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Heavy metal concentration from gas flaring sites in Umuebulu Etche l.g.a and Agbada II in ObioAkpor/Ikwere l.g.a, Rivers State, Nigeria

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Abstract
Heavy metal contamination is of great concern due to its effect as being carcinogenic in nature. Heavy metal concentration was determined in bitter leaf, plantain leaf, cassava leaf, cassava tuber, pepper leaf, pepper fruit, pawpaw leaf, pawpaw fruit, water leaf around gas flaring sites in Umuebulu Etche LGA and Agbada II in Obio/Akpor LGA Rivers State. Atomic Absorption Spectrophotometer was used for the determination of heavy metals (cadmium, arsenic, lead and chromium) concentration in the samples. These samples were subjected to standard laboratory analysis for the determination of heavy metals (cadmium, arsenic, lead and chromium) concentration. The concentrations of lead arsenic in crop samples from Agbada II and Umuebulu are below FAO/WHO permissible limit. The concentration of Chromium ranged from 0.000 to 0.410mg/kg in all the samples in Umuebulu and Agbada community. The concentration of chromium in bitter leaf, plantain leaf, pepper leaf, pepper fruit, cassava leaf, were above FAO/WHO permissible limit for both communities. The concentration of chromium in cassava tuber, pawpaw leaf, pawpaw fruit, water Leaf were below FAO/WHO permissible limit for Umuebulu and Agbada communities. The concentration of cadmium ranged from 0.000 to 1.4 mg/kg in all the samples in Umuebulu and Agbada community. Cadmium concentration in Bitter Leaf, Plantain Leaf, Pepper Leaf, Pepper Fruit were below FAO/WHO permissible limit except cassava leaf, cassava tuber cadmium concentration which are above FAO/WHO permissible limit for both communities. The study had shown that the crops harvested from the study area were polluted and can pose serious health problem to the humans and animals if consumed. Government and regulatory bodies should enforce the use of any of the flare gas recovery system (FGRS) to minimize the amount of gas being flared into the Environment.

Keywords
Heavy metals, bitter leaf, plantain, pepper, cassava, water leaf, pawpaw

Introduction

Gas flaring is the process of burning of associated gas from wells, hydrocarbon processing plants or refineries, either as a means of disposal or as a safety measure to relieve pressure. Gas flaring is one of the most challenging energy and environmental problem facing the world today (Eman, 2015). Flaring is a major concern in petroleum producing areas where there exists insufficient infrastructure to utilize the produced natural gas. It serves as a way of disposing the gas produced in those areas. This as simple as it may sound, creates series of negative impacts on the people in those arrears as well as the environment in general (Orimoogunje, et al, 2010). It consumes useful natural resources and produces harmful wastes, which have negative impacts on the society. Various ecological and human disasters which have continuously occurred

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over the last three decades implicate gas flaring by oil companies as a major contributor to environmental degradation and pollution of various magnitudes (Ebeniro 2012). In the early days of petroleum exploration, natural gas was not considered a useful product because of the difficulties in transporting it to where it can be utilized or the problems associated with it storage. As a result, gas was simply burned off at the well or vented into the atmosphere, to create rooms for other operations and supposedly to save the whole system from being burnt down by gas explosion (Aregbe, 2017). Gas flaring in Nigeria could be traced to the initial exploration activities as far back as 1906 by Shell D'Arcy (Shell-BP) now SPDC, the discovery of the first oilfield and exploitation in commercial quantity of crude oil in Oloibiri, in the present Bayelsa State in 1956 and the subsequent first ever crude oil export from Nigeria in 1958 marked the official gas flaring in Nigeria (Osuoka and Roderick, 2005).

Materials and Methods

The study areas

Locations. The research areas include Agbada II in Obio/Akpor LGA and Umuebulu in Etche LGA. While Umuebulu is located between latitude 04063.674N and longitude 007007.129'E, Agbada II is located between N4055'54.142" and 700'55.951" E.

Climate. The studied sites are located in the humid tropical belt of the Niger-Delta, and their closeness to the Atlantic Ocean and the Imo River has a significant impact on their climate. Rainfall is experienced all year round, with June and September seeing the highest amounts and November to February seeing the lowest. Over 2200 mm of rain falls on average each year. The moisture is brought in from the coastal region by the southwest trade winds. The regions had two distinct seasons, wet and dry. The dry season ran from November to March, while the wet season lasted from April to October. The lowest temperature values ranged from 25.3 to 26.0 between 0400 and 0800 h in the dry season, while the maximum temperature values ranged from 34.0 to 36.3 and occurred between 1300 and 1800 h. In the rainy season, temperatures range from 24.5 to 29.0 °C between the hours of 0400 and 0600. The period between 0900 and 1800h had higher temperatures (between 29 and 32 °C).

Vegetation. There is a combination of primary and secondary regrowth woods in the vegetation. There was little vegetation in the locations.

Land use. Agriculture is the main land use activity. Grown are crops like cassava, plantains, pawpaws, bitter and water leaves, among others. In addition, domestic animals are raised. Gas flaring and an oil flow station are two examples of the area's industrial operations.

Plants sampling and preparation

Plants Sampling. In the study area, samples of six (6) plant species were chosen. The plants were bitter leaf (Vernoniaamygdalina), plantain (Musaparadisiaca), pepper, pawpaw (Carica papaya), water leaf (Talinum trangulare), and bitter leaf (Vernoniaamygdalina) leaves, as well as the tubers and leaves of cassava (Manihot esculenta). The crops were harvested from farms sited at two (2) gas flare stations. The various crops were randomly harvested from three farms for each of the crop sample within each location, making up 81 samples in total. Samples of each crop collected were put in an uncontaminated polyethylene bag (Hart et. al, 2005). The bags were tagged for proper identification before taken to the laboratory for analyses. The control location was 3 kilometres away from Umuebulu flow station.

Preparation of samples. Similar crop varieties were combined from the several farms at each location. Before they began to pool, the leaves were separated from the stem and cleaned in de-ionized water. They were then drained in a colander and shred before drying. Both the pepper and the pawpaw were well cleaned in deionized water, and both were diced before drying. Aside from being washed in water to remove dirt and debris, the cassava was also peeled and thinly sliced before drying (Augustine and Sanford, 2000). All samples were dried in an air oven at 60 °C for roughly 72 hours, cooled to room temperature, and then ground in a hammer mill before being sieved through a mesh with a 1 mm diameter. Until they were needed for examination, the milling samples were kept in airtight plastic containers.

Laboratory analysis

The processed crop samples were subsequently examined for the presence of heavy metals using an atomic absorption spectrometer.

Determination of heavy metals. A 50 ml flask containing 1 g of oven-dried crop sample, 1 ml of 60% $HCLO_4$, and 0.5 ml of concentrated H_2SO_4 was added to. Concentrated HNO_3 (3 ml) and H_2SO_4 were also added. The contents of the flask were slowly metabolized at 250°C for 15 minutes while the flask was

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gently spun. It gradually warmed up to 250°C before stopping. The digest was next filtered with 541 Whatman filter paper, chilled, and transferred to a volumetric flask where it was diluted with distilled water to a final concentration of 50 ml. After digestion, the digested sample's residual acid concentration was reduced to 1% v/v. The Atomic Absorption Spectrophotometer Model 451 was used to analyze the digested samples for the presence of heavy metals. Standard solutions were used for the instrument's calibration. The metal concentrations were determined using the measured absorbances (Hart et.al, 2005). Cadmium, chromium, lead, and arsenic were the metals that were examined.

Results and discussion

Table 1 and 2 reveals the mean and standard deviation of the concentrations of heavy metals in crop samples from Agbada II and Umuebulu communities in Ikwere/ ObioAkpor and Etche Local Government Area respecttively in Rivers State.

Sample	**Lead (Pb)** (mg/kg)		**Cadmium (Cd)** (mg/kg)		**Chromium (Cr)** (mg/kg)		**Arsenic (As)** (mg/kg)	
	Mean	±STD	Mean	±STD	Mean	±STD	Mean	±STD
BL.L	0.000	0.000	0.013	0.006	0.147	0.074	0.000	0.000
PL.L	0.000	0.000	0.000	0.000	0.110	0.010	0.000	0.000
CA.L	0.000	0.000	0.767	0.058	0.410	0.137	0.000	0.000
CA.T	0.000	0.000	1.400	0.200	0.060	0.026	0.000	0.000
PP.L	0.000	0.000	0.013	0.006	0.230	0.044	0.000	0.000
PP.F	0.000	0.000	0.000	0.000	0.107	0.050	0.000	0.000
PW.L	0.000	0.000	0.017	0.006	0.023	0.015	0.000	0.000
PW.F	0.000	0.000	0.013	0.006	0.000	0.000	0.000	0.000
WL.L	0.000	0.000	0.000	0.000	0.013	0.006	0.000	0.000
FAO/WHO	0.3		0.2		0.1		0.5	

Note: BL.L = Bitter Leaf; PL.L = Plantain Leaf: CA.L = Cassava Leaf; CA.T= Cassava Tuber; PP.L = Pepper Leaf; PP.F = Pepper Fruit; PW.L Pawpaw Leaf; Pw.F – Pawpaw Fruit, WL.L – Water Leaf; FAO- Food and Agricultural Organization, WHO- World Health Organization.

Table 1: *Mean and standard deviation of the concentrations of heavy metals in crop samples from Agbada and FAO/WHO permissible limits.*

Sample	**Lead (Pb)** (mg/kg)		**Cadmium (Cd)** (mg/kg)		**Chromium (Cr)** (mg/kg)		**Arsenic (As)** (mg/kg)	
	Mean	±STD	Mean	±STD	Mean	±STD	Mean	±STD
BL.L	0.000	0.000	0.023	0.006	0.153	0.031	0.000	0.000
PL.L	0.000	0.000	0.000	0.000	0.130	0.017	0.000	0.000
CA.L	0.000	0.000	0.867	0.058	0.397	0.068	0.000	0.000
CA.T	0.000	0.000	1.633	0.153	0.037	0.015	0.000	0.000
PP.L	0.000	0.000	0.010	0.000	0.310	0.036	0.000	0.000
PP.F	0.000	0.000	0.000	0.000	0.120	0.030	0.000	0.000
PW.L	0.000	0.000	0.037	0.015	0.040	0.010	0.000	0.000
PW.F	0.000	0.000	0.033	0.006	0.000	0.000	0.000	0.000
WL.L	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000
FAO/WHO	0.3		0.2		0.1		0.5	

Note: BL.L= Bitter Leaf; PL.L = Plantain Leaf; CA.L = Cassava Leaf; CA.T = Cassava Tuber; PP.L = Pepper Leaf; PP.F = Pepper Fruit; PW.L = Pawpaw Leaf; Pw.F= Pawpaw Fruit; WL.L = Water Leaf; FAO- Food and Agricultural Organization, WHO- World Health Organization.

Table 2. *Mean standard deviation of concentrations of heavy metals in crop samples from Umuebule and FAO/WHO permissible limits.*

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Heavy metals contamination is of great concern due to its effect as being carcinogenic in nature. The National and International regulations on food quality set maximum permissible levels of toxic metals in human food, hence an increasingly important aspect of food quality should be to control the concentrations of heavy metals in food (Radwan and Salama, 2006).

The concentrations of heavy metals in crop Samples from Agbada 11 in table 1 and Umuebulu in table 2 shows that Lead and Arsenic concentration in the crop samples are below FAO/WHO permissible limit.

Cadmium concentration in BL.L - Bitter Leaf, PL.L – Plantain Leaf, PP.L – Pepper Leaf, PP.F – Pepper Fruit are below FAO/WHO permissible limit except CA.L – Cassava Leaf, CA.T Cassava Tuber cadmium concentration are above FAO/WHO permissible limit for both communities.

A similar report by Anacletus, Adisa and Uwakwe (2014) show that there was significant increase in the level of cadmium when leaves grown in non-gas flaring site were compared with gas flaring samples. Cadmium concentration level was below FAO/WHO permissible limit in plantain leaf, pepper fruit and water leaf across the study locations. A similar study by Chima and Akah (2017) also showed that cadmium was not detected in leaves of two plants at the various gas flaring sites. This indicate that not all plant takes up cadmium irrespective of its presence in the soil. Continuous exposure of cadmium in edibles results in the accumulation of cadmium in the kidneys causing kidney diseases.

According to Bernard (2008), Cadmium is efficiently retained in human body, in which it accumulates throughout life, it is primarily toxic to the kidney, it can also cause bone demineralization. From the present study, it has been discovered that people living in and around Agbada11 and Umuebulu flare sites and those consuming crops harvested from these areas may be at the risk of kidney problem and bone demineralization.

The level of chromium in BL.L - Bitter Leaf, PL.L – Plantain Leaf, PP.L – Pepper Leaf, PP.F – Pepper Fruit, CA.L – Cassava Leaf, are above FAO/WHO permissible limit for sample of both communities. The concentration of chromium in CA.T Cassava Tuber, PW.L Pawpaw Leaf, Pw.F – Pawpaw Fruit, WL.L – Water Leaf are below FAO/WHO permissible limit for Umuebulu and Agbada communities.

The result agrees with Nwaichi et al (2014) that Chromium was found to be high in bitter leaf and water leaf from oil polluted Agricultural zone when compared to regulatory standard.

This also agrees with Anacletus et al. (2014), that there was no significant difference in chromium concentration of vegetable from both gas flared sites. The levels of Chromium seem to be higher in plants when compared with other metals except for cassava leaf and tuber. A similar report by Osakwe and Okolie (2015) shows that plants absorb higher concentration of chromium from the soil compared to other metals. Abedemi (2013) likewise reported that chromium had highest concentration value of plant transfer ratio among all metals in his study. According to Richa et al (2002), the major non-occupational source of Chromium for human is food such as vegetables and meat. The study has revealed that chromium is present in and around Agbada11 and Umuebulu communities and the people leaving in the study area may be at the risk of taking the metal (Chromium) either through inhaling or oral consumption which can lead to cancer. The presence of Chromium in the study area will restricts the uptake of plant nutrients in soils around agbada11 and Umuebulu flare sites by forming insoluble compounds.

Conclusion

The study was able to determine the level of heavy metals present in crop samples taken from gas flaring sites in the communities of Agbada 11 and Umuebulu. The chosen crop samples are crucial to both people and other living things. Between the localities of Umuebulu and Agbada 11, certain agricultural samples had significant levels of chromium and cadmium. Additionally, it was shown that compared to other plants, the cassava plant appears to be more prone to absorbing cadmium and chromium.According to the study, samples of crops contain heavy metals including cadmium and chromium, which are dangerous to both human and animal health

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