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RESEARCH ARTICLE

BIOREMEDIATION OF WASTEWATER FROM DRAIN IN BURLA TOWN, ODISHA, BY VERMIFILTRATION

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ABSTRACT

The generation and treatment of the wastewater has become an important health issue in the developing countries due to inadequate facilities for treatment (Singh *et al.*, 2015). About 80% of the water supply used by human society comes as municipal wastewater in sewer system as sewage (Sinha *et al.*, 2008). In the present study an attempt has been made to assess the efficacy of vermifiltration of the wastewater collected from the drainage canal of Burla town, Sambalpur. The analysis was carried out by considering certain physico-chemical parameters like pH, electrical conductivity, TSS, BOD, COD, nitrate, fluoride, chloride which is considered indicators of the pollution loads in the wastewater. The study revealed that there was significant reduction of the various physico-chemical parameters on vermifiltration. There was significant reduction with respect to the duration of retention of the wastewater in the vermibed. There was reduction of pH, Electrical Conductivity, TSS, BOD, COD, Nitrate, Fluoride and Chloride by 1.2%, 36.9%, 40.3%, 60.5%, 44.4%, 47.2%, 39.7% and 55.1%, respectively by 30th day. The vermifitered water was odour free.

INTRODUCTION

Global scientific community is in search of a technology which should be economically viable, ecologically sustainable and socially acceptable for treatment of wastewater. About 80% of the water supply used by human society comes as municipal wastewater in sewer system as sewage (Sinha *et al*., 2008). Sewage has harmful chemical and high loads of organic matter measured in terms of BOD (biological oxygen demand), COD (chemical oxygen demand) and solids. Before discharging into the environment the sewage has to be treated to reduce the organic loads. If this untreated sewage is discharged into water courses is most important source of water resources and this will lead to depletion of dissolved oxygen when the organic load will be degraded by the aerobic microbes in the river or other water bodies. People living in rural and urban areas of developing countries depend upon onsite treatment of domestic wastewater and these systems should be relatively low cost and energy (Sharma *et al*., 2014). Various solutions adopted for the treatment domestic water in rural areas include constructed wetlands, soil infiltration trenches, vegetation based wastewater treatment and Vermifiltration (Ham *et al*., 2007). Among these technologies, Vermifiltration represents the most efficient technology (Kumar *et al*., 2014). Vermifiltration has the great potential in this aspect which adopts the traditional vermicomposting as a passive wastewater treatment. In vermifiltration process earthworm body works as a bio-filter and enhances the microbial metabolism by increasing their population. The resulting effluent carries comparatively less load of organic wastes and then can be reused for irrigation purpose and released to water bodies. Earthworms are versatile waste eaters and decomposers. The growth of 'beneficial decomposer bacteria' in domestic wastewater is promoted by the earthworms who act as aerator, grinder, crusher, chemical degrader and biological stimulator in the soil. Both processes-microbial process and vermi-process simultaneously work for the treatment of domestic wastewater using earthworms. Earthworms stimulate as well as accelerate microbial activity by increasing the population of soil microorganisms through improved aeration. Since there is no sludge formation, additional expenditure on its disposal in conventional treatment is reduced. The various investigators have found that the vermitechnology has potential for the treatment of wastewater (Hughes *et al*, 2011).

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Earthworm role in matter recycling

The role of earthworms in humificaton and breakdown of plant litter in natural soil has been known since the time of Darwin, but their potential to stabilize the organic refuse into useful components been known recently. Five earthworm species (*D. veneta, E. eugeniae, P. excavatus, P. hawayana and E. fetida*) were reported by C.A. Edwards (1998) to be the most potential earthworms for breakdown of organic wastes. Generally most organic wastes can be broken down by earthworms. Earthworms are highly adaptable to different types of environments like organic waste, provided, the physical structure, pH and the salt concentration are not above the tolerance level (Seenappa, *et al*., 1995). Extensive research on decomposition of animal manure viz. pig waste, cattle dung and poultry waste using earthworms has been done. The main emphasis of the research has been the conversion of animal and vegetable wastes into useful materials and then harvesting earthworms from the waste on a commercial basis (Butt, 1999). Temperature and moisture are controlled through the use of greenhouse curtains, shade cloth, fans, and an automatic mister. Castings are lifted and conveyed from the beds every other month by a retrofitted machine, and a harvester separates earthworms and eggs from the castings (NCSU, 1997). Earthworms convert the foul smelling organic matter into a dark, odourless, homogeneous material called castings or vermicast which is an ideal plant growth supplement which is often referred to as 'Black Gold' by gardeners. Earthworms feed on the waste itself and the microorganisms produced during decomposition. Their movement through the waste assists the break down and aeration of the material, providing ideal conditions for microbes to grow, which in turn enhances the decomposition rate of the organic matter. The waste entering the earthworm gut is subjected to biochemical break down by the enzymes secreted in the gut of the animal and by the microorganisms present inside it. The resulting product is colloidal humus that acts as a slow release fertilizer. The nutrients are easily available to the plants, but resist leaching. The rate of decomposition depends on the type of litter present.

Earthworms being the versatile waste eaters promote the wastewater treatment by basically accelerating the beneficial microbial growth (Dash, 1978). Vermifiltration process separates wastewater solids by allowing wastewater to be gravity-fed over filtration material. In this process the wastewater is allowed to pass through a soil bed containing earthworms. The earthworms during Vermifiltration act as biofilter which reduces the organic waste from the wastewater (Manyuchi *et al*., 2013).

Vermifilter with water recovery

It is possible to have single or multiple stage vermifilter depending on the strength of the wastewater and desired quality of renovated water. In principle, a single unit can produce any given purity of water by increasing the recyclable ratio, which reduces the organic loading (Bhawalkar, 1995). In the present study an attempt has been made to study the effect of Vermifiltration of wastewater of Burla sewage and changes in the physiochemical parameters of wastewater.

MATERIALS AND METHODS

Geographical location of study area

Burla is located at 21.5° N 83.87°E. It has an average elevation of 173 metres (567 feet).

Collection and analysis of water samples

For the analysis of wastewater (0 days water sample) were collected from Burla wastewater canals, near Sambalpur University, Jyoti vihar, Sambalpur, Odisha, India, in the month of June. The samples were filled in plastic drum of 40 litre capacity.

Preparation of vermifilter bed

The vermifilter bed was made up of layers of gravel and soil. The bed consisted of gravel at the bottom layer this was overlaid with 2 mm sieved 5 kg pasture soil. 25g% drainage water was added to each bed and kept for 5 days. 20 such beds were prepared. Then 50 earthworms (weighing about 30 gm) were added to each of 10 beds. Earthworms were not added to rest 10 beds. The 10 beds where earthworms were not added were taken as replicas of control, the other 10 beds were considered as treated. A mixed culture of *Perionyx exacavatus* and *Lampito mauritii* were inoculated in to the vermifiltered beds.

Experimental Procedure

Drainage wastewater collected from Burla Township (District, Sambalpur, Odisha) was kept in 3L plastic jar. The jar was kept at an elevated position over the vermifilter bed. An irrigation system consisting of rubber pipe was attached to the tap at the bottom of the plastic jar. The wastewater flowed through the pipe and it percolated through different layers of the vermifilter bed. At an interval of 15 and 30 days the water was collected in the bottles kept below the vermifilter bed through the hole of about 5mm made in the bottom of vermifilter bed. The different parameters of water quality of the waste water collected from drain were conducted initially. The water collection was done on 15th and 30th day as leachate from the control and vermifilter beds and various parameters like COD, BOD were conducted.

Water quality analysis

Ph

pH of water samples was measured by using digital pH meter (Systronics 361).

Conductivity

Conductivity of water samples was measured by using conductivity meter (ELICO 361).

Total Suspended Solids (TSS)

Washed Filter paper was and dried. It was then cooled and weighed. The filtration apparatus was the assembled. Then filter paper was wet with distilled water. Then 25 ml well mixed sample was taken in conical flask and that sample transferred to filter apparatus. The filter apparatus washed three times. Filter paper was transferred to evaporating dish and dried, cooled and weighed (APHA, 2005).

Calculation

A- B × 1000/ ml of samples = ppm suspended solids.

Where,
A = weight of filter + dried residue (mg), B = weight of filter (mg)

Biological Oxygen Demand (BOD)

The samples were filled in BOD bottles of known volume by avoiding any kind of bubbling and trapping of air bubbles in bottle by placing stopper. Then 1ml of $MnCl_2$ was added followed by addition of 1ml of alkaline iodide then it was allowed to stand for a few seconds. 1ml of concentrated sulphuric acid was then added. 100ml of sample were taken in conical flask and 1ml of starch indicator was added to it. Then entire contents of each flask were titrated against 0.1N $Na_2S_2O_3$ solutions. The colour changes from blue to colourless. This indicates the end of titration. Similarly the water samples were incubated for 5 days in 20°c after incubation the contents were titrated in the same manner (APHA, 1992).

Calculations:

BOD in mg/l =DO value at 1st day- DO value at 5th day

Chemical oxygen demand (COD)

0.4 gm of mercuric sulphate was placed in a reflux flask and 20ml of sample was diluted with 20ml of distilled water. Pumice stones or glass beds were added to it followed by addition of 10ml of standard potassium dichromate. Then 10ml of H_2SO_4 (Sulphuric acid) reagent was added slowly and mixed well. Then the flask was connected to a condenser and was refluxed for 2 hours. Then the condenser was cooled down with distilled water. It was then titrated against ferrous ammonium sulphate using 1 to 2 drops of ferrous indicator. The end point was from blue green to reddish green. The blank was also treated in the same manner (EPA, 1979).

Nitrate

50ml of sample was taken in a 100ml beaker. The sample was heated up to dryness. Then 2ml of PDA (Phenol disulphonic acid) was added to it. 10ml of liquid ammonia was added to it. A pale yellow color was developed. For standard graph, different amount of KNO_3 (Potassium nitrate) was taken ranging from 25-250µg. In blank test tube distilled water was taken instead of standard solution. Then OD of the solution was taken as 410nm. The nitrate standard curve was prepared and the amount of nitrate present in the sample was calculated. (APHA, 2005)

Fluoride

A standard curve was prepared in the range of 0 to 1.4 mg/lit by diluting appropriate volume of standard fluoride solution to 50ml in nessler tubes. 10ml of mixed reagent (equal volumes of SPADNS solution and Zirconyl acid reagent) was added to all samples and mixed well. The optical density of bleached color was measured at 570nm using reference solution setting zero absorbance. The percentage transmission was noted. If the sample contains residual chlorine it was removed by adding 1 drop of $NaAsO_2$ (Sodium arsenite) (1 drop = 0.05ml = 0.1 mg Cl) .The mg of fluoride present in the sample was calculated using standard curve. (Belcher *et al*., 1959)

Chloride

25 ml of sample was taken in a 50 ml conical flask. 0.5 ml $K_2Cr_2O_7$ (Potassium dichromate) were added to it. Then it was titrated with standard $AgNO_3$ (Silver nitrate) solution till $AgNO_3$ started precipitating as pale red precipitate. For better accuracy distilled water (25ml) was titrated in the same way to establish reagent blank. (APHA, 2005)

Calculation:

Chloride mg/L as Cl^- = (A-B) × N × 35.45 × 1000/ml sample

Where,
A = ml $AgNO_3$ required for sample
B = ml$AgNO_3$requiredforblank, and
N = Normality of $AgNO_3$ used.

RESULTS

pH

The initial pH of sewage water sample (0 day) was slightly basic in nature (7.34). The highest pH observed in initial sewage water sample (7.34). Reduction of pH was observed during vermifiltration. By 15th day the pH of untreated sewage water sample was reduced to 7.32 (reduction about 0.2% over initial pH) and vermifiltered (treated) water sample pH was measuring 7.31 (reduction 0.4%) (Table1, Fig.1) 30th day untreated wastewater sample's pH was decreased by 0.2% whereas treated sewage water sample pH was decreased by 1.2%. Two way ANOVA reveals that the reduction in pH is significant at 0.05 level both with respect to duration and treatment (Table 3).

Electrical Conductivity

The initial electrical conductivity (EC) of the wastewater sample was 1.906 mMhos/cm. Reduction in the EC occurred when waste water was treated with the vermifiltration technology (VFT). By 15th day EC of non vermifiltered wastewater was 190.3 mMhos/cm (reduction of 0.16% over initial EC) whereas vermifiltered water sample's EC was 174.5 mMhos/cm (reduction 8.44%). The EC of the non vermifiltered and vermifiltered water sample was 186.4 mMhos/cm (reduction about 2.2%) and120.3 mMhos/cm (reduction 36.9%), respectively by 30th day (Table 1 and Fig.2). The decrease in EC of water from the VF and nonVF bed was significantly different at 0.001 level of significance.

Total suspended solids (TSS)

At the beginning of the vermifiltration processes, the TSS of wastewater sample (on 0 day) was 7.58.4 mg/L. By 15th days non vermifiltered water sample's TSS was 663 mg/L and that of vermifiltered water sample's TSS was 584.8 mg/L. The removal of TSS in non vermifiltered sample was only 12.5% whereas in vermifiltered sample 22.89% over the initial TSS of wastewater (Table 1 and Fig. 3). On 30th day non vermifiltered water sample TSS was 580.2 mg/L (reduction about 23.5%) and vermifiltered water sample TSS was 454.8 mg/L (reduction about 40.03% mg/l). Significant reduction of TSS occurred with respect to duration as well as vermifiltration at 0.001 and 0.01level, respectively.

Table 1. Changes in Physicochemical parameters of wastewater during Vermifiltration

Parameters (% Reduction over 0 day)	Duration in days				
	0	15		30	
		Control	Treatment	Control	Treatment
	(Without EW)	(Without EW)	(With EW)	(Without EW)	(With EW)
pH	7.34± 0.01	7.32± 0.02 (0.27)	7.31± 0.01 (0.4)	7.32± 0.02 (0.27)	7.25± 0.04 (1.2)
Conductivity in mMho/cm	190.6±7.63	190.3± 6.32 (0.16)	174.5±10.00 (8.44)	186.4±4.99 (2.2)	120.3±14.01 (36.9)
TSS in mg/L	758.4 ±74.08	663.0±94.52 (12.5)	584.8± 19.01 (22.9)	580.2±20.22 (23.5)	454.8±18.47 (40.0)
BOD in mg/L	5.83±0.47	4.24±0.28 (27.3)	3.19± 0.32 (45.3)	3.95±0.29 (32.2)	2.3±0.41 (60.5)
COD in mg/L	64.3±2.16	61.0±1.49 (5.13)	45.9± 3.34 (30.5)	56.9±1.72 (11.5)	35.7±2.31 (44.4)
Nitrate in mg/l	126.9±3.14	113.8±2.44 (10.3)	87.0± 1.49 (31.4)	95.8±3.06 (24.5)	67.0±1.49 (47.2)
Fluoride in mg/L	0.98±0.02	0.95± 0.01 (3.06)	0.88±0.01 (10.2)	0.88±0.01 (10.2)	0.59±0.01 (39.7)
Chloride in mg/L	61.0±1.5	59.1±1.60 (3.1)	87.0± 1.49 (22.6)	48.3±1.16 (20.8)	27.4±2.07 (55.1)

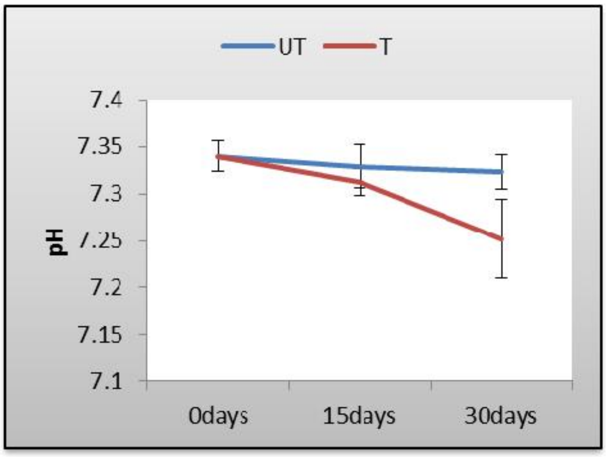

Figure 1: Effect on pH during vermifiltration of wastewater

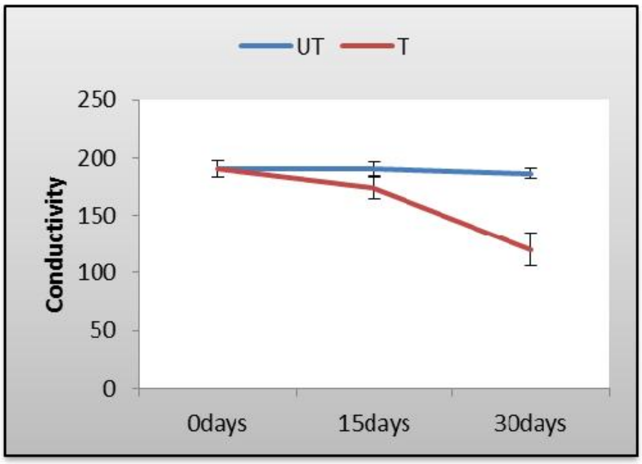

Figure 2: Effect on electrical conductivity during vermifiltration of waste water

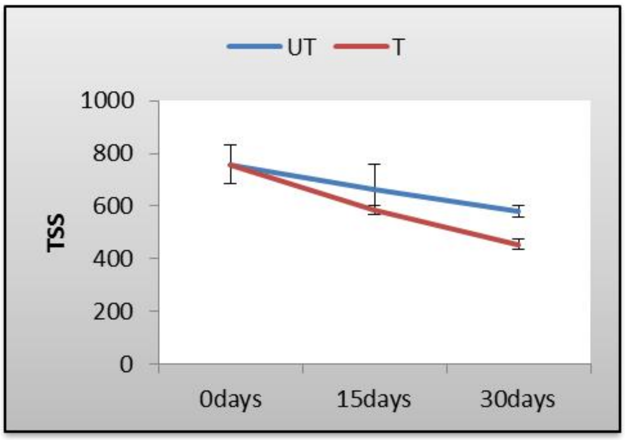

Figure 3: Effect of total suspended solids (TSS) during vermifiltration of wastewater

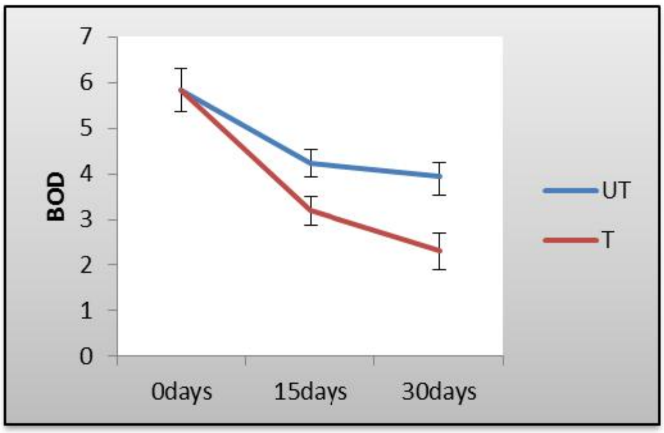

Figure 4: Effect on biological oxygen demand (BOD_5) during vermifiltration of wastewater

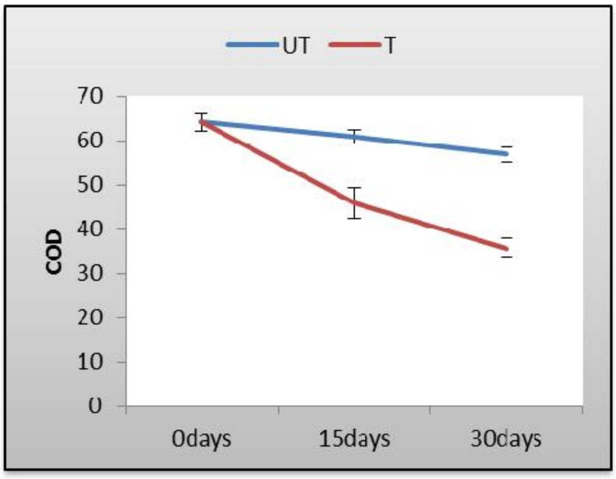

Figure 5: Changes in chemical oxygen demand (COD) during vermifiltration of wastewater

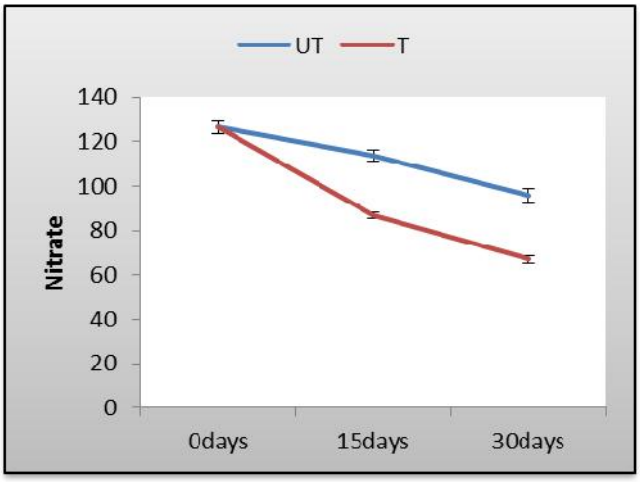

Figure 6: Effect on Nitrate content during vermifiltration of wastewater

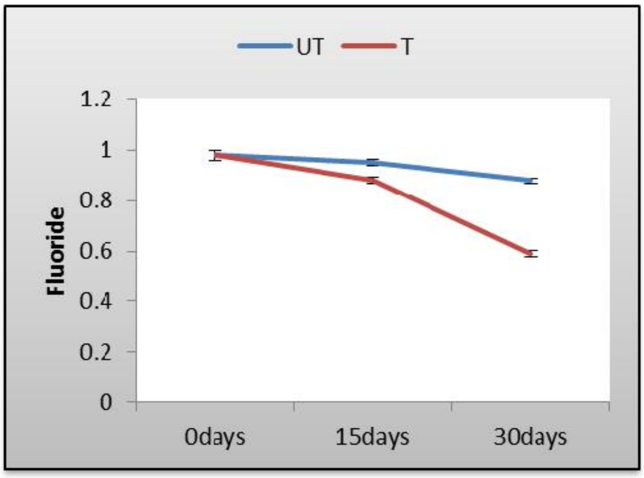

Figure 7: Effect on Fluoride content during vermifiltration of wastewater

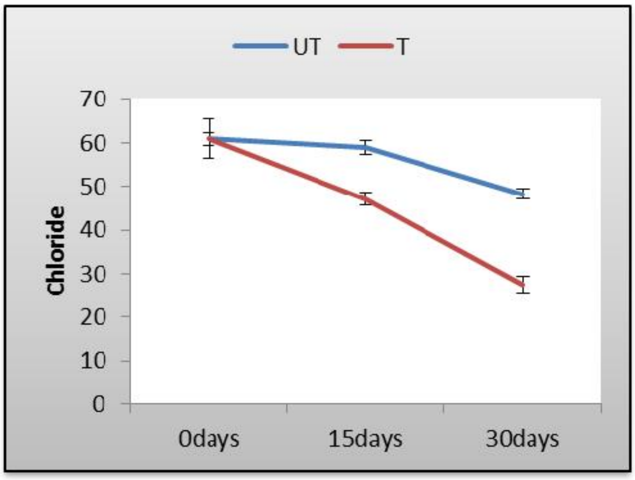

Figure 8: Effect on Chloride content during vermifiltration of wastewater

Biological oxygen demand (BOD)

BOD of wastewater sample (0 day) was found to be 5.83 mg/L. By 15th day water sample's BOD was 4.24 mg/L (reduction 27.3% over 0 day) and 3.19 mg/L (reduction 45.28%/L) in non vermifiltered and vermifiltered water sample, respectively (Table1 and Fig.4). By 30th day BOD was reduced by about 32.2% in non vermifiltered water sample and 60.5% in vermifiltered water sample (Table1). There was significant reduction in the BOD of wastewater sample with respect to vermifiltration and and detention time on vermibed (duration) at 0.001 level of significance.

Chemical oxygen demand (COD)

COD of the wastewater collected was 64.3 mg/L. After 15 days of vermifiltration COD of the control and treated was found to be 61 mg/L (reduction 5.13%/L) and 45.9mg/L (reduction 30.51%), respectively (Table 1,).In untreated water samples the COD was 56.9 mg/L (reduction 11.5%/L) and in treated about 35.7 mg/L (reduction up to 44.4%) by 30th day (Fig.5). Significant reduction in the COD was observed with respect to treatment and retention time on vermifilter and non vermifilters at 0.001 level of significance.

Nitrate

Nitrate content of the wastewater was 126.9 mg/L at the beginning (i.e. on 0 day). By 15thday nitrate content of untreated water sample's was 113.8 mg/L (reduction up to 10.3%) and treated sample was found to be 87 mg/L (reduction 31.4%) (Table 1).Untreated water sample's nitrate content by 30thday was 95.8 mg/L (reduction 24.5%) and treated up to 67 mg/L (reduction 47.2%) (Table 1 and Fig.6). Two way ANOVA showed significant removal of nitrate content of the wastewater with respect to treatment as well as duration.

Fluoride

Initial Fluoride content of the wastewater sample was 0.98 mg/L (0 day). It was gradually decreased up to 0.95 mg/L in 15th day in untreated water sample (reduction was 3.04%) and in treated sample it was 0.88 mg/L (reduction 10.2%) (Table 1). By 30thdayFluoride content of the wastewater was to be 0.88 mg/L and 0.59 mg/L in the non verfiltered and vermifiltered water samples, respectively (Table1 and Fig.7).The percentage reduction of Fluoride content in non vermifilter and vermifilter by 30 days was 10.2% and 39.7%, respectively (Table 1). Significant reduction of Fluoride content occurred with respect to treatment and duration of retention on the bed was observed in the present study.

Chloride

The chloride content of the wastewater sample was 61 mg/L and by 15th day, in untreated it was 59.1 mg/L (reduction about 3.1%/L) and treated was decreased up to 22.6%/ (47.2 mg/L) (Table1). By 30thday untreated water sample's chloride content was 48.3 mg/L and that of treated water sample was found to be 7.4 mg/L (Table 1 and Fig.8).By 30th day removal percentage of chloride in non vermifilter and vermifilter was found to be 20.8 and 55.1, respectively (Table 1). Two way ANOVA showed significant removal of chloride with respect to treatment and duration of retention on the beds at 0.001level of significance.

DISCUSSION

The present study was carried out to find out the effect of vermifiltration on various physicochemical parameters of wastewater collected from drainage canals of Burla town. Significant decrease in the organic load of wastewater was marked when it passed through the vermifilter bed.

pH

pH is the measure of acidity or alkalinity in a solution. Aquatic organisms require a narrow pH range for their optimal metabolic function. So it is important for the pH to be maintained within a certain range. The pH value of the wastewater sample decreased and was nearer to the neutral value when the wastewater was vermifiltered. Sinha *et al.* (2008) found that raw sewage was neutralized by the earthworms in vermifilter bed. The pH of wastewater treated in the beds without earthworms also improved but it was not consistent. The pH is brought to neural value in case of distillery waste collected from Trichy Distilleries, Senthaneerpuram, Tiruchirappalli district as reported by N. Natrajan and Kannadasan (2015). Xing *et al*. (2010) also found neutralization of domestic wastewater in wastewater treatment plant in Shanghai city China when it was passed through vermifilter bed. Das *et al*. (2015) also reported similar results. Azuar *et al*. (2015) found improvement in pH in palm oil industry effluents. The pH value improvement towards a neutral value is attributed to earthworm mediated rapid mineralization of organic matter in the wastewater (Rajpal *et al*., 2012). The improvement of pH of wastewater also indicates the inherent capability of the earthworms to act as buffering agent and neutralize pH (Azuar *et al*., 2015; Arora *et al*., 2014). The achievement of neutral pH of the vermifiltered wastewater also indicates lowering of organic load of the wastewater (Manyuchi and Phiri, 2014).

Electrical Conductivity

Conductivity is the measure of ability of a substance to transmit charge. Conductivity of water depends on the concentration of ions, its nutrient status and the variation in the dissolved solid content. The conductivity of the vermifiltered wastewater was significantly reduced by almost 37% after 30 days in the present study. Similar results were also found by Natrajan and Kannadasan (2015). Manyuchi and Phiri (2014) found that the EC in wastewater contaminated with diesel engine oil showed a 19.5% decrease gradually upon vermifiltration. Decrease in the wastewater EC was also indicates decreased organic pollutants hence successful vermiremediation. The decrease in EC during the process might have been due to the loss of weight of organic matter and release of different mineral salts in available forms (such as phosphate, ammonium and potassium) as reported by other researchers (Wong *et al*., 1997).

Total suspended solids

Suspended pollutants are found in surface waters of open bodies. Total suspended solids (TSS) are one of the water quality parameter to assess wastewater quality. In the U.S. Clean Water Act TSS is listed as a conventional pollutant (APHA, 2005). In the present study there was 40% reduction (significant at 0.001 level) in the vermifitered water by 30th day whereas only 23.5% reduction in the control (without earthworm beds). Kharwadea and Khedikar (2011) found 70-80% reduction in concentration of suspended solid in vermifiltered waterwhile in non-vermifilter it was found to be 60 to 70% at 2-3hr of detention time. Das *et al*. (2015) study results showed that the microbes and earthworms can significantly remove the suspended solids from the wastewater by over 95%. Xing *et al*. (2010) found good performance of vermifilter and removal rate for TSS ranged from 57.18 – 77.90%. Bhise and Anaokar (2015) also reported removal efficiency of TSS by 35.47% in the presence of earthworms. Sinha *et al*. (2008) also reported reduction in total suspended solids (TSS) by 90-95% from wastewater by general mechanism of ingestion and biodegradation of organic wastes, heavy metals and solids from wastewater and also by their adsorption through body walls.

Biologocal Oxygen Demand (BOD)

BOD measures the amount of oxygen needed by microbes to break down the organic matter in the water body. High BOD values indicated high levels of organic contaminants in the water body (Das *et al*., 2015). Vermifiltration of wastewater led to significant decrease in the BOD_5 in the present study. Sinha *et al*. (2008) reported that body of the earthworms works as a biofilter and they are found to remove the 5 days BOD (BOD_5) by over 90%. Thulimalini and Kurian (2009) found that BOD in the contaminated water decreased upon addition of vermicompost by 16.9%.The BOD and EC also indicated a linear decrease upon addition of vermicompost. Xing *et al*. (2010) study results showed that good performance of vermifilter was achieved where BOD_5reduced by (54.78 – 66.36%) in the wastewater. A.M. Kharwadea and I.P. Khedikar (2011) reported percentage of reduction in concentration of BOD in vermifilter ranging from 85 to 93 % while in non-vermifilter it was found to be 72 to 80 % at 2-3hr of detention time. The earthworm degrades the wastewater organic by 'enzymatic action' (which work as biological bringing the pace and rapidity in biochemical reaction) and that is the reason for BOD removal in vermifilter.

Chemical Oxygen Demand (COD)

COD is another measure of organic and inorganic material contamination in water and higher concentration of COD indicates that the water is highly polluted with both oxidizable organic and inorganic pollutants (Qtukune and Biukwu, 2005).

Present study elucidated 44.5% and 11.5% reduction in the COD in vermifiltered and non vermifiltered wastewater, respectively (significant at 0.001 level). Sinha *et al*. (2008) reported decrease in the COD by 80-90% when the wastewater was passed through vermifilter bed. Anusha and Sunder (2015) found reduction in COD of domestic wastewater sample by 74-80% collected from HKR Circle, Nituvalli Davangere in Karnataka on passage through vermifilter bed. Xing *et al*. (2010) study results showed removal rates of COD by 47.3 – 64.7% on Vermifiltration. Bhise and Anaokar (2015) also found removal efficiency of COD by 25.86%in the presence of earthworms. Ghatnekar *et al*. (2010) reported that COD of wastewater is reduced from 12000-14000 ± 11.45 ppm to less than 200-185 ± 12.66 ppm when wastewater was passed through bed containing earthworms. Kharwadea and Khedikar (2011) reported that percentage of reduction in concentration of COD in vermifilter ranges from 74 to 80%. COD reduction was greatly affected by detention time, higher the detention time lower will be COD. Earthworms secrete the enzyme that helps in the degradation of several other chemical which cannot be decomposed by microbes while in non-vermifilter, it was found to be 52 to 60 % .This may due to increase the formation of bio-films of decomposer microbes in geological system (gravels). Studies have shown the gut of endogenic earthworms like *Eisenia fetida* having microbes with cellulolytic activity. The cellulases helps to degrade the cellulose present in the ayurvedic effluents thereby reducing the BOD and COD (Fujii *et al*., 2012).

Nitrate

Nitrate in surface water is an important factor for water quality assessment and is contributed to freshwater through discharge of sewage and industrial wastes and run off from agricultural fields. It favours algal blooms and ultimately causes eutrophication. In the present study it was tried to see the reduction of nitrate from the wastewater through the vermifiltration process. Reduction of nitrate by 47.2% and 24.5% was observed in the vermifilter bed and control i.e. non vermifilter beds, respectively by 30 days. The reduction in the nitrate content between the treated and control was significant at 0.001 level. Sinha *et al*. (2008) found that the experimental vermi-filtration processes showed a perfect efficacy on sewage treatment, with high removal rates of COD, BOD and TSS, as well as some ability to remove N and P. M. Xing *et al*. (2010) found removal rates of total nitrogen (TN) and ammonia (NH_4-N) were 7.63 – 14.90% and 21.01 – 62.31%, respectively. This was because earthworm could improve activity of microorganism and stabilization of organic matter (P. Pramanik *et al*., 2009). They also observed abundance and enzymatic activities of earthworm had significant correlation with treatment efficiency of vermifilter. They supposed that the treatment efficiency was not influenced only by earthworm abundance, but also by earthworm growth state.

Fluoride

Fluoride concentration has got an important implication in human health. Its concentration should 0.8 to 1mg/L in the water or else it serious dental problems. It has to be reduced when it beyond the tolerable limits. In our present study reduction in the fluoride content was achieved through vermifiltration process. The fluoride content of the wastewater significantly (at 0.001 level) decreased by 39.7% in vermifiltered water whereas only by 10.2% in non-vermifiltered water. The role of different types of enzymes, microorganisms, and earthworms for effluent treatments has been studied. Kavian and Ghatnekar (1999) carried out extensive studies on celluloses from *L. rubellus*. Their studies confirmed that enzymes can act on specific recalcitrant pollutants to remove them by precipitation or transformation to other products .They can also change the characteristics of a given effluent to render it more amenable to treatment or aid in converting effluent material to value added products. Kavian and Ghatnekar (1999) also carried studies on the bio management of dairy effluents using an *L. rubellus* culture and concluded that sludge cake could support the growth of earthworms without processing. They also studied about the bio management of paper mill sludge using vermiculture biotechnology. *L .rubellus* was used to treat approximately 1.5 tones of the sludge coming out of the mill daily. The sludge was successfully converted into biofertilizer and plant tonics. M.F. Kavien and S.D. Ghatnekar (1999) demonstrated the utility of fungal species via *A. flavus* and *A. niger* in the treatment of pharmaceutical waste.

Chloride

Chloride concentration shows the presence of pollution due to sewage. Higher amount of chloride reacts with sodium making the water salty and also increases TDS values of water (Mallik, 2012). In our present study it was observed that there was 55.1% reduction in the chloride content in wastewater when processed by vermifiltration. Anusha and Sundar (2015) also studied application of vermifiltration in domestic wastewater treatment. They observed that initial chloride was found to 195 mg/L, it was reduced to 69%, 74% and 77% for 2hr, 4hr and 6hr respectively, when vermifiltered. The total suspended solids and the pollution load of the wastewater is passed through the earthworm gut and expelled as worm cast. Therefore there is reduction of these nutrients in the water passing through the vermifilter and increase of nutrients in the vermicasts (Sinha *et al*., 2008; Ghatnekar *et al*., 2010).

Conclusion

In the present study an attempt has been made to assess the efficacy of vermifiltration of the wastewater collected from the drainage canal of Burla town, Sambalpur. The analysis was carried out by considering certain physico-chemical parameters like pH, electrical conductivity, TSS, BOD, COD, nitrate, fluoride, chloride which is considered indicators of the pollution loads in the wastewater. The study revealed that there was significant reduction of the various physico-chemical parameters on vermifiltration. There was significant reduction with respect to the duration of retention of the wastewater in the vermibed. Vermifiltration technology is an extension of soil filtration where the microbial degradation activity is facilitated by the presence of the earthworms. Thus vermifiltration technology (VFT) can be utilized as a cost effective odour free process for the processing of the wastewater. Although removal of BOD, COD etc. is achieved by microbial geological system in absence of earthworms in the present study in the control the system is less effective. VFT utilizing the earthworms is found to be better than other bioconversion, biotreatment and biodegradation technologies as (i) it utilizes the waste organic materials that otherwise cannot be utilized by other technologies, (ii) achieve greater utilization than other technologies and (iii) this technology does this biotreatment by enzymatic action (G. Frasher-Quick, 2000), (iv) the byproduct of such technique can be easily used in agriculture and environmental decontamination, (v) Vermifiltration of the effluent at optimum conditions showed maximum reduction in various physic-chemical parameters and treated effluent well suited the irrigational water quality criteria, (vi) this technology does not add any additional harmful chemical substances into the environment and (vii) they are moderately easy to supervise and they can be adopted without difficulty to the local needs.

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