

**Research Article**

**The impact of cassava wastewater from wet *fufu* paste processors on surrounding soils: a case study of Ayetoro, Ogun State, Nigeria**

**Adedotun Temitope Adegoke<sup>1\*</sup>, Babajide Emmanuel Olowu<sup>2</sup>, Nurudeen Samuel Lawal<sup>1</sup>, Olubunmi Abosede Odusanya<sup>2</sup>, Oluseun Bamidele Banjo<sup>3</sup>, Oluwafemi Babatunde Oduntan<sup>4</sup>, Babasola Dapo Odugbose<sup>1</sup>**

<sup>1</sup> Department of Agricultural Engineering, College of Engineering and Environmental studies / Olabisi Onabanjo University, Ogun State, Nigeria

<sup>2</sup> Department of Crop Production, College of Agricultural Sciences/ Olabisi Onabanjo University, Ogun State, Nigeria

<sup>3</sup> Department of Forestry, Wildlife, and Fisheries, College of Agricultural Sciences/ Olabisi Onabanjo University, Ogun State, Nigeria

<sup>4</sup> Department of Aquaculture and Fisheries Management, Faculty of Renewable Natural Resources/ University of Ibadan, Oyo State, Nigeria

\*corresponding author: adedotun.adegoke@oouagoiwoye.edu.ng

Received 20 April 2020, Accepted 6 June 2020

**Abstract:** Cassava effluent has become a subject of growing environmental concern in developing countries largely due to ineffective disposal methods. In this study, the impact of land disposal technique by processors in Ayetoro, Ogun State Nigeria was investigated. Soil samples were collected from three disposal sites scattered across the study area at depths of 0 cm, 15 cm, 30 cm and 45 cm. Results were compared with samples obtained from control sites at a distance of 5 m from the disposal sites. The physicochemical parameters determined include soil pH, silt, sand, clay, organic carbon, exchangeable acid, total nitrogen, available phosphorous, zinc, lead, iron, sodium, copper, calcium, potassium, magnesium and manganese. The result shows that the pH varies significantly across the sites. The highest concentration was recorded for phosphorous while the lowest concentration was obtained for total nitrogen. The highest concentrations were recorded at the soil surface while the lowest were recorded at 45 cm depth. Idagba recorded the highest pollutant concentration and while the lowest were obtained at kano street. The activities and discharge techniques of processors had negatively impacted the soil quality which may also affect the ground water quality. There is a need to take proactive measures to protect the environment through adequate sensitization and enforcement of environmental laws.

**Keywords:** *disposal, effluents, method, milling, soil*

---

**To cite this article:** Adegoke, A.T., Olowu, B.E., Lawal, N.S., Odusanya, O.A., Banjo, O.B., Oduntan, O.B. and Odugbose, B.D. 2020. The impact of cassava wastewater from wet fufu paste processing industry on surrounding soil: a case study of Ayetoro community, Ogun State, Nigeria. *J. Degrade. Min. Land Manage.* 7(7): 2319-2326, DOI: 10.15243/jdmlm.2020.074.2319.

---

**Introduction**

Cassava is an agricultural product which is very essential in society and its importance for human and animal consumption cannot be overemphasized. The importance of cassava to the society is numerous which recommends the agricultural produce and its products to be useful

for man. Cassava is a drought-tolerant crop which can be cultivated in soil with minimal soil nutrients. In recent time, cassava has been observed to be planted commercially when compared to the earlier days when it is majorly planted as a subsistence crop, this has improved the economic value of the crop. As a result of this, different research work is being conducted to improve

processing technologies, increase crop productivity, and improves methods of harvesting the crop and also to improve the varieties planted. Different varieties of cassava are available, of which two prominent are available. These two varieties which are often cultivated are sweet and bitter variety. Bitter cassava variety contains glycoside which releases hydrocyanic acid during processing (Adeyemo, 2005).

Different parts of cassava plant are useful for commercial purposes. The root if well processed, can be eaten and also serve as food for livestock and human consumption after the cyanide content is removed completely. Different products made from cassava are cassava flour, cassava plantain, wet cassava dough (fufu), starch etc.

Cassava flake which is commonly referred to as gari in Africa and Farinha in America, is a good ingredient for making recipes. Cassava is also useful in the production of cassava bread which has replaced wheat flour as a result of the relatively avoidable cost of production.

During the production of the cassava products from the mill, by-products are often released which has adverse effects on the environment (Kolawole, 2014) when improperly disposed.

Quite a number of researches were carried out to observe the effect of heavy metals on soil contamination as a result of the discharge of effluent through the terrestrial or aquatic system (Igbiosa and Igiehon, 2015). Eze and Onyilide 2015, reported that cassava has some toxic chemicals called cyanogenic glucoside, which is stored inside the vacuole in the plant cell. The chemical is later converted into hydrogen cyanide and by the time it comes in contact with the cell wall a process called hydrolysis of linamarin and lotaustralin takes place. During the processing which entails boiling, cooking and frying, the linamarin content is reduced as a result of its hydrolyzed effect in the digestive system of animals and human beings by indigenous microbial flora and in the process hydrogen cyanide (HCN) is released. The hydrogen cyanide penetrates the human body through ingestion, inhalation, and or skin contact which then circulates into the body system through the bloodstream.

Wastewater generated from Cassava processing centres is of high volume which contains pollutants of different composition. These have been observed to have affected soil and water physicochemical parameters. The recent trend and manner in which the effluent is discharged directly to the water bodies which includes streams and rivers, and the soils have generated a major concern in the society. This could be as a result of high level of suspended solid, Total suspended solid, colour,

Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), cyanogenic content and also low dissolved oxygen. These pollutants pollute the receiving water bodies and make it difficult for water usage by the downstream (Adewumi et al., 2016). The effluent can also disturb the aquatic life by altering the animal and plant distribution.

Khan et al. (2011) investigated the level of concentration of toxicants for heavy metal in the roadside soil along the National highway, in Pakistan. The results indicated that the source of the heavy metals contamination is majorly from vehicular traffic while the available dumping sites of different hazardous waste material and the unregulated incineration located along the highway were responsible for contaminations. Also, Khan and Kathi (2014) carried out a research on petroleum hydrocarbon and heavy metal contamination of the roadside soil surface soil from a site which is very close to an agricultural field and automobile workshop. His findings showed that sampling sites located close to agricultural field had less contamination with low pollution level while compared with sites located to automobile workshops both along the highway, which suggests the impact of anthropogenic activities on these levels of contamination. Malik et al. (2010) researched into the investigation to know the sources and level of the contamination of metals on the soil surfaces in the industrial city of Sialkot, Pakistan which is popularly known in the world for the production of pharmaceutical industries and tanneries. With the use of GIS and a multivariate approach. The results obtained showed that the level of concentration of the metals which was measured in urban soil was high and also exceeded the permissible limit for soil surface and also advocated for an imperative need for detailed baseline in investigating the spatial distribution of heavy metals.

Further studies by Okonkwo and Mothiba (2005) which was carried out to determine the level and toxicity of trace metals as affects the aquatic organisms present in surface water from three South Africa rivers. The findings revealed that the concentration ranges for all the metals measured were below the permissible acceptable standard for drinking water except the values for lead (Pb) and Cadmium (Cd). Also, as reported by Mahanta and Bhattacharyya (2011) that there was a high level of significant variation in the heavy metals present in different land use type, after researching the assessment of heavy metals in urban soil of Guwahati City, India in which 31 sites in five different land-use types of roadside, industrial, residential, public utilities and commercial was considered.

Onyeike et al. (2002) also researched into the concentration level of inorganic ion present in streams and soils of three locations in Ogoni land, Nigeria which are affected by crude oil spillage. Their findings revealed that there is a significant variation in the concentrations of the polluted streams and soils in the three locations. Even though the cations and anions of the analyzed streams and soils were within the WHO permissible discharged values for the environment, but since inorganic ions also contribute to the pollution of the stream, this makes the stream unfit for agricultural, industrial and domestic purposes.

The main objective of this research work is to evaluate the effect of cassava effluent on the surrounding soils of wet fufu paste processing industry.

## **Materials and Methods**

### ***Study area***

Ayetero falls on the longitude 30° 3'E and latitude 7° 12'N and in a deciduous-derived savannah area of Ogun state.

### ***Samples collection***

Soil samples were collected from three different cassava processing sites. Kano Street, Idagba Street, Kikelomo Street. Soil samples from an uncontaminated area of each site were also collected to serve as controls for the analysis. The soil laboratory analysis was carried out at the Department of Crop Production laboratory, College of Agricultural Sciences, Olabisi Onabanjo University. The parameters analyzed include moisture content, silt, sand, clay, organic carbon, exchangeable acid, soil pH, total nitrogen, available phosphorous, zinc, lead, iron, sodium, copper, calcium, potassium, magnesium and manganese. A disinfected soil auger was used for the collection of the soil samples. Soil samples were collected in clean sterile bottles from a depth of 0 cm, 15 cm, 30 cm, and 45 cm from soil polluted with cassava effluent in Kano Street, Idagba and Kikelomo in Yewa North region of Ogun State, Nigeria. Soil samples, which were free of cassava effluent, was collected from control sites outside the processing plant at a distance of 5m. Collected soil samples were replicated three times to validate the results. Samples were collected during the rainy season between April and May 2019.

### ***Physicochemical properties analysis***

The physicochemical parameters of the contaminated soil and the control soil were analyzed. SP-AA 3000 Atomic Absorption

Spectrometer, (Shanghai Yanhe, China) was used to analyze the digested samples for metals contaminants. pH and soil temperature were determined using AD14 pH meter (Adwa Instrument, Hungary), and the mercury-in-glass thermometer (B60770-1800, SP Scienceware, USA). The Total Organic Carbon was ascertained as reported by Nelson and Sommers (1982). Total nitrogen was conducted using the Kjeldahl digestion method and percentage organic matter was investigated as reported by previous studies (Bremner, 1960). The particle size analysis of the soil was determined using the hydrometer method Bouyoucos (1962). The seventy-two soil samples were collected from different cassava processing plant sites.

## **Results and Discussion**

### ***Effects of physicochemical parameters across the different soil depths***

From Table 1 below, the mean concentration of soil pH was highest ( $9.14 \pm 0.13$ ) at the soil surface which shows that the soil is strongly alkaline. The pH content reduced slightly to ( $8.87 \pm 0.15$ ) at a depth of 15 cm which shows the presence of alkaline content at the depth region. This later increased to ( $9.11 \pm 0.16$ ) at a depth of 45 cm. Similarly, the control shows the pH value ( $9.19 \pm 0.09$ ) at 5 m distance from the factory, which suggests the nature of the soil indicating that the soil was alkaline before the application of cassava effluent. The soil pH ranges between 8.87 and 9.19 which indicates that the cassava effluent does not alter the soil pH. The concentration of the soil was alkaline all through the sampling period and conformed to the FEPA (1991) discharge standard of pH 9. The available phosphorus increased on the surface soil ( $313.15 \pm 83.35$ ) mg/kg at the point of discharge. However, there is a decrease in phosphorus down the soil depth. The available phosphorus of 0cm discharge point was significantly different from 0 cm at 5 m distance away from the discharge point. Therefore cassava effluent increased the soil available phosphorus. Also, the concentration at soil surface was significantly different from the soil depths of 15 cm, 30 cm, 45 cm and distance 5 m away from the effluent site. The phosphorus concentration at all the soil depths does not meet the 10 mg/kg FEPA discharge standard. The total nitrogen increased at the surface soil at the point of discharge but decreased down the depth. The total nitrogen at 45cm depth at discharge point is same as that of 0cm at 5m distance away ( $0.65 \pm 1.43$ ) g/kg from the discharge point. The high content of total nitrogen is therefore attributed to cassava effluent

Table 1. Physicochemical properties of soil samples at various depth across the three locations.

Parameters	Soil Depth (cm)				Distance from Disposal Site (m)
	0	15	30	45	5
pH	9.14±0.13 <sup>bc</sup>	8.87±0.15 <sup>a</sup>	8.92±0.06 <sup>ab</sup>	9.11±0.16 <sup>bc</sup>	9.19±0.09 <sup>c</sup>
Available P (mg/kg)	313.15±83.35 <sup>c</sup>	170.25±79.15 <sup>a</sup>	215.45±88.45 <sup>ab</sup>	99.90±34.40 <sup>a</sup>	90.45±19.65 <sup>a</sup>
Total N (g/kg)	0.65±0.15 <sup>b</sup>	0.55±0.23 <sup>b</sup>	0.42±0.04 <sup>ab</sup>	0.29±0.08 <sup>a</sup>	0.29±0.01 <sup>a</sup>
Organic C (g/kg)	6.30±1.43 <sup>b</sup>	5.28±2.24 <sup>b</sup>	4.08±0.38 <sup>ab</sup>	2.76±0.81 <sup>a</sup>	2.79±0.12 <sup>a</sup>
Clay (%)	5.00±1.00 <sup>a</sup>	8.00±2.00 <sup>b</sup>	7.00±1.00 <sup>ab</sup>	7.00±1.00 <sup>ab</sup>	8.00±2.00 <sup>b</sup>
Silt (%)	7.00±1.00 <sup>a</sup>	7.00±0.00 <sup>a</sup>	8.00±0.00 <sup>b</sup>	10.00±0.00 <sup>c</sup>	8.00±0.00 <sup>b</sup>
Sand (%)	88.00±0.00 <sup>b</sup>	85.00±2.00 <sup>a</sup>	85.00±1.00 <sup>a</sup>	83.00±1.00 <sup>a</sup>	84.00±2.00 <sup>a</sup>
Soil textural class	Sandy soil	Loamy sand	Loamy sand	Loamy sand	Loamy sand
Exchangeable Acidity (cmol/kg)	0.55±0.25 <sup>a</sup>	0.75±0.15 <sup>a</sup>	0.85±0.35 <sup>a</sup>	0.55±0.05 <sup>a</sup>	0.50±0.10 <sup>a</sup>
Calcium (cmol/kg)	17.60±3.73 <sup>a</sup>	13.57±7.01 <sup>a</sup>	7.63±1.35 <sup>a</sup>	4.05±1.44 <sup>a</sup>	6.51±2.15 <sup>a</sup>
Magnesium (cmol/kg)	24.29±3.51 <sup>c</sup>	9.55±4.35 <sup>bc</sup>	10.06±2.40 <sup>ab</sup>	7.56±2.80 <sup>a</sup>	7.40±1.89 <sup>ab</sup>
Potassium (cmol/kg)	8.78±0.72 <sup>c</sup>	4.41±0.13 <sup>ab</sup>	5.38±0.84 <sup>b</sup>	3.41±1.25 <sup>a</sup>	5.11±0.37 <sup>b</sup>
Sodium (cmol/kg)	2.45±0.15 <sup>b</sup>	1.7±0.13 <sup>a</sup>	1.75±0.40 <sup>a</sup>	1.45±0.25 <sup>a</sup>	1.85±0.05 <sup>a</sup>
Lead (mg/kg)	44.65±16.10 <sup>a</sup>	37.72±12.42 <sup>a</sup>	27.87±10.53 <sup>a</sup>	65.30±48.20 <sup>a</sup>	26.90±10.70 <sup>a</sup>
Manganese (mg/kg)	10.00±5.70 <sup>a</sup>	34.45±33.45 <sup>a</sup>	38.60±35.40 <sup>a</sup>	5.95±0.65 <sup>a</sup>	4.90±3.40 <sup>a</sup>
Iron (mg/kg)	100.50±15.50 <sup>a</sup>	101.00±14.00 <sup>a</sup>	108.25±16.75 <sup>a</sup>	115.00±25.00 <sup>a</sup>	122.75±2.25 <sup>a</sup>
Copper (mg/kg)	2.56±0.03 <sup>a</sup>	2.16±1.36 <sup>a</sup>	3.06±0.04 <sup>a</sup>	3.18±0.03 <sup>a</sup>	2.04±0.61 <sup>a</sup>
Zinc (mg/kg)	71.10±51.90 <sup>a</sup>	57.67±53.83 <sup>a</sup>	37.95±32.45 <sup>a</sup>	37.67±6.02 <sup>a</sup>	10.43±6.03 <sup>a</sup>
Moisture Content (%)	40.94±0.44 <sup>b</sup>	19.84±4.65 <sup>a</sup>	21.71±1.71 <sup>a</sup>	22.37±0.03 <sup>a</sup>	34.96±11.54 <sup>b</sup>

<sup>a,b,</sup> and <sup>c</sup> Represent Mean ± SD readings that are significant and non-significant ( $p < 0.05$ ) across the rows for each of the parameters and samples while the equals below detection level, respectively.

The negative effect was not observed at 45 cm depth. Also, a similar trend was observed in organic carbon with a high concentration of organic carbon at the soil surface on the effluent site (0.65±0.15) g/kg was recorded when compared 15 cm, 30 cm 45 cm distances and 5 m away from the effluent site. There was no significant difference in the Exchangeable Acidity content of the soil samples across the different soil depth and the control, although the highest mean Exchangeable Acidity content was observed at the 30 cm level (0.85 ±0.35) cmol/kg and the lowest mean content at the control (0.50±0.10) mg/kg. Figure 1A to Figure 1C show that the soil pH of the sample collected in all the location is alkaline in nature. Also, high presence of organic carbon is observed at the three locations considered. The total nitrogen available is low in all the locations in respective of the depth considered. There was an increase in total nitrogen concentration at 30 cm depth for Idagba and Kikelomo which could be as a result of some activities which could have been carried out on the land (Table 1). The highest concentration of exchangeable acid 1.2 cmol/kg was observed at 30 cm depth of Idagba in Figure 1A indicating that the land contains low acid content.

In Table 1, there was no significant difference in the calcium content of the soil samples across the different soil depth and control distance. The highest calcium content was observed in the soil

sample taken from the soil surface at the effluent site (17.60±3.73) cmol/kg, which is within the FEPA discharge limit (200) cmol/kg. The soil magnesium content at 45cm depth was significantly different from the soil surface and 15 cm soil depth. Also, soil sample concentration at the soil surface was significantly different from 30 cm, 45 cm depth and control depth 5m away as shown in Table 1. The highest magnesium content was observed in the soil sample taken from the soil surface level at the effluent site (24.29±3.51) cmol/kg. The soil sample at the soil surface (8.78±0.72) cmol/kg had the highest concentration. All the sampled soils concentration is within the FEPA discharge limit (200 cmol/kg), while the lowest concentration was at 45 cm depth, which implies that the potassium concentration was present at the effluent before the discharge at the effluent site. The soil sample of the control site (5.11±0.37) cmol/kg reveals that the soil composition had potassium content. From Figure (1D to 1F), magnesium concentration at Kikelomo and Idagba reduces with increase in depth in the areas with a very high concentration at the soil surface, which depicts that the effluent contained high magnesium concentration. Furthermore, a statistically significant difference was also observed in the sodium content of the soil sample across the different depth with the soil sample taken from the soil surface at the effluent site having the highest (2.45±0.15) cmol/kg.

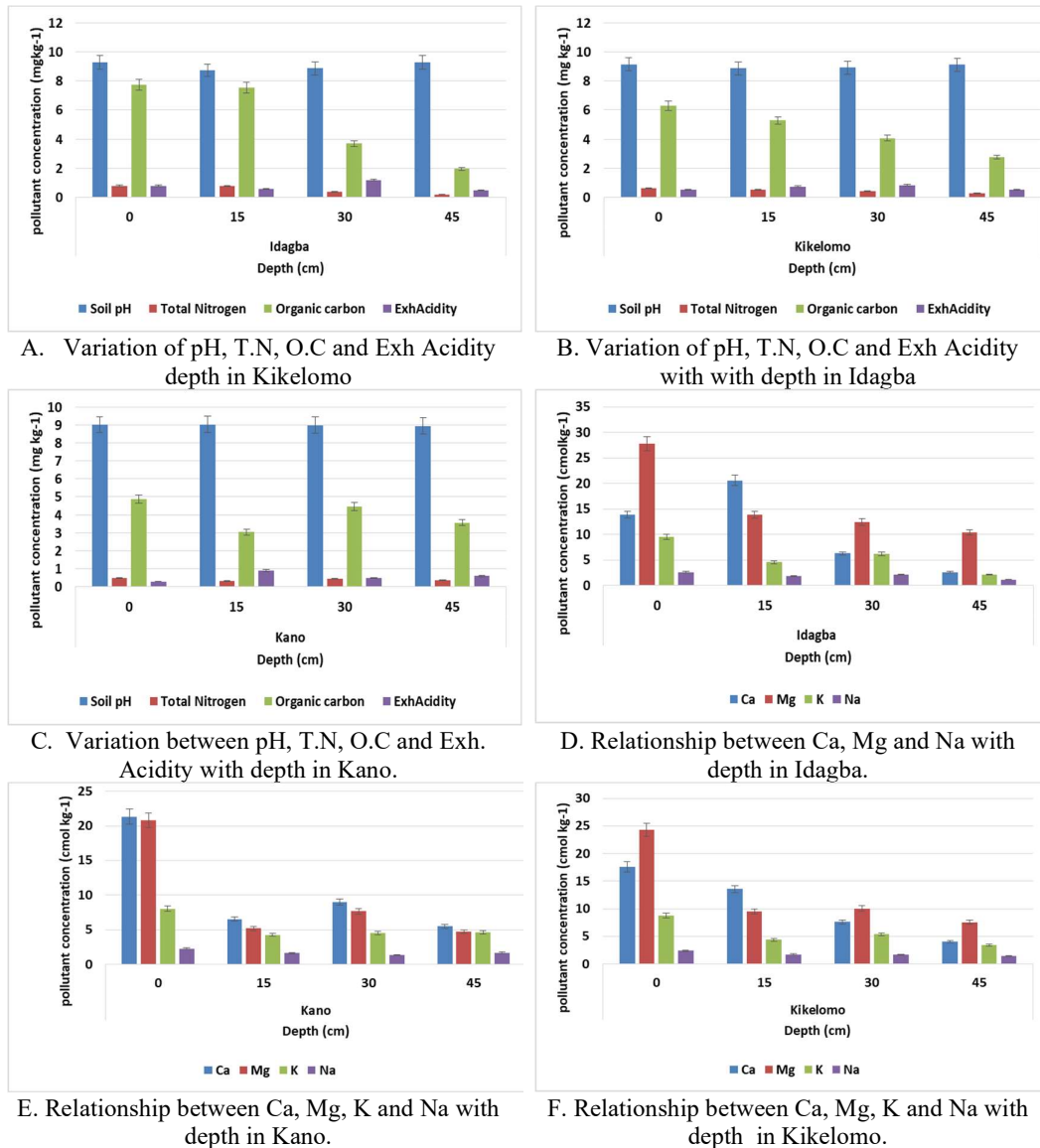


Figure 1. Variations of soil physicochemical parameters with depth across the three locations.

The control site with the highest iron concentration ( $122.75 \pm 2.25$ ) mg/kg shows that the soil was highly polluted prior to the effluent discharge activities carried out on the site. The concentration at the soil surface ( $100.50 \pm 15.50$ ) mg/kg was lower in comparison with other soil depths, which could be as a result of the cassava effluent on the soil surface as obtained from Table 1. This does not conform to the FEPA discharge limit (20 mg/kg), but similar to discovery by Malik et al. (2010). There was no significant difference across the soil depths for copper concentration. The highest mean concentration of copper was observed at 45 cm depth of the soil sample ( $3.18 \pm 0.03$  mg/kg) with the lowest concentration at the control ( $2.04 \pm 0.61$ )

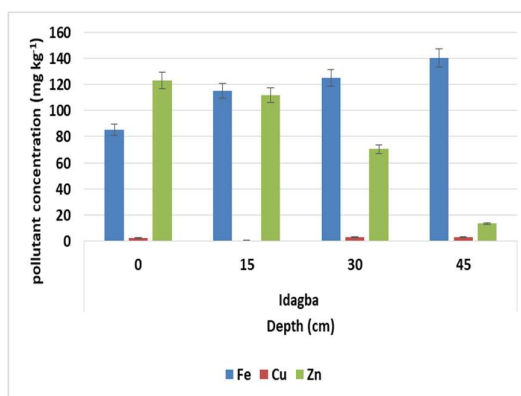
mg/kg, which does not meet the discharge standard of FEPA (0.9 mg/kg). The soil sample at the soil surface shows the highest zinc concentration ( $71.10 \pm 51.90$ ) mg/kg as shown in Table 1. Also, the zinc concentration reduces along with the soil depth which implies that the soil structure could serve as a form of a filter layer for the removal of zinc pollutant. There was no significant difference across the soil depth. Iron and zinc concentrations are high at Idagba in comparison to copper (Figure 2G and Figure 2I), which is similar to but only iron was high at Kano street in Figure 2H, which means that the zinc concentration was as a result of the nature of the land. There was no significant difference for lead concentration across the

different depth of the soil samples considered in Table 1 as well as the control site at a distance 5 m from the effluent site. The deposition of the effluent on the soil at different depth polluted the soil at all considered depth. The lowest lead concentration ( $26.90 \pm 10.70$ ) mg/kg at the control site was above the normal FEPA discharge standard. This does not correspond with what was reported by Okonkwo and Mothiba (2005). Similarly, the pollution level of the effluent soil at all depth was higher in manganese concentration in comparison to the control. The highest concentration of manganese at 30 cm ( $38.60 \pm 35.40$ ) mg/kg as shown in Table 1, shows that due to some activities which were carried out on the land prior to the subjection of the land to the effluent site could have resulted to the possible increase in the manganese concentration which does not meet the FEPA discharge limit (5 mg/kg). There was no significant difference across the soil depth. Also, there was no significant difference across all the soil depths. In Figure 2J, the lead content at 45 cm soil depth was high at Idagba and

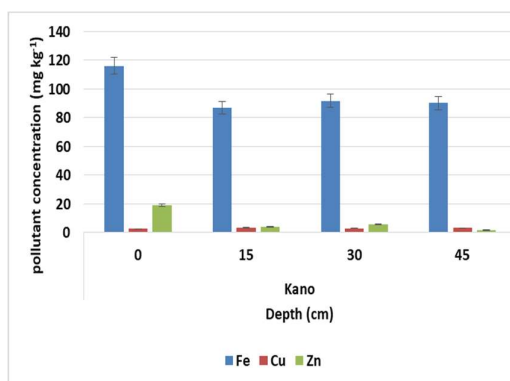
Kikelomo in comparison to other soil depth as indicated in Figure 2J. Also, Kano recorded high manganese concentration at 15 cm and 30 cm soil depth, respectively, which does not conform to 0.9 mg/kg FEPA standard.

The mean composition of clay in the soil samples was higher ( $8.00 \pm 2.00$ ) % at a control distance 5 m away from the effluent site compared to that of the effluent site at the soil surface, 15 cm, 30 cm and 45 cm depth respectively on the effluent site. Also, the mean silt composition of the soil samples was higher at 45 cm depth ( $10.00 \pm 0.00$ ) % compared to that of the soil surface, 15 cm, 30 cm depth and control distance of 5 m away from the effluent site.

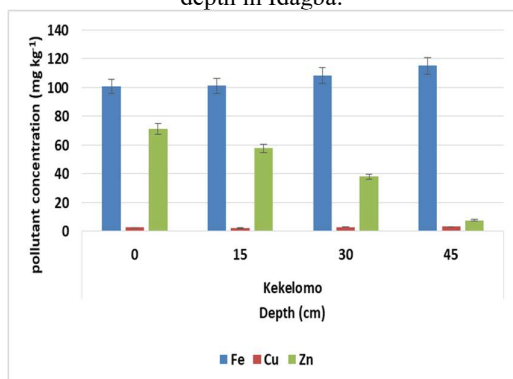
The highest mean soil moisture content was recorded at the surface of the soil ( $88.00 \pm 0.00$ ) % which was highly significant to 15 cm, 30 cm, 45 cm depth and 5 m distance respectively. The mean moisture content of the soil was moderately high ( $40.94 \pm 0.44$ ) % at the soil surface which shows the frequency of the activity. The moisture content reduced to ( $19.84 \pm 4.65$ ) % at 15 cm depth.



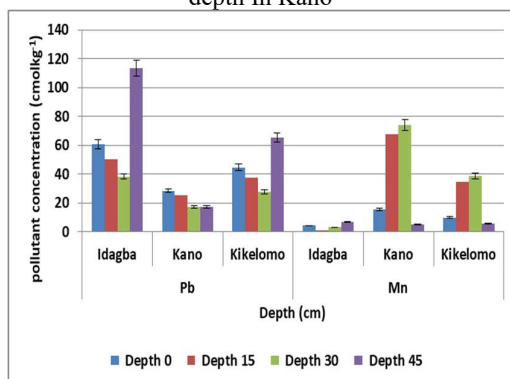
G. Relationship between Fe, Cu and Zn with depth in Idagba.



H. Relationship between Fe, Cu and Zn with depth in Kano



I. Relationship between Fe, Cu and Zn with depth in Kikelomo.



J. Relationship between Pb and Mn with depth in across the three locations.

Figure 2. Variations of metallic pollutants with depth across the three locations.

***The effect of physicochemical properties of the soil across the different soil locations***

A non-statistically significant difference was observed in the mean concentration of pH in the soil samples across the different location where the samples were taken from. Also, the mean available phosphorus concentration was significantly higher at Idagba (238.84±119.06) mg/kg compared to that of Kano street and Kikelomo, and low concentration of the average phosphorus was at Kano street (116.84±67.60) mg/kg. Also, there was no significant difference in the mean total nitrogen concentration across different soil locations. Similarly, there was no significant difference in the

mean concentration of organic carbon and Clay respectively across the different soil locations. Also, no significant difference was observed in the mean concentration of silt in the soil samples across different location where the samples were taken. Furthermore, a non-statistically significant difference was observed in the mean concentration of sand in the soil samples across the different location where the samples were taken from. This non-statistically significant difference was also noticed in the mean concentration of exchangeable acidity, calcium, magnesium, potassium and sodium content in the soil samples across the different study locations.

Table 2. Parameter values across the different study locations.

Parameters	Location		
	Idagba	Kano	Kikelomo
pH	9.07±0.27 <sup>a</sup>	9.01±0.06 <sup>a</sup>	9.04±0.14 <sup>a</sup>
Available P (mg/kg)	238.84±119.06 <sup>b</sup>	116.84±67.60 <sup>a</sup>	177.84±91.50 <sup>a</sup>
Total N (mg/kg)	0.49±0.27 <sup>a</sup>	0.38±0.09 <sup>a</sup>	0.44±0.16 <sup>a</sup>
Organic C (mg/kg)	4.76±0.27 <sup>a</sup>	3.72±0.09 <sup>a</sup>	4.24±0.16 <sup>a</sup>
Clay (%)	7.20±2.28 <sup>a</sup>	6.80±1.79 <sup>a</sup>	7.00±1.22 <sup>a</sup>
Silt (%)	8.20±1.09 <sup>a</sup>	7.80±1.48 <sup>a</sup>	8.00±1.22 <sup>a</sup>
Sand (%)	84.60±2.41 <sup>a</sup>	85.40±2.41 <sup>a</sup>	85.00±1.87 <sup>a</sup>
Soil textural class	Loamy Sand	Loamy sand	Loamy Sand
Exchangeable acidity (cmol/kg)	0.74±0.28 <sup>a</sup>	0.54±0.23 <sup>a</sup>	0.64±0.15 <sup>a</sup>
Calcium (cmol/kg)	10.40±7.00 <sup>a</sup>	9.34±6.91 <sup>a</sup>	9.87±5.55 <sup>a</sup>
Magnesium (cmol/kg)	14.76±7.51 <sup>a</sup>	8.78±6.80 <sup>a</sup>	11.77±7.09 <sup>a</sup>
Potassium (cmol/kg)	5.58±2.67 <sup>a</sup>	5.26±1.57 <sup>a</sup>	5.42±2.02 <sup>a</sup>
Sodium (cmol/kg)	1.93±0.51 <sup>a</sup>	1.78±0.35 <sup>a</sup>	1.85±0.36 <sup>a</sup>
Lead (cmol/kg)	60.08±31.34 <sup>c</sup>	20.90±5.63 <sup>a</sup>	40.49±15.68 <sup>ab</sup>
Manganese (cmol/kg)	4.68±2.86 <sup>a</sup>	32.88±15.20 <sup>b</sup>	18.78±6.37 <sup>a</sup>
Iron (mg/kg)	118.00±20.49 <sup>a</sup>	101.00±15.91 <sup>a</sup>	109.50±9.49 <sup>a</sup>
Copper (mg/kg)	2.46±0.97 <sup>b</sup>	2.74±0.81 <sup>a</sup>	2.60±0.51 <sup>a</sup>
Zinc(mg/kg)	67.01±51.28 <sup>a</sup>	6.92±7.00 <sup>a</sup>	36.96±28.09 <sup>ab</sup>
Moisture content (%)	31.46±11.21 <sup>a</sup>	24.46±9.97 <sup>a</sup>	27.96±9.40 <sup>a</sup>

<sup>a,b, and c</sup> Represent Mean ± SD readings that are significant and non-significant (p < 0.05) across the rows for each of the parameters and samples while d equals below detection level, respectively.

A statistically significant difference was observed in the mean concentration of lead in the soil samples across the different location where the samples were taken from. The samples from Idagba had the highest mean lead contents (60.08±31.34) mg/kg. Also, a statistically significant difference was observed in the mean concentration of manganese in the soil samples across different location, which corresponds with Mahanta and Bhattacharyya (2011). Although Kano has the highest mean manganese concentration (32.88±15.20) mg/kg, there was no statistically significant difference in the Iron content of the soil samples across the three study locations. Furthermore, there was no statistically

significant difference in the Copper and soil moisture contents of the soil samples across the three study locations. Lastly, a statistically significant difference was observed in the mean concentration of zinc in the soil samples across different locations. The Idagba community had the highest zinc concentration (67.01±51.28) mg/kg. This is in line with what was observed by Onyeike et al. (2002).

**Conclusion**

The result in this study reveals that high volume of cassava effluent is generated at the processing

stage which has effects on the physicochemical characteristics of the surrounding soil, which also showed that the concentration of the effluent on the receiving body decreases with depth. Due to the fact that cassava processing workers are not enlightened on the dangers surrounding the discharge of cassava processing effluents on the environment, there is a need for sensitization by different agricultural extension workers on ways of wastewater treatment and disposal.

## References

- Adeyemi, J.R., Babatola, J.O. and Olayanju, O. 2016. The impact of cassava wastewater from starch processing industry on surrounding soil: A case study of Matna Foods industry, Ogbese. *FUOYE Journal of Engineering and Technology* 1(1): 31-36.
- Adeyemi, O.K. 2005. Haematological and histopathological effects of cassava mill effluent in *Clarias gariepinus*. *African Journal of Biomedical Research* 8 (3): 179-183.
- Bouyoucos GJ. 1962. Improved hydrometer method for making particle size analysis. *Agronomy Journal* 54: 464-465.
- Bremner, J.M. 1960. Determination of nitrogen in soil by the Kjeldahl method. *Journal of Agricultural Science* 55: 11-33.
- Eze, V.C. and Onyilide, D.M. 2015. Microbiological and physicochemical characteristics of soil receiving cassava effluent in Elele, Rivers State, Nigeria. *Journal of Applied & Environmental Microbiology* 3(1): 20-24.
- FEPA (Federal Environmental Protection Agency). 1991. Guidelines and Standards for Environmental Pollution in Nigeria.
- Igbinosa, E.O. and Igiehon, O.N. 2015. The Impact of cassava effluent on the microbial and physicochemical characteristics on soil dynamics and structure. *Jordan Journal of Biological Sciences* 8(2): 107-112.
- Khan, V., Mariyum, A., Pasha, N. and Hasnain, A. 2011. Impact of organization culture on the job satisfaction of the employees (banking sector of Pakistan). *European Journal of Economics, Finance and Administrative Sciences* (35): 8-14.
- Khan, A.B. and Kathi, S. 2014. Evaluation of heavy metal and total petroleum hydrocarbon contamination of roadside surface soil. *International Journal of Environmental Science and Technology* 11:2259-2270.
- Kolawole, O.P. 2014. Cassava Processing and the Environmental Effect. *Proceeding of the 4th World Sustainability Forum*, MDPI Switzerland: 1-7.
- Mahanta, M. and Bhattacharyya, K. 2011. Total concentrations, fractionation and mobility of heavy metals in soils of urban area of Guwahati, India. *Environmental Monitoring and Assessment* 173:221-240.
- Malik, R.N., Husain, S.Z. and Nazir, I. 2010. Heavy metal contamination and accumulation in soil and wild plant species from industrial area of Islamabad, Pakistan. *Pakistan Journal of Botany* 42: 123-127.
- Nelson, D.W. and Sommers, L.E. 1982. Total carbon, organic carbon, and organic matter, in *Methods of Soil Analysis*: 539-594.
- Okonkwo, J.O. and Mothiba M. 2005. Physico-chemical characteristics and pollution levels of heavy metals in the rivers in Thohoyandou, South Africa. *Journal of Hydrology* 308:122-127.
- Onyeike, E.N., Ogbuja, S.I. and Nwinuka, N.M. 2002. Inorganic ion levels of soils and streams in some areas of Ogoniland, Nigeria as affected by crude oil spillage. *Environmental Monitoring and Assessment* 73(2): 191-204.