

HEAVY METALS ASSESMENT OF CASSAVA EFFLUENTS DISCHARGE IN OJA OBA, IGBOORA, OYO STATE, NIGERIA

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Abstract

This study was conducted to determine the concentration levels of selected heavy metals, iron (Fe^{2+}), cadmium (Cd^{2+}), manganese (Mn^{2+}), chromium (Cr^{3+}), zinc (Zn^{2+}), lead (Pb^{2+}), and copper (Cu^{2+}) in cassava effluent discharged during processing at oja oba, igboora, Oyo state, Nigeria. Cassava (*Manihot esculenta*) has been considered as one of the major sources of carbohydrate in the world. These heavy metals may be capable of affecting humans, animals, plant and ecosystems. The result of this research revealed the highest value of 1.89 mg/L iron (Fe^{2+}) concentration at 30-40 m away from the pollution source in the cassava effluent which is above the permissible limits set by WHO and USEAP standards. Also, recorded at its lowest level was 0.0060 mg/L cadmium (Cd^{2+}) concentration at 0-10m from the pollution source. High concentration of heavy metal reduces the soil mineral contents and increase acidity, which is detrimental to the quality of the soil that receives the cassava effluent discharge. Heavy metal pollution is of very serious public health concern due to its persistence, toxicity, and non-biodegradability in the environment. This calls for an increasing public health concern and monitoring to avert the harmful effects on water, plant, animals and humans. There must be an execution of formidable remediation of effluents treatment before discharge into the environments.

Keyword: *Effluent, Heavy metal, Concentration, Ecosystem, Pollution, Remediation.*

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Introduction

Cassava effluents are frequently being discharged indiscriminately into the environment by smallholder cassava processors in rural communities in Nigeria (Sylvester et al., 2018; Ayedun et al., 2015; Adeleken and Abegunde, 2011; Arimoro et al., 2008).

Cassava mill effluents are known to be toxic to biodiversity including some livestock, vegetation, microorganisms and fishes (Hazrat et al., 2019). Cassava mill effluents also alter the soil and water physico-chemical characteristics (Nwakaudu et al., 2012). Cassava mill effluents are known to be

toxic to the environment and its associated biota (Sylvester et al., 2017; Ganiyu et al., 2017).

During cassava processing, wastes are generated at different stages including peels from the peelings stage, cassava mill effluents from the dewatering or pressing stage and gaseous emissions from the frying stage (Osho et al., 2010). The liquid waste popularly known as cassava mill effluents is generated at the grating and dewatering stages and it account for about 16% of total weight of cassava tuber (Shankar, 2019). The wastes are discharged into the environment without any form of treatment (Akpan et al., 2011).

This cassava effluent changes the characteristics of the receiving soil with regard to microbial, physicochemical cations and anions exchange, soil particle size, bulk density and porositty (Barzegar et al., 2019; Enuneku et al., 2018; Adbulrachman and Yahaya, 2006).

Heavy metals are generally referred to as those metals which possess a specific density of more than 5g/cm^3 and adversely affect the environment and living organisms (Barzegar et al., 2015; Hanaa et al., 2000). A heavy metal is said to be toxic when its concentration in the plant and animal exceeds a certain threshold level (Kumar et al., 2020a; Kumar et al., 2020b; Chen et al., 2017). Heavy metals can contaminate the general environment through many routes (Kumar et al., 2020c; Mazhar et al., 2019; Ogundele et al., 2019; Nawab et al., 2017; Suvarapu and Baek, 2017; Momodu and Anyakora, 2010; Iqbal and Gupta, 2009).

The toxicity of cassava mill effluent is basically associated with its acidic, pH and cyanide content (Paul et al., 2019; Selvam et al., 2017; Sorensen et al., 2015; Olujimi et al., 2014). In acidic soils, plants are likely to take up toxic metals, which may prevent seed germination or eventual death (Prasad et al., 2008). When these cassava mill effluents are improperly disposed, they generate offensive odour and unsightly scene (Singh and Singh, 2019).

The discharge of waste products and contaminants into surface runoff get into rivers through drainage systems, leaching into liquid spills, groundwater and wastewater discharges and littering (Ravindra, and Mor, 2019; Selvakumar et al., 2017; Selvam et al., 2017). Soil contamination in our case occurs when drains from cassava processing factory are released by spill or underground leakage (Lutterodt et al., 2018; Selvakumar et al., 2017). This cassava effluent has a negative effect on our environment (Shrivaster, 2011; USEPA, 2007; Agedengbe et al., 2003). Effluent wastes contain varying concentration of heavy metals either as simple metals or complexes (Palaniappan et al., 2019; Singh et al., 2010; Tripathi et al., 2007). Opaluwa *et al.*, (2012) in their studies reported that cyanide forms complexes with zinc and hydrogen to form an acidic complex called hydrogen cyanide acid (Nwakaudu et al., 2012; Shrivaster, 2011; Prasad et al., 2008; Okonkwo et al., 2006). Cassava must be nicely and well prepared before consumption, as wrong preparation of cassava can leave enough residual of cyanide to cause serious cyanide intoxication, goiter, and even cause ataxia or partial paralysis (Alana et al., 2023; Honorato et al., 2020; Menezes et al., 2020; Desire et al., 2017).

The objective of this study is to assess the level of heavy metals in cassava effluents discharged during cassava processing at Oja Oba, Igboora, Oyo State, Nigeria.

Materials and Methods

Experimental Site

The study was carried out at Oja Oba, cassava processing area in igboora, Ibarapa central local government, Oyo State, Nigeria.

Experimental Design

The experiment was designed at 5 treatments, replicated 3 times. At the experimental site, surface samples were collected between 0-10 m, 10-20 m, 20-30 m 30-40 m, and 100 m

away as control. Three samples were collected each at intervals of 0-3 m, 3-6 m, and 6-9 m.

Cassava Effluent Collection

The cassava effluent samples were taken at Oja Oba, Igboora, Oyo State. Different effluent samples were taken at interval of 0-10m, 10m-20m, 20m-30m, 30m-40m, and 100m away from the pollution source which represent control. At each interval three samples were collected at 0-3m, 3-6m, and 6-9m. 20mls of effluent was taken at each point of collection. Fifteen cassava effluent samples were collected in specimen bottles.

Cassava Effluent Sample Analysis

The cassava effluents collected at different points in the experimental site area were first subjected to the digestion process before taking to Atomic Adsorption Spectrophotometer for quantification. Heavy metal analyzed were lead (Pb^{2+}), chromium (Cr^{3+}), manganese (Mn^{2+}), iron (Fe^{2+}), zinc (Zn^{2+}), copper (Cu^{2+}), and cadmium (Cd^{2+}).

A 20ml aliquot sample of the effluent sample was added into a beaker and 1mL of concentrated nitric acid (HNO_3) was added. The beaker was placed on a hot plate, and contents were gently boil to reduce the volume

to approximately 5mL. After, cooling, an additional 1mL of concentrated HNO_3 was added. The beaker was covered with watch glass and returned to the hot plate. Heating continued and more HNO_3 was added as necessary until the solution appeared light colored and cleared. The watch glass and beaker walls were washed with distilled water and filtered to remove insoluble materials that could clog the atomizer. The filtrates were transferred to 50 ml volumetric flasks and diluted to the mark with distilled water. The digested samples solution were analyzed using Atomic Adsorption spectrophotometer (AAS), with appropriate flame types and wavelength specified for the metals. A calibration curve of absorbance against metal concentration and read off the concentration in the samples (Achakzai et al., 2012).

Calculation of the concentration of the samples:

Concentration in water (mg/l) = $(C \times V)/M$

C = concentration of metal in the sample (ug/mL)

V = volume of final sample (ml)

M = volume of the initial sample (ml).

Result and Discussion

Table 1: Analysis of iron, Zinc, Manganese, Lead in cassava effluent.

Location	Iron (Fe^{2+}) mg/L	Zinc (Zn^{2+}) mg/L	Manganese (Mn^{2+}) mg/L	Lead (Pb^{2+}) mg/L
(0-10M)	1.35c	0.18c	0.2800b	0.0900a
(10-20M)	1.51b	0.02e	0.2933b	0.0700a
(20-30M)	1.89a	1.05b	0.4300a	0.0400b
(30-40M)	1.89a	1.09a	0.0443c	0.0467b
(100/C)	0.82d	0.11d	0.0367c	0.0167c

Means with the same letter(s) are not significantly different

Table 2: Analysis of iron, Zinc, Manganese, Lead in cassava effluent.

Location	Iron (Fe^{2+}) mg/L	Zinc (Zn^{2+}) mg/L	Manganese (Mn^{2+}) mg/L	Lead (Pb^{2+}) mg/L
(0-10M)	1.35c	0.18c	0.2800b	0.0900a

TABLE 3: Analysis of Cadmium, Chromium, Copper in cassava effluent

Location	Cadmium (Cd ²⁺) mg/L	Chromium (Cr ³⁺) mg/L	Copper (Cu ²⁺) mg/L
(0-10M)	0.0060b	0.0220ab	0.0570a
(10-20M)	0.0063	0.0160bc	0.0450a
(20-30M)	0.0333a	0.0333a	0.0563a
(30-40M)	0.0300a	0.0200bc	0.0467a
(100/C)	0.0000b	0.0120c	0.0150b

Means with the same letter(s) are not significantly different

Table 4: WHO and USEAP standard for heavy metals in water

Heavy metals	WHO ¹⁸	USEPA ¹⁹
As(iii) As(v)	0.05	0.01
Pb	0.05	0.015
Cd	0.005	0.005
Cr	0.05	0.05
Hg	0.001	0.002
Zn	5.0	5.0
Cu	1.5	1.3
Co	0.01	—
Fe	0.03	0.3
Mn	0.3	0.05

Discussion

Heavy Metal Content Present in Cassava Effluents

Cassava effluent collected at a distance of 20-30m from the pollution source contained the highest significant concentration of iron (Fe²⁺) at 1.89mg/L. In contrast, the control sample taken at 100m away from the pollution source showed the lowest significant concentration of iron (Fe²⁺), measuring 0.82mg. Also, cassava effluent collected at 10-20m from the pollution source produced the lowest significant concentration of zinc (Zn²⁺) at 0.20mg/L, while the sample taken at 30-40m recorded the

highest significant zinc concentration (Zn²⁺) of 0.09mg/L.

Cassava effluent taken at 20-30m has 0.4300mg/L manganese concentration and different significant value amongst the various distances, while others have no significant difference in the concentration of cassava effluents. The effluent collected at 30-40m distance from the pollution source has the highest significant concentration of manganese (Mn²⁺) at 0.0443mg/L. While, the effluent taken at 0-10m from the pollution source contained lowest significant concentration of manganese (Mn²⁺) at 0.2800mg/L. Moreover, effluent taken at 0-

10m from the pollution source contained highest significant of lead (Pb^{2+}) concentration at 0.900mg/L. Meanwhile, effluent at 0-10m and 10-20m was not significantly different in concentration value. However, the effluent taken 100m away from the pollution source contained lowest significant concentration of lead (Pb^{2+}) at 0.0167 mg/L.

From the table 1, it was revealed that iron (Fe^{2+}) in cassava effluent at 20-30m and 30-40m was high above the WHO permissible level. The highest value of zinc (Zn^{2+}) at 1.09mg/L is low to WHO permissible level. The lowest value of cadmium (Cd^{2+}) at 0.0000mg/L is low to WHO and USEAP permissible level. Manganese (Mn^{2+}) in cassava effluent was low, while the highest value of lead (Pb^{2+}) at 0.0900mg/L is beyond the WHO permissible level and therefore toxic and harmful to occupant of the study area. Cadmium (Cd^{2+}) in the study area was very low at 100m from the pollution source of 0.0000mg/L according to WHO and USEAP standard. Therefore, it was not toxic to the health of occupant of the area. Concentration of copper (Cu^{2+}) at all intervals of the location was low to the WHO and USEAP permissible level, was not toxic and harmful to occupant of the area.

Limitation and future work

The authors ensured that reliable results were obtained from the experiments. Yet, there were small channels of effluent flow that could not be sampled, which may have slightly limited the overall representation of the study area. In future, Authors plan to design a controlled, single channel effluent flow system from the point source. This will allow for more consistent and comprehensive sampling along a defined pathway.

Conclusion and Recommendation

The heavy metal content of the cassava effluent shows concentration higher than the recommended WHO permissible level of heavy metals. It is therefore regarded as toxic

waste to human, animals and plants that get in contact with it.

Recommendation is given on formidable remediation of effluents treatment before discharge into the environment and proper monitoring of environmental pollution by appropriate arm of government.

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Compliance with ethical standards

Conflict of interest

The authors boldly declare that there was no conflict of interest regarding the publication of this research paper.

Author's declaration

The authors affirm that the content of this manuscript is original, has not been published elsewhere, and is not under consideration for publication in any other journal. The authors accept full responsibility for the integrity and accuracy of all data and interpretations presented herein.

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