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The Effects of Geophagy on Pregnant Women in Nigeria

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Geophagy, the act of deliberately eating clay is a common practice among pregnant women and children in Nigeria. Several edible Clays such as Montmorillonite, Chabazite-Na, Diaspore, Faujasite-Na, Lizardite-1M, Montmorillonite 15A, lizardite and Montmorillonite were collected across the country from the following states Bauchi, Benue, Gombe, Kogi, Nasarawa, Osun and Plateau respectively. Geochemical analysis were carried out using the XRD and ICP-OES to determine the elements in the clay and the mineralogy of the clay. Heavy metals analyzed for include Aluminium (AL), Arsenic (As), Chromiun (Cr), Cupper (Cu), Iron (Fe), Lead (Pb), Selinium (Se) and Zinc (Zn). The result of the analysis indicates that the Heavy metals have very high concentrations in almost all the clay samples collected. The level of contamination of As, Pb, and Se in the clays from all the states of the study area is also exceptionally high. These metals occur in concentrations far above the WHO recommended dose for human consumption and hence may contribute to so many health hazards, like deformed babies and different types of cancers among women.

Key Words: Heavy Metals, Clay materials, Geophagy, Public health, Fetus, Pregnant women, WHO

Introduction

The deliberate ingestion of earthy or soil-like materials such as clay and chalk is referred to as Geophagy (Crawford and Bodkin 2011). It is common among animals and also in humans but most often in rural societies among pregnant women and children. 40% of women among African descendants practice geophagy (George and Ndip, 2011). People practice geophagy for different reasons. In South Africa, many pregnant women practice geophagy due to cravings, taste and smell of the clay material (George and Ndip, 2011).

In Nigeria clay and earthy materials are used by traditional doctors (Dibias) to cure different diseases most especially in Igbo land eastern-Nigeria (Izugbara and Emmanuel, 2003). Many pregnant women in Africa believe that Geophagy is good for fetal development most especially in Nigeria where the Igbo and Tiv women eat clay during pregnancy. Most time pregnant women who are unable to get adequate medical treatment practice geophagy to derive the necessary element for the development of their unborn babies.

From general survey in the study area, it was discovered that some women eat clay to eliminate nausea. This belief can be attributed to the fact that clay acts as coating material on the gastrointestinal tract and may absorb dangerous toxins (Doel et al., 2012). Among the black descendants it is believed that regular consumption of clay by pregnant women might boost the women's immune system.

This research was carried out to see the effect of clay consumption among the pregnant women from Osun, Kogi, Benue, Nassarawa, Plateau, Bauchi and Gombe state Nigeria.

Literature Review

Geophagy is a phenomenon with cultural and biological underpinning which is believed to give relief to the body under stress (Engberg, 1995). Research reviewed that geophagy is mostly practiced by African descendant (George and Ndip, 2011). Most pregnant women in Africa practice geoghagy because of the belief that particle sizes of the clay makes it suitable to form coatings in the gastro-intestinal tract (Doel et al., 2012). Pregnant women in Africa believe that geophagy is good for fetal development most especially in Nigeria where the Igbo women seek for traditional doctors called Dibias to administer clay material to them during pregnancy (Izugbara and Emmanuel, 2003) .

The act of geophagy constitute to so many health problems faced by pregnant women and their unborn babies. For example, lead (Pb) exposure can cause intelligence decline in children and cause cancer in adults (Wang et al., 2009). Zinc (Zn) is generally

considered to be non-toxic, but can cause vomiting, dehydration, electrolyte imbalance, abdominal pain, nausea, dizziness diarrhea and growth retardation of the unborn baby (Scherz and Kirchhoff, 2006). The study reviewed that Copper (Cu) concentration is far above the (WHO, 2008) daily intake recommendation. Copper has been found to cause cancer hypertension in the dark skinned populations (Pfeiffer and Mailloux, 1987).

For the clay materials to be considered safe for consumption it should be subjected to treatment such as phytoremediation before it is excavated. This is the use of living green plants for in-situ-risk reduction of contamination from earthy materials. For example Thlaspi. caerulescens has been shown to absolve Zn, Pb and other heavy metals from soil (Brett et al., 1998).

Poverty is one of the reasons why people practice geopghagy . More than 2 billion people are said to be poor and in Africa over 45% are under this category (WHO, 2003).

AIM

This research work is aimed primarily at determining the risk associated with the consumption of Clay materials among pregnant women in Nigeria.

Objectives

1. Identify the mineralogy and geochemistry of the geophagic clay minerals
2. Relate geophagy practice with common illnesses and disorders in places where it is common
3. Outline the adverse effects of geophagic practice.

Methodology

Direct method of sample collection was used. This involves preliminary planning and reconnaissance survey. A market survey was conducted and pregnant women from the following states in Nigeria were found to consume edible clay –Plateau, Kogi, Benue, Nassarawa, Osun, Gombe and Bauchi as shown in Figure.1.

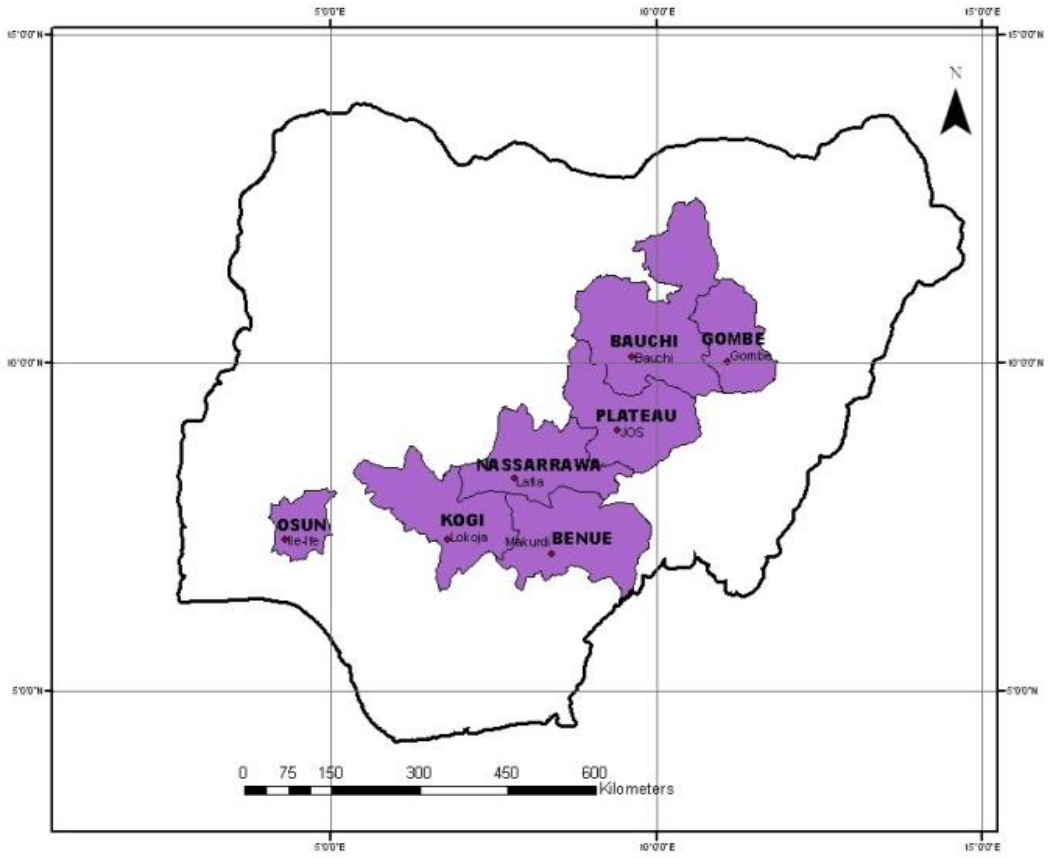


Figure 1. Map of Nigeria Showing the study area.

The study also involved interview with women practicing the act. The survey data were collected by face-to-face interaction with women who practice geophagy in the study area. The study was carried out from June 2010 to November 2012.Two field assistants were used for each of the states. The field assistants were natives who were undergraduate students from various universities in the study area.

The introductory part of the research was to gather information on the socio-demographics of the pregnant women and to also investigate why this act is being practiced. To effectively understand the effect of the clay on the pregnant women, the mineralogy/elemental composition of these clays were determined. Seven samples were analyzed using ICP-OES and XRD analytical methods. The Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) was carried out at the Geochemistry Laboratory of the Department of Geology and Mining, University of Jos to determine the elemental composition of the clay samples while X-Ray Diffraction Spectrometry (XRD) was done at the National Steel Raw Materials Exploration Agency, Kaduna Nigeria to determine the mineralogy of the clay.

Anthropogenic Factor (AF) was calculated to see the influence of human activities on the clay as seen in Table 4.The equation for calculating AF is shown below-

$$AF = \frac{Cm}{Cb} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where Cm = Measured concentration of sample.
Cb= Average abundance on the earth crust given the values used.

To assess the pollution of the heavy metal, Geoaccumulation index *(I*geo*)* was used to assesses Heavy metals pollution in terms of seven (0 to 6) enrichment classes.

The equation for calculating Geoaccumulation index (Muller, 1979) is shown below-

$$I(geo) = \log2 [(Cm/1.5xCb)] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The results are shown in Table 5. The factor 1.5 is introduced in this equation to minimize the effect of possible variations in the background values which may be attributed to lithogenic variations in soils. The seven proposed descriptive classes for *Igeo* values are given below

- >5,Extremely contaminated
- 4 – 5,Strongly to extremely contaminated
- 3 – 4,Strongly contaminated
- 2 – 3,Moderately to strongly contaminated
- 1 – 2,Moderately contaminated
- 0 – 1,Uncontaminated to moderately contaminated
- ≤0 ,Uncontaminated

Table 1. The socio-demographic characteristics of the respondents.

	level of education				Marital status		occupation			
	No formal education	primary	Secondary	tertiary	Single	married	House keepers	Farmers	Petty traders/business women	Working class
Pregnant women	10	100	90	10	30	180	30	50	110	20
Percentage %	4.76	47.62	42.89	4.76	14.29	85.71	14.29	23.81	52.38	0.95

Total no of women (20-40yrs) =210

Table 2. Mineralogy and geochemistry of the clay samples

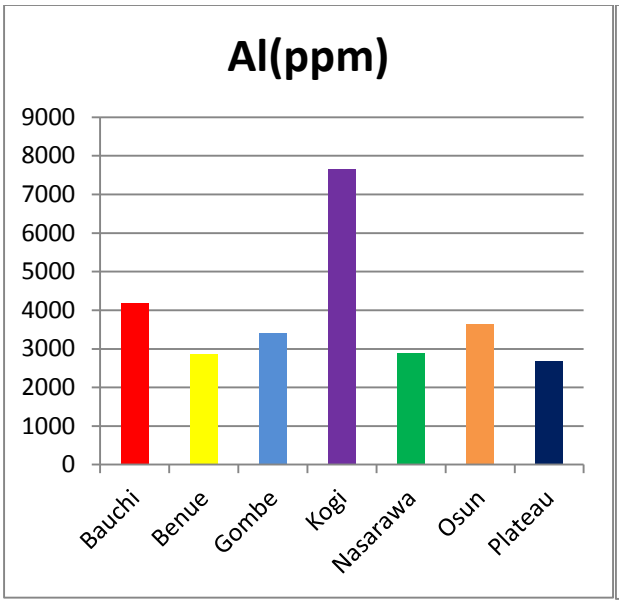
	Al (ppm)	As (ppm)	Cr (ppm)	Fe (ppm)	Cu (ppm)	Pb (ppm)	Se (ppm)	Zn (ppm)
Bauchi	41950.20	105.28	16.24	5774.40	1.590	186.78	99.14	14.61
Benue	2869.72	96.511	6.16	1881.85	1.42	86.29	170.70	7.234
Gombe	3418.09	99.036	13.20	4340.04	23.87	45.24	192.98	0
Kogi	7637.27	0	22.42	5774.40	12.79	63.82	0	82.89
Nasarawa	2876071	104.78	5.99	1853.88	3.31	45.45	140.34	13.30
Osun	3639.84	16.65	8.93	1784.96	6.67	110.47	94.13	31.07
Plateau	2695.92	78.04	6.25	2370.29	1.126	22.59	176.79	22.59

Table 3. Concentration of heavy metals in the clay samples

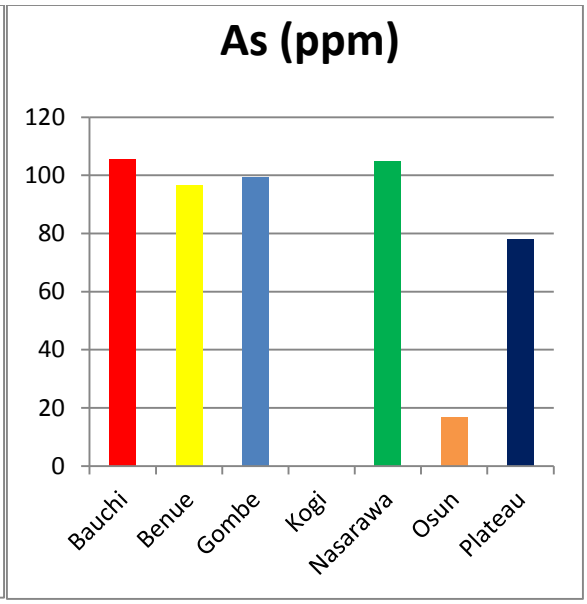
	Al (ppm)	As (ppm)	Cr (ppm)	Fe (ppm)	Cu (ppm)	Pb (ppm)	Se (ppm)	Zn (ppm)
Bauchi	0.051	50.10	0.12	0.092	0.023	1.870	1985	0.185
Benue	0.035	46.01	0.044	0.030	0.021	8.639	3418	0.092
Gombe	0.042	47.39	0.0094	0.069	0.351	4.530	3864	0
Kogi	0.093	0	0.160	0.092	0.188	6.390	0	1.051
Nasarawa	0.035	49.95	0.043	0.029	0.049	4.551	2810	0.167
Osun	0.044	7.94	0.0064	0.028	0.098	11.06	1884.8	0.394
Plateau	0.033	37.20	0.045	0.038	0.017	2.262	3540	0.286

Table 4. Values of index of geoaccumulation (Igeo) of heavy metals

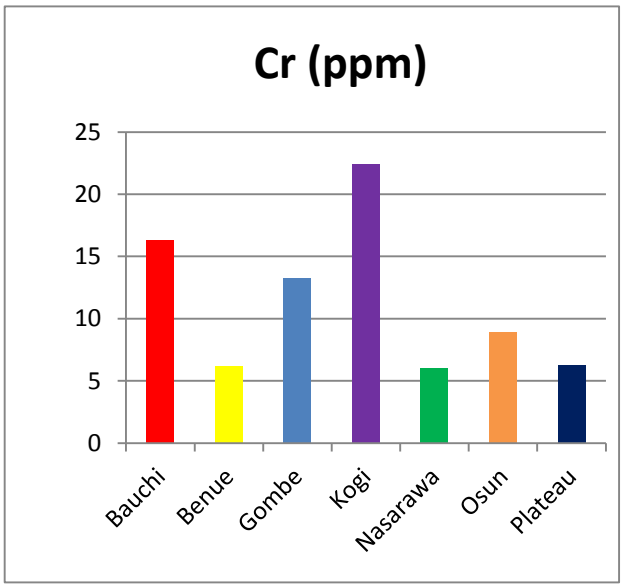
	Al	As	Cr	Fe	Cu	Pb	Se	Zn
Bauchi	0.01024	**10.012**	0.0232	0.0184	0.00473	**3.7529**	**398.26**	0.03715
Benue	0.00704	**9.2326**	0.00873	0.00602	0.0042	**1.7336**	**685.75**	0.01840
Gombe	0.00837	**9.5095**	0.01896	0.01385	0.0704	**0.9091**	**775.45**	0
Kogi	0.01867	0	0.0322	0.0184	0.03793	**1.2824**	0	0.2108
Nasarawa	0.0069	**10.028**	0.00873	0.0059	0.0099	**0.91333**	**563.92**	0.03383
Osun	0.00903	**2.3896**	0.01294	0.00568	0.0197	**2.2196**	**378.25**	0.07902
Plateau	0.0066	**7.4664**	0.00897	0.07526	0.00333	0.4539	**710.43**	0.05746



WHO daily recommended value = 0.03



WHO daily recommended value =0.01



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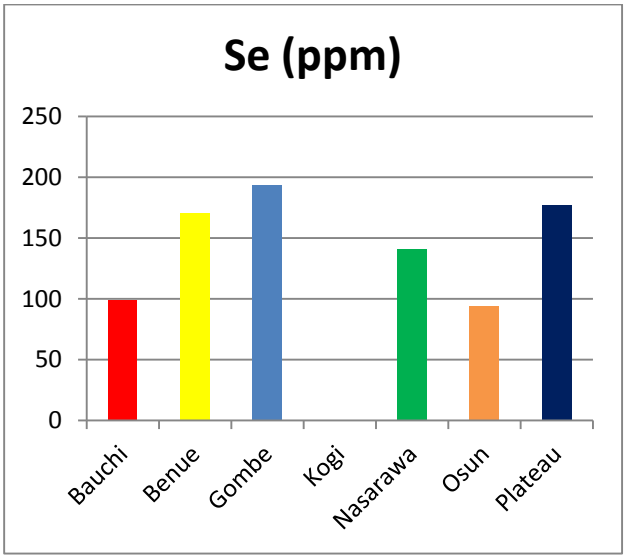

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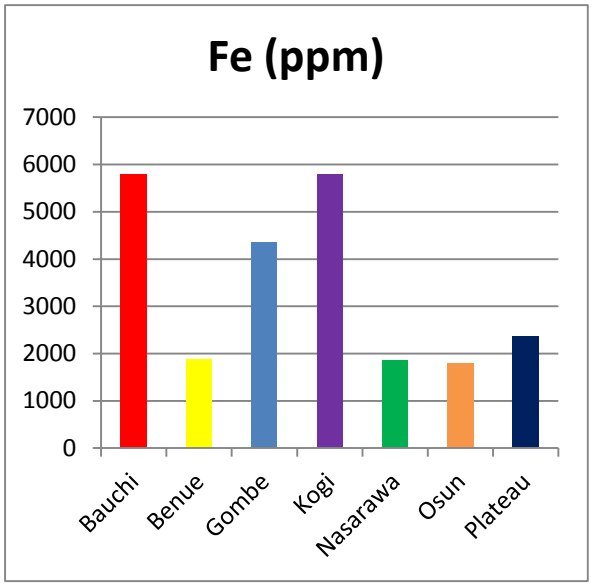
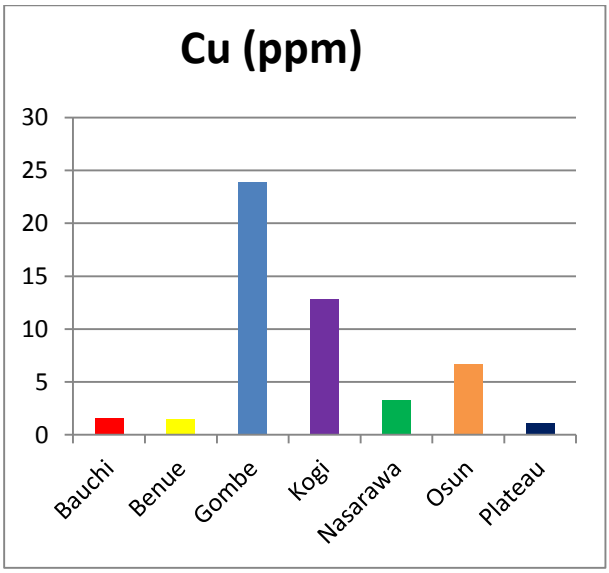
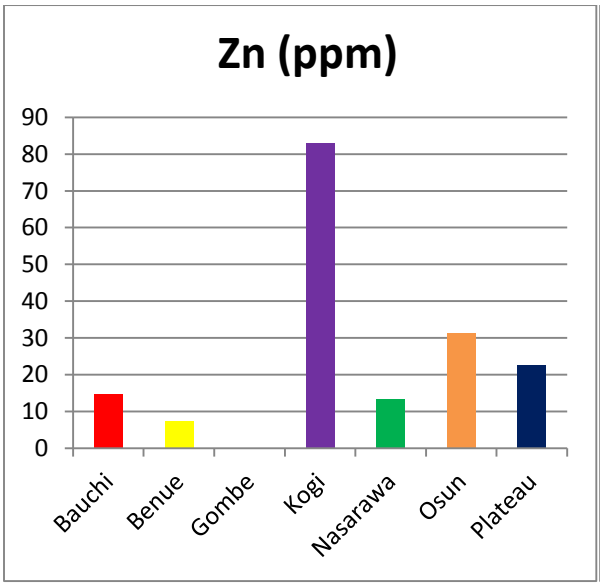


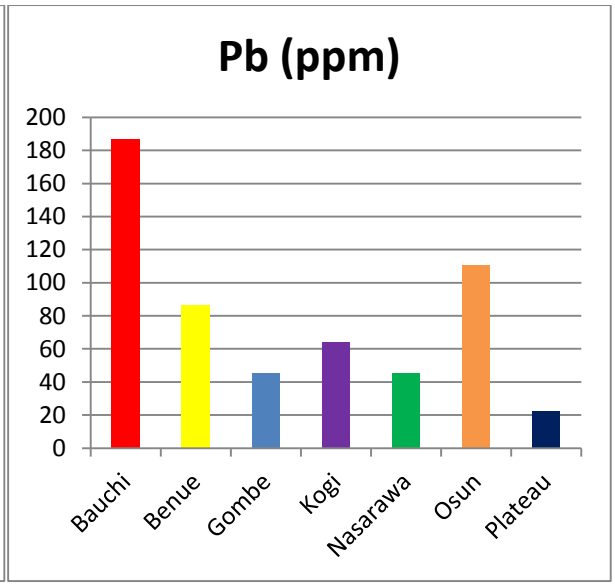
WHO daily recommended value =0.01



WHO daily recommended value =2



WHO daily recommended value =0.01



WHO daily recommended value =0.01

Figure 2. Histograms showing the concentration of heavy metals in Clay samples collected from the seven states

Results

The socio-demographic characteristics of the pregnant women are shown in Table1. In the age brackets of 20-40, there were 210 pregnant women. The educational profile of the respondents shows that most of the pregnant women only had little education but it was recorded that about 4.76% women had no education, while persons with primary education was about 47.62%, persons with secondary education were about 42.89% while 4.76% had tertiary education as shown in Table 1.

The XRD analysis carried out as seen in Table 2 analysis shows that the clay consumed in Bauchi state is Montmorillonite while the clay from Benue state is Chabazite-Na. From the analysis the compound name, chemical name and chemical formula of the clays were also determined. Fig.2 shows reasons why people are involved in the practice. The ICP-OES analysis determined the concentration of heavy metals in the samples (Clay materials) as shown in Table 3.

The anthropogenic factor (AF) calculated for all the samples are shown in Table 4 to determine the influence of human activities on the clay samples, while the values of index of accumulation (Igeo) of heavy metals were also calculated to see the level of contamination of the heavy metals as shown in Table 6.

Finally, the concentration of the heavy metals from the study area is represented in histogrames as seen in Figure.4.

Discussions

Women in the study area indulge in geophagy for many reasons; For some women it is a way of satisfying their natural craving while the rest of the respondents believed that the act help in reducing vomiting and salivating during pregnancy.

Most of the women are married with majority being petty traders as shown in Table 1. Most of the respondents who practice geophagy are actually poor and illiterate. Basic socio-demographic characteristics of the pregnant women indicate that only 5% of the women have tertiary level of education as seen in Table 1.

The highest concentration of aluminum was found in the sample from Kogi State (7646ppm). About 32 weeks of exposure to aluminium can increase the migration of MCF-7 human breast cancer cell and breast cancer has been one of the highest cause of death among women in recent years (Plilippa, et al., 2013). Daily recommended value for Aluminium is 0.03pmm (WHO, 2008) pregnant women consuming clay might be vulnerable to cancer.

Arsenic have concentrations between 16.67ppm to 105.4ppm in samples from Bauchi, Benue, Gombe, Nasarawa, Plateau and Osun States while the sample from Kogi state recorded 0 ppm . Exposure to arsenic has therapeutic effect on cancer of the cervic (Hung-Chin et al., 2010). Arsenic can also cause high blood pressure and other cardiovascular diseases in pregnant women (Richard, 2007). Daily recommended value is 0.01pmm (WHO, 2008).

Chromium recorded high concentration in the clay sample from Kogi State as shown in Fig.2 (22.45ppm) while Plateau state had the lowest value of 5.99ppm which is far above WHO recommendation value of 0.05ppm (WHO, 2008). Chromium (Cr) has been reported to be responsible for lung cancer and death (Shanker and Venkateswarlu, 2011).

Copper concentration is highest in the sample from Gombe state with about 23.90 ppm. The lowest concentration of Copper (Cu) was recorded in samples from Nassarawa with about 3.317ppm . Excess Copper may be the largest factor in the etiology of hypertension. Copper has been a cause of cancer hypertension in dark skinned populations (Pfeiffer and Mailloux, 1987). Daily recommended value is 2ppm (WHO, 2008).

Kogi State had the highest concentration of iron (Fe) with 5781 ppm. Pregnant women from Kogi and Bauchi State may suffer from liver damage. Iron (Fe) can serve as supplement for those who lack Iron in their blood .High level of Fe in the blood can lead to Hemochromatosis and eventually death (WHO, 2008).

Clays from Bauchi had the highest concentration of lead (Pb) with 187.0 ppm followed by Osun state with 110.6 ppm while Plateau State had the lowest concentration of 22.62 ppm. Daily recommended value for lead (Pb) is 0.01ppm (WHO, 2008) Studies suggest that lead absorption is harmful at any concentration and that no safe level of lead exposure exists. Lead exposure can cause intelligence decline in children and causes cancer in adults (Wang et al., 2009).

Plateau state recorded the highest concentration of Se at 177.0 ppm. Selenium acts as an antioxidant if taken in sufficient amount but from the study area most especially Plateau and Benue State, the pregnant women are consuming Se far above the daily recommended dose by WHO which is 0.01ppm (WHO,2008). If Selenium is taken in high dose it can cause type 2 diabetes and selenosis (Fordyce et al., 2009).

Zinc (Zn) concentration in the clay was high in samples from Kogi state with 82.99 ppm Zn in the clay. Clay sample from Osun State also had a high concentration of 31.11 ppm while minimal concentration was recorded from the other states in the study area. Studies have shown that over exposure to

zinc can lead to abnormal drowsiness, nausea/vomiting, diarrhea and growth retardation of the unborn baby (Scherz and Kirchhoff, 2006). Daily recommended value for Zinc (Zn) is 0.01 (WHO, 2008).

From the influence of Anthropogenic factor (AF) calculated it was discovered that Selenium (Se) had the highest value from all the states except for Kogi state. From Geoaccumation Index (Igeo) calculation, Se was also more polluted from all the states except Kogi State. This signifies that the element Selenium (Se) was contaminated due to both anthropogenic and geological processes.

Conclusion

During the course of this research work, it was observed that most of the people that engaged themselves in geophagy in Nigeria are pregnant women. These women practice geophagy because it is an inherited culture that have been practiced by their ancestors in order to aid fetus development and to stop vomiting during pregnancy.

Geochemistry of the clay samples varies according to the geology of the region where the clay is extracted giving rise to very noticeable variations in the concentrations of the elements. Toxic elements like Arsenic (As), Lead (Pb), Aluminum (Al), Selenium (Se), Zinc (Zn) and Chromium (Cr) were found in the clay samples from the study area.

This study shows that most of these elements in the clays are far above the WHO standard and can cause several diseases such as breast cancer due to abnormal concentrations of aluminum, cervical cancer due to abnormal concentrations of arsenic, lung cancer due to high concentrations of chromium, hypertension due to abnormal concentrations of copper, intelligence decline in children due to abnormal concentrations of lead. The pregnant women can also be exposed to type 2 diabetes due to high concentrations of selenium and finally the unborn babies can experience growth retardation due to abnormal concentrations of zinc in the study area.

From this research it was discovered that it is risky to practice geophagy in the study areas because most of the heavy element exceeded the WHO, 2008 standard for daily intake. However if the clay are subjected to treatment through phytoremediation which is, the use of plants for in-situ-risk reduction of contamination from clay it can reduce the risk, for example Thlaspi. caerulescens has be shown to absolve Zn, Pb and other heavy metals (Brett et al., 1998).Lastly, the general level of poverty should be alleviated. Most of the women cannot afford modern counseling and medication in hospitals and clinics, therefore locals are forced to adhere to their traditions and values hence sticking to consumption of clay materials during pregnancy.

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