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TREATMENT OF KITCHEN WASTE WATER USING VERMIFILTRATION TECHNIQUE

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ABSTRACT

There is a need of an economic waste water treatment in the developing country due to the unaffordable construction and maintenance cost. Due to the unsustainable fulfillment of requirement of waste water management in future an attempt is made to study the efficiency of vermifilter compared with non vermifilter in the removal of BOD,COD, turbidity, total dissolved solids and total suspended solids. The removal efficiency of parameters analyzed was improved of 57.3%, 51.7%, 88.2%, 86.02%, and 80.697%, COD, BOD, Turbidity, TDS, and TSS respectively by the presence of earthworms.

Keywords*: COD, BOD, Turbidity, Total Dissolved solids and Total suspended solids*

1. INTRODUCTION

Wastewater is generated with the combination of domestic, agricultural commercial or industrial activities etc. Large quantity of the water from the society flows as a wastewater in the sewerage system. To treat waste water there are many treatment process is available but they are expensive. To solve this problem a low cost and ecofriendly type of waste water treatment is used that is Vermifiltration technique. Vermifiltration technique is a latest technique which is used to treat wastewater by saving cost, and energy. Compare to conventional water treatment no chemicals are used in this type treatment technique. The vermifilter is a simple filtering system which is made by using plastic container. The bottom layer is filled up of gravels which provide space for aeration and percolation of water, above this layer a layer of sand, covered with cow dung, clay and loaded with vermis-Eisenia fetida earthworms.

2. OBJECTIVES

- To develop vermin filtration kit to treat BGSIT boys hostel kitchen wastewater.
- To evaluate the potentiality of using earthworms in lab scale reactor to treat boys hostel kitchen wastewater.
- To find the degree of efficiency obtained in BOD, COD and Suspended solids removal through vermin filtration process.
- To find the degree of efficiency obtained in BOD, COD and Suspended solids removal without earthworms by ordinary filtration.
- To give a comparative study for the Vermifilter and Non- Vermifilter treatment processes.

3. BACKGROUND

Rajiv et al (2008) reported that Earthworms‟ body works as a „biofilter‟ and they have been found to remove the 5 days‟ BOD (BOD5) by over 90%, COD by 80–90%, total dissolved solids(TDS) by 90–92%, and the total suspended solids (TSS) by 90–95% from wastewater by the general mechanism of „ingestion‟ and biodegradation of organic wastes, heavy metals, and solids from wastewater and also by their “absorption” through body walls. There is no sludge formation in the process which requires additional expenditure on landfill disposal. This is also an odor-free process and the resulting vermin filtered water is clean and disinfected enough to be reused for farm irrigation and in parks and gardens.

Prasad et al (2013)states that Cost effective and ecofriendly water treatment process is need of this modern age. The earthworm species like *Eisenia fetida* (Tiger worm); *Perionyxexcavatus* (Indian blue worm) and *Eudriluseuginae* (African night crawler) are very efficient in bioremediation and purification of waste water. The gut microbes of earthworm play an important role in breakdown and detoxification of complex organic materials. Earthworm Vermicast is hydrophilic in nature which adsorbs heavy metals and other chemical pollutants from waste water. Several factors which affect the Vermifiltration process like hydraulic retention time, bed thickness, number of earthworm individuals, species of earthworm and developmental stages of earthworm etc. Constructed wetlands are the newer concept efficient in removal of BOD, TDS, and Nitrogen etc. from waste water. Vertical Subsurface flow constructed vermifilter is the combined form of vertical sub surface flow constructed wetland and Vermifiltration.

Manyuchi et al (2013) reported that Vermifiltration was used for treatment of sewage wastewater using the Eisenia fetida earthworm species. The earthworms‟ gut acted as a bioreactor and they reduced the sewage wastewater solid and liquid organic wastes through ingestion and expelling these as vermicompost. 500 earthworms were used in the vermifilter over a 5 period of days. The treated water pH increased from being acidic to neutral. The sewage wastewater biological oxygen demand (BOD5), chemical oxygen demand (COD), total dissolved and soluble solids (TDSS) and turbidity decreased by 98%, 70%, 95% and 98% respectively through Vermifiltration. Vermifiltration significantly decreased the sewage water physicochemical parameters compared to an ordinary bio-filter without earthworms. The vermi-treated sewage water compared well with the set standards for irrigation water. Vermifiltration technology can therefore be applied as an environmentally friendly technique for sewage water treatment for irrigation purposes.

4. EXPERIMENTAL INVESTIGATION

A. Experimental Setup

The study was carried out in a Vermiculture kit of size 35cm of diameter and 50cm height. The Vermiculture kit contained about 20 to 22kg of gravels with a layer of sand, each of about 3cm garden soils on top. This forms the vermifilter bed. It has provisions to collect the filtered water at the bottom in a chamber which opens out through a pipe. Above the chamber lies the metal mesh supported by the pillars to allow only water to trickle down while holding gravels above the bottom most layers is made of gravel aggregates of size 20mm and this layer fills up to a thickness of 10cm, above this lies the gravel of size 10mm, these gravel layer fills up to a depth of 10cm, above this there is a mixed layer of sand and 5mm aggregates for about 12cm in thickness. A wire mesh is provided on this layer. On the top of this, there is soil layer for about 3cm. In the top most layer of the filter system, bed material placed in which Earthworms were released.

As the earthworms play the critical role in wastewater purification their number and population density (biomass) in soil, maturity, and health are important factors. This may range from several hundred to several thousands. There are reports about 8–10,000 numbers of worms per cubic meter of the worm bed and in quantity (biomass) as 10 kg per cubic meter (cum) of soil for optimal function .In this experiment we started with 200 worms in the soil bed.

The inflow is given with the help of PVC drum containing boys hostel kitchen wastewater kept on an elevated platform just near the vermifilter kit. The PVC drums had tap at the bottom to which an irrigation system consisted of simple 10mm diameter pipe with holes for trickling water that allowed uniform distribution of wastewater on the soil surface. Kitchen wastewater from the drum flowed through the irrigation pipes by gravity. The wastewater percolated down through various layers in the vermifilter bed passing through the soil layer inhabited by earthworms, the sandy layer and the gravels. The water was collected at the bottom chamber of the kit. The next day this treated wastewater from the kit were collected and analyzed for BOD, COD, pH, turbidity, TSS and TDS. Figure 1 and 2 Schematic Diagram of Vermifiltration Unit and Experimental Set up of Vermifiltration Kit respectively

- The main sources of wastewater are from almost all the stages of washing glossaries.
- Waste streams are also generated from the various utilities such as washing of rice, floor washing, and all kinds of grams.
- The wastewater for the experiment work was collected from the boys‟ hostel kitchen.
- Wastewater was collected using cans of capacity 5 liters and transported to BGSIT College that day itself for analysis which is stored in incubator.
- Influent untreated wastewater is analyzed for parameters like pH, turbidity, COD, BOD, TSS and TDS during the study period as per standard methods.

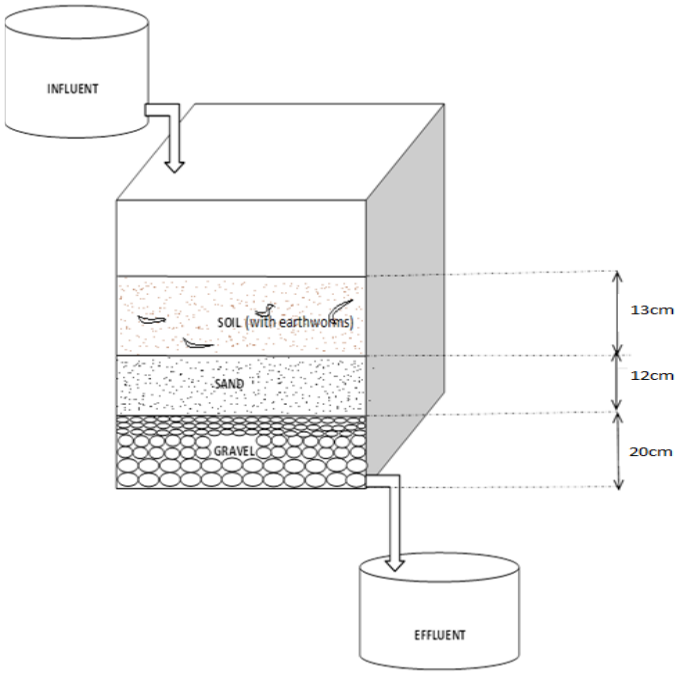

Figure 1: Schematic Diagram of Vermifiltration Unit

Figure 2: Experimental Set Up of Vermifiltration Kit

B. Earthworm Species Used In The Study

The species of earthworm used in this study was collected from Hemmanahalli, Maddur tq. Mandya District. Earthworms are cultivated in Hemmanahalli Maddur tq. Mandya District for the purpose of vermicomposting. Earthworms were present extensively in red soil which was collected using a polythene bag along with soil and manure which there were present.

Figure 3: Earthworms Used in Study

Then collected earthworms were kept in the same room for adjusting it to the lab environment, and allowed them to Vermifiltration unit. For initial purpose of their rapid growth small amount of cow dung was given to earthworms. In this study, Eisenia fetida, commonly known as red wrigglers or tiger worm is used. Figure 3 shows Earthworms used in the study.

5. RESULTS

A. Variation of pH Value in Treated Wastewater

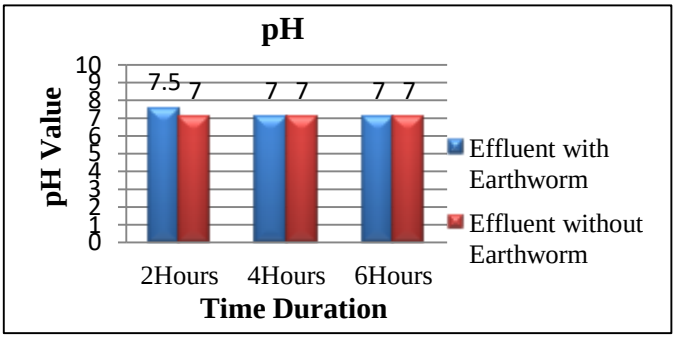

Chart 1: Variation in pH Value for different time duration.

Results indicated that the pH value of raw wastewater is almost neutralized by the earthworms in the vermifilter unit. The pH value of treated wastewater without earthworms also improved but it was not consistent throughout the experiment. Chart 1 shows the variation in pH value.

B. Removal of Turbidity

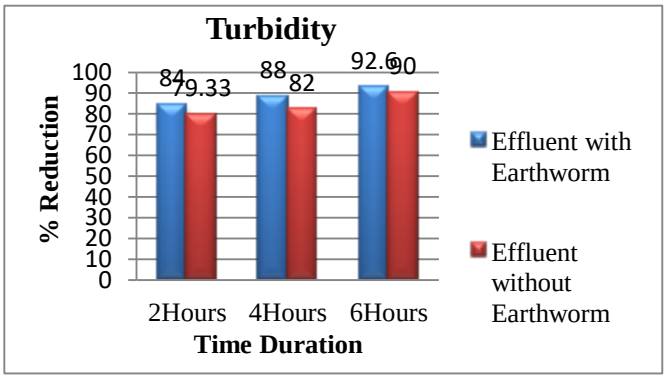

Chart 2: Variation in Turbidity for different time duration.

Results indicated that the average reduction in turbidity by earthworms is over 88.2% while that without earthworms in the control unit is also significantly high and over 83.77%. It appears that the filter media of the unit also plays very important role in turbidity removal by adsorption of

suspended particles on the surface of the soil, sand and the gravels. Turbidity of treated wastewater is affected by HLR. Chart 2 shows variation in turbidity for different time duration.

C. Removal of Total Suspended Solids

Results showed that the earthworms can significantly remove the suspended solids from the wastewater by over 80.697%, which in the non vermifilter unit is over 77.2% only. Chart 3 shows variation in Total Suspended Solids for different time duration. Chart 3 shows Variation in Total Suspended Solids for different time duration.

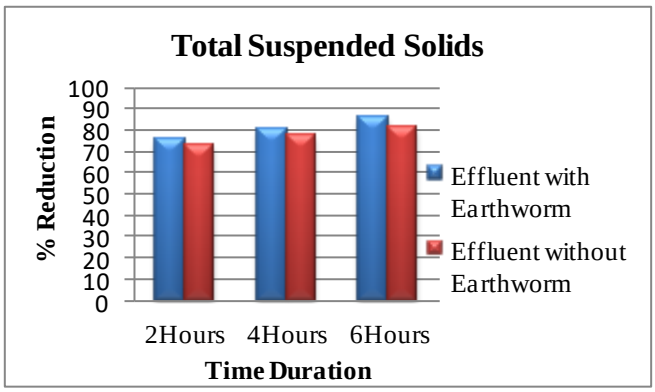

Chart 3: Variation in Total Suspended Solids for different time duration.

D. Removal of Total Dissolved Solids

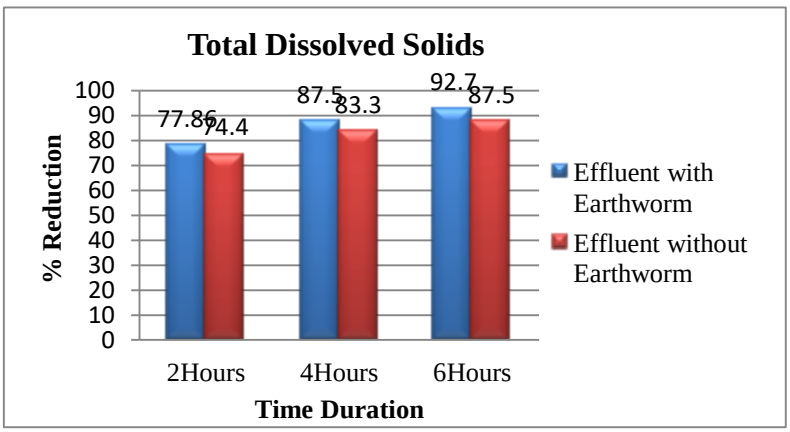

Chart 4: Variation in Total Dissolved Solids for different time duration

Total suspended solids (TSS) and total dissolved solids (TDS) showed drastic reduction during control and Vermifiltration process. The total reduction in TDS content was about 86.02% in Vermifiltration unit and that was significantly higher than total removal in control unit, i.e. 81.73%. Results thus clearly suggested the capability of earthworms to remove solid fractions of wastewater during vermi-bio filtration processes. The non vermifilter unit showed a gradual removal of TDS during treatments process while in Vermifiltration unit TDS removed sharply during initial stages of the experiment thereafter; the removal process was more or less steady till last observation. The difference between both units could be due to difference in biological components and working capabilities of both units. Chart 4 shows Variation in Total Dissolved Solids for different time duration.

E. Removal of Total Dissolved Solids

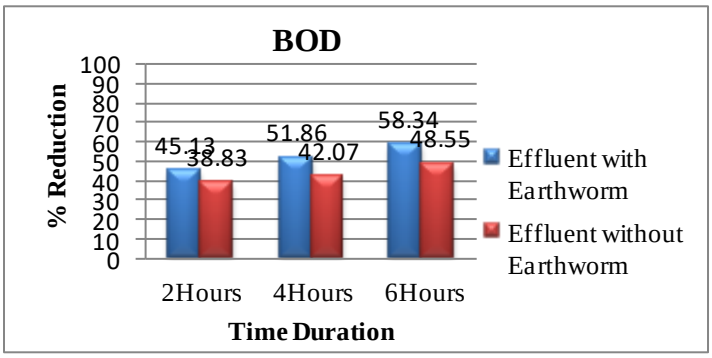

Chart 4: Variation in Total Dissolved Solids for different time duration

BOD is also an important indicator of organic load of wastewater. The BOD load in effluents from non vermifilter and Vermifiltration unit was significantly lower than initial levels, but vermi-bio filtration showed more removal efficiency than control unit. Results show that the earthworms can remove BOD (BOD5) loads by over 51.7%. BOD removal in the non vermifilter unit is just around 43.15%. Chart 5 shows Variation in Total Dissolved Solids for different time duration.

F. Removal of Total Dissolved Solids

Results showed that the average COD removed from the wastewater by earthworms is over 57.3% while that without earthworms is just over 46.6%. COD removal by earthworms is not as significant as the BOD, as but at least much higher than the microbial system.

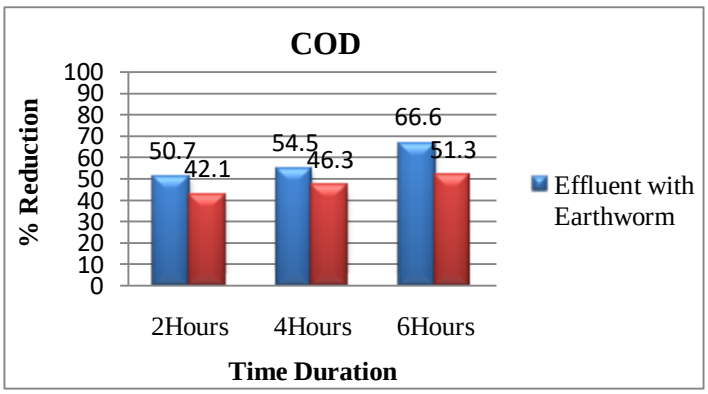

Chart 5: Variation in Total Dissolved Solids for different time duration

Again, the enzymes in the gut of earthworms help in the degradation of several of those chemicals which otherwise cannot be decomposed by microbes. Chart 5 shows Variation in Total Dissolved Solids for different time duration.

6. CONCLUSION

Healthy soil is a bio-geological medium acting as an "adsorbent" of organics, inorganic. Any wastewater from the households and commercial organizations can be successfully treated by the earthworms and the technology can also be designed to suit a particular wastewater. Though significant removal of BOD, COD, TDS and TSS is achieved by the microbial-geological system unaided by earthworms as shown from our study in the non vermifilter kit the system fails to work for longer time as it is frequently choked due to the formation of sludge and colonies of bacteria and fungi (in the vermifilter bed) in the absence of the earthworms. The values obtained from the experimental are well within the limits, shows Vermifiltration system has good performance in treatment of waste water.

This laboratory scale study may allow extension of methodology to applications like controlling water pollution in rural areas. The earthworm production, growth, breed & survive in the moist environment is very well was observed during the process of experiment. Greater interaction with wastewater components also provides better opportunity for the worms to eat all the solids and prevent any sludge formation.

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