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Heavy Metal Concentrations in Food Crops Grown In Crude Oil Impacted Soils in Olomoro, Delta State-Nigeria and Their Health Implications

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This research examines the heavy metal concentrations in crude-oil impacted soil (site 1) and un-impacted soils (site 2), in Olomoro, an oil producing community in Delta state. It also examines heavy metal concentrations in cassava tubers (cortex) and in plantain fruits (mesocarp) grown and harvested at both sites and the health implications of consuming these food crops. Heavy metal concentrations of soils pooled from both sites were compared. Results showed higher values of Cr, Cu, Fe, Pb, and Zn at site 1 than site 2, indicating that there is significant difference between both soils ($p<0.05$). Food crops grown and harvested from both sites were also compared, and results showed higher values in crops harvested at site 1 than those harvested at site 2, indicating a significant difference between food crops grown and harvested from both sites ($p<0.05$). Crops harvested from site 1 were compared with WHO acceptable limits for food and results showed that only Pb was above permissible limits (0.30mg/kg). Zn and Pb showed high accumulation in both food crops suggesting that there is a likely possibility of Zn and Pb poisoning if contaminated food crops are ingested. Research methods also involved the use of two structured questionnaire. The first questionnaire examined 130 households with 10 numbers of items to identify the common diseases experienced in households among others, while the second questionnaire administered to medical personnel showed the degree of prevalence of these common diseases. Common ailments experienced by household members were acute headache, body pain, stomach disorder, nausea/ vomiting and dizziness (acute symptoms of Pb and Zn poisoning) which were reported to be prevalently high among the people, while cancer, bone malformation in children, mental illness and depression (chronic symptoms) were not as prevalent as the acute symptoms of Pb and Zn toxicity mentioned earlier. The paper recommends among others that agricultural activities be carried out 5km away from petroleum activities/ oil spill sites and that public awareness and enlightenment be done in rural areas to warn the people about the dangers of consuming contaminated food crops and the associated health implications, since most of the populace are illiterates.

KEYWORDS: Crude Oil, Food Crops, Impacted Soils, Heavy metals, Oil pollution

I. INTRODUCTION

Background of the Study

Crude oil has had profound impact on the world civilization than any single natural resources in recorded history. Nigeria joined the league of oil producing nations on August 3rd, 1956 when crude oil was discovered in Oloibiri, a village in Ogbia L.G.A of Niger Delta (present day Bayelsa State) and today ranks as the leading oil and gas producer in Africa and the 6th largest oil exporter in the world. According to the statistics bulletin of Central Bank of Nigeria (CBN, 2004), the average contribution of oil to the government export revenue and natural earnings between 1970 and 2004 was 93 percent .Crude oil exploration has taken place in five major sedimentary basins, namely; the Niger Delta, the Anambra Basin, the Benue Trough, the Chad Basin and the Benin Basin. The most prospective basin is the Niger Delta. The Niger Delta Region, the world's largest wetland accounts for 7.5 percent of the total landmass of Nigeria (Ugbomeh and Atubi, 2010). With an estimated population of about 2 million, the region's oil resources account for 90 percent of the nation's export earnings. The region also houses over 600 oil fields, 5284 on and off-shore oil wells, 10 export terminals, 272 flow stations, 4 refineries and a Liquefied Natural Gas (LNG) project, with an estimated oil reserve of 30 billion barrels (Lubeck, Michael and Lipschutz; 2007). There is no doubt that Crude oil and other associated petroleum activities have brought prosperity, better living conditions and general economic development to Nigeria (Okpara, 2004). However the irony is that the region that produce this large percentage of national wealth continue to experience abject poverty, psychosocial and environmental abuse and degradation resulting from intensive exploration/exploitation of the petroleum resource yielding the wealth.

The Niger Delta Region, over the years, have witnessed massive soil fertility loss (Nwuche and Ugorji, 2010), agricultural decline (Duru, 2005), oil spillage and gas flare (Ezebuiro, 2004), fisheries decline and depletion of biodiversity (Ikelegbe, 2004). Oil spill has also been observed to cause death of plants, and have been linked with blood contamination of people working at impacted sites (McKelvey, Charon, and Jeffery; 2007).One of the greatest problems associated with oil pollution is the constant exposure to high concentrations of heavy metals from oil (Nkwocha and Duru, 2010). Crude oil is a complex mixture containing hundred of aliphatic, alycyclic and aromatic hydrocarbons and non hydrocarbon compounds including heavy metals as well as varying amounts of oxygen, nitrogen and sulphur (Okolo, Nnamdi, and Odu; 2005). The uncontrolled input of heavy metal in soil through oil spillage is undesirable because once accumulated in the soil, the metals are generally very difficult to remove. Nigerian crude oil contain heavy metals such as Zn, Al, As, Ba, Fe, Pb, Co, Cu, Cr, Mn, Hg, Cd, Sb, Ni and V, therefore plants growing in crude oil impacted soils can accumulate the toxic metals at high concentrations causing serious risk to human health when consumed (Nkwocha and Duru, 2010). Once heavy metals contaminate a soil, it remains so indefinitely. They may find their way into many environments through agricultural crops, soil surface and ground water where they undergo a process of redistribution and are now detected at different levels of concentration in the food chain (Oviasogie and Ukpebor, 2003). Most frequent metal contamination include: Zn, Pb, Fe, Cu, and Cr, hence the need to investigate their levels in crude oil impacted soils in Olomoro community, Delta state, because to a greater or lesser degree, all of these metals are toxic to humans, through the dietary pathway . It is based on this premise that this study seeks to investigate the heavy metal concentration in plants found in crude oil impacted soil of Olomoro community.

II. STATEMENT OF THE PROBLEM

This study has become very imperative due to the environmental degradation occasioned by oil spill in Olomoro community of Delta State, Nigeria. Over the last forty years, oil exploration and exploitation has impacted negatively on the socio-physical environment of the Niger Delta oil bearing communities including Olomoro, massively threatening the subsistent farming and peasant economy, the environment, livelihood, and basic survival of the people (Ezebuiro, 2004). Several hectares of land have been rendered useless by oil spills in this community. The community faces some specific problems like unemployment, potential loss of habitat such as mangrove and unsafe water for drinking.Heavy metal pollution may constitute hazard to the health of Olomoro people who grow and consume crops grown on crude oil impacted soils. Data on heavy metals in soil is important in determining the quality and health impact such soil could have on the food chain; – soil-plant-animal-humans. Most people who live in Olomoro, farm in crude oil impacted soils, since most of their farmland has been lost to oil spillage. Most farmers are ignorant of the consequences of growing crops in contaminated soils; it is therefore possible that the crops harvested could contain heavy metals. It has been widely documented that the consumption of food crops contaminated with heavy metals may lead to serious systemic health problems in the body of the affected person (Griggs, 2004). Despite these findings, few studies in Nigeria have attempted to examine the effects of growing and consuming food crops grown in oil impacted soils, therefore, there is a need to carry out this study, in order to address the health related implications of consuming these food crops, so as to reduce health problems and if possible avoid the loss of lives in Olomoro community.

Research Aim and Objectives

The aim of this study is to investigate the heavy metal levels; Zn, Cu, Pb, Fe and Cr in soils and food crops found in crude oil impacted soils in Olomoro community and the health implications.

[1] In order to achieve the stated aim, the following objectives were pursued:
[2] To determine heavy metal concentrations in crude oil impacted and un-impacted soils.
[3] To determine heavy metal concentrations in cassava tubers and plantain fruits grown and harvested from crude oil impacted and un-impacted soils.
[4] To compare the results obtained in objective two (2) with the WHO internationally accepted limits for food.
[5] To examine the health implications of the impacts on the surrounding community.
[6] To recommend appropriate remedial measures to combat the impacts.

Research Hypotheses

The following hypotheses were tested in the course of the study:

[1] Ho: There is no significant difference between heavy metal concentrations in soils impacted with crude oil and un-impacted/control site.
[2] Ho: There is no significant difference between heavy metal concentrations in food crops grown in crude-oil impacted soil (Site1) and un-impacted/control site (Site2).

[3] Ho: There is no significant difference between heavy metal concentrations in food crop (food quality) grown in crude-oil impacted site (site 1) and the WHO acceptable limits for food.

III. CONCEPTUAL FRAMEWORK

The conceptual framework adopted for this work is the hydrogeo-pollution cycle (Egboka, Nwankwor, Orajaka, Ejiofor, 1989). Hydrogeo-pollution cycle involves two processes; hydrologic and geologic cycles. In both processes pollutants and contaminants may be produced and cyclically dispersed from one point of hydrologic cycle to another. Pollutants and contaminants may be generated through natural or anthropogenic processes and circulated into the environment (atmosphere, lithosphere, biosphere and hydrosphere) through the activities of air, water, chemical, physical and microbiological processes. These complex and cycle processes may be continuous with respect to distance and time and may be localized or regional in aerial spread. Thus, pollution at one source or area may threaten nearby or distant places unless its spread is checked or controlled. Pollutants from spilled crude-oil can reach soil, plant and man through a combination of the actions involving the hydrologic and the geologic cycle. The geologic cycle involves movement of rocks, sediments and soils. Geologic characteristics of rocks can play a role in contaminants spread or retention. The hydrologic cycle involves water evaporation, precipitation, ground water flow, water run-off and aquifers. The sources of pollution and contamination can be either point sources or distributive sources. Point sources of pollution and contamination can be geometrically defined and are discernible in size, shape and location. Distributed sources of contamination are spread throughout a large area with boundaries which are difficult to define. Point sources include hazardous chemical and oil spill sites, waste dump sites, mining operation wastes and sewage areas. Distributed sources are widespread and may receive contaminant input through the spread of pollutants by rain, soil erosion, wind, flooding and other natural elements (Sullivan and Kreiger, 1992). Through a complex interplay of both hydrologic and geologic cycles, a combination termed; hydrogeopollution cycle is formed. Contaminant and pollutant spread can be enhanced from either point sources or distributive sources. In view of the above therefore, this work is meant to examine the distribution of heavy metals in soils and plants in the study area. This study is prompted by the fact that agricultural activities and human habitation is close to oil spill sites. Moreover excess heavy metal is dangerous human health and to the environment as this could lead to the contamination of the food chain (soil – water–plant-humans).

Study Area

The area plays host to the Shell Producing and Developing Company (SPDC), making population density high, as a result of influx of a large number of migrant settlers most of who provide manpower. Other means of livelihood amongst the local population include: farming, fishing, trading, civil service, and sundry artisan undertakings. Geology of the area consists of a sedimentary basin with nearly level plain and saprolitic parent material. Study area marks the geological boundary of the Sombreiro-Warri formation and the meander belts of the Upper Deltaic plains of the Niger Delta (Short and Stuable, 1967). The Sambreiro-Warri formation has been described by Allen (1965) as older sands of the Niger Delta comprising massive, generally fine to medium grained and fairly sorted but consolidated sands. Climate is characterized within the humid tropical climatic zone of the Nigerian equatorial hot and humid climate. Annual rainfall varies from 1650mm to 1800mm for a length of rainy season greater than 250 days. Rainfall distribution is bimodal which peaks in July and September and the two-weeks break in August. Vegetation is mosaic with swamp marshes, due to high intensity of rainfall. The study area is located at two sites of cultivated land in Olomoro, Isoko South Local Government Area of Delta State, Nigeria. The area lies within Latitude 5^{o}38'N and 5^{o}45'N and Longitude 6^{o}22'E and 6^{o}37'E. Site 1 is a farmland containing spilled crude oil with two flow stations, gas compressor and many oil wells nearby. Cassava, Plantain, Maize and other food crops are cultivated in this farmland. Site 2 is also a farmland in which cassava and plantain are cultivated among others. It lies by a tarred road with few inhabited houses. The site 2 is 4.25km away from Site 1. Traffic is relatively low. Crude oil spillage and other petroleum activities are completely absent.

IV. STUDY METHODOLOGY

Population and Sample technique

The study population includes the number of inhabitants, households and hospitals in Olomoro community. In 2006, Olomoro had a population of 10,230 people according to the National Population Commission (NPC, 2006). The projected population as at May 2013 was 12,306 people. From direct field observation and counting by the researcher, the total number of villages, wards, and households in Olomoro were 7 villages, 102 wards, and 418 households respectively. A pilot counting technique was employed in order to identify all households in Olomoro. To ease this sampling technique, the seven villages represented the clusters, thus seven clusters were established. They include Irri cluster, Oviri cluster, Ikiagboda cluster, Uwherun cluster, Iwride cluster, Jekota cluster and Oleh cluster. A total number of 102 wards constitute the entire 418 household population from the seven clusters, that is, Irri cluster-13 wards, Oviri cluster-18 wards, Ikiagboda cluster-9 wards, Uwherun cluster-22, Iwride cluster-17, Jekota-9 and Oleh-14 wards, making a total of 102 wards as earlier stated.However, not all wards were sampled. Only a total number of 53 wards were sampled among the seven clusters. The wards were chosen on the basis of odd numbers in the clusters i.e if the first ward is chosen, the next ward would be the third, then the fifth ward and so on. Therefore the number of sampled wards in the following clusters; Irri, Oviri, Ikiagboda, Uwherun, Iwride, Jekota and Oleh were 7,9,5,11,9,5 and 7 respectively. As earlier stated the total number of household in the following clusters; Irri, Oviri, Ikiagboda, Uwherun, Iwride, Jekota and Oleh were 53, 72, 47, 85, 68, 32 and 61 respectively. However, not all household were chosen. A systematic technique was adapted to select one (1) out of every three (3) household. Therefore, the total number of sampled household in the order of cluster arrangement used earlier (starting with Irri and ending with Oleh) were 17, 24, 15, 28, 22, 10 and 20 respectively making up a total of 136 sampled households. Therefore based on the population of households in each ward, 32.5% of the household population was sampled. Questionnaire method was adopted to elicit the views of the people on possible pollution sources to their farmlands; crops they produce and consume and the diseases prevalent among them etc. Data was collected from hospitals were the residents attend.

Sample Collection, Preparation and Instrumentation

Three (3) sample points were selected randomly by the researcher at a depth of 20m (bottom soil) at both sites of the study area (site 1 and site 2). 15 soil samples each were collected from site1 and site 2, making a total of 30 samples collected from the study area. The samples weighed 20kg each and were put into sterilized cellophane bags and labeled before finally taken to the laboratory for analysis. The laboratory analysis was done in Quality Analytical Laboratory Services Limited, Isihor, Benin city. Three (3) samples of Cassava tubers and Plantain fruits were randomly selected at both sites.All soil samples were air dried for five days under room temperature to ensure constant weight. The samples were ground manually to powder with an agate mortar and pestle to grain size of 125μm. Selected samples of cassava tubers and plantain fruits were washed with clean water, peeled, sliced, dried in an oven at 70c for a period of 72 hours. The specimen were then cooled to ambient temperature, milled and sieved through a mesh of 1mm diameter and then carried for laboratory analysis The analysis of Cu, Cr, Fe, Pb, and Zn in soil and plant samples was done using the Atomic Absorption Spectrometer (AAS Model 451). . The prepared plant samples were digested slowly on an electro thermal heater for about 20 minute, then cooled and filtered through a 541 Whatman filter paper into a volumetric flask. The residual acid concentration of the digested plant samples were brought to 1 percent v/v after digestion. The digested plant samples were then analyzed for trace heavy metals. Student T-test was used to test hypotheses 1 and 2 while multiple regression analysis was used for hypothesis 3

Summary on Findings

- There was a significant difference between soils pooled from both sites. Higher values of heavy metals was recorded in soil pooled from site 1(crude- oil impacted) than soil pooled from site 2 (control).
- There was a higher concentration of heavy metals in cassava tubers and plantain fruits harvested from site 1 than those harvested from site 2.
- Pb in the both food crops were found to be above WHO acceptable limits for food (0.3mg/kg).
- The values of Pb and Zn recorded in cassava tubers were higher than the values recorded in the corresponding soil samples, indicating hyperaccumulation and a likely threat to Pb and Zn poisoning.
- Acute symptoms of Zn and Pb poisoning such as headache, abdominal pain, body pain, stomach disorder, nausea, vomiting, dizziness and depression were prevalently high among the people of Olomoro.
- The questionnaire survey showed that the most prevalent diseases/ ailments among the people of Olomoro in the order of the most prevalent to the least prevalent is acute headache / stomach disorder >body pain >nausea > dizziness> cancer> depression> mental illness> bone malformation in children i.e the most prevalent disease/ ailment is acute headache and stomach disorder while the least prevalent is bone malformation in children.

V. DISCUSSION ON THE FINDINGS

Heavy Metal Concentration in Soils at Crude-Oil Impacted site (Site 1) and Control Site (Site 2)

The mean concentrations of heavy metals in soil sampled at site 1 recorded 6.65mg/kg, 0.77mg/kg, 87.03mg/kg, 0.78mg/kg and 3.06mg/kg for Cu, Cr, Fe, Pb and Zn respectively. At site 2, mean concentrations of Cu, Cr, Fe, Pb and Zn recorded 1.96mg/kg, 0.004mg/kg, 57.88mg/kg, 0.05mg/kg and 2.62mg/kg respectively (table1). There was a significant difference between soil samples at site 1 and site 2. This could be attributed to the presence of spilled crude-oil at site 1, which must have been washed by rain from nearby flow stations, gas compressors, giant electric generators and numerous oil wells. The low concentrations of heavy metals found in control site (site 2) which was 4.25km away from site 1 is a confirmation that spilled crude-oil was responsible for the higher values recorded at site 1. This is expected since any area near petroleum activities has higher level of pollutants including heavy metals (Nkwocha and Duru, 2010). It was observed that Fe had the highest mean concentration of 87.03mg/kg and 57.88mg/kg at both site 1 and site 2 respectively, while Cr had the least mean concentration of 0.77mg/kg and 0.004mg/kg at both site 1 and site 2 respectively (table 1)

Table 1: Concentration of Heavy Metals (mg/kg) in crude-oil impacted soils (Site 1) and control (site2)

SITE 1(Crude - Oil impacted)						**SITE 2 (Control)**			
S/N	**Heavy Metal**	**SSA**	**SSB**	**SSC**	Mean	**SSD**	**SSE**	**SSF**	**Mean**
1	Cu	6.70	7.00	6.25	6.65	1.94	1.95	2.00	1.96
2	Cr	0.76	0.85	0.70	0.77	ND	0.002	0.01	0.004
3	Fe	90.40	90.45	80.25	87.03	62.75	50.40	60.50	57.88
4	Pb	0.70	0.80	0.85	0.78	0.01	0.03	0.10	0.05
5	Zn	3.02	3.10	3.05	3.06	2.74	2.50	2.63	2.62

Source: Author's Laboratory Analysis (2013)
ND: Not Detected
SS: Sample Station

Heavy Metal Concentration In cortex of cassava tubers and Mesocarp of Plantain Fruits

All heavy metals in cassava tubers and plantain fruits at Site 1 recorded higher values than crops at site 2 (control), except for Cr which was not detected at both sites. (tables 2 A and 2 B). In the cortex of cassava tubers harvested at site 1, the mean concentrations of heavy metals Cu, Cr, Fe, Pb and Zn recorded 0.22mg/kg, ND, 13.84mg/kg, 170mg/kg, and 3.95mg/kg respectively, with Fe being the most abundant, and Cr being the least. (Table 2(A)). It was observed that the values of Pb and Zn recorded in cassava tubers were higher than the values recorded in the corresponding soil samples indicating hyper accumulation (tables 4.1 and 4.2 (A)). The mean concentration of Pb (1.70mg/kg) in cassava tubers was higher than WHO (1988) acceptable limits for food (0.30 mg/kg).

Table 2 (A): Concentration of Heavy Metals (mg/kg) in Cassava Tubers harvested from site 1 (crude-oil impacted) and site2 (control)

SITE 1(Crude - Oil impacted)						**SITE 2 (Control)**			
S/N	**Heavy Metal**	**SSA**	**SSB**	**SSC**	**Mean**	**SSD**	**SSE**	**SSF**	**Mean**
1	Cu	0.24	0.20	0.23	0.22	0.11	0.32	0.21	0.21
2	Cr	ND	ND	ND	ND	ND	ND	ND	ND
3	Fe	13.95	13.78	13.80	13.84	3.00	3.05	2.91	2.99
4	Pb	1.75	1.66	1.70	1.70	0.20	0.05	0.10	0.15
5	Zn	3.91	4.00	3.95	3.95	ND	0.13	ND	0.04

Source: Author's Laboratory Analysis (2013)

In the mesocarp of plantain fruits, harvested at site 1, the mean concentrations of heavy metals Cu, Cr, Fe, Pb and Zn recorded 0.34mg/kg, ND, 14.72mg/kg, 1.39mg/kg and 3.67mg/kg respectively, with Fe being the most abundant heavy metal, and Cr being the least (Table 2 (B)) .Cr having the least recorded value may be attributed to its unavailability in the corresponding soil as shown in table 4.1 and also because Cr is not readily absorbed by plants (Nkwocha et al, 2010; Okoronkwo et al, 2005; Hart et al, 2005 and Gideon – Ogero, 2008). It was observed that the values of Pb and Zn recorded in plantain fruits were higher than the values in the corresponding soil samples at site 1, indicating hyper accumulation of the metals as earlier observed in cassava tubers (Table 1 and 2b). Therefore cassava and plantain could serve as bio-indicators in contaminated soils.

Table 2 (B): Concentration of Heavy Metals (mg/kg) in Plantain Fruits harvested from site 1 (crude-oil impacted) and site2 (control)

SITE 1 (Crude – oil impacted)						SITE 2 (Control)			
S/N	**Heavy Metal**	**SSA**	**SSB**	**SSC**	**Mean**	**SSD**	**SSE**	**SSF**	**Mean**
1	Cu	0.30	0.35	0.38	0.34	0.14	0.20	0.12	0.15
2	Cr	ND	ND	ND	ND	ND	ND	ND	ND
3	Fe	14.87	14.80	14.50	14.72	2.08	2.15	2.10	2.11
4	Pb	1.48	1.40	1.30	1.39	ND	0.05	0.01	0.02
5	Zn	3.10	3.90	4.02	3.67	ND	0.01	ND	0.003

Source: Author's Laboratory Analysis (2013)

Health Implications

Heavy metals found in food crops, have a potential hazard to man through the dietary pathway (Batra, 2012). Some heavy metals like Pb are toxic even in small concentrations. Pb was observed to be above WHO (1984) acceptable limits in both cassava and plantain (3.0mg/kg), therefore posing serious health risks to people who ingest these food crops. General symptoms of Pb poisoning such as headache, abdominal pain, body pain, stomach disorder, nausea, vomiting, dizziness and depression (Mills, 1971) were commonly experience by the people. Of particular concern was the high prevalence of acute headache, body pain and stomach disorder sourced from the medical personnel. The most vulnerable populations affected by consumption of contaminated products were women, Okwute (2014). In pregnant women, Pb can easily cross the placenta and damage foetal brain and may also cause development of auto-immunity in which a persons' immune system attacks its own cells, leading to diseases related to the nervous and circulatory system (Mills, 1971). Majority of the women (30.8%) complained of nausea as a common ailment, while 48.5% complained of dizziness. It was observed that although depression is a symptom of Pb and Zn poisoning, the people's social life were completely unaffected, and they seem to be very happy and friendly even with strangers. This was supported by the response majority of them gave when asked if they were depressed. Only about 23.8% strongly agreed to being depressed, while majority argued that they were not.

In children, Pb poisoning may cause mental retardation and learning disorders (Curtis, 1999). This accounts for the reason why majority of the people are farmers and secondary school certificate holders, since they lack the mental capacity to attain a higher level of education. Only 7.7% strongly agreed to experiencing mental illness/learning disorder among their children, while majority (52.3%), strongly disagreed. This could be attributed to the fact that most people did not like to be affiliated among people whose households were known for mental illness. Zn and Pb were found to readily accumulate in both crops harvested from site 1. Therefore, there is also a likely threat to Zn poisoning if contaminated food is ingested. It is important to note that Zn in small quantities is essential for normal body metabolism (Batra, 2012) and is crucial for the body when high Cu levels are detected in body tissues (Taylor et al, 1984). Continual accumulation of Zn in the body may lead to serious health problems. Symptoms of Zn poisoning include nausea, vomiting and headaches (Prasad, 1995). All these symptoms mentioned were commonly experienced among household members and were reported to be prevalently high by medical personnel. Pb and Zn accumulated in the body over long periods may result to cancer (Essien, 1992). Only about 21.5% of the sampled population agreed to have cancer as an ailment in their household while majority were not sure if they had cancer or not. Therefore, there is a possibility that a high percentage of people have cancer without knowing, although as reported by medical personnel, cancer was prevalently low among the people.

VI. RECOMMENDATION

Based on the inferences, findings and experiences in the course of this research work, the following is hereby recommended:

[1] Farmers should test soil before planting to avoid food contamination.
[2] People should live or carryout agricultural activities within a distance of at least 5km away from oil spill sites.
[3] Public education should be carried out to create awareness among the people on the dangers of consuming contaminated food crops.
[4] People should wash their food crops especially leafy vegetables, to avoid heavy metal accumulation in the body, and consequently heavy metal poisoning.

[5] Strict law enforcement on oil companies in order to minimize oil spills.
[6] Bioremediation of soil by planting phyto-remediants in crude-oil impacted soils or cleaning soil with micro organism that degrade oil components

VII. CONCLUSION

Garri, a product of cassava, is consumed daily by the people of Olomoro in large quantities, while plantain serves as a staple food commonly used in preparing their local delicacy "boiled unripe plantain and pepper soup". Not only are these staples consumed in olomoro, but in other localities by millions of Nigerians. It is therefore important that the levels of heavy metals found in these food crops be checked before consuming, so as to avoid serious health implications.Most of these rural communities affected by oil spill and oil-related activities in the Niger Delta still remain the food baskets of the nation. As more people, especially those living in urban areas depend on the agricultural products from these rural communities for their food, they are more and more exposed to heavy metal poisoning, and its associated health problems.

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