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Vermi-Biofiltration- A Low Cost Treatment for Dairy Wastewater

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Abstract: ***The wastewater generated in dairy industry contains very high organic loading and total solids and is mostly treated in ETP (Effluent Treatment Plant) plant, where the sludge is formed increasing the expenditure for processing and disposal along with the operation cost. Vermi-bio-filtration is a combination of conventional filtration process along with vermicomposting. Earthworms body act as a 'biofilter' and they were found to decrease BOD-97.95%, COD-91.64%, TSS-76.39%, TDS-84.27%. Oil and grease content was also found to be reduced by 84.13%. They treat the wastewater by the mechanism of 'feeding' and 'biodegradation. Also increase the hydraulic conductivity and natural aeration by grinding the soil particle. In the present study vermifilter was designed. The effluent passed through top layer of the filter and found out the efficiency of removal of physicochemical parameter. The suspended solids trapped on top of the vermifilter and processed by earthworms. There is no sludge formation in this process which requires additional expenditure on landfill and disposal. The process is odour-free, ecofriendly and cost effective. The final vermi-filtered water was clean enough to be used for irrigation, in parks, and garden.***

Keywords: BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), TDS (Total dissolved solid), TSS (Total suspended solids), oil and grease, earthworms, vermi-bio-filter, vermifiltration

1. Introduction

The wastewater generated in dairy industry contains very high organic loading and total solids and is mostly treated in ETP (Effluent Treatment Plant) plant, where the sludge is formed increasing the expenditure for processing and disposal along with the operation cost. Vermi-bio-filtration is a combination of conventional filtration process along with vermicomposting. Earthworms body act as a 'biofilter' and they were found to decrease BOD-97.95%, COD-91.64%, TSS-76.39%, TDS-84.27%. Oil and grease content was also found to be reduced by 84.13%. They treat the wastewater by the mechanism of 'feeding' and 'biodegradation. Also increase the hydraulic conductivity and natural aeration by grinding the soil particle. In the present study vermifilter was designed. The effluent passed through top layer of the filter and found out the efficiency of removal of physicochemical parameter. The suspended solids trapped on top of the vermifilter and processed by earthworms. There is no sludge formation in this process which requires additional expenditure on landfill and disposal. The process is odour-free, ecofriendly and cost effective. The final vermi-filtered water was clean enough to be used for irrigation, in parks, and garden.

2. Materials and Method

2.1 Materials Used

Vermifilter bed was made up of different sizes of gravel, sand, garden soil, a sprinkler, 200 Eisenia fetida earthworms were used based on 5000-10000 worms/m^2 and 10 lit of plastic drum[8].

Eisenia fetida worms were obtained from Mahatma Phule Agriculture college, Shivajinagar, Pune and influent was collected from dairy, Pune

Table 1: Characteristics of the influent

Parameter	*Values*
Odor	Unpleasant
Colour	whitish
pH	6.5-8.8
Total Dissolved Solid	1434 mg/lit
Total suspended solids	950-900 mg/lit
BOD5	2000-2500 mg/lit
COD	3700-4000 mg/lit
Oil and grease	80 g/lit

Table 2: MPCB Standards for disposal of wastewater

Sr.No	*Parameter*	*MPCB Standards*
1	pH	5.5-9
2	BOD_5	<30
3	COD	<250
4	TSS	<100
5	TDS	<2100
6	Oil & Grease	<10

2.2Parameter studied in Dairy Wastewater Vermifiltration

The untreated dairy waste water was fed to the vermifilter and treated dairy wastewater was collected at the bottom of the vermifilter in chamber was analyzed for BOD (biological oxygen demand), COD (chemical oxygen demand), TSS (total suspended solids), TDS (total dissolved solid), pH, and oil and grease.

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2.3 Preparation of vermifilter bed

Vermifilter bed made up of different layers of gravel, sand and garden soil with earthworms. The bottom most layer was made of 4-5cm of aggregate at a depth of 40mm, above this layer 2-3 cm of aggregate at a depth of 30mm. Another layer aggregate 1-2 cm size mixed with sand was introduced. The top most layer consists of garden soil with worms at a depth of 120mm.

2.4 Experimental Procedure

5L of dairy wastewater was kept in 20L of plastic drum. The drum was kept near vermifilter bed at elevated platform. The plastic drum had a tap at the bottom to which an irrigation system is attached. The irrigation system consisted of rubber pipe with holes of 3mm for trickling water that allowed uniform distribution of dairy wastewater on vermifilter bed. The dairy wastewater flowed through the pipe by gravity. The wastewater percolated down through the different layers of the vermifilter bed and at the end was collected in a chamber at the bottom of the kit After a detention period of 24 hours, this treated wastewater were collected and analyzed for BOD5, COD, TSS, TDS, and oil and grease.

Figure 1: 5-4 cm size of gravel used in formation of vermifilter bed

Figure 2: 2-3 cm size of gravel used in formation of vermifilter bed

Figure 3:1-2cm size of gravel used in formation of vermifilter bed

Figure 4: Soil bed with earthworms.

Figure 5: Actual Experimental Setup

3. Result and Discussion

3.1 Variation in pH

No considerable variation was observed between vermi treated wastewater and untreated dairy wastewater. The graph shows an increase in pH of effluent but within limit.

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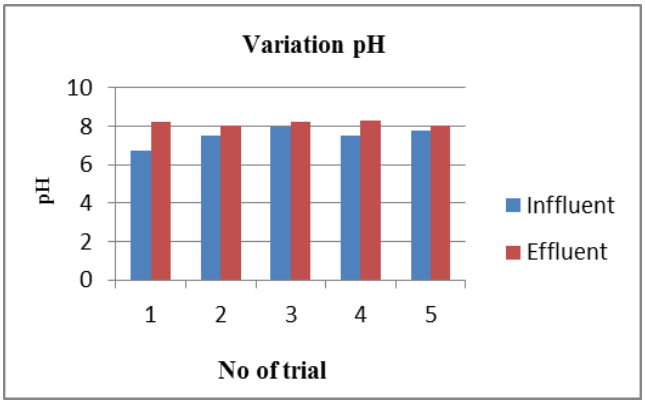
Table 3: variation in pH of influent and effluent of dairy wastewater and MPCB Standards for disposal

Expt No	*Influent pH*	*Effluent pH*
1	6.72	8.20
2	7.5	8.04
3	8	8.3
4	7.5	8.25
5	7.8	8.02



3.2 BOD and COD Removal

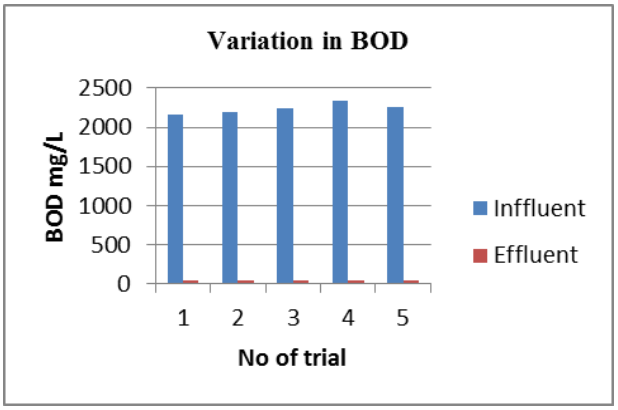
BOD describes the amount of dissolved oxygen essential to breakdown organic contaminants through aerobic bacteria. Also, the chemical decomposition of organic and inorganic contaminants in wastewater which cannot be biologically removed is term as COD. Results indicate that the overall efficiency of BOD and COD of the treated dairy wastewater from the vermifilter were found to be always greater than 90 % and 85%. Since the earthworms are primarily accountable to biodegrade waste as compared to inorganic waste through enzyme as a biocatalysts to quicker the rate of biochemical reaction, BOD removal efficiency was found to be much better than that of COD removal efficiency in vermifilter[10].The BOD values remaining after vermin-biofiltration of the dairy wastewater was acceptable for use of irrigation purpose.

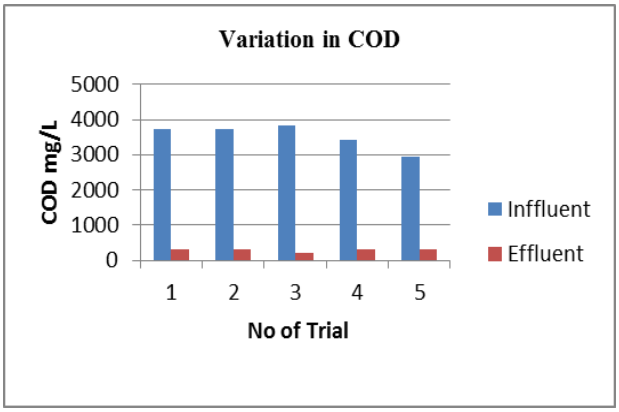
Table 4: Reduction in BOD_5 by vermifiltration of Dairy wastewater

Expt No	*Influent BOD5 (mg/l)*	*Effluent BOD5(mg/l)*
1	2166	40
2	2267	45
3	2234	48
4	2345	39
5	2250	42

Table 5: Reduction in COD by vermifiltration of Dairy wastewater

Expt No	*Influent COD (mg/l)*	*Effluent COD(mg/l)*
1	3744	320
2	3811	310
3	3842	214.1
4	3433	305
5	2945	295





3.3 Removal of TSS And TDS

Total dissolved and suspended solids refer to the organic and inorganic contaminants which are either suspended or dissolved in the wastewater. TSS and TDS both reduced during vermi-biofiltration. In the initial period of experiments, TSS and TDS increased because of dissolution of soil particle. The earthworms in the vermifilter significantly removed the TDS from the dairy wastewater by about 80-85%. The TSS from the dairy wastewater by about 90-95%.The sludge formed due to accumulation of solids in the conventional system, clog the filter system. On the other hand, the vermifilter system was protecting from the congestion due to solid biomass. Earthwarms consume the solid biomass and clear the path for efficient process conditions and resulted into high removal efficiency of TSS and TDS from wastewater.

Table 6: Reduction in TSS by vermifiltration of Dairy wastewater

Expt No	*Influent TSS (mg/l)*	*Effluent TSS(mg/l)*
1	980	432
2	983	88
3	990	95
4	1120	82
5	1122	89

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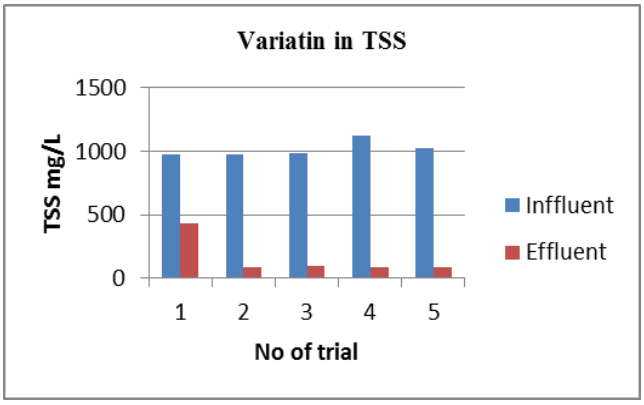
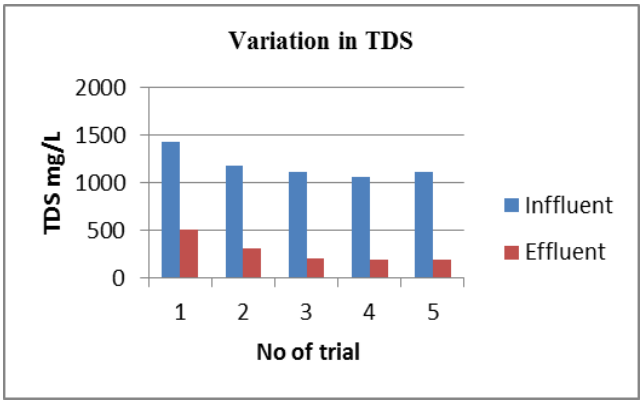


Table 7: Reduction in TDS by vermifiltration of Dairy wastewater

Expt No	*Influent TDS (mg/l)*	*Effluent TDS(mg/l)*
1	1434	510
2	1180	310
3	1110	210
4	1070	200
5	1120	198



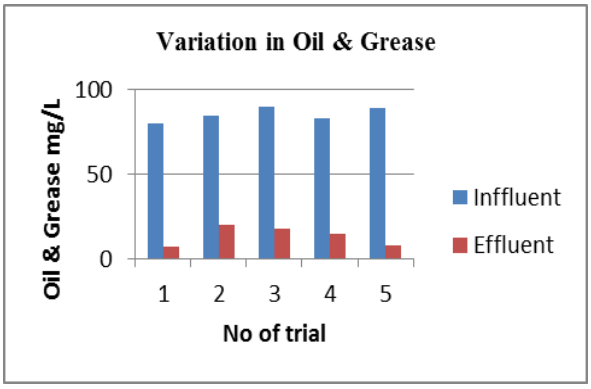
3.4 Removal of oil and grease

The presence of oil and grease in the effluent causes death to aquatic plant and animals by forming a layer on the top and depleting the DO.

The conventional techniques remove oil and grease using skimming tank and oil and grease traps in treatment plants but main disadvantage of these methods is their low efficiency of removal. On the other hand earthworms in the vermifilter efficiently remove oil and grease by about 85%.

Table 8: Reduction in oil & Grease by vermifiltration of Dairy wastewater

Expt No	*Influent Oil & Grease (mg/l)*	*Effluent Oil & Grease (mg/l)*
1	80	7
2	85	20
3	90	18
4	83	15
5	89	8



Conclusion

Results showed that vermifilter achieves good performance; the results were better than conventional wastewater treatment. The vermifilter treatment was cost effective, 60 to 70% of cost reduction is possible, odor free with the good efficiency of removal of parameter. The BOD, COD, TSS, TDS and O&G were reduced by 97.95%, 91.64%, 84.27%, 76.39%, and 84.13% respectively. There is no sludge formation in this process instead of that vermi compost was formed which can be used as fertilizer. The vermifiltered water is most suitable for irrigation purpose but would require further treatment for other uses.

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