International Journal of Civil Engineering, Construction and Estate Management
Vol.11, No.1, pp.1-13, 2023
Print ISSN: 2055-6578(Print),
Online ISSN: 2055-6586(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Effects of Cassava Wastewater on Opa Stream in Ile-Ife, Nigeria

J.O. Jeje
[1]Department of Civil Engineering, Obafemi Awolowo University, Ile-Ife.

doi: https://doi.org/10.37745/ijcecem.14/vol11n1113 Published March 15 2023

Citation: Jeje J.O. (2023) Effects of Cassava Wastewater on Opa Stream in Ile-Ife, Nigeria, *International Journal of Civil Engineering, Construction and Estate Management*, Vol.11, No.1, pp.1-13,

ABSTRACT: *This study is aimed at determining the impacts of indiscriminate disposal of cassava wastewater into the nearby stream. The cassava wastewater quality was tested in accordance with the standard methods for the examination of water and wastewater for both physical and chemical parameters such as temperature, conductivity, hardness, pH and turbidity. The physicochemical properties of both water and cassava wastewater was conducted before and after the disposal of the cassava wastewater and the result of the experiments showed that the effluent is acidic with pH of 3.8 and of high conductivity of 40 µs/cm^2. The cyanide content is also very high with 11.88 mg/kg as compared to 1.5-3.5 mg/kg recommended by WHO. The total solids, and total suspended solids are also in high range of 2000 mg/kg and 3000 mg/l respectively. Its hardness is 800 mg/l, chloride 2000 mg/l. The dissolved oxygen was not detected. The physicochemical properties of the after experienced significant difference ($p<0.05$).*

KEYWORDS: cassava wastewater, physicochemical properties, cyanide content.

INTRODUCTION

One of the greatest threats to sustainable development is environmental degradation (Abiona *et al*., 2005). Environmental degradation, which is the gradual lowering of environmental quality, is due to human activity and natural causes. Natural causes such as soil erosion, leaching, volcanic activities, forest fires are common features and constitute a threat to the natural environment but these are usually mitigated by other natural processes (Abiona *et al*., 2005). Human causes of environmental degradation include industrialization, urbanization, logging, agriculture, agricultural products processing, etc. The extent of the threat from these activities is usually associated with the degree of the activity and absence of mitigating measures (Adefemi and Awokunmi, 2010).

Cassava (Manihot esculenta) is an important tropical crop finding significant use as a food source. It ranks as the most important root crop in the world and ranks second among African staple crops. Unfortunately, cassava contains two cyanogenic glycosides, linamarin and lotaustralin, the former being the principal cyanogenic glycoside (Oliveira *et al*., 2011). In addition, cassava contains the enzyme linamarase. Catalysed by linamarase, linamarin is rapidly hydrolysed to glucose and acetonecyanohydrin. Under neutral conditions, acetonecyanohydrin decomposes to acetone and hydrogen cyanide. This cyanide producing potential of cassava poses a threat to man and animals with respect to food safety (Oliveira *et al*.,2011). Several health problems have been reported which have been attributed to high dietary cyanide exposure. Some of these include acute poisoning, goiter and cretinism, konzo, a paralytic disease of the legs and tropical ataxic neuropathy. This potential toxicity of cassava calls for the need to ensure food safety in the consumption of cassava.

Cassava (Manihot esculenta) is a very significant food crop in Nigeria and most of the tropical regions. It provides about 40 % daily calorie in Sub Saharan Africa and about 70 % of the daily Calorie intake of over 50 million Nigerians (Ariyomo,*et al*.,2017). Cassava is used to produce a wide range of industrial products such as ethanol, glue, glucose syrup extensively used by pharmaceutical and confectionary industries, for starch production and consumables like bread as well as for African delicacies like fufu and gari production. Cassava wastewater often becomes putrid with main pollutant as cyanide, biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved and suspended matters amidst others. The disposal of cassava wastewater is a great concern in developing countries where adequate legislation policy and standards are not strictly adhered to, and where they are followed, there are limited space for land-based treatment and disposal (Ariyomo,*et al*.,2017).

Cassava and its wastewater have been reported to be toxic and poisonous (Ajimmy and Izah, 2017; Ngwoke *et al.,* 2021; Akani and Nmelo 2006). The toxicity of cassava and its wastewater is basically associated with its pH and cyanide content. Cassava wastewater has been observed to be highly acidic, with pH as low as 2.6 (Izah *et al.* 2017). Also, Obueh and Odesiri-Eruteyan (2016) reported the pH of fermenting cassava to be between 5.5 and 6.3. Cassava wastewater may therefore influence the acidity of soils when large amounts are added to the soil. It is reported that when soil pH is too acidic, plants cannot utilize N.P.K and other nutrients (Jideofor, 2015). In acidic soils, plants are also likely to take up toxic metals, which may lead to their eventual death.

produces a weak acid). Another effect of cyanide in the soil is its strong bonding with cations to form complexes such as potassium hexacyanoferrate (1I) ($K_4Fe\ [CN]^6$) (Akpan *et al.*, 2017). Cyanide in soils has also been reported to be herbicidal (Goetz, 2010; Akpan *et al.* 2017)..

Globally, more than 268 million tons of cassava is produced annually (Abiona, 2005). African countries produce over 103 million tons per annum while Nigeria account for about 35 million metric tons from the total amount with possible increase to 40 million tons as the call to embrace indigenous agricultural farming increases. Recently, production figures ranked Nigeria as the leading producer of cassava in the world. By implication, the quantity and quality of cassava wastewater generation in Nigeria is high (Olukanmi and Olatunji, 2018). The deleterious effects and adverse impact of indiscriminate disposal of cassava wastewater is not limited to public health but also has negative impact on crops and plants, soil, surface and groundwater resources, property values, ecological impact and social life of a community.

The wastewater is usually generated in different ways such as during washing, moisture grating, extraction through pressing, as well as processing cassava tubers into food, feed, starch and other products. Most cassava processing industry discharges significant quantities of wastewater whose major component is cyanide to rivers, lakes, sewage canals which eventually flows back to streams or downstream surface water locations (Oliveira *et al*., 2011). Cassava contains cyanide which is toxic. Studies on toxic effects of cyanide on aquatic life include (Abiona *et al.*, 2005). Hydrocyanic acid (HCN) resulting from the processing of cassava tubers may lead to death of fish and other aquatic organisms. Suspended solids of effluents may settle on a stream bed and spoil fish breeding grounds (Arimoro *et al.*, 2017). Discharge of cassava effluents has become serious problems that pose threat to aquatic environment and its life forms. The aim of the present study is to determine the effects of cassava effluents on environmental variables and macroinvertebrate communities in the receiving water body (Goetz, 2010; Ukaegbu-Obi, 2018;. Abiona *et al.*, 2005).

MATERIALS AND METHODS

Water samples were collected from the Opa stream,Ile-Ife in south western Nigeris to enhance this study. Fresh samples of cassava wastewater were collected after grounding cassava tubers into paste. A digital pH meter was used which has an electrode that enables it perceive and respond to changes in pH both in cassava wastewater and waterbody. A conductivity meter was used to measure the electrical conductivity of both water and cassava wastewater samples in $\mu s/cm^2$. A turbidimeter was used to measure the turbidity of both samples. It has a knob to set the wavelength to measure the different parameters.

Pipette of 50 ml,100 ml as deem fit for various experiments was used to measure the indicators used. The burette was used to titrate different titrants (H_2SO_4, $AgNO_3$, etc.) and the droppers were used for indicators. The conical flask was used during different titration of water samples as well.

Description of the study area

The cassava processing factory as well as the river is located at Opa, Ife Central Local Government (7^o31′44.4672″ North on latitude and on longitude 4°34'10.3128" East) in Osun State of Nigeria. The factory commenced full production in 2018. The area is popular and known for cassava production all year round, which is readily processed into garri flour. Water usage in the factory was estimated at 140 liters/hour. This water usage starts from washing of cassava roots through the entire production processes. With this water usage, the amount of wastewater generated is enormous and the impact on the environment could be highly devastating if not properly handled. The cassava wastewater is channeled through an unlined open channel drain into the Opa stream which is located at approximately 5m from the cassava factory.

Sampling

The samples were collected using 2 litres. plastic kegs. which were sterilized by washing with detergent and rinsed with distilled water before use. The water samples were collected from five different points of the river at different intervals while the cassava wastewater samples were collected through dewatering of cassava paste and washing of cassava tubers.

The flowrate of the stream was determined in order to know the rate at which the river recovers or dilutes itself after the cassava wastewater has been disposed in it. In determining the flowrate of the river, the float method was used which involves:

1. Determining the cross-sectional area of the water flowing in the river by measuring the width and the depth at regular intervals across the flow.
2. Using a float, (an empty plastic bottle was used) measure the speed of flow.
3. Calculate the flow in litres per second which is the product of the average stream area and average velocity of the flow.

The average cross-sectional area of the river is 4.2 m x 2.1 m, with a breath of 4.2 m and the speed of flow using three different plastic bottle of the same weight across a specified section of the river were 33s , 31s, and 35s calculating the average speed flow to be 33 seconds. The flowrate is therefore 0.14 m^3/s.

Determination of physical parameters

The water samples were collected and temperature was measured using the thermometer. The ambient temperature was measured first by holding the thermometer in the air and then dipped in the water samples to determine their temperature.The differences in the colour of the samples was noted. This can also be done using a spectrometer adjusted to a wavelength of 430 mm to make it behave has a colourimeter. A turbidimeter was used to measure the turbidity in NTU of the water samples.The conductivity of the water samples was measured using conductivity probe cleansed and rinsed with distilled water. The probe is then dipped in the water sample and the conductivity was read and recorded.

Determination of chemical parameters

This pH was measured immediately the samples were collected and the readings were recorded. The chloride was determined in the laboratory by titration. The estimation of chloride ions concentration gives an indication of various natural and other phenomenon that are operative in such water systems. A number of methods are available for the estimation of chlorides in water but the method used in this project is known as MOHR method. This method is based on the titration of 100 ml of water sample with standard silver nitrate solution ($AgNO_3$) in the presence of potassium chromate ($K_2Cr_2O_7$) as indicator.

The HCN contents of the samples were determined using the alkaline titration method of Association of Official Analytical Chemists. Water sample of 100ml was titrated by adding 8 ml of 6 N NH_4OH solution and 2 ml of 5 % KI solution. This was then titrated against 0.02 N $AgNO_3$ solution to get a light turbid end point. The titer values were then used to calculate the cyanide concentrations in mg HCN/kg. [1 ml of 0.02 N $AgNO_3$ = 1.08 mg HCN]

RESULTS AND DISCUSSIONS

Three random samples by volume of cassava wastewater were collected at quick succession in a day operation and pooled together to give a composite sample. Composite samples were collected periodically (one sample per practical) in accordance with the prescribed standard methods for the examination of water and waste water (APHA, 1998). All samples were analyzed within 12 – 24 hours of collection. This was to make the activities of microorganisms present in the sample active during the experiments. The physicochemical parameters (temperature, total solids, total dissolved solids, total suspended solids, pH, conductivity, hardness, BOD, COD, alkalinity, dissolved oxygen, cyanide, nitrate, chloride, odor and color) of the sample were determined in accordance with Standard Methods for the Examination of Water and Wastewater (Ukaegbu-Obi,2018). Odour and colour were done by visual inspection. The results of the physicochemical properties of the raw cassava wastewater are shown in Table 1. The clear trend of all measured parameters is that they are higher than the WHO recommended standards and there was no trace of dissolved oxygen. From the result of the analysis (Table 1), it can be seen that all the characteristics of the cassava wastewater analyzed exceed the allowable limits stated by WHO. The electrical conductivity of the effluent is high indicating the presence of conducting ions while the pH value showed that this effluent is acidic. World Health Organization (WHO, 2009) admissible limit for pH value in effluent water is 6.5 – 8.5. The high values of pH may be attributable to the presence of prussic acid.

Analysis of water samples from the stream

The water samples were collected in 2 litres plastic jars in the morning from two points before the discharge of the cassava effluent, one point at the point of discharge and two points at some distances after the discharge.

The results obtained from the five sampling points are presented in Table 2 to Table 6. In comparison to WHO standard method of water analysis, the physiochemical parameters of the

Vol.11, No.1, pp.1-13, 2023
Print ISSN: 2055-6578(Print),
Online ISSN: 2055-6586(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

water before the discharge of cassava effluent were within the range of WHO while pH, cyanide contents increased after the discharge of the effluent into the waterbody.

Table 1: Physicochemical parameters of the cassava effluent from the factory

Parameters	Average value of three test samples	WHO Standards
Colour	Coloured	Colourless
Odour	Objectionable	Unobjectionable
Conductivity (µs/cm^2)	40	
pH	3.8	6.5 – 7.5
Total Solids (mg/l)	20000	2030
Total Suspended Solids (mg/l)	3000	30
Alkalinity (mg/l)	900	100
Hardness (mg/l)	800	500
Dissolved Oxygen (mg/l)	0	4
Temperature (^{o}C)	27.5	25
Cyanide (mg/l)	0.20	0.05
Chloride (mg/l)	2000	500
Turbidity (NTU)	200	5

International Journal of Civil Engineering, Construction and Estate Management
Vol.11, No.1, pp.1-13, 2023
Print ISSN: 2055-6578(Print),
Online ISSN: 2055-6586(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Table 2: Physicochemical parameters of water samples taken at the point of cassava processing plant wastewater discharge into the waterbody

Parameters	Test 1	Test 2	Test 3	Test 4	Test 5	Average	WHO Standard
pH	4.8	4.3	7.2	6.0	7.8	6.02	6.5 - 7.5
Conductivity (μs/cm^2)	50	30	50	40	30	40	
Turbidity (NTU)	69	27	66	78	25	53	5
Acidity (mg/l)	500	860	720	180	800	612	
Alkalinity (mg/l)	180	367	207	810	300	372.8	100
Chloride (mg/l)	16.5	10.49	18.99	16.49	10.50	14.59	250
Hardness (mg/l)	290	305.2	315.28	360.32	300	31.16	500
TS (mg/l)	400	300	520	560	250	406	2030
TSS (mg/l)	200	150	270	200	100	920	30
Temp (°C)	15.0	17.0	16.6	17.5	15.5	16.32	25
Colour	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Colourless
Cyanide (mg/kg)				12.42	11.34	11.88	1.5 – 3.5

International Journal of Civil Engineering, Construction and Estate Management
Vol.11, No.1, pp.1-13, 2023
Print ISSN: 2055-6578(Print),
Online ISSN: 2055-6586(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Table 3: Physicochemical parameters of water samples taken at 28.49m from the point of cassava processing plant wastewater discharge into the waterbody

Parameters	Test 1	Test 2	Test 3	Test 4	Test 5	Average	WHO Standard
pH	4.5	5.8	8.5	7.8	8.0	6.92	6.5 - 7.5
Conductivity (µs/cm^2)	30	20	40	50	20	32	
Turbidit (NTU)	50	15	12	52	17	29.7	5
Acidity (mg/l)	300	301	434	255	300	318	
Alkalinity (mg/l)	50	47	150	61	45	70.6	100
Chlor (mg/l)	15.5	10.49	24.99	10.50	10.50	14.39	250
Hardness (mg/l)	120.5	100.5	225.2	135.12	110.5	138.36	500
TS (mg/l)	130	150	120	280	150	166	2030
TSS (mg/l)	150	180	130	150	180	158	30
Temp (^{o}C)	15.5	17.5	16.2	16.5	15.5	16.24	25
Colour	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Colourless
Cyanide (mg/kg)				8.42	9.18	8.8	1.5 – 3.5

International Journal of Civil Engineering, Construction and Estate Management
Vol.11, No.1, pp.1-13, 2023
Print ISSN: 2055-6578(Print),
Online ISSN: 2055-6586(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Table 4: Physicochemical parameters of water samples from a well 22.13m from the first point of the waterbody

Parameters	Test 1	Test 2	Test 3	Test 4	Test 5	Average	WHO Standard
pH	5.0	5.4	7.6	5.8	5.5	5.86	6.5 - 7.5
Conductivity (µs/cm^2)	40	20	30	40	30	32	
Turbidity (NTU)	15	12	12	20	15	14.8	5
Acidity (mg/l)	305	405	434	457	400	400.2	
Alkalinity (mg/l)	120	125	150	144	125	132.8	100
Chloride (mg/l)	25.5	28.99	24.99	28.99	28.5	27.36	250
Hardnes (mg/l)	200	200.2	225.2	207.18	230	212.52	500
TS (mg/l)	30	40	30	40	40	36	2030
TSS (mg/l)	120	150	140	100	150	132	30
Temp (°C)	15.6	16.3	17.2	15.5	15.5	16.02	25
Colour	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Colourless
Cyanide (mg/kg)				7.02	5.94	6.48	1.5 – 3.5

Vol.11, No.1, pp.1-13, 2023
Print ISSN: 2055-6578(Print),
Online ISSN: 2055-6586(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Table 5: Physicochemical parameters of water samples taken at 13.27m from the point of cassava processing plant wastewater discharge into the waterbody

Parameters	Test 1	Test 2	Test 3	Test 4	Test 5	Average	WHO Standard
pH	5.5	6.0	8.2	7.5	8.0	7.04	6.5 - 7.5
Conductivity (µs/cm^2)	30	40	40	40	30	36	
Turbidity (NTU)	40	13	50	56	50	41.8	5
Acidity (mg/l)	250	300	293	130	250	244.6	
Alkalinity (mg/l)	30	38	122	271	40	100.2	100
Chloride (mg/l)	12.5	13.49	10.99	6.49	10.5	10.79	250
Hardness (mg/l)	80.5	88.9	108.09	9.09	100.0	77.32	500
TS (mg/l)	250	200	280	320	200	250	2030
TSS (mg/l)	120	150	160	169	100	139.8	30
Temp (°C)	15.5	16.5	17.6	16.7	15.0	16.26	25
Colour	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Colourless
Cyanide (mg/kg)				9.72	10.8	10.26	1.5 – 3.5

International Journal of Civil Engineering, Construction and Estate Management
Vol.11, No.1, pp.1-13, 2023
Print ISSN: 2055-6578(Print),
Online ISSN: 2055-6586(online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Table 6: Physicochemical parameters of water samples taken at 30.62m from the point of cassava processing plant wastewater discharge into the waterbody

Parameters	Test 1	Test 2	Test 3	Test 4	Test 5	Average	WHO Standard
pH	7.5	5.9	8.1	7.8	7.0	7.26	6.5 - 7.5
Conductivity (µs/cm^2)	40	50	40	40	50	44	
Turbidity (NTU)	40	41	49	55	42	45.4	5
Acidity (mg/l)	300	350	302	285	350	317.4	
Alkalinity (mg/l)	50	60	61	50	60	56.2	100
Chloride (mg/l)	11.0	10.99	8.99	7.49	10.99	9.89	250
Hardness (mg/l)	120.5	130.5	126.11	94.58	130.5	120.44	500
TS (mg/l)	300	300	320	320	300	308	2030
TSS (mg/l)	120	150	140	130	100	128	30
Temp (°C)	25	20	20	16.7	21.5	20.64	25
Colour	Coloured	Coloured	Coloured	Coloured	Coloured	Coloured	Colourless
Cyanide (mg/kg)				8.42	9.18	8.8	1.5 – 3.5

CONCLUSION

The cassava wastewater characteristics shows that the values of all physicochemical parameters obtained exceed the World Health Organization Standard for industrial wastewaters and therefore should not be discharged directly into the water bodies in their surroundings. This study also shows that the physicochemical properties of the waterbody after the discharge of the cassava effluent experienced significant difference ($p<0.05$). Furthermore, the pH and cyanide value of the stream after the discharge exceeds the WHO standard.

REFRENCES

Abiona, O.O., Sanni, L. and Bamgbose, O. (2005). An evaluation of microbial load, heavy metals and cyanide contents of water sources, effluent and peels from three cassava processing location. International Journal of Food and Agricultural Environment Vol.3, 207-208.

Adefemi, S. O. and. Awokunmi, E. E. (2010). Determination of physico-chemical parameters and heavy metals in water samples from Itaogbolu area of Ondo-State, Nigeria. African Journal of Environmental Science and Technology, 4(3), pp 145- 148.

American Public Health Association (APHA) (1998). Standard method for examination of water and waste water, 20th Ed. American Public Health Association Inc, New York. American Water Work Associated (AWWA).

Ajimmy, I. R. and Izah. R.S.C. (2017) Organosomatic index and behavioral response of heterobranchus bidorsalis exposed to rhonasate 360sl containing glyphosate (isopropylamine salt glycine). , *ASIO Journal of Microbiology, Food Science & Biotechnological Innovations* 3(1).

Akani, N.P. and Nmelo, S.A. (2006) . Effects of Cassava Mill Effluents on the Microbial Population and Physicochemical Properties of Loamy Soil in Nigeria. Proceeding of the 10th Annual Conference of Nigerian Society for Microbiology , Keffi, In: Nassarawa .

Akpan, J.F., Eyong, M.O. and Isong, I.A. (2017). The Impact of Long-term Cassava Mill Effluent Discharge on Soil pH and Microbial Characteristics in Cross River State. Asian Journal of Soil Science and Plant Nutrition, 2(1): 1-9

Ariyomo, T O., Jegede T. A. F.and Omobepade. B. P. (2017) Toxicity of Cassava Effluents to Catfish, Clarias gariepinus, and the Effect on Some Target Organs. , *Annal of Aquatic Research* 4(2), 1034.

Oliveira, M.A., Reis, E.M. and Nozaki, J. (2011). Biokenetic parameters investigation for treatment of cassava mill effluents. Water, Air and Soil Pollution, 126(3-4): 307-319.

Ngwoke M., Igwe O. and Ozioko O.B. 2021, Acute toxicity assessment of produced water effluent stream on selected local organisms in Delta state, Nigeria, Environmental Monitoring and Assessment, 193(5), 10.1007/s10661-021-09032-y

Obueh, H.O. and Odesiri-Eruteyan, E. (2016). A Study on the Effects of Cassava Processing Wastes on the Soil Environment of a Local Cassava Mill. Journal of Pollution Effects and Control, 4(4): 177

Jideofor, M.I.(2015). Chemical Adjustment of Effluent from Cassava Processing Plant prior to Safe Disposal. Nigerian Journal of Technology (NIJOTECH), 34 (4):883 – 889.

Izah, S.C., Bassey, S. E. and Ohimain, E. I. (2017). Assessment of Heavy Metals in Cassava Mill Effluents Contaminated Soil in a Rural Community in the Niger Delta Region of Nigeria". EC Pharmacology and Toxicology, 4(5): 186-201.

World Health Organization. (2009) Cyanide in drinking-water. Background document for preparation of WHO Guidelines for drinking-water quality. Geneva, World Health Organization (WHO/HSE/ WSH/09.01/3).

Goetz, C.G. (2010). Cyanides. In: Encyclopedia of Movement Disorders. Science Direct. 269-271

Ukaegbu-Obi, K.M., Appeh, O.G., Itaman, O.V. and Nwosu, P.C (2018). Microbial and Physicochemical analyses of Soil Receiving Cassava Mill Wastewater in Umudike,Abia State, Nigeria. Nigerian Journal of Biotechnology, 35 (2):99 – 107.

Olukanmi, D.O. and Olatunji, T.O. (2018). Cassava Waste Management and Biogas Generation Potential in Selected Local Government Areas in Ogun State, Nigeria. Recycling, 3(58):1-12