International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 01 | Jan -2017 www.irjet.net p-ISSN: 2395-0072

# Phytoremediation of domestic sewage by *Hibiscus Rosa and Catharanthus Roseus plants*

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**Abstract -** *Due to rapid urbanization, mining activities, industrialization, etc. the water resources both surface and subsurface are getting polluted which is difficult to treat, recycle and the treatment requires high cost. The present study deals with the Phytoremediation for the domestic sewage treatment by Hibiscus Rosa and Catharanthus Roseus plant species. The volume of 0.027 $m^3$ two plastic crates were used to plant the Hibiscus Rosa and Catharanthus Roseus in each separate crate. The vertical subsurface flow has been adopted in this study with two beds of aggregates and red soil. The bed consist bottom layer of coarse aggregate with 12 mm size and 6 cm depth, middle layer of fine aggregate with 2.36 mm size and 6 cm depth, Top layer was filled with red soil of size 0.6 mm and 6 cm depth. The sewage sample collection was done on alternatives days of every week for 5 weeks. 10 liters per day of domestic sewage was fed to each plant species by maintaining the Hydraulic Retention time of 5 hours. Then the physico-chemical characteristics of domestic sewage such as Turbidity, pH, TSS, BOD, COD, Nitrates and Sulphates were done before treatment and after the treatment and compared with the CPCB standards. Results showed that comparing with the Hibiscus Rosa plant; Catharanthus Roseus plant reduced the pollutants with better efficiency.*

***Key Words***: *Domestic waste water, Water quality parameters, Phytoremediation, Hibiscus Rosa, Catharanthus Roseus, Hydraulic retention time.*

## 1. INTRODUCTION

Earth surface consists of 71% of water and these are distributed as 97.2% sea &ocean water, 2.15% glaciers and other ice, 0.61% of ground water, 0.009% fresh water lakes, 0.008% inland seas, 0.005% soil moisture, 0.001% atmosphere and 0.0001% river. Surface water is available as oceans, rivers and streams, lakes and reservoirs. Surface water is mainly used for public supply and irrigation. Due to mining, livestock industries, urbanization and household activities the domestic water is getting polluted. Domestic sewage consists of large amount of dissolved and suspended pollutants, organic and inorganic matter. The organic matter mainly generates from food and vegetables wastes which also includes disease causing microbes. For cleaning of houses various substances are used which includes harmful chemicals. Once the domestic sewage enters the receiving water bodies such as lakes, rivers or streams, the microorganisms start to decompose the organic wastes and the dissolved oxygen level in the sewage will get reduced due to metabolic activities [1].

Therefore, nowadays receiving water bodies are getting polluted due to direct discharge of sewage and by the various microbial activities in the contaminated sewage causes the eutrophication, and it also carries pathogens which will affect on swimming areas, agricultural land and irrigation. Various pathogens and harmful chemicals kill the aquatic life and algal blooms will form, which can suffocate for the fisheries. Hence to remove the pollutants such as BOD, COD, pH, Turbidity, TSS, Sulphates and Nitrates the Phytoremediation method is very much essential, this is less expensive and eco-friendly [1].

Phytoremediation is the process to remove or to break down the pollutants by using plants and trees. Phytoremediation is the use of plants to partially remediate selected contaminants in domestic sewage. For the remediation it utilizes the various plant biological processes and the physical characteristics of plant. Phytoremediation is also called as vegetative remediation or green remediation and it varies with the different conditions, media, contaminants, and plants [1].

## 2. EXPERIMENTAL WORK.

### 2.1Experimental set up

**Figure -1**: Experimental set up

### 2.2 Materials used

Materials used for the experimental set up were:

1. Plastic crates of size 0.5 m×0.3 m×0.25 m were used for planting 2 types of plants.
2. The 20 liters capacity plastic buckets were used for fill the domestic sewage.
3. PVC perforated pipes of diameter 15 mm and 20 mm have been used for the distribution of wastewater and collection of treated wastewater respectively.
4. ½ inch plastic taps have been used for the purpose of distribution, collection of untreated and treated wastewater and Beakers.

### 2.3 Materials used for the bed construction

Bed construction constitutes 2 layers of aggregates and red soil in the plastic crates such as:

1. Bottom layer is filled with coarse aggregate of size 12 mm with volume of 9 kg, 6 cm depth.
2. Middle layer is filled with fine aggregate of size 2.36 mm with volume of 9 kg, 6 cm depth.
3. Top layer is filled with red soil of size 0.6 mm with volume of 9 kg, 6 cm depth and free board of 7cm is provided for each crate.

## 3. METHODOLOGY

Firstly the aggregates and red soil are filled in the crates and the bed settling was allowed for 7 days with tap water. 60 days old plants of *Hibiscus Rosa* & *Catharanthus Roseus* were planted in the each separate crate & fresh water was fed to the plants for 5 days. Each crate has 4 plants.

Domestic sewage was collected of about 20-25 liters using composite sampling from Shivaji garden, Belagavi. The 10 liters of wastewater was poured in each bucket and the wastewater was made to pass with 15mm diameter PVC perforated pipes with 2mm holes spaced at 5cm. The 10 liters per day of sewage was made to flow slowly by maintaining a velocity of 0.1 meter/second for Hydraulic retention time of 5 hours. The 20mm PVC pipe of 0.45 m length with 3 mm spaced at 5cm is provided at the bottom of crate with 1% of slope to collect the percolated wastewater. The treated wastewater was analyzed and compared the result values with the CPCB standards.

## 4. RESULTS AND DISCUSSION

The experimental result includes the wastewater quality parameters before and after the treatment. The parameters were such as turbidity, pH, TSS, BOD, COD, sulphates, nitrates. Weekly three trials had been done on alternate days and experiment was carried out for 5 weeks. The average of three trials is considered as one week result. The pollutants removal efficiency from wastewater treated with plants were compared with pollutants removal efficiency wastewater without plants i.e., bed efficiency. 15 trials were done till 5 weeks which includes results of both untreated and treated values.

### 4.1 Turbidity reduction in NTU

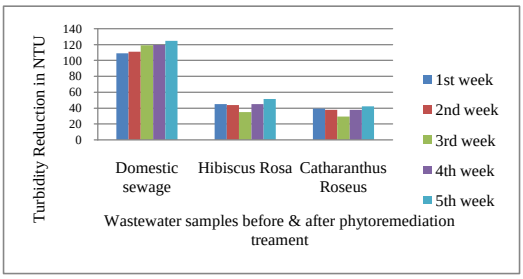


**Fig -2:** Turbidity reduction

**Fig.2.** illustrates that the treatment for domestic sewage by *Hibiscus Rosa* and *Catharanthus Roseus* was corresponding to X-axis. *R*eduction in turbidity concentration values in NTU before and after the treatment was corresponding to Y-axis. The turbidity of wastewater before treatment was in the range of 110-125 NTU. With the *Hibiscus Rosa* plant the reduction of turbidity was up to 30-50 NTU and with *Catharanthus Roseus* was up to 25-43 NTU. Hence the *Catharanthus Roseus* plant was showing better efficiency to remove turbidity than *Hibiscus Rosa* plant.

## 4.2 pH variation

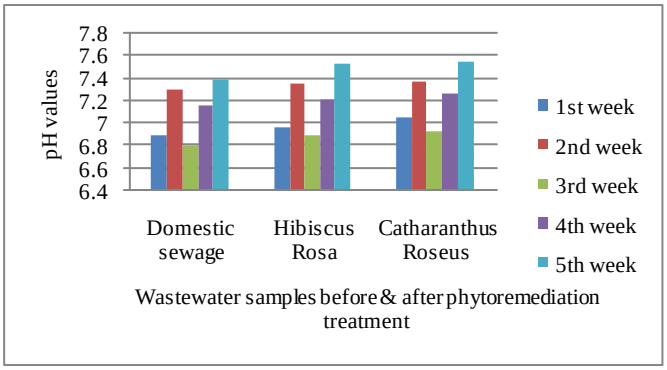


**Fig-3:** pH variation

**Fig.3.** illustrates that the treatment for domestic sewage by *Hibiscus Rosa* and *Catharanthus Roseus* was corresponding X-axis. Variation in the pH for the domestic sewage before treatment and after treatment with the plants *Hibiscus Rosa* and *Catharanthus Roseus* corresponding Y- axis. It shows that pH variation, which were within the limit of CPCB standards i.e., pH must be 5.5-9.0.

## 4.3 TSS reduction in mg/L

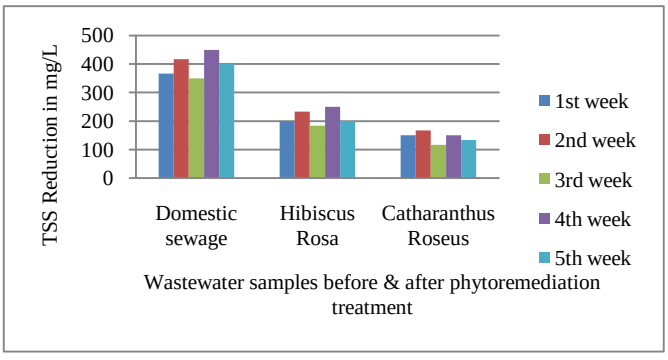


**Fig-4:** TSS reduction

**Fig.4.** illustrates that the treatment for domestic sewage by *Hibiscus Rosa* and *Catharanthus Roseus* was corresponding to X-axis. *R*eduction in TSS concentration values in mg/L before and after the treatment was corresponding to Y-axis. As per CPCB standards the TSS must be less than 200 mg/L. Figure 4.29 shows that TSS before treatment was 350-450 mg/L and after the treatment Catharanthus Roseus plant showing better results with reduction of TSS up to 125-160 mg/L which was lies within the CPCB standards.

## 4.4 BOD reduction in mg/L

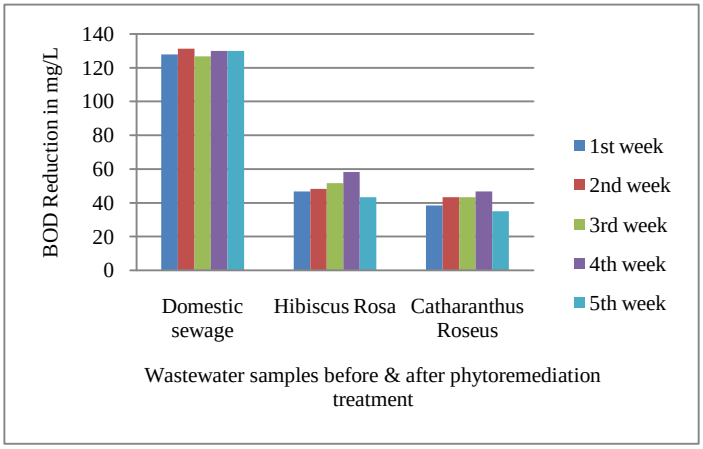


**Fig-5:** BOD reduction

**Fig.5.** illustrates that the treatment for domestic sewage by *Hibiscus Rosa* and *Catharanthus Roseus* was corresponding to X-axis. *R*eduction in BOD concentration values in mg/L before and after the treatment was corresponding to Y-axis. As per CPCB standards the BOD must be less than 100 mg/L for land irrigation discharge. The BOD value of domestic wastewater was found to be between 120-135 mg/L before the treatment. BOD reduction of *Hibiscus Rosa* plant was found that 44-58 mg/L and of *Catharanthus Roseus* plant was 35-45 mg/L. Hence the BOD results were well within the CPCB standards after the treatment and therefore the domestic wastewater can be discharged for land irrigation.

### 4.5 COD reduction in mg/L

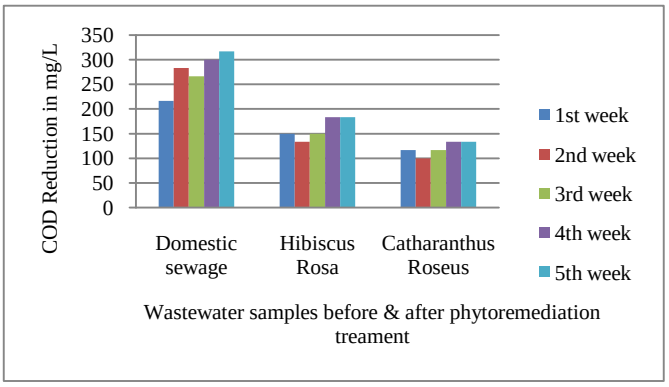


**Fig-6:** COD reduction

**Fig.6.** illustrates that the treatment for domestic sewage by *Hibiscus Rosa* and *Catharanthus Roseus* was corresponding to X-axis. *R*eduction in COD concentration values in mg/L before and after the treatment was corresponding to Y-axis. As per CPCB standards the COD must be less than 250 mg/L for discharge. The COD value found before treatment of wastewater was in the range of 220-350 mg/L and after the treatment it was in the range of 180 mg/L for *Hibiscus Rosa* and *Catharanthus Roseus* plant reduced the COD up to 100 mg/L respectively. Hence the COD results were well within the CPCB standards therefore the wastewater was suitable to discharge for land irrigation.

### 4.6 NITRATES reduction in mg/L

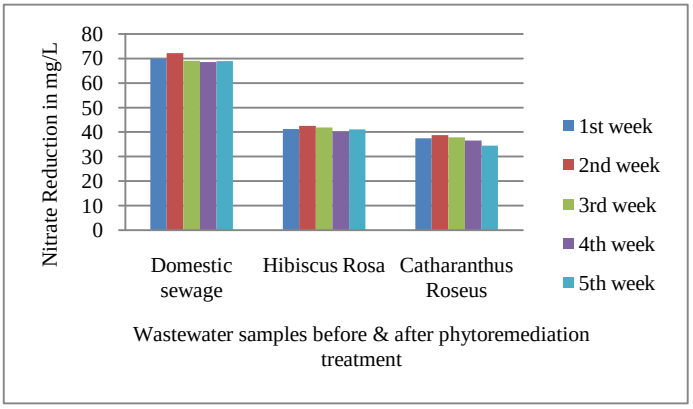


**Fig-7:** Nitrates reduction

**Fig.7.** illustrates that the treatment for domestic sewage by *Hibiscus Rosa* and *Catharanthus Roseus* was corresponding to X-axis. *R*eduction in nitrate concentration values in mg/L before and after the treatment was corresponding to Y-axis. Nitrate in wastewater cannot be recognized easily because it is colorless, odorless and tasteless parameter. Nitrate ion is a stable and highly soluble therefore it is very difficult to remove from the wastewater. Presence of high concentration of nitrates will form the algal bloom in the receiving water bodies. Before wastewater treatment nitrates concentration in wastewater was 65-70 mg/L. *Hibiscus Rosa* plant reduced nitrates up to 40-45 mg/L and *Catharanthus Roseus* plant reduced up to 30-35 mg/L.

### 4.7 SULPHATES reduction in mg/L

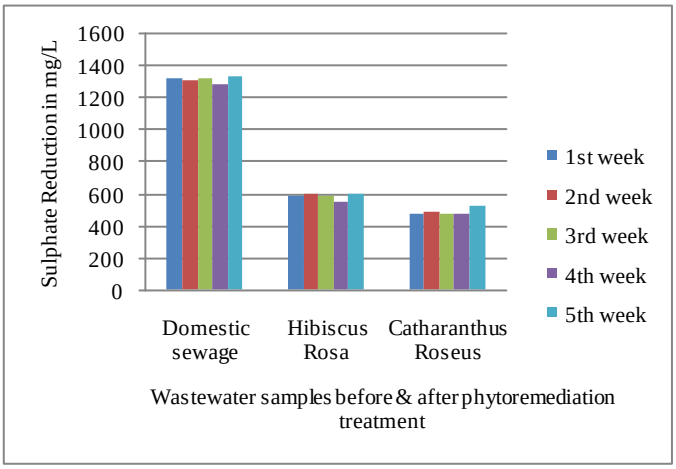


**Fig-8:** Sulphates reduction

**Fig.8.** illustrates that the treatment for domestic sewage by *Hibiscus Rosa* and *Catharanthus Roseus* was corresponding to X-axis. *R*eduction in sulphate concentration values in mg/L before and after the treatment was corresponding to Y-axis. Sulphates before treatment it was 1300 mg/L and after treatment with both plants it was 580-600 mg/L for *Hibiscus Rosa* and 450-500 mg/L for *Catharanthus Roseus* plants respectively.

### 5. CONCLUSIONS

The study included the Phytoremediation of domestic wastewater using *Hibiscus Rosa* and *Catharanthus Roseus* plants.

1. The cost of treatment for domestic sewage is high, there is a need for cost effective treatment. Phytoremediation is well suitable for treatment of domestic sewage which reduces the cost and this method is eco-friendly.

2. Before treatment from analysis the domestic sewage results shows that some parameters were above the permissible limit such as Turbidity-125 NTU, pH-5.91, TSS-320 mg/L, BOD-110 mg/L, COD-250 mg/L, Nitrates-70.68 mg/L, Sulphates-1328.5 mg/L for land discharge for irrigation. Hence there is a need of treatment for domestic sewage before discharge.
3. *Hibiscus Rosa* reduced the turbidity up to 62% and *Catharanthus Roseus* reduced 67.8% of turbidity.
4. The pH variation of domestic sewage was found between 5.9 to 8. Hence the pH values were within the limit.
5. The efficiency of TSS removal found for *Hibiscus Rosa* was 46% and for *Catharanthus Roseus* was found to be 64% respectively.
6. The $BOD_3$ reduction of *Hibiscus Rosa* and *Catharanthus Roseus* were found as 61% and 68% respectively.
7. *Hibiscus Rosa* reduced sulphates up to 56% and *Catharanthus Roseus* reduced 63%.
8. The removal efficiency of nitrates from domestic sewage by *Hibiscus Rosa* was found 40.7% and by *Catharanthus Roseus* 47% respectively. Algae growth can be reduced by the removal of nitrates from plants.
9. The removal efficiency of pollutants by *Catharanthus Roseus* plant showed better results than the *Hibiscus Rosa* plant. Hence for the treatment of domestic sewage by Phytoremediation method *Catharanthus Roseus* plant is more suitable.

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