Potential health risk assessment of toxic metals contamination in clay eaten as pica (geophagia) among pregnant women of Ho in the Volta Region of Ghana.

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Nii Korley Kortei
University of Health and Allied Sciences

nkkortei@uhas.edu.gh*Corresponding Author*
ORCiD: https://orcid.org/0000-0002-8863-4694

Papa Toah Akonor
CSIR-Food Research Institute

Nana Yaw Barima Manaphraim
University of Health and Allied Sciences

Matilda Ayim-Akonor
CSIR-Animal Research Institute

Nathaniel Owusu Boadi
Kwame Nkrumah University of Science and Technology College of Agriculture and Natural Resources

Edward Ken Essuman
University of Health and Allied Sciences

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Abstract

Introduction: Geophagia although pleasurable and somewhat a necessity among pregnant women, also comes along with its own attendant problems such as exposure to potentially hazardous substances like bacteria, fungi, helminthes and ova, radioactive materials, and toxic elemental minerals in the soil depending on the geographical location.

Methodology: This study evaluated the potential health risk involved during the exposure of pregnant women to toxic elemental minerals via the consumption of clay as pica (geophagia). Elemental mineral analysis was carried out using Buck Scientific 210VGP Flame Atomic Absorption Spectrophotometer (Buck Scientific, Inc. East Norwalk, USA). Risk assessment methods were also used to ascertain the various risks factors and the overall risk level.

Results: Concentrations of the macro elements investigated were 1.38 ± 1.5, 2.40± 1.5, 7.74± 1.5, 4.01± 1.0, 13.24± 2.2 and 13.76± 2.1 mg/Kg for Fe, Cu, Zn, K, Mg and Na respectively. While that for the micro elements were 1.63± 0.03 µg/Kg, 4.72±0.8, 0.53±0.02 and 1.85±0.3 mg/kg respectively for Arsenic, Manganese, Lead and Nickel. Estimated Daily Intake (EDI), Hazard Quotient (HQ), Target Hazard Quotient (THQ) and Total Target Hazard Quotient (TTHQ) values ranged 0.611- 5.44 (mg/kg Bw/day), 6.26x10 -4 – 106.5, 0.067-10.34 and 15 respectively.

Conclusion: There is the likelihood of posing adverse health problems when clay samples obtained from Anfoega which is sited in the Volta region of Ghana is consumed due to the fact that the calculated HQ’s of these elemental minerals were >1 which points to high content of Manganese (Mn) and Nickel (Ni). It is also likely to cause adverse health problems in an individual’s life time since THQ for Arsenic, Lead and Nickel were above 1. Ultimately, the cumulative effect of these toxicants were exceedingly great (≤ 15) which implied a high level of unsafety associated with this clay. Per the results from this study, it is not safe for pregnant women to consume clay as pica since these toxic elements may cause detrimental effects on the foetus of the unborn child.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Tables

Table 1. Exposure parameters used for the health risk estimations via consumption of clay [27] (US EPA)

Parameter	Unit	Child	Adult
Body Weight (BW)	Kg	15	75
Exposure	Days/ years	365	365
Frequency (EF)			
Exposure	Years	6	30
Duration			
Ingestion Rate (IR_{clay})	mg/day	200	100
Average Time (AT)	Days/years		
For carcinogenic		365x70	366x70
For non-carcinogenic		365x ED	365x ED

Table 2. Concentrations of minerals (macro) levels in Clay samples

Mineral Element	Mean concentration	Recommended Dietary Intake (RDI) WHO [28]
Iron	1.38 ± 1.5 mg/Kg	18 mg
Copper	2.40 ± 1.5 mg/Kg	0.9 mg
Zinc	7.74 ± 1.5 mg/Kg	11 mg
Potassium	4.01 ± 1.0 mg/Kg	3100-3500 mg
Magnesium	13.24 ± 2.2 mg/Kg	280-350 mg
Sodium	13.76 ± 2.1 mg/Kg	500-2400 mg

Table 3. Mean concentrations of Heavy metals in clay samples

Mineral element	Mean Concentration	WHO/FAO PMTDI (µg/Kg BW/day)	PMTDI for 60
Arsenic	1.63 ± 0.03 µg/Kg	3.0	180
Manganese	4.72 ± 0.8 mg/Kg	4.9 mg/Kg	294
Lead	0.53 ± 0.02 mg/Kg	3.0	180
Nickel	1.85 ± 0.3 mg/Kg	5.0	300

Table 4: Reference doses (RFD) mg $kg^{-1}day^{-1}$ for heavy metals used in this study

Heavy metals	Reference Doses	Cancer slope factor	References
Arsenic	$3.0x10^{-4}$	1.50	[27] [31]
Copper	$4.0x10^{-2}$	N/A	[31]
Lead	$3.5x10^{-3}$	8.5×10^{-3}	[27]
Manganese	0.14	N/A	[31]
Nickel	0.02	9.10×10^{-1}	[31] [32]

Table 5: Calculated Estimated Daily Intake, Hazard Quotient, Target Harzard Quotients and Cancer Risks of the Heavy metals in clay samples

Heavy Metal	Sample	EDI (mg/kg Bw/day)	HQ	THQ	Cance Risk
Arsenic	Clay	1.88	$6.26x10^{-4}$	2.62	2.82
Copper	Clay	2.767	0.069	0.067	N/A
Lead	Clay	0.611	$1.75x10^{-3}$	1.69	0.052
Manganese	Clay	5.44	38.86	0.377	N/A
Nickel	Clay	2.13	106.5	10.34	19.38

N/A – Not available

Total Target Harzard Quotient (Clay) = 2.62 + 0.067 +1.69 + 0.377 + 10.34

=15

Figures

Figure 1

Map of Ghana showing sampling site of clay samples used in the study