Effects of Cassava Mill Effluent (CME) On the Heavy Metal Contents of Surface and Deep Soil around Cassava Mill at Ikot Osurua, Akwa Ibom, Nigeria.

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Abstract
This work examined the levels of heavy metals contamination on the surface and deep soil samples around cassava mill in Ikot Osurua, Ikot Ekpene. It also compared the concentrations of the elements in the surfaces soil and deep soil with a control sample. Cd, Cr, Pb, Fe, Zn and Cu were analyzed by the use of Atomic Absorption Spectrophotometer (AAS) and the results obtained were; Cd ranges from 0.108 ± 0.002 < 0.814 ± 0.002 < 1.216 ± 0.002. Pb 0.023 ± 0.000 < 0.063 ± 0.003 < 0.912 ± 0.002. Cr 0.117 ± 0.002 < 1.334 ± 0.002 < 2.092 ± 0.001. Fe, 2.203 ± 0.001 < 8.108 ± 0.003 < 11.057 ± 0.008. Zn, 1.532 ± 0.001 < 2.391 ± 0.001 < 10.421 ± 0.001 and Cu, 2.005 ± 0.004 < 19.043 ± 0.002 < 25.706 ± 0.002. The levels of Cd, Cr, Pb, Fe, Zn, and Cu were within the permissible levels, however with the deep soil having the highest concentration in all except Cr. Contamination Factor (CF) indication showed very high for Cd, Cr, Pb, Zn, and Cu, while Fe is moderate and considerable. CF for surface soil, revealed Cd (7.56), Cr (17.96), Pb (27.48), Fe (2.89), Zn (1.56), and Cu (9.50). While CF for deep soil revealed Cd (11.31), Cr (11.56), Pb (39.64), Fe (3.94), Zn (6.80) and Cu (12.82). From the results, the pollution lead index (PLI) value of surface soil is 7.366 which denote perfection and the deep soil is 11.009 which indicates deterioration. Results showed that soil samples around cassava mills, Ikot Osurua are not polluted with respect to those metals. However, there is need for proper monitoring so as to maintain the present levels or device mitigation process that can control the future against bioaccumulation and biomagnifications in food chain or further result in the risk of superficial and ground water contamination.

Keywords: *Cassava Mill Effluent, Heavy Metal, Contamination Factor, Deep Soil, Surface Soil*

INTRODUCTION

Increasing level of the heavy metal in the environment from various anthropogenic sources has become a source of concern for environmentalists (Opeolu *et al*, 2008). As a result, there is a need for increasing awareness of the emergency created by environmental pollution caused by human activities. Toxic organics materials in many cases can be degraded, but the metals that are released into the environment tend to persist indefinitely, accumulating in living tissues through the food chain (Cossica *et al*, 2002).

Evidence of the potential and observed human hazard due to environmentally acquired heavy metals and their ecological impact have been extensively studied. In Nigeria and in most tropical countries, processed cassava tuber has been the staple food and with the present increase in production, it is gradually transforming from a famine reserve commodity and rural staple food to cash crop for urban consumption and to an export commodity for international market (IFAD, 2005; Ohochukwu, 2005). In this part of the country, cassava tuber is processed and made readily for consumption mainly either as garri, starch or as dried or wet cassava flour. In each of these, the major processing stage is the milling stage and this leads to the continous establishment of cassava milling machines all over the environment in the form of small and medium scale businesses. The residues obtained during the process include the solid and liquid wastes. Liquid effluents contain many nutrients, suitable to increase soil fertility as opposed to the water carried by them, which is pollutant to the environment (Horsfall and Spiff, 2006). Compounds that are generally toxic to living organisms will also at toxic concentrations prevent germination as well as inhibit growth. Continuous discharge of the effluent into the soil for a long period of time leads to extinction of some bacteria and fungi types that were originally available in the soil. When cassava effluent is released directly into streams and rivers, it would cause rapid growth of bacteria, resulting in oxygen depletion and death of fish and other aquatic life (Oboh et al, 2002).

Although, several studies have been conducted or carried out on the biochemical change associated with the fermentation of cassava marsh and liquid effluent (Okafor and Uzuegbu, 2008; Okafor and Ejiofor, 2000), there are few and scanty reports on the effect of the disposal or discharge of these mill effluents or processing waste on land especially in soil physical and chemical properties.

Materials and Method

Sample Collection and Preparation

The soil samples were collected from cassava mill at Ikot Osurua, Ikot Ekpene local Government Are, Akwa Ibom State.Surface soil sample was taken from 0 – 15cm, deep soil was taken from 15 – 30cm while the control soil was taken from about 100 meters from the mill. All the samples was put into different polyethylene bags and transported to the Chemistry laboratory of Akwa Ibom State Polytechnic, Ikot Osurua. The soil samples were air-dried for 24hours and then sieved with a 2mm mesh sieve as described by Nwachukwu *et al.,* (2018) and stored in polyethylene bag for analysis.

Treatment of Sample

1.00g each of the different samples were weighed separately using a weighing balance into a different digestion beakers. 10ml of nitric acid and 20ml hydrochloric acid were introduced into the mixtures. The digestion beakers containing the mixture were heated separately at the temperature of 140^{O}C until dense colourless fumes were obtained indicating that digestions were completed using heating mantle. The content in the three (3) beakers were allowed to cooled. 30ml of distilled water was added to the contents and was properly shaken. It was then filtered with Whattman filter paper and the three (3) solutions were made up to 100ml with distilled water. Thereafter, it was transferred into a sample bottle and reading of the heavy metals concentration and absorbance of the solutions using Atomic Absorption Spectrophotometer was carried out.

Determination of Heavy Metals in the Sample

The heavy metals were determined using Atomic Absorption Spectrophotometer with standard analytical procedure (A.O.A.C., 2012).

Pollution Assessment

Contamination factor (CF). The level of contamination of soil by metal is expressed in terms of a contamination factor (CF) calculated as:

$$CF = \frac{\text{Cm Sample}}{\text{Cm Background}}$$

Where the contamination factor CF < 1 refers to low contamination, $1 \leq CF \leq 3$ means moderate contamination; $3 \leq CF \leq 6$ indicates considerable contamination and CF > 6 indicates very high contamination.

Result and Discussion

Results

The results of the heavy metal composition in surface soil, deep soil and control sample around Ikot Osurua Cassava Mill are presented in the Tables below.

Heavy Metal Contents (Mg/kg) in soil sample around Ikot Osurua Cassava Mill

Heavy Metal	Surface Soil Sample (Mg/kg)	10cm Deep soil sample (Mg/kg)	Control Soil sample (Mg/kg)	WHO Standard 2015
Cadmium (Cd)	0.8135 ± 0.002	1.255 ± 0.002	0.1075 ± 0.002	0.8mg/kg
Lead (Pb)	0.0632 ± 0.0030	0.9115 ± 0.002	0.023 ± 0.00	100mg/kg
Chromium (Cr)	2.092 ± 0.001	1.3335 ± 0.002	0.1165 ± 0.002	50.00mg/kg
Iron (Fe)	8.108 ± 0.003	11.0565 ± 0.008	2.203 ± 0.001	425mg/kg
Zinc (Zn)	2.391 ± 0.001	10.421 ± 0.001	1.532 ± 0.001	50mg/kg
Copper (Cu)	19.0425 ± 0.002	25.7055 ± 0.002	2.0045 ± 0.004	10mg/kg

Value are Mean ± Standard Deviation

Mean of triplicate value ±

Metal	CF for Surface Soil	Indication	CF for Deep Soil	Indication
Cadmium (Cd)	7.56	Very high contamination	11.31	Very high contamination
Chromium	17.96	Very high contamination	11.56	Very high contamination
Lead	32.46	Very high contamination	39.64	Very high contamination
Iron	2.89	Moderate contamination	3.94	Considerable contamination
Zinc	1.56	Moderate contamination	6.80	Very high Contamination
Copper	9.50	Very high contamination	12.82	Very high contamination
PLI	7.366	Perfection	11.009	Deterioration

Discussion

The result of the analysis revealed that copper had the highest concentration (19.0425 ± 0.002mg/kg) in surface soil sample followed by iron (8.108 ± 0.003), Chromium (2.092 ± 0.0014), Zinc (2.391 ± 0.001), Cadmium (0.8135 ± 0.002) and Lead (0.632 ± 0.028)mg/kg. Showing Cu > Fe > Cr >Zn > Cd > Pb. The concentration of the heavy metals in the deep soil sample also revealed that copper had the highest concentration (25.7055 ± 0.002)mg/kg followed by Iron (11.056 ± 0.008), Zinc (10.421 ± 0.001), Cadmium (1.2155 ± 0.002), Chromium (1.335 ± 0.002) and Lead (0.9115 ± 0.002) mg/kg. This showed Cu > Fe > Cr > Zn > Cd > Pb. The concentration of the heavy metals in the control sample on the other hand revealed that Iron (2.803 ± 0.001) >, Copper (2.0045 ± 0.004)>, Zinc (1.532 ± 0.001) >, Chromium (0.1165 ± 0.002) >, Lead (0.023 ± 0.00) >, Cadmium (0.1075 ± 0.002mg/kg).

Cadmium : The Cadmium content in the deep soil sample (1.2155 ± 0.002mg/kg) was found to be higher than that observed in the surface soil sample (0.8135 ± 0.00212mg/kg) followed by control soil sample (0.1075 ± 0.002mg/kg). The Cadmium content in the deep soil and surface soil samples was found to be higher than 0.287 ± 0.051mg/kg reported by Ruqia *et al.,* (2015). The deep soil sample was also found to be higher than the WHO standard (0.8mg/kg) while the surface soil sample was in the range and the control lower than the standard. Cadmium is a highly toxic non-essential metal which accumulates in the kidney of mammals and cause kidney dysfunction, skeletal damage and reproductive deficiencies. Therefore, harvesting plants in that environment with higher concentration of cadmium may pose and adverse effect.

Chromium

The Chromium content in the surface soil sample (2.092 ± 0.0014mg/kg) was found to be higher than that observed in deep soil sample (1.335 ± 0.002mg/kg) followed by control sample (0.1165 ± 0.002mg/kg). The Chromium content in all soil samples was found lower when compared to 4.309 ± 0.822mg/kg reported by Ruqia *et al.*, (2015) for soil sample and also lower than the WHO recommended value for Chromium (100mg/kg) in soil.

Chromium is a micronutrient, essential for carbohydrate metabolism in animals. In high concentration, chromium II has been reported to be carcinogenic causing cancer of the respiratory organs (Langard, 1980). Therefore, the lower concentration is the soil sample will net pose any adverse effect if plant found in this environment is consumed.

Lead

The lead content in the deep soil sample (0.9115 ± 0.002mg/kg) was found to be higher than that observed in surface soil sample (0.632 ± 0.00283mg/kg) followed by control soil sample (0.023 ± 0.00mg/kg) followed by control soil sample (0.023 ± 0.00mg/kg). The lead content in deep soil samples and surface soil sample was found to be higher when compared to 0.061 ± 0.061mg/kg reported by Ruqia *et al.*, (2015) and lower than that in the control and also lower than the WHO standard value for lead (50.00mg/kg) in soil. Lead is known to induce reduced cognitive development and intellectual performance in children and cardiovascular disease and increased blood pressure in adults (WHO, 1992). However, the lower concentration of lead in the soil sample will pose no essential risk to human health when harvesting plant in the environment.

Copper

The copper content in the deep soil sample (25.70-55 ± 0.002mg/kg) was found to be higher than that observed in surface soil sample (19.0425 ± 0.002mg/kg) followed by control soil sample (2.0045 ± 0.004mg/kg). The copper content in all samples was found to be higher when compared to 0.607 ± 0.0025mg/kg reported by Ruqia *et al*., (2015) and WHO recommended value for copper (10mg/kg) in soil. Copper is an essential micronutrient required in the growth of both plants and animals. In humans, it helps in the production of blood haemoglobin while in plants, copper is especially important in seed production, disease resistance of water. Though copper is indeed essential in high doses in humans, it can cause anaemia, liver and kidney damage and stomach and intestinal irritation. Therefore, high concentration of copper in the soil will pose health risk to the consumers of plant in the environment.

Iron

The iron content in the deep soil sample (11.0565 ± 0.008mg/kg) was found to be higher than that observed in surface soil sample (8.108 ± 0.003mg/kg) followed by control soil sample (2.803 ± 0.001mg/kg). The iron content in all the soil samples was found to be lower when compared to 143.1 ± 151.4mg/kg reported by Ruqia *et al*., (2015) and the WHO standard value for iron (425mg/kg) in soil.

Iron occurs naturally through geological sources, industrial wastes, domestic discharge and also from by-products. Excess amount of iron causes rapid increase in pulse rate and coagulation of blood in blood vessels, hypertension and drowsiness. Therefore, the low concentration of iron in the soil poses no danger in this location.

Zinc

The Zinc content in the deep soil sample (10.421 ± 0.001mg/kg) was found to be higher than that observed in the surface soil sample (2.391 ± 0.001mg/kg) followed by control soil sample (1.532 ± 0.001mg/kg). The Zinc content in all samples was found to be higher when compared to 0.222 ± 0.031mg/kg reported by Ruqia *et al*., (2015) but lower than the WHO recommended value for zinc (50mg/kg) in soil.

Zinc is one of the important trace elements that play a vital role in physiological and metabolic process of many organisms. Nevertheless, higher concentrations of zinc can be toxic to the organism.

It is evident in this rsearch that the disposal of Cassava mill Effluent on soil of this location has greatly changed the chemical content of the soil by increasing all the analysed heavy metals. This is in accordanc with the study of Nwachukwu et al., (2018) who observed that several chemical and biochemical properties of the investigated soils changed in response to POME contamination and opined that this may have been why Okwute and Isu (2007) suggested proper treatment of POME before discharging. This suggestion may also be applicable with CME

Conclusion

Conclusively, the concentration of heavy metals Cd, Cr, Pb, Zn, Fe and Cu in this research were higher in the deep soil than surface soil and control soil. The values however were all below the WHO acceptable levels of these metals in soil. Therefore, the soil analyzed here do not pose any risk with respect to these metal except cadmium. However, the presence of the effluent on the soil has increased the metal concentration as compared to the control sample and thus this site must be continuously monitored to prevent geoaccumulation and bioaccumulation due to the nearness of this site to human resident and domestic activities.

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