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SUSTAINABILITY OF CONSTRUCTED WETLANDS IN USING BIOCHAR FOR TREATING WASTEWATER

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ABSTRACT
Constructed wetland (CW) is a reliable, cost effective and sustainable technology for the treatment of different sorts of wastewater via different treatment processes including biological, chemical and physical processes. Coconut Shell (CS) as Biochar was obtained through decomposition of organic material without oxygen. It offers simple, cost effective strategies to treat wastewater and decrease carbon footprint. Consolidation of both (Constructed wetland and Biochar) technologies was adopted to increase the productivity in the treatment of domestic wastewater. Reduction of parameters like nitrogen, pH, turbidity other physicochemical parameters from wastewater using biochar from coconut shell was investigated by mixing the biochar with the wetland soil. Further, in this study analyzed the effect of biochar on the growth of the plants in the wetland*(Typha latifolia)*. The biochar amended wetlands showed greater removal efficiencies of 99.9% and 85% in turbidity and TDS, respectively as compared to the normal wetlands which exhibited an efficiency of 98% and 77.7% in removing turbidity and TDS, respectively.
Key words: Biochar, Constructed wetland, Wastewater treatment, Wetland species

INTRODUCTION

The present India is confronting unfavorably developing environmental issues. One of the principal purposes behind industrial pollution the release of effluents containing substantial metals which are nonbiodegradable and can't be lessened to non-poisonous structures. Hence forth, it is compulsory to treat wastewater due to its possible adverse influences on human health and the environment.

Constructed wetlands are characterized as simulated wastewater treatment plans containing low (typically under 1 m significant) channels were inserted with aquatic plants treated through various methods. There are two sorts of constructed wetlands. Free water surface, wetlands and Vegetated submerged bed systems. FWS seems like natural wetlands as they enclose aquatic plants which are embedded in a soil layer on the base of the wetland and water moves via, the leaves and stems of plants. VSB contain a media bed (some form of crushed rocks in many forms)are implanted with sea-going plants and they don't look like normal wetlands since they have no standing water.[1] The presence of wetland plants is one of the most noticeable features of constructed wetlands in contrast to soil-only filters.[2] Wetland plants can enhance metal removal and/or stabilization.[3] *Typha Latifolia* which is an aquatic Macrophytes has been the requisite features to be used in phytoremediation due to its fast growth, spreading easier and simple way to harvesting.[4]

Biochar is manufactured by pyrolysis (in the absence of oxygen or very little oxygen) of biological materials. It is gaining rising interest because of its capability to increase soil nutrients status, improve crop yield and sequester carbon (C) in the soil.[5]Recently the use of biochar in the treatment of wastewater has taken its course. The characteristics of biochar vastly vary depending upon the feedstock, temperature, duration, and method of pyrolysis with BOD, COD, turbidity and related analysis.[6-9]

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EXPERIMENTAL

Study area

The experimental work was carried out in SRM University, located in SRM Nagar of Potheri Village, India. The temperature ranges from 20-40°C and an annual precipitation of 1213 mm. Figure 1 shows the location map of SRM University.[10]

Fig.-1: Location map of SRM University

Preparation of biochar

Coconut shell (CS) was used as the raw material for the preparation of biochar. The raw material was purchased from the nearby markets and was dried under the sun for 24 hrs.It was then grounded and made to a uniform size and fed into a muffle furnace which was programmed at a temperature of 300°C for pyrolysis.

Collection of Wastewater

Domestic wastewater was analyzed for the study. The wastewater was collected from Sewage Treatment Plant III which was located behind SRM Dental College, at SRM University Kattankulathur campus. As per the guidelines of water and wastewater analysis (CPCB, 1997), the wastewater was collected in amber glass with the proper cap is cleaned 3 times with hexane and one time with acetone in the laboratory before it was taken to site. Samples were collected using grab sampler at different depths by immersing the bottles into the water without formation of bubbles and were mixed thoroughly. These samples were kept far away from sunlight and were stored in arefrigerator.[11-13]

Experimental Setup

The study included two experimental setups. Each constructed wetland setup consisted of a PVC tub which is 0.6 m in length, 0.4 m wide and 0.3 m deep. The two wetland systems were named as Normal Wetland (NW) and Biochar Wetland (BW) and were constructed with a slight inclination of 1-2% between inlet and outlet region. The setup was divided into two parts. The first part consisted of gravel alone for the elimination of bigger grit particles existing in the domestic wastewater. The second region of Setup NW consisted of gravel, sand, and soil while setup BW contained layers of gravel, sand and soil mixed with the CS biochar. The wetland species *Typha latifolia* was used for the study which was first planted in an uncontaminated site which was waterlogged for a period of one month. After the plants were established, it was transferred into the constructed wetlands A and B.[13,14]

Sampling and analysis

The domestic wastewater was passed through the wetland systems and B and the water samples were collected after a retention time of 24, 48, 72, 96, and 120 hours. The analyzed parameters include pH, turbidity, BOD, COD and total nitrogen. Analysis of pH was accomplished through digital pH meter MK VI. The turbidity was measured through Systronics digital nephelo-turbidity meter 132. The BOD, COD and total nitrogen were measured using LovibondSpectrodirect.[8, 9]

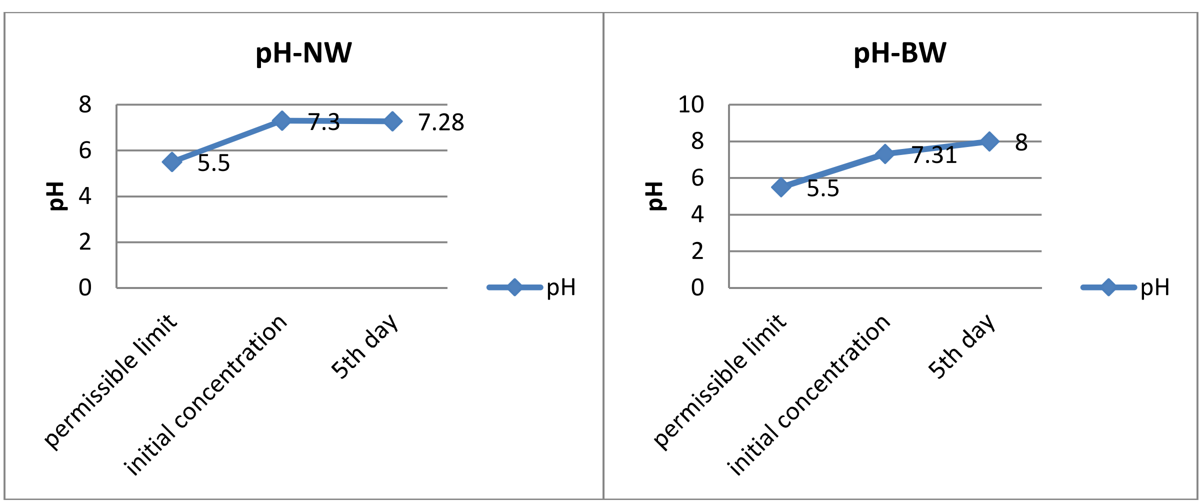
RESULTS AND DISCUSSION

The domestic wastewater was collected from the SRM University treatment plant and the same treated with two constructed wetland unit one with Biochar combined and another without biochar designed as per the standard and the wastewater was poured into the units for treatment and the samples are collected every day in morning hours with the retention period maintained as 24 hours and the same was continued till five days retention time and the results are discussed in the following table 1 and reduction efficiency was presented in the following Figures- 2a to 2f.

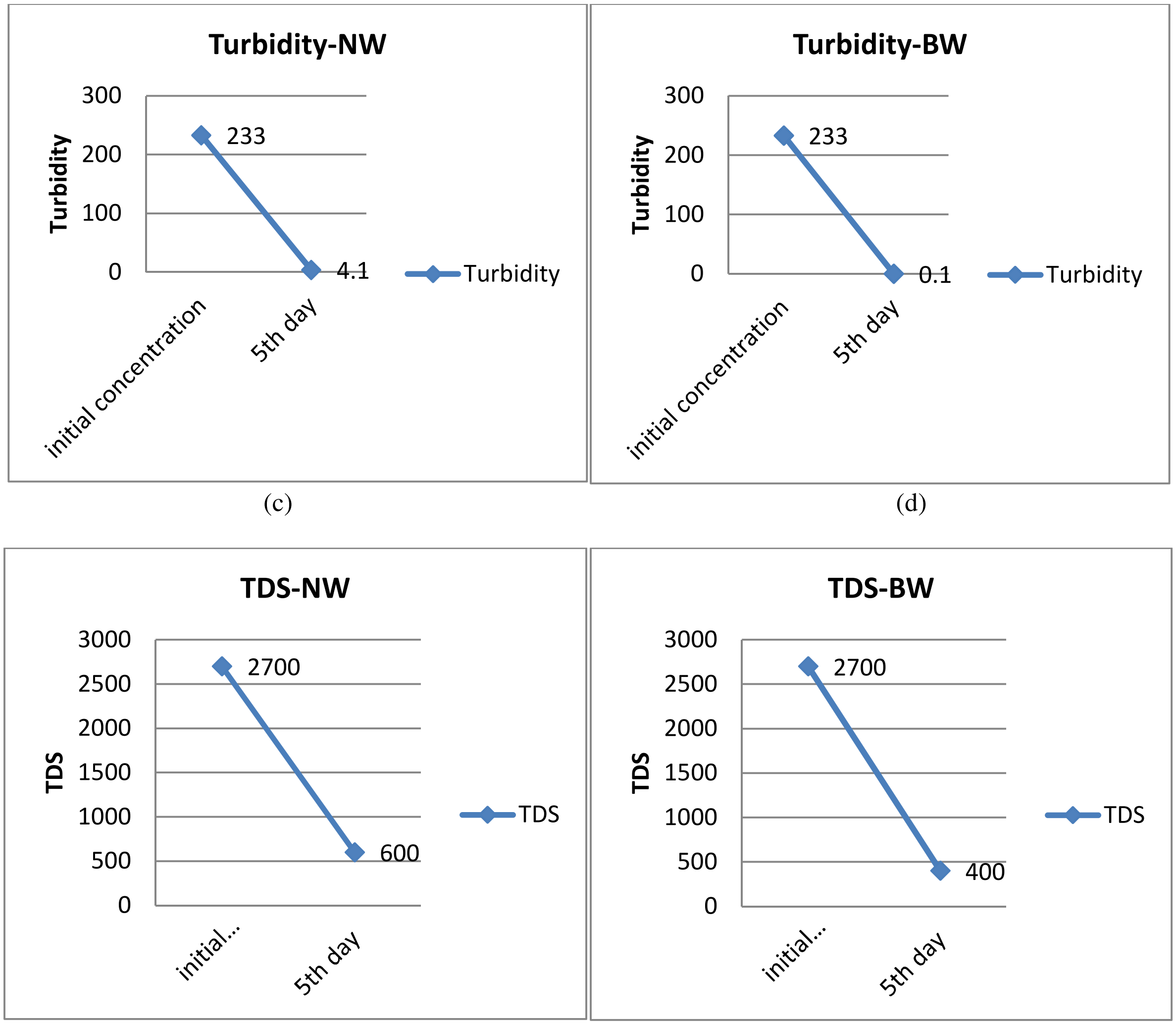
Table-1: Characteristics of wastewater before and after treatment

Parameter	Permissible limits	Influent concentration	24 hrs		120 hrs	
			BW	NW	BW	NW
pH	5.5-9	7.31	7.4	7.16	8.02	7.49
Turbidity (NTU)		63.8	17	54	0.1	4.1
TDS(mg/l)	2100	2700	2450	2560	400	600
BOD (mg/l)	30	563	79	122	24	20
COD (mg/l)	250	799	250	384	105	126
Total Nitrogen(mg/l)	50	65	61	56	15.2	4.3

At the beginning, the pH value was 7.31. when it passes through the wetland beds, the pH increased to 8.0 in BW. The increase in nature of pH values in wetland BW is due to the alkaline nature of biochar and it's reflecting the contribution of ash concentration.[4,5] The observed pH ranges among the two wetlands and the possible and suggested limits of pH from 5.5 to 9,0 as represented in the Fig.-2(a) and (b).
Turbidity reduction has been achieved to a very great extent.[7] Turbidity removal efficiency of 98.2% has been achieved in NW system whereas the BW system showed more efficiency in turbidity removal by 99.9% as represented in Fig.-2 (c) and (d).
The pH, turbidity and Total Nitrogen of Initial, Biochar and Normal wetland are shown in Fig.-3(b). At the initial conditions very low values indicating the low performance is evident. In the second and third stage the larger values indicate the performance of *Typha Latifolia* is convinced from the observed values.[8,9] The similar results are discussed by many researchers.[15-18]



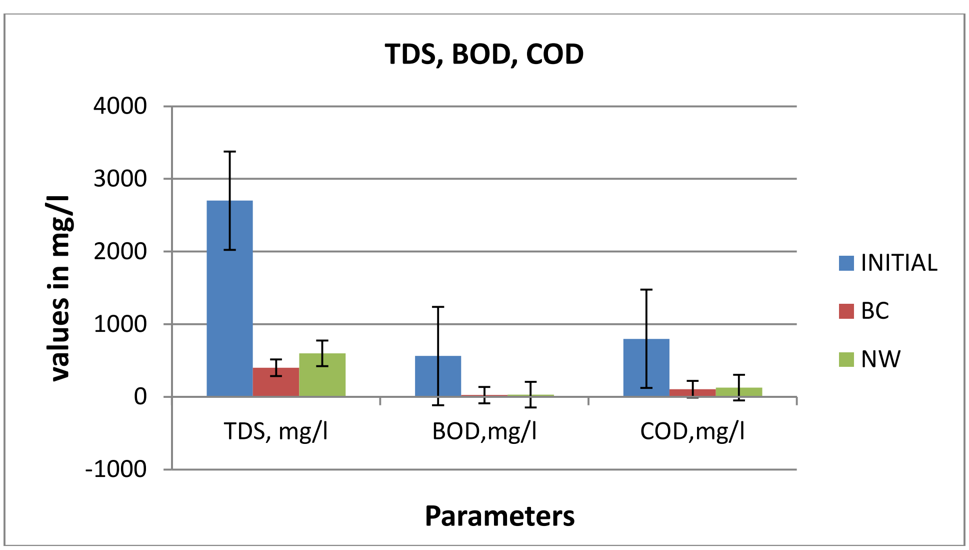
(a) (b)



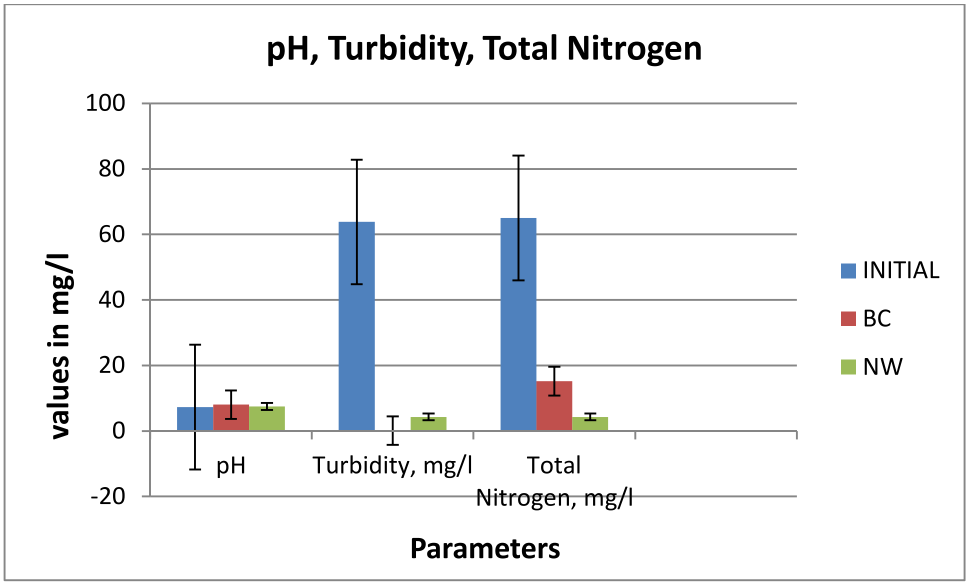
(c) (d)

(e) (f)

Fig.-2: pH of (a) Normal Wetland and (b) Biochar Wetland, Turbidity of (c) Normal Wetland and (d) Biochar Wetland, TDS of (e)Normal Wetland and Biochar Wetland.



(a)



(b)

Fig.-3: (a) Comparison of TDS, BOD and COD using Biochar wetland and Normal wetland, (b) Comparison of pH, turbidity and total nitrogen using Biochar wetland and Normal wetland.

CONCLUSION

From the above results, it can be concluded that the pH values in the biochar mixed wetland have been increased than that of the normal wetlands. An efficiency of 99.9% reduction in turbidity has been achieved from the BW which is slightly more than that achieved in the normal wetland of 98%. The TDS removal efficiency in BW is 85% and implies that the biochar has played a major role in the reduction TDS as compared to the NW, where the removal efficiency of TDS was 77.7%.Biochar wetlands showed BOD and COD removal efficiency of 95% and 86% respectively. While normal wetlands exhibited a removal efficiency of 94% and 83% in BOD and COD respectively. From the above experiments, it can be concluded that the CS biochar is a very effective treatment option.

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