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 physicochemical parameters before treatment ranges from 3.91 to 5.94, 28.6 to 28.7(S/cm), 12480 to 13999 (mg/l), 7900 to 1.9511(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, 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(S/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 esculenta 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 a few. Different cultivars of cassava which abound worldwide mature at different time. However, certain varieties contain 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 Akindahunsi, 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 (Raimbault, 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 Akindahunsi (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 microorganisms. 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 Eisenia fetida, Eudrilus eugeniae, Lumbricus rubellus (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. FUNAAB 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 22.90°C in August to 36.32°C in March (Ufoegbune and Fabiyi, 2016). The relative humidity is high ranging from 75.520°C in February to 88.150°C in July (Aiboni, 2001). Map of the study area is shown in figure 1.

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) litters 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 physio-chemical parameters were tests 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)

\[ TSS = \frac{(W_2 - W_1)}{50} \]  

Where: \( W_2 \) = weight of solid on the fiber (mg), \( W_1 \) = 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).

\[ TS = TDS + TSS \]  

**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).

RESULTS AND DISCUSSION

The results for the vermicomposting cassava effluent with earthworm and without earthworm are presented in Tables 1 to 3. Likewise, the descriptive graphs of the vermicomposting 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 vermicomposting of the cassava effluent died within seventy two (72) hours of the experiment.

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

The vermicomposting of the cassava effluent using earthworms performed better on the treatment of Electrical Conductivity (EC), Hardness, Chloride (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  | 12627      | 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      |
More so, the physiochemical parameter values 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 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(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 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(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 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(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 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(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 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(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 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(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 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 guard from study will help in policy and management of environmental pollution.

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