

EFFECT OF CASSAVA EFFLUENT LEACHATE ON HEAVY METAL CONTENT IN WELL WATER AROUND OJA OBA, IGBOORA, OYO STATE

¹ Popoola, O.J., ¹ Akanji, K.A., ² Oyekan, A.P. ³ Adaramola, K.A. and ³ Adedokun, A.

¹Department of Crop Production Technology, Faculty of Plant and Environmental Sciences; ²Department of Agricultural and Bio-Environmental Engineering (Soil & Water Engineering option), Faculty of Engineering and Technology; ³Department of Science Laboratory Technology, Faculty of science and Basic Technology
^{1,2,&3}Oyo State College of Agriculture and Technology, Igboora, Nigeria.

Corresponding Author: (ORCID: <https://orcid.org/0009-0000-1866-4495>)

E-mail: monidele04@gmail.com; Phone No: +234 803 246 2496

Abstract

Availability of water for human usage is both required in quantity and purity. The purity of water is ascertained when such is free from aesthetical attraction, microbial and heavy metal contamination. This experiment was designed to determine concentration levels of the following heavy metals; iron, cadmium, manganese, chromium, zinc, lead, copper in well water around cassava processing at Oja-Oba, Igboora, Oyo state. Cassava (*Manihot esculenta*) has been considered as one of the major sources of carbohydrate in the world. These heavy metals are capable of affecting human's health, animals, plant and ecosystems. The result of this research show that heavy metals concentration is present in the well water used in cassava processing unit Oja-oba market, Igboora. Lead was identified to have the highest concentration compared to other heavy metals in the well water, which is above WHO and USEAP standards. If this is not remediated, its accumulation could be harmful to the soil, humans, plants, and animals and more so capable of affecting the entire environments. The concentration of the heavy metal in the well water samples are varied from each other. Heavy metal pollution remains a significant challenge due to its toxic, persistent, and non-biodegradable nature. High concentration of heavy metal reduces the mineral contents and increases the acidity, which is detrimental to the soil receiving the cassava effluent discharge. This necessitates urgent increase in public health concern and monitoring to avert the harmful effects on water, plant, animals, and humans.

Keyword: Leachate; Toxicity; Harmful; Pollution; Contamination; Purity.

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Introduction

Industrial effluent discharges are worldwide sources of potential pollution (Baros et al., 2007; Yan-Joe et al., 2003; Shudram and Shaw, 2000; Ajao, 1985). Acute toxicity tests

give firsthand information on the effects of such discharges on organisms and the ecosystem as a whole and are valuable in creating awareness as to their potential harmful effects on the environment

(Kantachote et al., 2005; Kaviraj and Gahathakurata, 2004; Jordan et al., 2004; Ajao, 1985). While, industrialization develops the world and makes life better. Ironically, human lives are haunted by the huge volume of waste products of industries dumped in the environment (Arimoro et al., 2008; Bagge-Ravn et al., 2003; Igboeli, 1995; Jones, 1989).

With the current emphasis on environmental health and water pollution issues, there is an increasing awareness of the need to dispose of these waste waters safely and beneficially (Baroni et al., 2007; JECFA, 1989; Ajiwe et al., 1986; Ajayi and Adeleye, 1977). Hillman, (1988) has drawn attention to the particular concern attached to heavy metals, and carcinogens, mainly organic chemicals (Baros et al., 2007; Igbebe et al., 1992; Hillman, 1988). Moreover, too many processing plants in one area will eventually overwhelm natural ecosystems nearby, frequently causing unwanted fertilization and eutrophication of coastal waters (Giamoulis et al., 2005; Groten and Vanbladersen, 1994; Groten et al., 1990; Gazza, 1990; CEC, 1980). Local impacts are particularly obvious because wastes from processing industries are generally produced throughout the year, giving no chance for the environment to recover (Akaninwor and Gwin, 2006; Ezekwe, 2002, Freeze and Cherry, 1999; Galas-Gorcher, 1991). Impacts are likely to be detrimental when the same ecosystem receives wastes from cluster of processing industries (Obodo, 2004; Sabae, 2004; Bagge-Ravn, et al., 2003; Fleisher et al., 1998; Edokplayi, 1993). If wastes are organic in nature, they are subject to bacterial decay (Egeronu and Ibe, 2004; UNEP, 1995; Darmond and Denton, 1990; Beychok, 1967). As a result, the oxygen concentration in the water is reduced with an increase in Biological Oxygen Demand (BOD) (Ajiwe and Okonkwo, 2007; Agedengbe et al., 2003; Alloway, 1995; EPA, 1986; Eleanor, 1980). This can starve aquatic life of the oxygen it needs

and anaerobic decomposition of organic matter leads to the breakdown of proteins and other nitrogenous compounds, releasing hydrogen sulphide, ammonia and methane, all of which are potentially hazardous to the ecosystem and toxic to marine organisms in low concentration (Adbulrachman and Yahaya, 2006; Abiona et al., 2005; Abdulla and Chmielnicka, 1990; Agbese, 1988). Agbese, (1988) asserted that industrial pollution is gradually changing Nigeria's environment as many towns and villages have been polluted by toxic wastes (UNEP, 2002; Silva et al., 1993; Timothy et al., 1989; Richtwete, 1986). In these industries, there appear to be no organization programmes for disposal of effluents and industrial wastes (Tehobanoglous et al., 2005; Kryoyer, 1995; Lawal and Singh, 1981; Klabunde, 1980). Many factories discharge their wastes directly into rivers, streams or into open gutters causing serious environmental problems (Osho et al., 2010; Odoemena, 1999; Yang, 1996; O'mel, 1985; Okoro, 1981; Okon et al., 1971). The pollutants generated from the industries are of great diversity structurally and include toxic metals, organic and inorganic solids and liquids (Marcorchio et al., 2007; Lee, 2007; Nascimes et al., 2000; Mara et al., 1998; Niewhick, 1998; Marce et al., 1993; Okotere, 1982; Mombeshora et al., 1981; Leopold, 1977; Sundaresan, 1977).

Each step in the food industry system-food production, processing, transportation, storage, distribution and marketing-has some impact on the environment (Shahidul et al., 2010; Njoku and Oyeka, 2007; Okoye et al., 2002; Ojelabi and Fasunwan, 2001; Myong, 2001; Nieto, 2000; Odoemena et al., 1999; Montgomery, 1995; EPA, 1986; Eleanor, 1980). There is much concern about environmental pollution. Due to the highly diversified nature of the food industry, various food processing, handling, and packaging operations generate wastes of different types and volumes which, if not treated, could lead

to increasing disposal and severe pollution problems (Nriagu et al., 2007; Nwaje and Iwegbue, 2007; Okonkwo et al., 2006; Schumacher et al., 1993). These wastes represent a loss of valuable biomass and nutrients if not recovered by appropriate methods of technologies for upgrading, bioconversion or reutilization (Onyedineke et al., 2010; Benka-Coker and Ojior, 1995; Oskarsson, 1989; Sundaresan, 1977). The objective of this study is to evaluate the effect of cassava effluent on the heavy metal content of well water in Oja-oba area, of Igboora, Oyo State.

Materials and Methods

Study area

The study was conducted at Oja-oba, Igboora, Oyo State. It is located on Latitude; 070 24' 42.8 North, Longitude 0030 17' 52.0 East at an altitude of 134m above sea level. It has an average rainfall of about 1455 mm and temperature range of 270c to 300c. It has a bimodal mode of rainfall (Fawole, et al., 2024).

Experimental Design

Nine well were sampled at 30 M away from each other, and water samples taken in triplicates. The 9th well was at 60 M away from the 8th well, as control sample. Twenty-seven well water samples were analyzed for heavy metal content in a recognized laboratory. Heavy metal analyzed were lead (Pb^{3+}), chromium (Cr^{3+}), manganese (Mn^{2+}), iron (Fe^{2+}), zinc (Zn^{2+}), copper (Cu^{2+}), cadmium (Cd^{2+}).

Heavy metals analysis

1mL of concentrated nitric acid (HNO_3) was added to 20mL of water sample in a beaker. The mixture was reduced to 5mL by gentle boil on a hot plate and thereafter left to cool. Additional 1mL of concentrated HNO_3 was added, covered with watch glass and returned to the hot plate to continue with heating. As heating continued more HNO_3 was added until the solution appeared light, cleared and then filtered. The filtrates were transferred to 50mL volumetric flasks and diluted to the mark with distilled water. The digested samples solution was analyzed using Atomic Absorption spectrophotometer (AAS), with appropriate flame types and wavelength specified for the metals.

Result and Discussion

Table 1: Analysis of Iron, Zinc, Manganese, Lead

TREATMENT	Fe (mg/L)	Zn (mg/L)	Mn (mg/L)	Pb (mg/L)
Well 1	0.44c	0.15e	0.13a	0.00b
Well 2	0.35d	0.10e	0.23a	0.00b
Well 3	1.84a	0.77b	0.14a	0.04b
Well 4	0.24e	0.13e	0.01a	0.00b
Well 5	0.44c	1.80a	0.03a	0.23a
Well 6	0.76b	0.17e	0.004a	0.01b
Well 7	0.47c	0.20e	0.02a	0.02b
Well 8	0.32d	0.54c	0.01a	0.22a
Well 9	0.05f	0.33d	0.004a	0.00b

Means with the same letter (s) are not significantly different using Duncan Multiple Range Test (DMRT) at 5% probability level.

Table 2: Analysis of Cadmium, Chromium, Copper.

TREATMENT	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)
Well1(control)	0.00b	0.01e	0.00e
Well 2	0.00b	0.01e	0.01c
Well 3	0.002a	0.13b	0.05a
Well 4	0.00b	0.01e	0.00de
Well 5	0.001ab	0.17a	0.03b
Well 6	0.001ab	0.08c	0.013cd
Well 7	0.00b	0.04d	0.01cde
Well 8	0.001ab	0.09c	0.03b
Well 9	0.00b	0.09c	0.03b

Means with the same letter (s) are not significantly different using Duncan Multiple Range Test (DMRT) at 5% probability level

Table 3: 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	0.03	0.05

Discussion

The concentration of iron (Fe^{2+}) in the well water samples was significantly different (P

≤ 0.05). Well 3 produced the highest significant concatenation of Fe^{2+} (1.8mg/L) when compared to others. However, wells 1, 5

and 7 had identical Fe^{2+} concentration of 0.44mg/L which were not significantly different from one another. Well 9 produced the lowest significant concentration of Fe^{2+} at 0.05mg/L.

For zinc (Zn^{2+}), well 5 produced the highest significant concentration of 1.80mg/L, followed by well 3 with 0.77 mg/L, and well 8 with 0.54mg/L. However, well 2 had the lowest significant concentration of Zn^{2+} at 0.6mg/L, which was not significantly different from the concentrations in well 1 (0.15mg/L), 4 (0.13mg/L), 6 (0.17mg/L) and 7 (0.20mg/L). The concentration of manganese (Mn^{2+}) in the wells was not significantly different. But, well 2 at 0.23mg/L had the highest concentration followed by well 3 at 0.14mg/L, and well 1 at 0.13mg/L.

Moreover, well 4 at 0.01mg/L, and well 8 at 0.01mg/L had the lowest significant concentration of manganese.

The concentration of lead (Pb^{2+}) in the wells was significantly different in well 5 at 0.23mg/L, was the highest significant concentration, followed by well 8 at 0.22mg/L. However, well 1 to 8 had 0.00mg/L, 0.00mg/L, 0.04mg/L, 0.00mg/L, 0.00mg/L, 0.00mg/L, 0.02mg/L, and 0.00mg/L, which are not significantly different.

The concentration of cadmium (Cd^{2+}) in wells was not significantly different. However, well 3 had the highest significant concentration at 0.002mg/L, followed by well 5, 6, 8 that had 0.001mg/L, 0.001mg/L, 0.001mg/L. While, the lowest significant concentration were recorded in wells 1, 2 and 9 which had 0.00mg/L, 0.00mg/L, and 0.00mg/L respectively.

The concentration of chromium (Cr^{3+}) in wells was significantly different. Well 5 had the highest significant concentration at 0.17 mg/L, followed by well 3 at 0.13 mg/L. However, well 8 and 9 had 0.09mg/L, 0.009mg/L concentration of chromium (Cr^{3+}). Also, well 1, 2 and 4 had 0.01mg/L, 0.01mg/L and

0.01mg/L as the lowest concentration of chromium (Cr^{3+}).

Well 6 had the highest significant Copper (Cu^{2+}) concentration at 0.013 mg/L. However, well 5, 8 and 9 had 0.03mg/L, 0.0036mg/L, 0.03mg/L which were not significantly different. However, well 1 at 0.00mg/L had the lowest significant concentration of copper (Cu^{3+}).

From the table 1, it was revealed that Iron (Fe^{2+}) in well water was high above the WHO permissible level at 0.05mg/L. The highest value of Zinc (Zn^{2+}) at 1.80mg/L below to WHO permissible level at 5.0mg/L. The value of Manganese (Mn^{2+}) is low below permissible level of WHO. The lowest value of lead (Pb^{2+}) was below WHO permissible level. The lowest value of Cadmium (Cd^{2+}) is very low to WHO permissible level. The highest value of chromium is high to WHO permissible level. The highest value of Copper (Cu^{2+}) is very high to WHO permissible level. According to WHO and USEAP standard is toxic to the health of occupant of the WHO and USEAP permissible level. Therefore, it is toxic and harmful for the occupant of the study area.

Conclusion

The analysis of well water samples from the study area revealed the presence of heavy metals in concentrations exceeding the permissible limits set by the World Health organization (WHO). Therefore, this indicates that the well water is contaminated and unsafe for human and animal consumption.

Recommendation

Proper treatment is recommended for the well water by the experts. The appropriate arm of government should sensitize the people on the danger inherent in drinking water contaminated with heavy metals.

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