



Evaluation of Vermifiltration of Cassava Effluent Using Earthworm

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ABSTRACT: The objective of this study was to evaluate the vermifiltration of different cassava effluent concentrations using of earthworms by applying standard methods. Results for physiochemical parameters before treatment ranges from 3.91 to 5.94, 28.6 to 28.7(μS/cm), 12480 to 13999 (mg/l), 7900 to 9511(mg/l), 168 to 207(mg/l), 8068 to 9718(mg/l), 225 to 284(mg/l), 114 to 132(mg/l), 1040 to 1680(mg/l), 400 to 540(mg/l), 52 to 72(mg/l), 24 to 40(mg/l), 20 to 30(mg/l), 33 to 65(mg/l) for pH, Temperature, EC, TDS, TSS, TS, COD, BOD, Hardness, chlorine, calcium, magnesium, sodium and potassium, respectively, while after treatment ranges from 6.45 to 10.1, 28.6 to 29, 12021 to 12621(μS/cm), 8100 to 9846(mg/l), 199 to 211(mg/l), 8299 to 10057(mg/l), 260 to 291(mg/l), 140 to 120(mg/l), 760 to 1160(mg/l), 260 to 440(mg/l), 48 to 62(mg/l), 22 to 39(mg/l), 19 to 28(mg/l), 31 to 60(mg/l) for pH, Temperature, Electrical Conductivity (EC), TDS, TSS, TS, COD, BOD, Hardness, Chlorine, Calcium, Magnesium, Sodium and Potassium, respectively, across the different concentrations (100%, 75%, 50% and 25%) of cassava effluent. It was therefore, observed that the use of earthworm in the treatment of cassava effluent was effective, though, it could not treat the cassava effluent to the acceptable World Health Organization (WHO) Standards for irrigation use.

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Cassava (*Manihot esculanta crantz*) is the world's third most important crop and an essential source of food and income throughout the tropics providing livelihood for over five hundred million (500,000,000) people (Awu *et al.*, 2016). Cassava constitutes a major staple food for over fifty million (50,000,000) Nigerians, providing more than 70% of their daily energy requirements (Awu *et al.*, 2016). Nigeria is the world largest producer of cassava; the crop is produced in 24 of the country's 36 states. In 1999, Nigeria produced 33 million tons, while a decade later; it produced approximately 45 million tons, which is almost 19% of the world production. The average yield of cassava per hectare is about 10.6 tons (Henry, 2019). Cassava is usually propagated by planting short section of stem of about 20 to 25cm length (Oboh, 2005). Cassava has the advantage of being available all year round since it can be left on the ground after maturity for up to three years before harvesting without having significant spoilage. Cassava has so much economic importance and can be processed into different products such as garri, fufu, tapioca, flour just to mention but a few. Different cultivars of cassava which abound worldwide mature at different time. However, certain varieties contains large amount of cyanogenic glycosides which can hydrolyzed to hydrocyanic acid (HCN) by their endogenous enzymes

when the plant tissue is damaged during harvesting, processing or other mechanical handling (Oboh and Akindahusi, 2003). The two important wastes that are generated during the processing of cassava tubers include cassava peels and the liquid (effluent) squeezed out of the cassava mesh. Studies revealed that the liquid waste (cassava effluent) contains heavy loads of microorganisms, lactic acid, lysine and amylase capable of hydrolyzing the glycosides (Rimbault, 1998). During the processing of cassava tubers to various products, liquid waste generated responsible for several environmental and vegetative degradation. This no doubt has been causing serious environmental pollution as a result of the indiscriminate discharge. Uzochukwu *et al.*, (2001) reported that high level of cassava liquid waste is produce daily and drained onto roads, streets, rivers and agricultural lands in gari producing communities of Nigeria. These singular activities tend to expose the waste water to microbial contamination. The reports of Uzochukwu *et al.*, (2001) also revealed that cassava liquid waste contains fermentable sugars, starch, cellulose, while Oboh and Akindahusi (2003) documented it to contain cyanogenic glycosides and essential elements such as Zinc (Zn), Magnesium (Mg), Iron (Fe), Calcium (Ca), Sodium (Na) and Potassium (K).

Vermifiltration is an effective, low cost and environmental friendly process of treating waste water with the help of earthworms and other micro-organisms. The idea of vermifiltration has been derived from vermicomposting which is the treatment of the solid waste using earthworms. Generally, the common species of earthworm employed for the vermifiltration are *Eiseniafetida*, *Eudriluseuginea*, *Lumbricusrebellus* (Arora *et al.*, 2015). The mechanism in which the vermifiltration works is that the earthworm acts as bio-filters. They feed on the trapped organic matter on the soil bed present in the sewage and along with the aid of micro-organism (Taylor, 2000) considerably improves the quality of water by bringing down the level of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Turbidity of the waste water without any skilled supervision and forming any sludge and odour (Arora *et al.*, 2015). The problem of efficient disposal and management of waste water has become more rigorous due to rapidly increasing population, intensive agriculture and industrialization, over the last few years. The various types of environment and disposal problems caused by the production of large quantities of waste water in Nigeria requires sustainable approach in a cost effective manner and this has become a very important issue for maintaining healthy environment (Edwards and Bater, 1992). Vermifiltration is being considered as a potential option in the hierarchy of waste water management that involves the stabilization of organic material by the joint action of earthworm and microorganisms. Although microbes are responsible for the biochemical degradation of the waste water, earthworms are the important drivers of the process by conditioning the substrate and altering the biological activity (Aora *et al.*, 2007). Vermifiltration is an aerobic treatment system which consists of a biological reactor containing media that filters organic material from waste water. This media also provides a habitat for aerobic bacteria and composting earthworms that produce humus. This process has the capacity of treating cassava liquid waste before it can be safely discharged into the environment. The objective of this study was to determine the physiochemical characteristics of different cassava effluent concentrations before and after vermifiltration

MATERIALS AND METHODS

Study Area: The study area of this research is Federal University of Agriculture, Abeokuta (FUNAAB) which is located approximately on latitude 70 30' N and longitude 30 54' E. FUNNAB is next to Ogun-Osun River Basin Development Authority (OORBDA), along Osiele-Abeokuta road, off Abeokuta-Ibadan road in the north Eastern end of the

city at Alabata and is from the city center of Abeokuta which lie (Ufoegbune and Fabiyi, 2016). FUNNAB lies within the humid lowland rain forest region with two distinctive seasons. The wet season extends from March to October while the dry season extends from November to February. The mean annual rainfall is 1113.1mm while the mean monthly temperature varies from 22.90C in August to 36.320C in March (Ufoegbune and Fabiyi, 2016). The relative humidity is high ranging from 75.520C in February to 88.150C in July (Aiboni, 2001). Map of the study area is shown in figure 1.

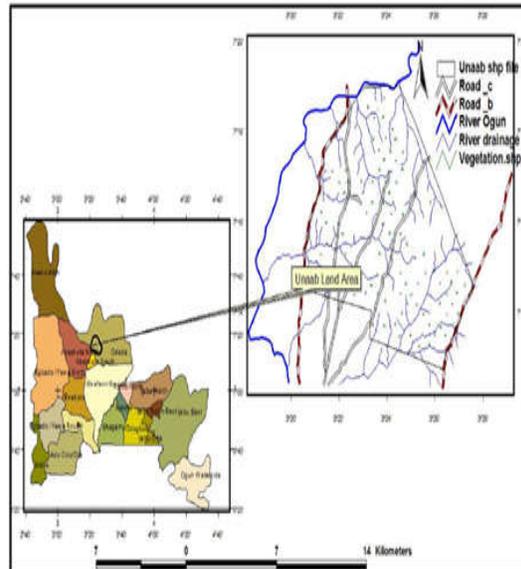


Fig 1: Map of Ogun State showing the study area

Materials: The materials used to carry out this research study include; Worm bin, earthworm (*Eisenia Foetida*), Cassava waste water, Water bucket, Weigh scale, Distilled water, Soil, Volumetric flask, Kegs, Valves, Bottles, ethylene diamine tetra-acetic acid (EDTA) solution, Hanna combo multimeter. The cassava waste water was collected from a gari-processing factory at camp community, Abeokuta Ogun State while the earthworms used were gotten by hand picking within the premises of the Federal University of Agriculture Abeokuta (FUNAAB), Ogun State. **Experimental Setup:** The research study was made up of 8 different experimental setups to determine the effect of vermifiltration on different concentration of the cassava effluent of 100%, 75%, 50% and 25%, respectively. The eight (8) set up was divided into two (2) groups of four setup each. Each setup consisted of Bucket which served as a medium holding rest of the materials such as 1kg of soil, 115g of earthworm, two (2) liters of water and different concentrations of cassava effluent at 100%, 75%, 50% and 25% respectively. The second group setup had the

same composition but without earthworm which serves as control to the first group setups.

Physiochemical Parameters Test: Some physiochemical parameters were tested before and after treatment with earthworm and comparison made to the control. The physio-chemical parameters tested include; pH, Temperature, Electrical conductivity (EC), Total Suspended solid (TSS), Total Dissolved Solid (TDS), Total Solid (TS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Hardness, Chloride (Cl), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K).

Parameter Test Procedures: Each parameter test was replicated and an average was taken as the true value of the parameter test. Some physical parameters were determined in-situ using Direct Reading Engineering Method (DREM).

Direct Reading Engineering Method (DREM): This method was used mainly for the analysis of physical parameters such as pH, Temperature, Electrical conductivity (EC), Total Suspended solid (TSS), Total Dissolved Solid (TDS), Total Solid (TS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD). The Hacc Multimeter (model 150) was used to measure these parameters.

Titrimetric Method: This method deals with titrating the cassava effluent sample with Ethylene Diamine Tetra-Acetic Acid (EDTA) solution for Chloride and Hardness

Gravimetric Method: This method was used in determination of Total Suspended Solid (TSS), Total Dissolved Solid (TDS) and Total Solid (TS) respectively. The test procedure was that a glass fiber was dried in oven at 100°C to obtain a known constant weight W1. A 50ml volume of each cassava effluent sample taken from the experimental setup was filtered through fiber bed. The fiber was dried in a desiccator and weighed immediately to obtain the second weight W2. The total suspended solid concentration was calculated using equation (1)

$$TSS = \frac{(W_2 - W_1)}{50} \quad (1)$$

Where: W2 = weight of solid on the fiber (mg), W1 = weight of the empty dried glass fiber (mg), 50 = volume of cassava effluent sample (ml)

The total solid (TS) was obtained by calculating the arithmetic sum of the total dissolved solid (TDS) and the total suspended solid (TSS) as shown in equation (2).

$$TS = TDS + TSS \quad (2)$$

Atomic Absorption Spectrophotometric Method: This method was used in the determination of all the metallic elements such as Magnesium (Mg), Sodium (Na), Potassium (K) and Calcium (Awu *et al.*, 2014). Plate 1 to 4 are not necessary in a research paper and has been deleted

RESULTS AND DISCUSSION

The results for the vermifiltration of cassava effluent with earthworm and without earthworm are presented in Tables 1 to 3. Likewise, the descriptive graphs of the vermifiltration of cassava effluent are shown in Figures 1 to 14. The use of descriptive graph for analysis was to show the obvious physiochemical parametric differences in the treatment which could not be seen statistically.

Generally, Tables 1 to 3 and Figures 1 to 14 results showed that the use of earthworm in the treatment of cassava effluent was effective, though, it could not treat the cassava effluent to the acceptable World Health Organization (WHO) Standards for irrigation use. It was also generally observed that the earthworms used in the vermifiltration of the cassava effluent died within seventy two (72) hours of the experiment.

Likewise, the results revealed that the vermifiltration of cassava effluent using earthworms was better than without earthworm.

The vermifiltration of the cassava effluent using earthworms performed better on the treatment of Electrical Conductivity (EC), Hardness, Chlorine (Cl), Magnesium (Mg) as shown in Figures 3, 9, 10 and 12, respectively, than other parameters. This agrees to the findings of Arora *et al.*, (2015).

Also, it was observed that the Chemical Oxygen Demand (COD) and the Biological Oxygen Demand (BOD) increases as the cassava effluent concentrations decreases.

The Physiochemical Parameter Values before Treatment Ranges from 3.91 To 5.94, 28.6 to 28.7(Ms/Cm), 12480 To 13999 (Mg/L), 7900 To 9511(Mg/L), 168 To 207(Mg/L), 8068 To 9718(Mg/L), 225 To 284(Mg/L), 114 To 132(Mg/L), 1040 To 1680(Mg/L), 400 To 540(Mg/L), 52 To 72(Mg/L), 24 To 40(Mg/L), 20 To 30(Mg/L), 33 To 65(Mg/L) For pH, temperature, EC, TDS, TSS, TS, COD, BOD, hardness, chlorine, calcium, magnesium, sodium and potassium, respectively, across different concentrations (100%, 75%, 50% and 25%) of cassava effluent.



Table 1: Result before treatment of cassava effluent

Sample	pH	Temp.	EC (µS/cm)	TDS (mg/l)	TSS (mg/l)	TS (mg/l)	COD (mg/l)	BOD (mg/l)	Hardness (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)
A	3.91	28.7	13999	9511	207	9718	225	114	1680	540	72	40	30	65
B	4.93	28.7	13099	9030	200	9230	258	119	1300	460	60	34	28	53
C	4.94	28.6	12999	8200	189	8389	260	127	1280	420	52	25	25	46
D	5.94	28.6	12480	7900	168	8068	284	132	1040	400	52	24	20	33

Table 2: Result after treatment of cassava effluent with earthworm (vermifilter)

Sample	pH	Temp.	EC (µS/cm)	TDS (mg/l)	TSS (mg/l)	TS (mg/l)	COD (mg/l)	BOD (mg/l)	Hardness (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)
A	6.45	28.6	12621	9846	211	10057	260	120	1160	440	62	39	28	60
B	6.13	28.7	12090	9180	200	9380	265	128	1040	340	58	32.2	25	50
C	7.73	28.9	12271	8712	208	8920	277	137	900	280	50	23	21	45
D	10.1	29	12021	8100	199	8299	291	140	760	260	48	22	19	31

Table 3: Result after treatment of cassava effluent without earthworm (control reactor)

Sample	pH	Temp.	EC (µS/cm)	TDS (mg/l)	TSS (mg/l)	TS (mg/l)	COD (mg/l)	BOD (mg/l)	Hardness (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)
A	6.36	28.9	13029	9825	223	10048	253	118	1700	1660	66	31	29	64
B	6.61	29.1	13000	9108	223	9331	260	120	1380	1940	58.5	52	27	51
C	7.1	29.1	12770	8500	226	8726	265	126	1300	400	51	53	23	45.5
D	9.04	29.1	12100	8002	203	8205	290	130	1000	560	49	60	20	32

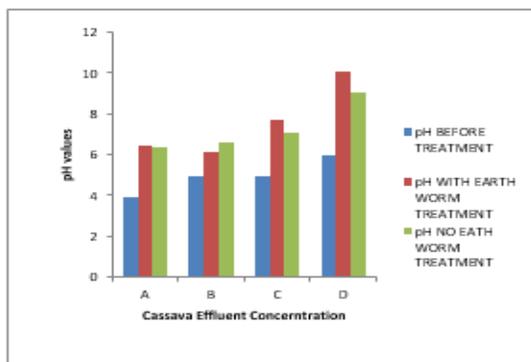


Fig. 2: pH values of the cassava effluent

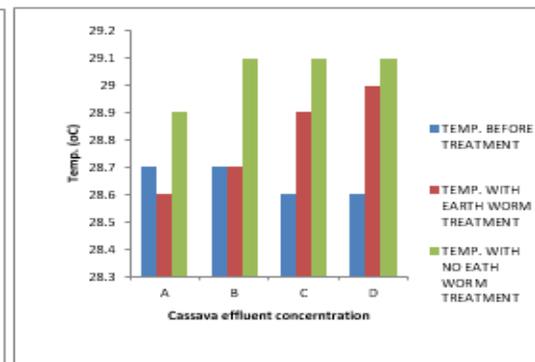


Fig. 3: Temp. Values of the cassava effluent

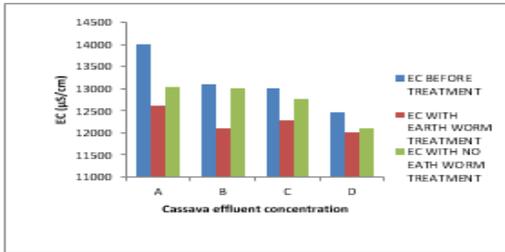


Fig. 4: EC values of the cassava effluent

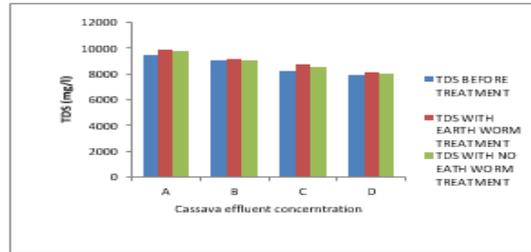


Fig. 5: TDS Values of the cassava effluent

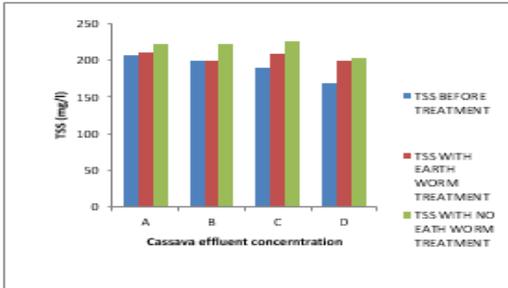


Fig. 6: TSS values of the cassava effluent

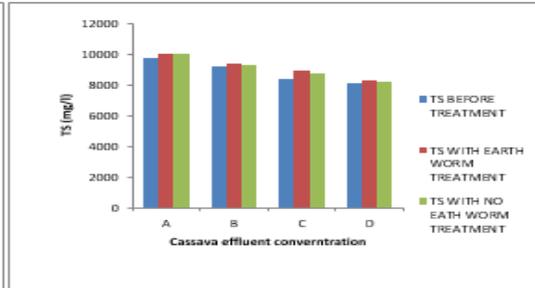


Fig. 7: TS Values of the cassava effluent

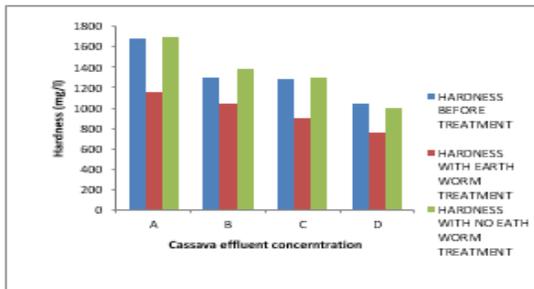


Fig. 10: Hardness values of the cassava effluent

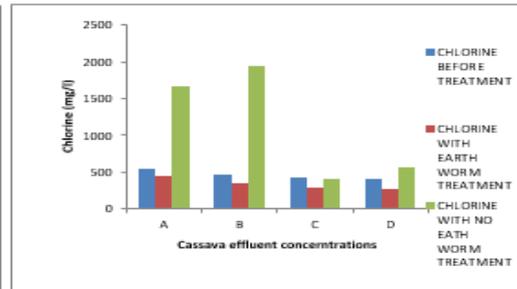


Fig. 11: Chlorine Values of the cassava effluent

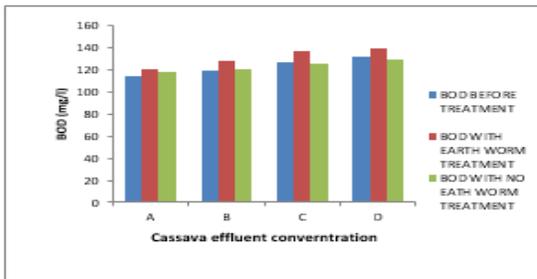


Fig. 8: BOD values of the cassava effluent

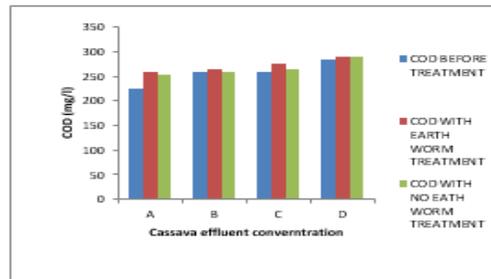


Fig. 9: COD Values of the cassava effluent

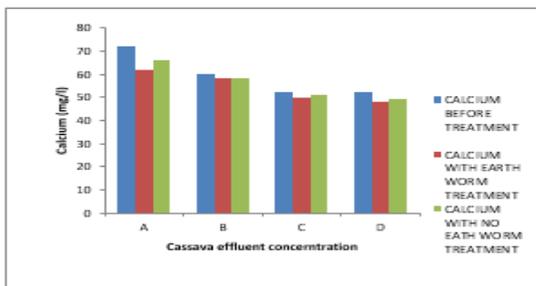


Fig. 12: Calcium values of the cassava effluent

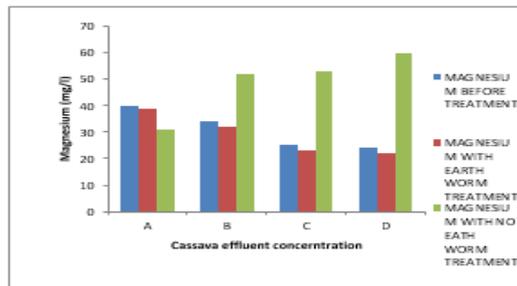


Fig. 13: Magnesium Values of the cassava effluent

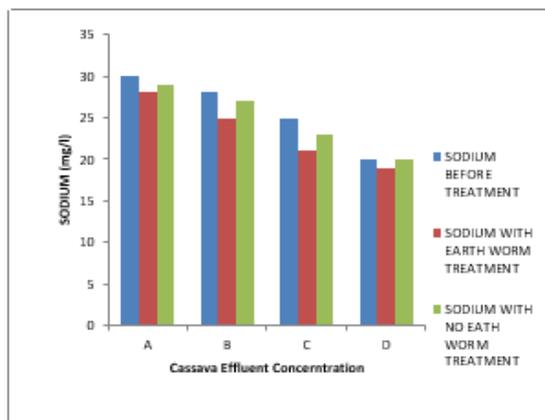


Fig. 14: Sodium values of the cassava effluent

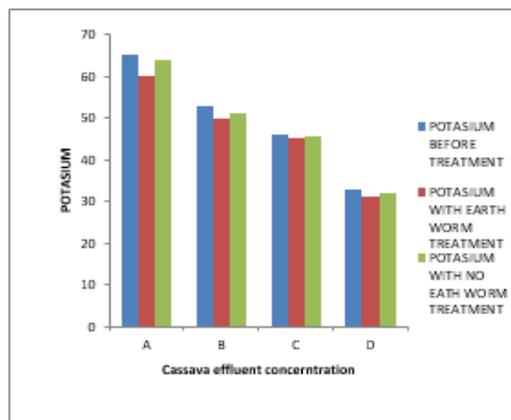


Fig. 15: Potassium Values of the cassava effluent

More so, the physiochemical parameter values after treatment ranges from 6.45 to 10.1, 28.6 to 29, 12021 to 12621($\mu\text{s}/\text{cm}$), 8100 to 9846(mg/l), 199 to 211(mg/l), 8299 to 10057(mg/l), 260 to 291(mg/l), 140 to 120(mg/l), 760 to 1160(mg/l), 260 to 440(mg/l), 48 to 62(mg/l), 22 to 39(mg/l), 19 to 28(mg/l), 31 to 60(mg/l) for pH, temperature, electrical conductivity (EC), TDS, TSS, TS, COD, BOD, hardness, chlorine, calcium, magnesium, sodium and potassium, respectively, across different concentrations (100%, 75%, 50% and 25%) of cassava effluent. More so, the physiochemical parameter values after treatment ranges from 6.45 to 10.1, 28.6 to 29, 12021 to 12621($\mu\text{s}/\text{cm}$), 8100 to 9846(mg/l), 199 to 211(mg/l), 8299 to 10057(mg/l), 260 to 291(mg/l), 140 to 120(mg/l), 760 to 1160(mg/l), 260 to 440(mg/l), 48 to 62(mg/l), 22 to 39(mg/l), 19 to 28(mg/l), 31 to 60(mg/l) for pH, temperature, electrical conductivity (EC), TDS, TSS, TS, COD, BOD, hardness, chlorine, calcium, magnesium, sodium and potassium, respectively, across different concentrations (100%, 75%, 50% and 25%) of cassava effluent.

Conclusion: effluents from cassava processing have been causing serious environmental pollution. Vermifiltration method using earthworms was employed in this study to treat different concentrations of cassava effluent. Results from study showed that the use of earthworm in the treatment of cassava effluent was effective, though, it could not treat the cassava effluent to the acceptable world health organization standards for irrigation use. Information guarded from study will help in policy and management of environmental pollution.

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