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THE IMPACT OF SOIL AND WATER POLLUTION ON FOOD SAMPLE IN NIGER-DELTA REGION, NIGERIA

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Abstract
Through the on-going petroleum exploitation and exploration activities at Niger-Delta region of Nigeria, heavy metals and hydrocarbons have been transported to nearby farms and surface waters within the region. This study investigated the levels of pollution and various likely environmental havocs. Samples of processed food, unprocessed food and river waters were taken from three locations, processed and analyzed for hydrocarbon and heavy metal contents. The results showed a linear correlation of the concentration of the hydrocarbon and heavy metals content with the sites of crude oil processing.

Keywords: Soil Pollution, Food crops, Water Pollution, Niger-Delta, Petroleum

Introduction

Human being cannot survive without food and water. The food crops are nurtured for the major purpose of consumption, respiratory breakdown of energy and for other human activities. While plants use processes like photosynthesis, chemosynthesis e.t.c to grow, man depends on these plants and water for food. However, through crude oil production activities, soil and surface water at Niger-Delta area have been heavily polluted by metals and hydrocarbons through spillages and pipeline failures. This has adversely affected the growth of crops in the area whereby stunted growth and yellow colored leaves are visibly noticed.

The extraction, refining and processing of crude oil are important as it has become the major source of energy globally and currently generates over 90% of Nigeria's total revenue (Obanijesu et al, 2007a). This activity however goes along with the deposition of heavy metals such as copper, lead, cadmium, cobalt, arsenic and mercury amongst others (Obanijesu et al, 2007b) and hydrocarbons (Ugochukwu and Leton, 2004) in high concentrations on soil and surface/subsurface water within the environment. These heavy metals and hydrocarbons can contaminate or pollute the soil and the water by altering the pH thereby making the ecosystem unsafe for various agricultural activities (Clark, 1998).

Studies have shown that food nutrients and heavy metals as pollutants through interactions can synergize the induction of chemical hazard related problems (Colborn *et. al*, 1993). These metals are highly toxic to human health and play no known positive role in metabolism. There have been cases of bioaccumulation of some of these heavy metals along the food chain leading to food poisoning (Enujiugha, 2001). Elements such as cadmium, arsenic, selenium, mercury, chromium, lead e.t.c. can cause accumulative detriments to marine organisms (Frazier, 1979). Bio-accumulation of metals such as lead and chromium by fish has been variously reported (Devra et al, 1992). This could cause danger to human health. Accumulation of copper, manganese, lead and iron in the algae is dangerous especially when such constitutes major components of a food chain that ultimately ends with men (Atlas, 1978; Kilburn, 1991).

This study is focused on the evaluation of hydrocarbon and heavy metal contents of some food crops grown in the Niger-Delta region of Nigeria. The control sample was obtained from South Western Nigeria, an area far away from the crude oil producing region.

Although, man cannot do without exploration of oil due to its importance, the adverse impacts of this activity on human nutrition should be reduced to the barest minimum. Since man has now become a subject of the environment, or the respondent to nature, there is the need to study the effect of pollution in order to proffer solutions that minimize its harmful effects on man.

Materials and Method

Sample collection

Three locations, Bonny camp, Alesa Eleme areas (both in the Niger-Delta region) and Odo-Oba area in Oyo state were used for the study. For the food crops, both processed (garri) and unprocessed (cassava and maize) samples were collected. Cassava roots garri (processed cassava roots) and maize seeds were collected from the three locations. The first site (location 1) was a farm located about 100m away from an exploratory zone at Bonny Camp; the second site (location 2) was a farm located in an area adjacent to a stream at the point of discharge of the produce water within 76m away from a crude oil refining site at Alesa-Eleme (this stream water is used by the farmers to wet their farmlands) while the third site (location 3) is within South-Western Nigeria which is far away from the crude oil producing region. Water samples were also collected from streams very close to the first two locations.

At each farm, five crop samples of cassava were taken by digging out the roots. Also, five samples of maize were taken by tearing away the maize bunches from their stems. Both were carried out using stratified sampling method. They were carefully labeled and placed in plastic containers to avoid metal contamination from the container. From each stream, ten water samples were taken using systematic sampling method. The samples were thoroughly agitated after the collection and placed in a plastic container. All samples were transported in ice packs to the laboratory for analysis.

Heavy Metals Analysis

Each of the crop samples was ashed and digested in conical flasks using $3.0cm^3$ concentrated tetraoxosulphate (VI) acid at $100^{O}C$. The digestate was made up to 100 cm^3 with distilled deionized water and analyzed by for Atomic Absorption Spectrophotometer (AAS). The water samples were subjected to the same analytical procedure.

Total Hydrocarbon Analysis

10g of each sample was weighed into thimble and a known amount of internal standard solution was added to form another solution. The thimbles were placed in a soxhlet extractor and dichloromethane was added in ratio 1:3 (new solution: dichloromethane) in a flat bottom flask and refluxed for 3hours. The extract was cooled to room temperature and put into separating funnel for the separation of free fatty acids from the hydrocarbons. The solvent portion was passed through anhydrous Na_2SO_4 to remove traces of water. The resulting solution was centrifuged and the supernatant injected into a PYE-UNICAMPU 4500 gas chromatograph (G.C) equipped with a flame ionization detector for analysis. A 25m length, 0.25mm film thickness and 0.25mm internal diameter capillary column was used and the packed area was analysed with a PERKIN-ELMER LCI-100 laboratory computing integrator. The column was programmed at 12^oC per minute using nitrogen as the carrier gas with a flow rate of 30 cm^3/min.

Results and Discussion

The water quality at the area has been seriously polluted by both the trace element (Table 1) and hydrocarbon (Table 2). Metals are known to be serious threats to human lives. High concentration of Lead in the human body system causes anaemia (Obioh et al, 1998), copper causes liver disease and haemolytic anaemia (Nelson and Cox, 2000), cobalt causes sterility, hair loss, diarrhoea and eventually death (Robert et al, 2000) while cadmium generates lung damage (Nelson and Cox, 2000). Also, high intake of hydrocarbon from petroleum such as Volatile Organic Compounds (VOC) leads to death; hence the people using this water within Niger-Delta for drinking and cooking are susceptible to all these problems. The high occurrence and values of lead may be due to its use in drilling operations (being a constituent of the drilling mud) and its subsequent high concentrations in produce water which is discharged into the environment on daily basis where it can contaminate the surface and groundwater being used for processing the food items. This is evident from the data of offshore water sample which showed the presence of mostly all these heavy metals at concentrations above the FEPA (1991) standards.

Table 2.0 shows the values of hydrocarbon content of water samples from different sources. The high values recorded for the Near Shore in location 1 is an indication of the high contamination at the site. A reduction in value was observed with progressive movement into the offshore. This may not be unconnected with tidal/storm action which ensures proper mixing of effluents with the sea water. The value obtained for shallow well at location 2 is the highest, followed by that of the borehole while that of the deep well is the least. This is expected because the shallow well is prone to contamination with crude oil especially from pipe burst which are the major source of surface contamination.

Tables 3 and 4, show the heavy metal and hydrocarbon concentration of the food samples available in the Niger-Delta area. This could be a source of health hazard to them since the concentrations of all the metals and hydrocarbon content are alarmingly higher than the maximum recommended dietary limits. Recommended dietary limit is the maximum allowable concentration of metal in food (NAS, 1998; Robert et al, 2000). Garri which is even a processed version of cassava, whereby the cassava is crushed, dewatered (to drastically reduce the cyanide content) and fried before consumption still has very high quality of these pollutants.

The values obtained for the Total hydrocarbon content of all the different food samples studied (both processed and unprocessed) are true reflectors of the sites. It was observed that location 2 is heavily polluted while location 1 experiences mild pollution.

For cassava, the total hydrocarbon contents of location 1 and location 2 are several magnitudes higher than standard. However, in the course of processing to obtain Garri, the values decreased. This reduction may be due to the method of processing and the type of water used in processing it. The garri from location 2 gave the highest value of lead concentration out of the three samples tested. This may not be unconnected with the water used in processing it and the fact that the cassava used for its processing already has high value of lead concentration. This shows that the methods and techniques of food processing in highly polluted areas should be reviewed as a matter of urgency, so that environment-food interactions would produce positive nutritional changes.

It is evident from this research that environment-food interactions are unavoidable. Therefore, the effectiveness of processing methods and techniques employed in the oil producing areas require more technological improvement for the reduction of the hydrocarbon and heavy metal contents in both the water quality and unprocessed and processed foods. Also, the hydrocarbon and heavy metals content of the water samples near the shore is a bio-indicator of how heavily polluted the marine environment is, and this tells about bioaccumulation in the marine organisms which can pass readily to humans through the food chain.

Conclusions

This study has shown that the various oil producing activities affect the environment through the release of trace elements and hydrocarbons which may adversely affect the health of the indigenes. It is therefore advisable for the oil-producing companies operating within Niger-Delta region of Nigeria to minimize the waste generation as much as possible and in the event of waste generation, the waste (in whatever form of production) should be properly treated before disposal into the environment.

Table 1: Heavy metals concentration of water samples (ppm)

Sample type	Cadmium	Copper	Lead	Cobalt
Near Shore-1	85	102	142	55
Off Shore-1	3.90	3.8	4.3	6.3
Shallow Well-2	Nd	0.106	Nd	6.5
Deep Well-2	Nd	0.097	0.055	0.107
Max. Limit*	‹ 1.0	‹ 0.05	‹ 1.0	‹ 0.5

*Source: FEPA (1991)

Table 2: Hydrocarbon contents of water samples

Sample Types	Total Hydrocarbon (ppm)
Near Shore –1	295.5
Off Shore –1	34.02
Shallow Well –2	556.20
Deep Well –2	10.5
Borehole –2	26.70
Maximum discharge Limit*	10

*Source: FEPA (1991)

Table 3: Heavy metal concentration of food samples (ppm)

Sample type		Cadmium	Copper	Lead	Cobalt
Cassava	Location 1	0.14	0.167	1.464	0.253
	Location 2	0.186	0.256	1.675	0.515
	Location 3	Nd	Nd	Nd	Nd
Maize	Location 1	Nd	Nd	0.002	Nd
	Location 2	0.005	0.164	0.276	0.162
	Location 3	Nd	Nd	Nd	Nd
Garri	Location 1	0.035	0.37	0.893	Nd
	Location 2	0.215	0.342	2.880	0.401
	Location 3	Nd	Nd	0.001	Nd
Tolerable dietary upper intake level		0.00**	4-10*	0.00**	6-10*

*Source: NAS (1998)

**Source: Robert et al (2000)

Table 4: Hydrocarbon contents of food samples (ppm)

Crop	Location 1	Location 2	Location 3	Standard
Cassava	927	974.4	7.23	10mg/l
Maize	Traces	13.0	Nd	
Garri (Processed food)	107.87	528.2	10.41	

Nd = Not detected

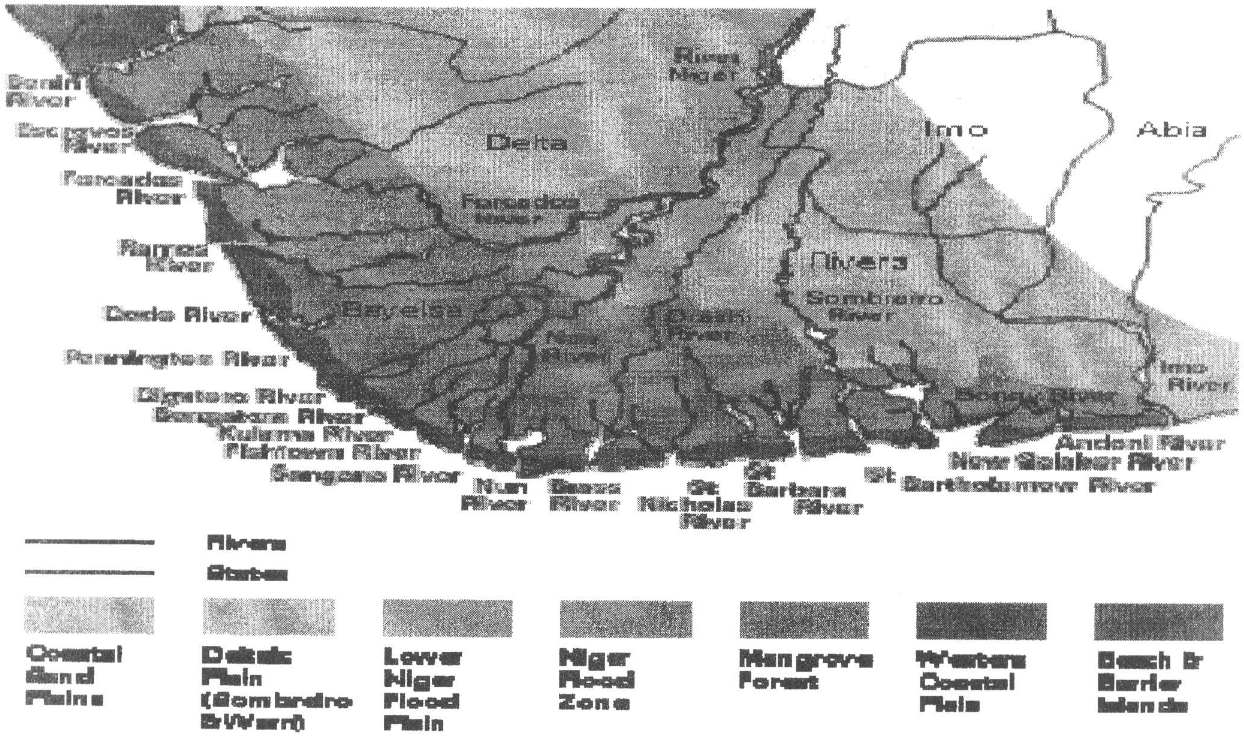

Fig 1: Niger Delta: Rivers, States and Vegetations (Waado, 2005)

References

Atlas, R.M. (1978), "Microorganisms and Petroleum Pollutants". Bioscience, Vol.28, pp. 387-391.

Clark R.B (1998), "Marine pollution" 2nd Edition, Clarendon Press, Oxford, UK. pg.220

Colborn T, Frederick, S.V.S, and Ana M. Solto (1993) "Development Effects of Endocrine Disecupting chemicals in wildlife and humans", Environmental Health Perspectives, Volume 101, Number 5; pp 378-384.

Devra, L.D, Aaron, B., and David, G.H. (1992) "Agricultural Exposures and Cancer Trends in developed countries", Environmental Health Perspectives, World Research Institutes, Volume 100, pp39-44.

Enugiugha, V.N (2001), "Food and Environmental Interactions", Balanced Diet Maiden Issue, pp 26-27

FEPA (1991), "Guidelines and Standards for Environmental Pollution Control in Nigeria", Federal Environmental Protection Agency, Nigeria

Frazier, J.M., (1979) "Bioaccumulation of Cadmium in Marine Organisms", Environmental Health Perspectives, Volume 28, pp 75-79

Kilburn, H.K. (1991) "Evidence that the Human Nervous System is Most Sensitive to Environmental Toxins" Environmental Carcinogenesis Review-part c of Journal of Environmental Science and Health, Vol.8, No.2, pp 3217-3336

Nelson, L. N and Cox, M. M., (2000). Lehninger Principles of Biochemistry, Fourth edition, W.H freeman and company, New York.

NAS (1998), "Dietary Reference Intakes", **National Academy of Sciences**, Retrieved March 18, 2006, http://www.nal.usda.gov/etext/000/05.html

Obanijesu, E.O, Waheed, M.A and Macaulay, S.R.A (2007a), "West African Gas Pipeline (WAGP) Project: Associated Problems and Possible Remedies", First International Conference on

Environment Research, Technology and Policy, Ghana.

Obanijesu, E.O, Dada, E.O and Bello, O.O (2007b), "Use of Diatomaceous Materials for Heavy Metals Recovery from Oil and Gas Produced Water", Society of Petroleum Engineers, Texas, USA SPE Paper 106557

Robert, K. M., Daryl, K. G., Peter, A. M., and Victor, W. R. (2000), Harpers Biochemistry, 25th edition, New York, McGraw-Hill, pp 658 – 670

Ugochukwu, C.N.C and Leton, T.G (2004), "Effluent Monitoring Of An Oil Servicing Company and Its Impact On The Environment" AJEAM-RAGEE, Vol 8, pp 27-30