

# **Treatment Efficiency of Wastewater by Horizontal Flow Constructed Wetland Using Canna Species– A Case Study**

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**ABSTRACT:** A case study is carried out to know the treatment efficiency of wastewater sample collected. The wastewater is collected in integrated sampling method at the upstream of Vrishabhavathi River at the upside of the kumbalgodu region. Vrishabhavathi River receives wastewater from residential, commercial and industries located at south Bangalore.

In this study two filter media of horizontal flow was constructed of sizes 10 ft X 5ft X 2.5 ft using coarse aggregate of sizes 10 mm to 40mm. Treatment efficiency was carried out between two filter media out of which canna species plants were grown in one filter media. The test results showed that treatment efficiency can be achieved more than 50% comparing to filter media without vegetation and more than 90% comparing to mechanical conventional treatment systems. Especially it gives better treatment performance for chemical and biological parameters in lesser time. Natural treatment methods are more advantageous than conventional treatment methods as they consume more power, more economy and also more maintenance with labour for operational requirements.

**KEYWORDS:** Wetland, wastewater, Filter media.

## **I. INTRODUCTION**

Nowadays fresh water is a limited natural resource. It is very much necessary to conserve water. While earth is covered by 97% of water in the form of salt water, that can only be consumed after desalination, which is highly expensive process. India is likely to be scarcity of water by 2050. Therefore it is very much important to reuse the used water by treating it by adopting various process. Wastewater is the mixture of water and waste products which arise from domestic and industrial sources. From the past several years we have practised conventional treatment system the treatment of wastewater. This requires trained manpower for operation and maintenance which is little costly, to overcome this and to improve the vegetation wetland is becoming more popular and effective nowadays around the world because of its low cost, low maintenance and suitable alternative to conventional treatment process for treating wastewater. "Constructed wetlands are engineered system, designed and constructed to utilize the natural functions of wetland vegetation, soils and their microbial population to treat contaminants in surface water, ground water are waste streams [10]. Constructed wetlands treat the sewage water using highly effective and ecologically sound, design principles that use plants, microbes, sunlight and gravity to transform wastewater into garden and reusable water. Constructed wetlands are an effective environmentally friendly means of treating liquid and solids wastes. CWs are effective at reducing loads of BOD/COD, Nitrogen, phosphorous and suspended solids by up to 98%. They rely on natural wetland functions which includes plants and microorganism which uptake and breakdown the nutrients either

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aerobically or anaerobically. There are many different types of CWs designed for a variety wastewater types. We are dealing only with subsurface flow constructed wetlands with vegetation and without vegetation.

## II. RELATED WORK

Shruthi Dyamanagowdru et.al (April 2015) conducted a study on the treatment of domestic sewage using two species Vetiver and *Canna siamensis*. They have proved to give better efficiency than conventional treatment. In this study experiments were conducted to remove pH, turbidity, total dissolved solids, suspended solids, BOD, COD, nitrates and phosphate from domestic sewage at 2 days, 4 days, 6 days retention time. Plant vetiver met good treatment efficiency than plant *Canna siamensis*. In addition to that it is economical and also environmental friendly technique. It is suitable to small scale municipal wastewaters, institutional sewage and also for industrial effluent.

Sivakumar et.al (2013) conducted a study on the treatment of textile industry using aquatic macrophytes in constructed wetland system. In this study, experiments were conducted to remove pH, EC, chlorides, BOD, COD, sulphates, phenols from the textile industry wastewater in constructed wetland using *Eichhornia crassipes* at 6 days retention time. From the experiments it was found that the removal percentage of various parameter like EC, TDS, chlorides, sulphates, phenols, BOD, COD, is about 87.2%, 90.2%, 82.6%, 86.8%, 78.5%, 91.3% and 92.8% respectively. At last this study showed that *Eichhornia crassipes* might be used as absorbent for removing various parameters in a textiles industry discharge.

## III. MATERIALS AND METHODOLOGY

Wastewater is the mixture of water and waste products which arises from domestic and industrial sources. Vrishabhavathi River receives wastewater from residential, commercial and industries located at south Bangalore. The wastewater is collected in integrated sampling method at the upstream of Vrishabhavathi River at the upside of the kumbalgodu region. The sampling point is showed in figure 1.

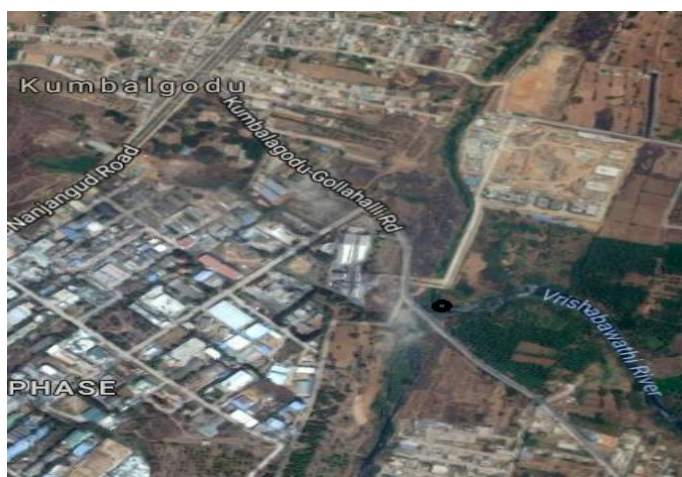


Figure 1: Sampling Point

If this wastewater is allowed to utilize it may cause health hazardous in the community. Therefore practicing wetlands are more effective and environmentally friendly for treating wastewater. This paper presents the efficiency of treating wastewater using *Canna* species over natural purification. For study purpose two filter media of horizontal flow was constructed of sizes 10 ft X 5ft X 2.5 ft using coarse aggregate of sizes 10 mm to 40mm using top sizes gravel at the top. *Canna* species was grown in one filter media. Wetland has been constructed using filter media and *Canna* vegetation as shown in figure 2.

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**Figure 2: With and without vegetation**

Filter media: The media perform several functions as rooting materials for vegetation, help to evenly distribute the wastewater, provide surface area for microbial growth and surface flow. Very large particles have high conductivity, but have little wetted surface area for unit volume of microbial habitat.

Wastewater is allowed to flow into the wetland through a pipe in a controlled manner for media having vegetation and media without vegetation separately. Constant flow rate is maintained through its feeding. Once the tank is filled it is allowed to given retention time about 10, 20 and 30 days. Water is collected and analyzed for various parameters and methods as shown in Table 1.

**Table 1: Physico-chemical method for analysing sampling**

Parameters	Methods	Equipment used
pH	Electrometric	pH Meter
Colour	Electrometric	Spectrophotometer
Turbidity	Nephleometer	Turbidity Nephleometer
TSS	Electrometric	Spectrophotometer
TDS	Electrometric	Spectrophotometer
Total Hardness	Titrometric	Volumetric glassware
Chloride	Argentometric	Volumetric glassware
Nitrate	Electrometric	Spectrophotometer
Phosphorous	Calorimeter	Polymetric glass
Nitrogen	Jaldal digestion	Volumetric glassware
Fluoride	Ion selective electrode	Ion meter
BOD @ 5 Days	Dilution	Volumetric glassware
DO	Winkler method with Azide modification	Volumetric glassware
COD	Open Reflux	Volumetric glassware

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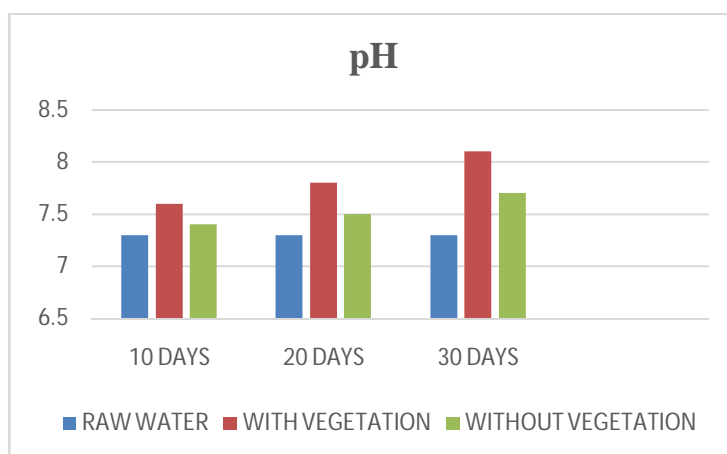
## IV. EXPERIMENTAL RESULTS

The treated effluent from the constructed wetlands was analyzed for 10, 20 and 30 days retention time and the experimental results are tabulated in table 2.

**Table 2: Results showing the treatment efficiency for 10 days retention period**

Operational Parameters	Raw Sewage	10 Days		20 Days		30 Days	
		With Vegetation	Without Vegetation	With Vegetation	Without Vegetation	With Vegetation	Without Vegetation
<b>Ph</b>	7.3	7.6	7.4	7.8	7.5	8.1	7.7
<b>Colour</b>	4	3	3	2	3	2	2
<b>Odour</b>	Objectionable	Objectionable	Objectionable	Slightly Objectionable	Slightly Objectionable	Acceptable	Slightly Objectionable
<b>Turbidity</b>	176	75	32	53	26	29	21
<b>TSS</b>	141	65	29	37	60	23	19
<b>TDS</b>	963	775	814	553	732	391	594
<b>Total Hardness</b>	363	264	310	248	298	256	312
<b>Chloride</b>	596	137	176	120	162	97	159
<b>Nitrate</b>	351	32	57	24	39	19	25
<b>Phosphorous</b>	54.1	41.7	49.2	29.3	44.6	21.6	43.7
<b>Nitrogen</b>	12.3	3.5	5.1	2.24	3.39	1.76	2.12
<b>Fluoride</b>	0.85	0.37	0.25	0.25	0.22	0.16	0.18
<b>BOD @5 Days</b>	315	48	56	12	19	Nil	Nil
<b>DO</b>	Nil	0.84	Nil	1.53	0.75	3.4	2.36
<b>COD</b>	1018	775	881	361	546	215	312

The above parameter concentrations are analysed in the graph plotted below from figure 3 to figure 15.



**Figure 3: Comparison of variations in pH**

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Higher increase in pH is observed in with vegetation. It showed increase in pH of 7.6, 7.8 and 8.1 for with vegetation and 7.4, 7.5 and 7.7 for without vegetation.

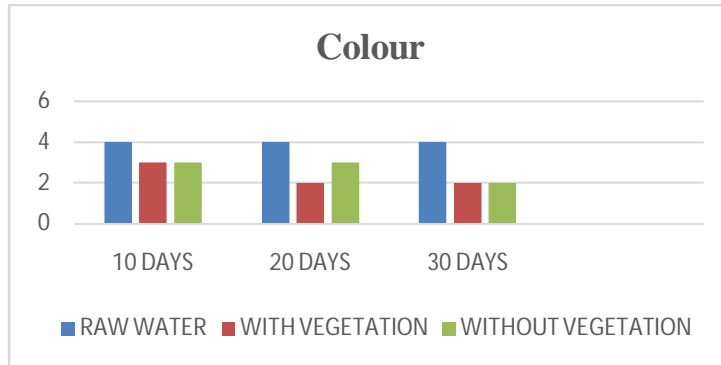


Figure 4: Comparison of variations in colour

The colour decreases from 3, 2 and 2 for with vegetation and 3, 3 and 2 for without vegetation.

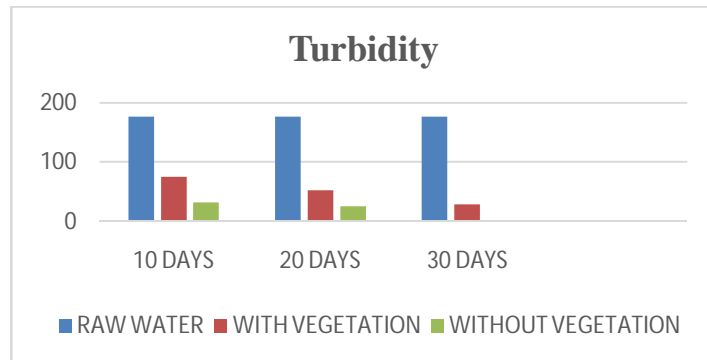


Figure 5: Comparison of variations in Turbidity

The rate of decrease of Turbidity with time varies as shown in the figure 5. Higher decrease in turbidity is observed in without vegetation. It showed decrease in turbidity of 75, 53 and 29 mg/L for with vegetation due to the present of soil particle in the root zone of vegetation and 32, 26 and 21 mg/L of concentration was found in without vegetation.

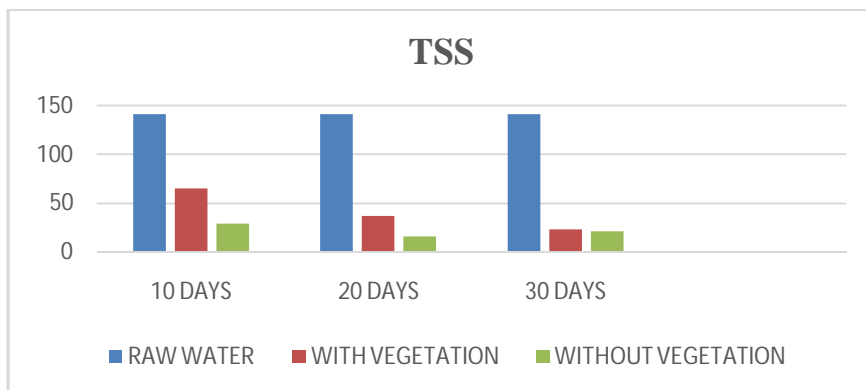


Figure 6: Comparison of variations in Total Suspended Solids

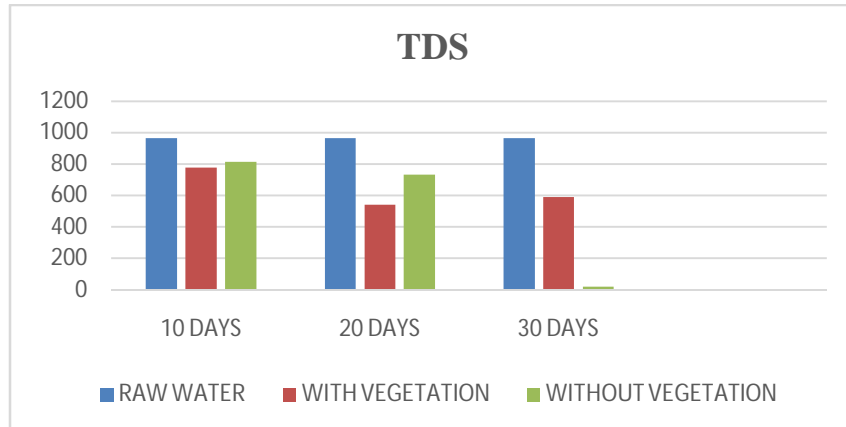
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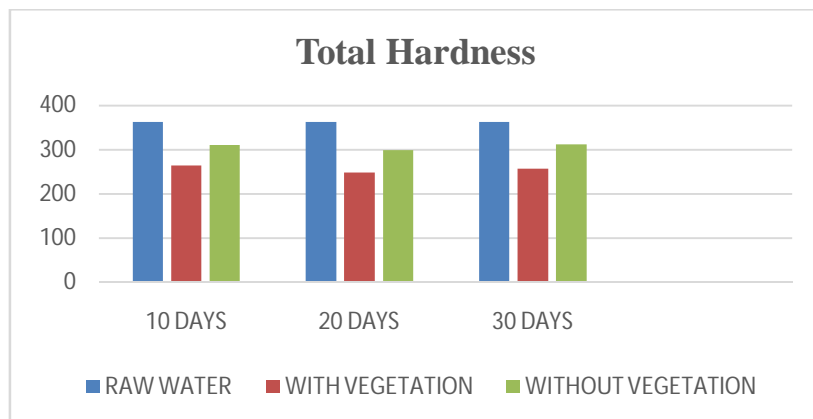
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The rate of decrease of TSS with time varies as shown in the figure 6. It showed decrease in TSS of 65, 37 and 23 mg/L for with vegetation and 29, 16 and 19 mg/L for without vegetation.



**Figure 7: Comparison of variations in Total Dissolved Solids**

The rate of decrease of TDS with time varies as shown in the figure 7. It showed decrease in TDS of 775, 543 and 391 mg/L for with vegetation and 814, 732 and 594 mg/L for without vegetation.



**Figure 7: Comparison of variations in Total Hardness**

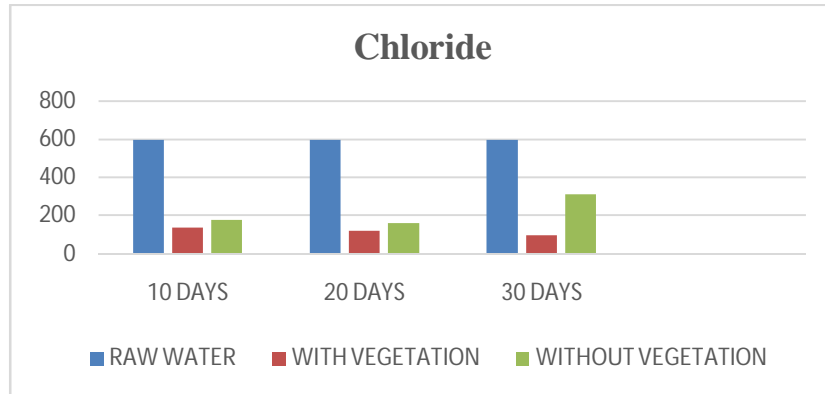
The rate of decrease of Total hardness with time varies as shown in the figure 7. It showed decrease in Total harness of 264, 248 and 256 mg/L for with vegetation and 310, 298 and 312 mg/L for without vegetation.

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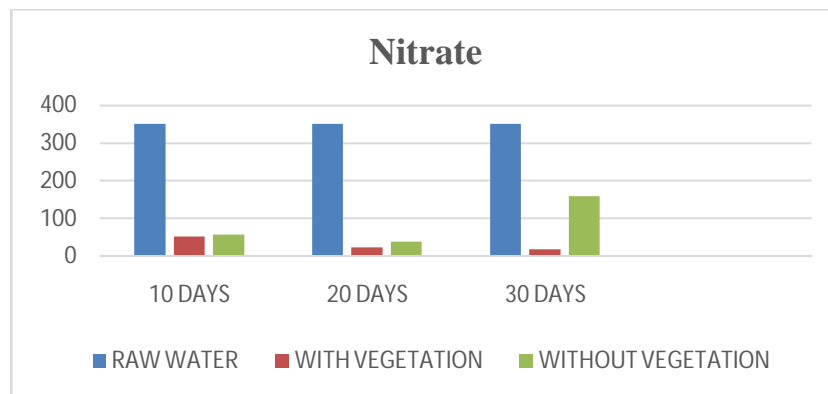
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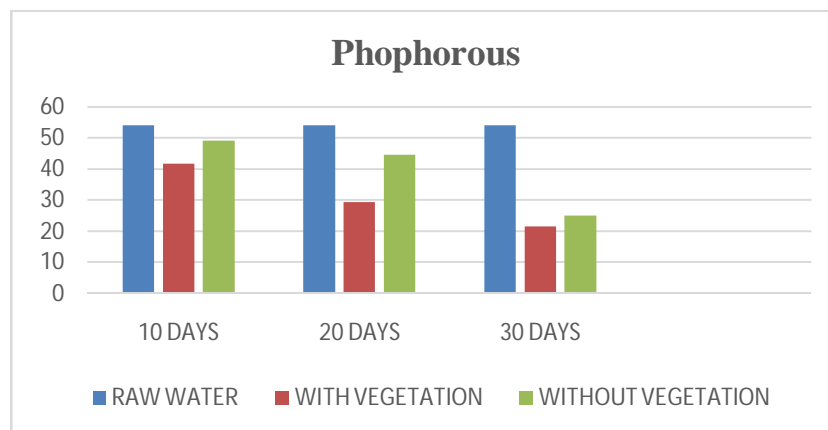
**Figure 8: Comparison of variations in Chloride**

The rate of decrease of chloride with time varies as shown in the figure 8. It showed decrease in chloride of 137, 120 and 97 mg/L for with vegetation and 176, 162 and 159 mg/L for without vegetation.



**Figure 9: Comparison of variations in Nitrate**

The rate of decrease of Nitrate with time varies as shown in the figure 9. It showed decrease in chloride of 32, 24 and 19mg/L for with and 57, 39 and 25 mg/L for without vegetation.



**Figure 10: Comparison of variations in Phosphorous**

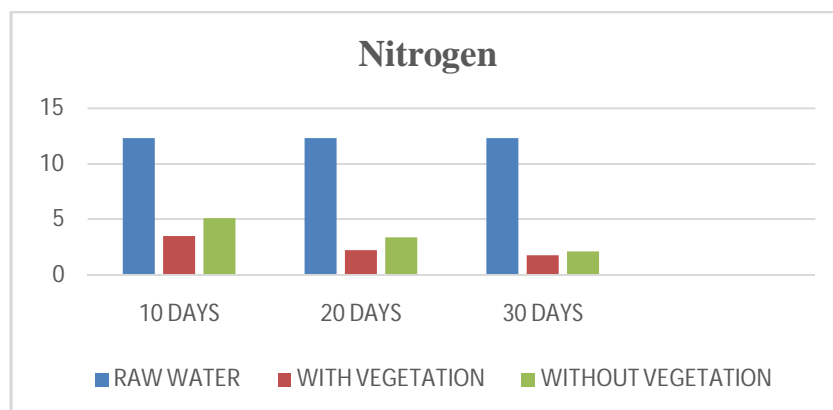
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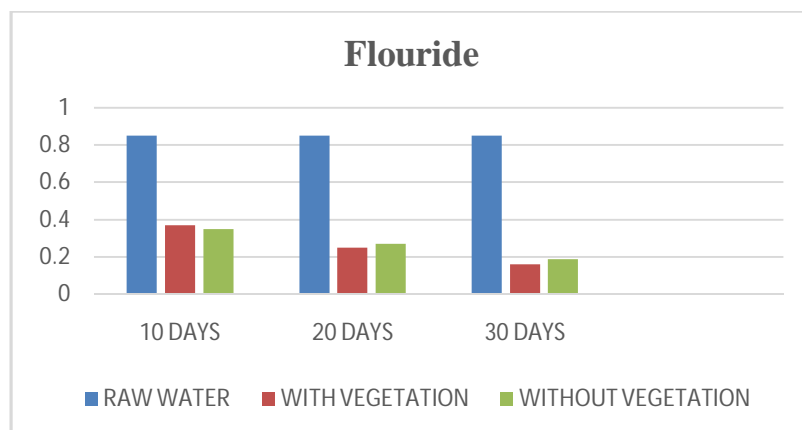
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The rate of decrease of Phosphorous with time varies as shown in the figure 10. It showed decrease in chloride of 41.7, 29.3 and 19mg/L for with and 57, 39 and 25 mg/L for without vegetation.



**Figure 11: Comparison of variations in Nitrogen**

The rate of decrease of Nitrogen with time varies as shown in the figure 11. It showed decrease in chloride of 3.5, 2.24 and 1.76mg/L for with vegetation and 5.1, 3.39 and 2.12 mg/L for without vegetation.



**Figure 12: Comparison of variations in Flouride**

The rate of decrease of Flouride with time varies as shown in the figure 12. It showed decrease in chloride of 0.37, 0.25 and 0.16mg/L for with vegetation and 0.25, 0.22 and 0.18 mg/L for without vegetation.



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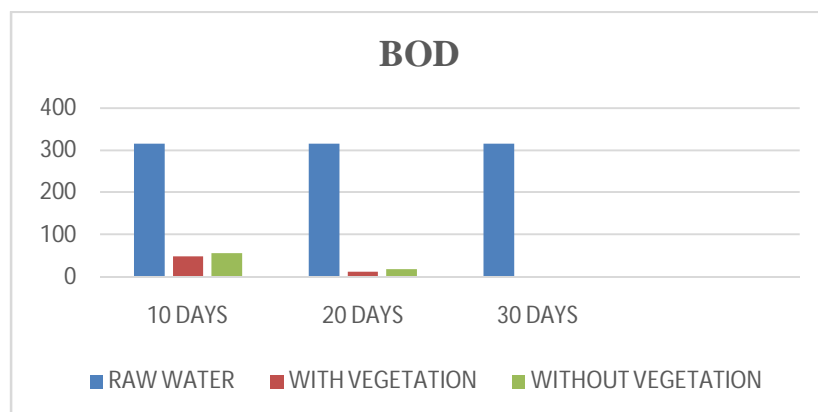


Figure 13: Comparison of variations in Fluoride

The rate of decrease of BOD with time varies as shown in the figure 13. It showed decrease in chloride of 48, 12 and 0mg/L for with vegetation and 56, 19 and 0 mg/L for without vegetation.

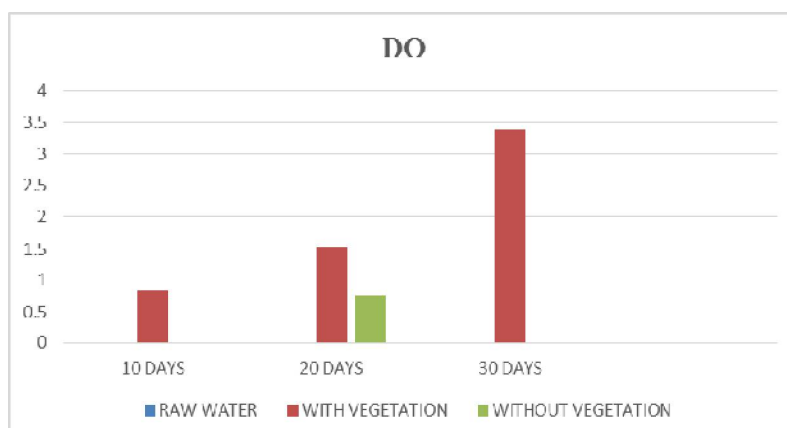


Figure 14: Comparison of variations in DO

The rate of increase of DO with time varies as shown in the figure 14. It showed decrease in chloride of 0.84, 0.25 and 0.16mg/L for with vegetation and 0.25, 0.22 and 0.18 mg/L for without vegetation.

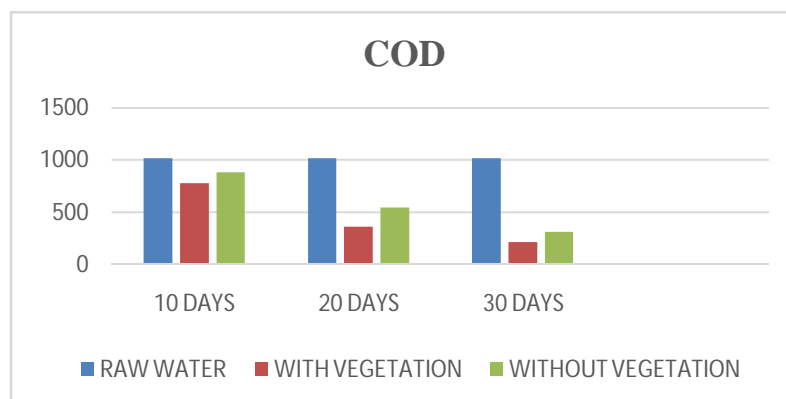


Figure 15: Comparison of variations in DO

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The rate of decrease of COD with time varies as shown in the figure 15. It showed decrease in chloride of 775, 361 and 215mg/L for with vegetation and 881, 546 and 312 mg/L for without vegetation.

## V. CONCLUSION

The test results showed that treatment efficiency can be achieved more than 50% comparing to filter media without vegetation and more than 90% comparing to mechanical conventional treatment systems. Especially it gives better treatment performance for chemical and biological parameters in lesser time. Natural treatment methods are more advantageous than conventional treatment methods as they consume more power, more economy and also more maintenance with labour for operational requirements. In addition to that transformation of pollutants from one system to other can be avoided in case of Wetlands. Canna Species is best suited to remove most of the parameters and get adapt to all types of changing environment and it can be used for all types of climates. It is well known for its beautiful flowers and by planting this species aesthetic consideration can also be achieved along with wastewater treatment. The result showed that the Phosphorous, Nitrogen, COD, Chloride, Nitrates can be removed efficiently by adopting this method. The result showed that the Turbidity and TSS are found to be slightly more due to small amount of soil particles present in the root zone of the grasses.

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