100^{-1}g, each significantly different from each other; nickel was detected in only akuru aku and apiri api, which ranged from 1.0-1.5 mg 100^{-1}g.No cobalt was detected in the samples. It showed that akuru aku had the greatest value in calcium (6.30mg 100^{-1}g),whereas ike nzu (ogbake nzu) had the greatest values in magnessium (0.37 mg 100^{-1}g),potassium (0.02 mg 100^{-1}g), and phosphorus (98.48 mg 100^{-1}g).Ike nzu also had the greatest values in chromium (25.0 mg 100^{-1}g) and lead (17.50 mg 100^{-1}g), whereas akuru aku had the greatest value (1.5 mg 100^{-1}g).

Key words: Assessment, Heavy metals, Minerals, edible chalk

INTRODUCTION

Edible chalk (*Nzu*) is a type of chalk sold in local stores and markets. It is made with sand, clay, wood ash and salt and comes in a variety of forms from powders, molded shapes and blocks. It is a naturally occurring mineral consumed by members of some Nigerian communities for pleasure, and by pregnant women as a remedy for morning sickness (Abrahams, 2013). It is known as *La Craie* or *Argile* in *French*, *Nzu* and *Ndom* by the Igbo and *Efiks/Ibibios* of Nigeria, respectively, and *Mabele* by the Lingala of Congo. It is sold in blocks, pellets and powder forms. From ages, Igbo people are known to use *nzu* for various events such as child birth celebration, symbol of peace and harmony; herbalists also use *nzu* for advertisements; *nzu* is also used to beautify or decorate traditional cultural dancers, and it is also used for the preservation of foods like beans (Okeke and Obasi,2014).

It was so reported that Igbo people in the United States of America (U.S.A) exported and introduced *nzu* to non-Nigerians which has increased its consumption rate, but recently, there was a report on the presence of heavy metals like lead in *nzu* which is dangerous to the mother and the baby if its high level is consumed (Campbel, 2002). This seems to be a problem which calls for research on the mineral and heavy metal contents of four different samples of edible chalk processed in Mbaise, Imo State, knowing full well that people of Owerri in particular, and Imo State in general, consume *nzu* so much.

Statement of the Problems

Edible chalk (*nzu*) is eaten by people of different ages because of the importance attached to it by the *Igbos* in Nigeria. Despite the love and the cultural importance attached to it among the *Igbos*, it has been reported to

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue III March 2025

contain lead, arsenic, alpha (Campbel, 2002), lindane, endrin and endosuifan among other pollutants. According to Ekong (2012), there are some reports regarding the health risks of consuming *nzu* including the alteration of the normal concentration of haemoglobin, red blood cell counts and erythrocyte sedimentation rate. Another possible side effect of eating it is the alteration of growth rate and demineralization in the femur bone.(Ekong, 2012).Other reports suggest that *nzu* also causes numerous gastrointestinal disorders such as nausea, ulcers and gastritis (Okeke and Obasi,2014). It is on this note that the researchers are interested in carrying out a study on the comparative study of mineral and heavy metals contents of four samples of *nzu*.

Purpose of the Study

The main purpose is comparative study of the mineral and heavy metal contents of four samples of edible chalk produced in Mbaise, Imo State,Nigeria.

Specifically, the study set out to:

1. find out some mineral (calcium, magnesium, potassium and phosphorus) and heavy metal (cobalt,nickel,chromium and lead) contents of four samples of edible chalk produced in Mbaise, Imo State.

2. compare the heavy metal contents in four samples of edible chalk produced in Mbaise, Imo State.

3. compare the mineral contents of four samples of edible chalk produced in Mbaise, Imo State.

Design of the study

The study adopted an experimental research design. It involved laboratory analysis of four different samples of edible chalk (*nzu*) produced in Mbaise in Imo State. The Laboratory analysis was to know the mineral and heavy metal contents of each of the samples in order to know how safe its consumption is.

Area of the Study

The samples for the study were collected from Mbaise in Imo State. Mbaise is located in the southern part of Imo State. Imo State has a boundary with Enugu State in the North, River state in the South, Ebonyi State in the East and Abia State in the West.

Many families in Mbaise are involved in *nzu* making and some of the people of Mbaise are farmers and civil servants. The analysis was carried out in Nigerian Institute of Laboratory Technology, Samanda, lbadan, Oyo State.

Sample and Sampling Techniques

The four samples of edible chalk were bought from Afor Oru market in Ahiazu-Mbaise.

These samples were separately pounded and packaged for laboratory analysis.

Sample A (ordinary form – *ike nzu (Ogbake nzu*): it is the edible chalk (*nzu*) that is rectangular in shape and it is used for both rubbing and eating, no salt is added to it.

Samples B (*Akuru Aku*). It is the edible chalk (*nzu*) that is generally consumed by people; it is round in shape and small in size.

Sample C (the smoked form- *Apiri api or apiraka*). It is the chalk (*nzu*) that is used to rub on the body and it is round in shape and of big size.

Sample D (*Oru* – pink edible chalk). It is the edible chalk (*nzu*) that is pink in colour and it is used by women during child birth and it is also rubbed on children bodies to prevent rashes.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue III March 2025

Method of Laboratory Analysis

Mineral content of the sample was determined following the dry ash extraction method (AOAC,2000). A measured weight of the sample was burnt to ashes (as in ash determination) thereby removing all the organic materials leaving the inorganic ash. The resulting ash was dissolved in 5ml of dilute (0.1 m) HCl solution and then diluted to 100ml in a volumetric flask. This extract was used in specific analysis for the different mineral elements.

Mineral analysis

Determination of Calcium and Potassium by Flame Photometry

The instrument, Jaway digital flame photometer, was set up according to the manufactures instruction. It was switched on and allowed about 10 to 15 minutes to equilibrate. Meanwhile, standard calcium and potassium solutions, respectively were prepared and diluted in series to contain 10, 8, 6, 4, and 2pp of K. After calibrating the instrument, 1ml of each standard was aspirated into it and sprayed over the non-luminous flame. The optical density of the resulting emission from standard solution was recorded. Before flaming, the appropriate element fitter (K) was put in place with the standards measured, the test sample extracts were measured in time and they were plotted into standard curve which was used to extrapolate the content of each test element and calculated as shown below:

$$\text{Ca/K (mg/100g)} = \frac{X}{100\ Va\ W} \times \frac{VF \times DX \times 100}{}$$

Where X is the concentration of the test element from the curve.

Determination of Chromium, Lead, Nickel, Cobalt, Magnesium and Phosphorus

Chromium, Lead, Nickel, Cobalt, Magnesium and Phosphorus in the test samples was determined by the spectrophotometer method (AOAC, 2000). A measured volume of the dry ash (2mg) digest of the samples was dispersed into a 50ml volume flask. At the samples time, the same volume of distilled water and standard p solution were measured into different flask to serve as reagent blank and standard respectively. Then, 2ml of the chromium, lead, nickel, cobalt, magnesium and phosphorus standard reagent (molybdo vanadate solution) respectively was added to each flask and allowed to stand at room temperature for 15 minutes. Content of each flask was diluted to the 50ml mark with distilled water and its absorbance was measured in a spectrophotometer at a wavelength of 540nm with the reagent blank at zero.

$$\text{Cr,/Pb/Ni/Co/Mg/P (mg /100g)} = \frac{100}{W\ As\ Va} \times Au \times C \times Vt$$

Where W = Weight of sample ashes

Au = Absorbance of test sample

As = Absorbance of standard phosphorus solution, C = Concentration of standard phosphorus solution Vt= Total extract volume

Va= Volume of extract analyzed

Statistical Analysis

Means and standard deviation were subjected to one-way analysis of variance (ANOVA) to see if there are significant differences among the four samples of edible chalk (*nzu)* in their mineral and heavy contents using SSPS (2000) Inc. USA.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue III March 2025

RESULTS

Mineral Contents of *Nzu*

Table 1: Mineral contents of edible chalk (*nzu)*

Edible chalk sample	Calcium	Magnesium	Potassium	Phosphorous
	mg/100g	mg/100g	mg/100g	mg/100g
Sample-A	$5.88^{b}\pm0.02$	$0.37^{a}\pm0.03$	$0.018^{a}\pm0.01$	$98.48^{a}\pm0.01$
Sample-B	$6.30^{a}\pm0.01$	$0.36^{a}\pm0.02$	$0.016^{a}\pm0.02$	$30.72^{c}\pm0.03$
Sample-C	$5.34^{c}\pm0.01$	$0.32^{b}\pm0.01$	$0.02^{a}\pm0.0$	$38.70^{b}\pm0.02$
Sample-D	$2.52^{d}\pm0.03$	$0.22^{c}\pm0.01$	$0.02^{a}\pm0.01$	$10.74^{d}\pm0.01$
LSD ($p<0.05$)	0.0237	0.4528	0.2650	1.298

Key: *(±)* standard deviation, mean score with different letters in the same column are significantly different ($p<0.05$), LSD=Least significant difference.

Table 1 presents the mineral contents of four samples of edible chalk (*nzu)* obtained from Mbaise in Imo State. The minerals examined were calcium, magnesium, potassium and phosphorous with their values varying significantly ($p<0.05$). Calcium content of 6.30mg/100g in sample B (*akuru aku*) was the highest, followed by 5.88mg/100g in sample A (*ike nzu*) and 2.52mg/100g in sample D (*oru*) was the least found. Magnesium of the *nzu* samples ranged between 0.37mg/100g in *ike nzu*, sample A to 0.22mg/100g in sample D (*oru*). In addition, the potassium content of *nzu* samples was within values of 0.018mg/100g in sample A (*ike nzu*) and 0.02mg/100g in sample D (*oru*). Phosphorous content differed among the samples of *nzu*. The values ranged from 98.48mg/100g in sample A (*ike nzu*) to 10.74mg/100g in sample D (*oru*).

Table 2: Heavy metal contents of edible chalk *Nzu*

Edible chalk sample	Cobalt mg/100g	Chromium mg/100g	Lead mg/100g	Nickel mg/100g
Sample-A	BDL	$18.0^{b}\pm0.02$	$17.50^{a}\pm0.01$	BDL
Sample-B	BDL	$15.0^{c}\pm0.02$	$15.25^{b}\pm0.03$	$1.50^{a}\pm0.03$
Sample-C	BDL	$14.50^{c}\pm0.01$	$10.25^{c}\pm0.03$	$1.0^{a}\pm0.0$
Sample-D	BDL	$25.0^{a}\pm0.03$	$5.25^{d}\pm0.02$	BDL
LSD ($p<0.05$)		0.3284	0.3362	0.583

Key: *(±)* standard deviation, mean score with different letters in the same column are significantly different ($p<0.05$).LSD= Least Significant Difference, BDL= Below Detectable Limit

Table 2 revealed the result of heavy metal contents of the four samples of edible chalk. The heavy metals of *nzu* samples analyzed were cobalt, chromium, lead and nickel. The values of heavy metals of *nzu* samples varied among the samples significantly ($p<0.05$). However, cobalt was found below detectable limit (BDL) in all samples while nickel was discovered in samples A and D at BDL and samples B and C had 1.50mg/100g and 1.0mg/ 100g, respectively. Chromium content in the samples ranged from 14.50mg/100g in sample C to 25.0mg/100g in sample D. Nickel content varied from 1.0mg/100g in sample C to 1.50mg/100g in from sample B.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue III March 2025

DISCUSSION

Mineral content of edible chalk *Nzu*

The result in Table 1 revealed the comparison of the mineral contents of the four samples of *nzu*. There was a significant difference ($p<0.05$) found on the minerals namely calcium, magnesium, potassium and phosphorous of the samples of edible chalk (*nzu*). The calcium content of 6.30mg/100g in sample B was higher, compared to 5.88mg/100g in sample A, 5.34mg/100g in sample C and 2.52mg/100g in sample D. These values were found below 552mg/kg which is detectable limit in soil sample (Abrahams, Davies, Solomon, Trow and Wragg, 2013).Calcium has been known to be responsible for bone formation and development in the human body. The level of calcium found in these samples could be attributed to a number of factors which include the weathering of rocks in the soil and human activities such as fertilizer application, deposition of industrial chemicals which include petro-chemicals. David, Benjamin, Patrick, (2009) reported that calcium and other minerals such as Zn, Cu, Mn, Mg are essential for human body processes. Magnesium content of edible chalk (*nzu*) was in the range of 0.22- 0.37mg/100g. These values of magnesium discovered in the samples of edible chalk is similar to 224mg/kg (0.22 mg/100g) and their values varied significantly at ($p<0.05$). ref(2014)? The variation observed in magnesium could be attributed to the effect of difference in the chemical profile of soil types and geographical location of the soil. Edible chalk compositions varied from one location to another (Abrahams,2013). Magnesium content found in edible chalk (*nzu*) samples in this work was below 507mg/kg as reported by Abrahams (2013) in his research on clay soil.The point at which the edible chalk is located might have contributed to the amount of mineral content of the *nzu* found in this work and those reported in literature. Potassium content of the *nzu* was within the range of 0.016 to 0.20mg/100g in all the samples. This result discovered about potassium was in line with the report by Kelle-Henrietta, (2014). Edible chalk has been reported to contain low potassium content compared to soil such as humus or sandy soil. The level of potassium in humus or sandy soil may be determined by human practices on the soil such as fertilizer application and some industrial waste (Miller and Donahuer, 2001).

Nutritional importance of potassium is to support various bio-chemical processes in the body system. Therefore, consumption of *nzu* by people has been reported to supply body with minerals. Phosphorous content of the *nzu* samples varied significantly ($p<0.05$). The value of phosphorous showed that 98.48mg/100g in sample A is higher compared to phosphorous content of edible chalk (nzu) from sample B, C, and D respectively. Phosphorous content of *nzu* could be attributed to high content of phosphorous in soil profile generally due to its importance in the soil and plant requirement (Jain, Jagtap and Patel, 2014). Phosphorus is an essential element because of the large amount of phosphorus required for plant growth.

It is also an essential part of the process of photosynthesis, involved in the formation of all oils, sugars, starches, etc. (Singh and Rathore, 2013). Phosphorus is abundant in the fruits of plants and seeds and also plays an important role in plant processes. Similarly, Singh (2013) reported that phosphorus is necessary for seed germination and essential for flowering and fruits formation.

Heavy Metal Contents of Edible Chalk (*Nzu*)

The results of the heavy metals analyzed in the four samples of *nzu* namely, cobalt, chromium, lead and nickel are presented in Table 2. Atimanar and Aldoleya, (2004) had earlier classified them as metals with atomic mass greater than the atomic mass of calcium. The cobalt content in the edible chalk samples was below detectable limit (BDL). This observation was in line with the mean concentration in ppm of cobalt in edible clay samples obtained from different markets in Onitsha and FAO permissible limit (PL) in food substances in the research carried out by Kelle-Henrietta in 2014. Nickel was discovered in two samples, B and C. Nickel content of *nzu* was between 1mg/100g in sample C and 1.5mg/100g in sample C. Kelle-Henrietta (2014) stated that 1.62mg/1000kg was discovered in edible chalk sample. However, cobalt and nickel are classified as essential heavy metals that are needed by living organisms in trace quantities for optimum performance of life processes (Atimanar and Aldoleya, 2004). Insufficient supply of these essential metals in an organism leads to problems associated with growth and ability to complete its life cycle, while sufficient supply results in optimum conditions, an excess supply results in toxic effects and possibly death (Atimanar and Aldoleya,

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue III March 2025

2004).

The result of the comparison of the heavy metals in samples of edible chalk is presented in Table 2.The contents of chromium and lead in the samples varied significantly ($p<0.05$). Chromium content of 25mg/100g in edible chalk sample D was higher than 18mg/100g in sample A, 15mg/100g in sample B and 14.5mg/100g in sample C. But quantity of chromium found in this work was higher than 1.89mg/1000kg reported by Kelle-Henrietta, (2014) in clay samples from different geographical locations and 23mg/kg reported by (Abrahams, 2013). The variation found in this work and those earlier reported in literature may be due to the effect of weathering of rock and volcanic activities (Biney, 2000). Lead (Pb) of edible chalk (*nzu*) ranged from 5.25mg/100g to 17.50mg/100g in samples A to D. Kelle-Henrietta *et al.*, (2014) reported that 3.17ppm in edible chalk was obtained in different markets in Onitsha, Anambra State, while some samples did not show the presence of lead. However, Bryan,(2002) categorized chromium and lead as non- essential heavy metals that may be tolerated at very low concentrations but becomes toxic at higher concentrations. All heavy metals, according to Young and Blevin, (2001), are potentially harmful to most organisms at some levels of exposure and absorption. However, the minimum tolerance levels for heavy metals concentration in plants, fish and man have been published by World Health Organization. However, in some developed countries, concern has been expressed about this consumption – not only in the UK (Food Standards Agency, 2003), but also in Canada (Health Canada, 2007) and the USA (New York City Department of Health and Mental Hygiene, 2012) because of the lead content. The UK Food Standards Agency (2006) had reported (presumably total) Pb concentrations in Calabash chalk that range from 8.2 mg/kg to 16.1 mg/kg, whilst Dean, *et al*. (2004) determined a mean total content of < 40 mg/kg. While these total concentrations are significantly greater than previous World Health Organization guideline limits of 1mg of lead/kg in foodstuffs, an important consideration is the bioavailability (defined here as the fraction that reaches the human systemic circulation from the gastrointestinal [GI] tract) of soil lead. The bioavailability of this lead – and other chemical elements – is strongly dependent on bio- accessibility since if an element is not bio-accessible, it will not be available for absorption (Cave, 2011).

Safety of the edible chalk to the health of the consumers

The findings of the study showed that the mineral contents studied in edible chalk have contribution to the mineral supply to the body of the consumer, thereby preventing deficiency of these nutrients or improving its availability in the body. The main concern was the presence of the heavy metals due to the fact that the clay soil used for the production of the edible chalk is extracted from ground, which is the clay soil, and is not good for planting.

Cobalt

Recommended intake of cobalt is expressed in unit of B-12. An adult needs averagely 2.4 microgram (µg) of B-12 per day, the amount of cobalt in the sample of edible chalk studied (below detectable limit) showed that cobalt does not pose any danger to the health of the consumer. In the soil environment, the heavy metals availability is highly dependent on some soil factors such as soil pH, organic matter, organic clays and oxides coated with organic matter, amount of heavy metals, cation exchange capacity, clay and silt available, with the soil pH having the greatest effect of any single factor in the solubility and retention of heavy metal ions in the soil.

Nickel

According to the United States of America's Department of Agricultural Research Service (2010), humans may need only 25 to 35 micrograms (µg) of Nickel per day. Compared to the content in the four samples studied, A- BDL, B- 1.50µg/100kg, C- 1.0µg/100kg and D – BDL; the content of nickel in the edible chalk samples is not risky in the diet of the consumer.

Chromium

In the consumption of chromium, the recommended dietary intake (RDI) of ages 1 to 3 has a safe amount of

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue III March 2025

11 µg per day, ages 4 to 8 have RDI of 15µg per day, and 9-13 years of age have RDI of 25µg / day. In adults, 25µg/day and 21µg / day for male and female respectively, compared to the amount of chromium in the samples of edible chalk studied, sample A has 18.0µg / 100kg, B has 15.0µg/ 100kg, C has 14.50 µg/ 100kg and D has 25µg/100kg. The concern is on samples A and B which are mostly consumed; daily consumption of 44 pieces of sample B would be equivalent to 15.0 µg/ 100kg, which shows that for an individual to consume 15µg/day, he must have eaten 44 pieces which is not realistic from the survey study of the amount maximally consumed per day. Averagely, children take five pieces per day while an adult can take up to ten per day. With this level of consumption, there may not be any danger per day but its accumulation over a long period of time can be of great danger in the future. An example is that it results from accumulation of lead in the body, which substitutes calcium in bone tissues and leads to disruption of mineralisation, alteration of compositional properties and bone formation mechanisms, as well as the gradual depletion of bone minerals (Gangoso et al, 2009; Ekong et al, 2012)

Lead

The amount of lead in each of the samples is as follows: Sample A-17.50mg/100kg, B-15.25 mg/100kg, C - 10.25 mg/100kg, D - 5.25 mg/100kg, which is very high. There is no amount of lead that is safe in the human body; low level of lead can cause lead poisoning which can cause problems in mental development. The findings of this report are in line with the findings of the Ministry of Health, Canada that the content of lead in consumed edible chalk is high. This may pose a big danger to the health of pregnant women and children who are known to be most consumers of edible chalk The high concentrations of this toxic heavy metal might be due to indiscriminate waste disposal, burning of hazardous waste, agricultural activities, and combustion of fossil fuels.

Conclusion

From the findings of the study, there is significant difference in the contents of mineral (calcium, magnesium, potassium and phosphorous) in the four samples of edible chalk. As much as the amounts of the mineral content varied, it does not pose any danger if moderately consumed, rather it will improve the availability of these minerals in the consumers. Of the heavy metals, the amount of lead in each of the samples of edible chalk may be harmful to the health of the consumer.

RECOMMENDATIONS

1. The use and consumption of edible chalk (*nzu*) for humans should be monitored and regulated as the material has been scientifically proved in this work, like in most earlier reports, to contain some minerals. Some provide nutritional benefits while others are known to be toxic with a high lethality value in edible chalk (*nzu*).

2. People in Imo state, especially the pregnant women should be properly educated on the health implication of consumption of nzu. Though its consumption has become habit as a result of traditional or cultural belief.

REFERENCES

1. Abrahams P.W., Davies T.C., Solomon, A.O., Trow, A.J., and Wragg, J. (2013) Human geophagia, calabash chalk and undongo: Mineral Element Nutritional implications" Pilos one (8) (1) :e53304. doi: 10.1371/journal pone. 0053304.
2. Atimanar, G and Aldoleya, A. (2004). Prospects of Arbuscular mycorrhizal fungi in phytoremediation of heavy metal contaminated soils. Current Science, 86 (4): 528-534
3. Biney, C.A., Calamari, D., Naeve, H., Maembe, T.W., Nyakageni, B. and Saad, M.A.H.(2000). Review of heavy metals in the African aquatic environment. Ecotoxicological Environment, 8:134-159.
4. Bryan, G.W. (2002). Some aspect of heavy metal tolerance in aquatic organisms. In: Effect of pollutants on aquatic organisms A.P.M. Lockwood(ed) Cambridge University Press. 7-34.
5. Campbell H.(2002): Calabash chalk (Calabar stone, La craie, argile, nzu, mabele). CB upper Newtownards Road, Belfast..

6. Cave M.R, Wragg J, Denys S, Jondreville C., and Feidt, C. (2011) Oral bioavailability. In: Swartjes FA, editor. Dealing with contaminated sites (from theory towards practical application). Dordrecht: Springer. 287–384.
7. David N.O, Benjamin L.K and Patrick O.Y, (2009). Some Physicochemical and heavy metal levels in soils of Waste dumpsites in Port Harcourt Municipality and Environs. J. Appl. Sci. Environ. Mgt. 13(4): 65-70.
8. Dean J.R, Deary M.E, Gbefa B.K, and Scott W.C (2004) Characterisation and analysis of persistent organic pollutants and major, minor and trace elements in Calabash chalk. Chemosphere 57: 21–25.
9. Dominy, N.J., Davoust E, and Minekus, M. (2004). Adaptive function of soil consumption; an in vitro study modeling the human stomach and small intestine.Journal of Experimental Biology 207:319-324.
10. Ekong, M.B (2012). Evaluation of edible chalk effect of femur bone morphometry and mineralization in young wistar rats. A pilot study "international journal of applied basic medical research 2 (2): 107-110.
11. Food Standards Agency (2003) Calabash chalk warning. Available: http://www.
12. Food Standards Agency (2006). Annual report of incidents 2006. Available: http://www.food.gov.uk/multimedia/pdfs/incidentsar.pdf Accessed 22 March 2012. Food.gov.uk/foodindustry/imports/banned_restricted/calabash chalk Accessed 22 March 2012.
13. Gangoso,L, Alverez-Liovet,P,RodiguezMavaro,AA, Rafael,M, Giraldo,F,& Doriazar,JA (2009). Long term effect of lead poisoning on bone mineralisation sources. Environmental Pollution,157:569-574
14. Geissler, P.W (2000). The significance of earth eating; social and cultural aspects of geography among Luo children. Africa 70:4, 653-82.
15. Health Canada (2007). Calabash chalk may pose health risk for pregnant and breastfeeding women available: Implications. PLoS ONE 8(1): e53304. doi:10.1371/journal.pone.0053304.
16. Highfield, Roger (April 3, 2008). The medicinal monkey; roots of modern healing found in our hairy relatives. Daily telegraphsAl 9.
17. Hunter, J.M and R.de Klein, (2004). Geography in Central America. Geographical Review, 74 (2); 157-169.
18. Hunter, John M, (2007). Geography in Africa and in the United States. A Culture- Nutrition Hypothesis geographical Review 63: 170-195.
19. Jain S.A, Jagtap M.S, and Patel K.P, (2014). Physico-Chemical Characterization of farmland Soil used in some villages of Lunawada Taluka, Dist : Mahisagar (Gujarat) India,Intl. Journal of Science and Res. Publication, 4(3),1-5.
20. Johns T, (2006). The chemical ecology of human ingestive behaviours. Annual Review of Anthropology 28: 27-50.
21. Krief. S, Huffman M.A, Sevent T, Hladik C,M, Grellier P, Loiseau P.M, and Wrangham
22. R.W (2006). Bioactive properties of plant species ingested by chimpanzees in the Kibale national park, Uganda. American journal of primatology 68 (1): 5-71.
23. Miller R.W. and Donahuer R.L.(2001) Soils in our environment, 7th edn, Prentice Hall, Inc. Upper Saddle River, New Jersey.
24. New York City Department of Health and Mental Hygiene (2012) Calabash chalk containing lead and arsenic. Available: http://www.nyc.gov/html/doh/ downloads/pdf/lead/lead-calabash-chalk-faq.pdf Accessed 22 March 2012.
25. Okeke, C. O. and Obasi,G.T. (2014). Semantic content of Igbo tradition in Nigeria" International Journal of Linguistics and Literature (LJLL)) 3(2), 47-62
26. Ramulu S.U.S, (2001). Re-use of municipal sewage and sludge in agriculture, scientific publishers Jodhpur, India 86.
27. Singh D.P and Rathore M.S, (2013). Available nutrient status and their relationship with soil properties of Aravalli mountain ranges and Malwa Plateau of Pratapgarh, Rajsthan, India.African Journal of Agric.Res.,8(41),5096-5103.
28. Vermeer, D.E, and Ray, E.F. (2004). Nigerian geographical clay; A traditional Antidiarheal pharmaceutical science 227.634-636.
29. Wiley, A.S. and Solomon, H.K (2000). Geography in pregnancy: A test of a Hypothesis, current Anthropology 39 (4): 532-545.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue III March 2025

30. Wilson, M.J (2003). Clay mineralogical and related characteristic of geographic materials Journal of chemical ecology 29: 1525-1547.
31. Young, A.J and Blevin, R.D. (2001): Heavy metal concentration in the Hudson River Basin (Tennessee). Archives of Environmental Contamination and Toxiology, 10:541-560.

APPENDICES

Sample A.