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Characterization and Treatment of Vellalore municipal sewage water by adsorbents

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Abstract
The urban wastewater treatment plants can be an important part of circular sustainability due to integration of energy production and resource recovery during clean water production. Municipal sewage water contains large quantities of organic and inorganic compounds which cause toxic and hazardous pollutants in the environment. The adsorbents like coconut shell, coir pith, rice husk and tea waste were selected for the treatment of Vellalore municipal sewage water.

Keywords: wastewater treatment plants, energy production, resource recovery, sewage water

1. Introduction
The high rate of increase in human population and rapid pace of industrialization have created an acute problem of disposal of waste products. The domestic wastes and industrial effluents are being indiscriminately discharged into the rivers, the adjoining fields and ponds without any treatment or proper treatment. This has led to pollution hazards not only to the aquatic life but also to the human life.
Various industrial operations generate waste effluents with different characteristics. The disposal of industrial waste effluents through open drainage system has heavy impact on soil quality (Kishore and Rao, 1979; Singh and Singh, 1999) [1]. Biomonitoring studies on plants and fishes grown in this water will indicate the quality of the water, its impact on fishes and plants to predict the impact of their utilization on human health.
Fish culture in sewage water is one of the ways for effective recycling of wastes and of preventing pollution. But the sewage also contains potentially toxic heavy metals and hazardous pathogens that may effect plant via human and animals through food chain (McGrath *et al*., 1994) [3].
Shrichand *et al*. (1994) [4] investigated the removal of Chromium (VI) of around 97 per cent of aqueous waste water by using adsorbents based on coconut jute carbon at natural pH. Sharma *et al*. (1997) [5] used activated carbon derived from coconut shell for the adsorption of phenol from synthetic waste water.
Removal of Chromium from synthetic effluent by adsorption on activated carbon was studied by Raj and Raghavan (2002) [6]. Rathi and Puranik (2002) [7] reported on mixed stream waste water treatment using adsorption. Kumar and Bhagavanulu (2003) [8] studied the adsorption of basic dye from its aqueous solution onto bio organic waste.

2. Materials and Method
Characteristics of Study Area
The Sanganur canal, an open drainage in Coimbatore has its origin from the Western Ghats, namely, Kuridimalai Hills and flows from west to east and enters Coimbatore city limit at Coimbatore-Mettupalayam Road and flows for about 10km within the city. It is a major open drainage system which has intricate linkage with storm water supply, domestic sewage and industrial effluent disposal (forming municipal sewage). Sewage and sullage from adjoining areas, flow in this drain and finally confluences with Singanallur pond and Noyyal river at the upstream of Check dam at Vellalore.

Fig 1: Sampling station of Sanganur canal Vellalore municipal sewage

Treatment using adsorbents
Coconut shell, coir pith, rice husk and tea waste were used for the treatment purpose. To 200 ml of the undiluted Vellalore municipal sewage taken in conical flasks 2 gms of each item was added and plugged tightly. The conical flasks containing the samples were agitated in an electrical shaker at 120 rpm for 48, 72 and 96 hour respectively. To improve microbial degradation 37^0C was maintained during the treatment.

3. Results and Discussion
Removal of Pollution Load in Different Hours of Treatment
The Vellalore municipal sewage water after subjected to various treatments for 48, 72 and 96 hours with the selected adsorbents (coconut shell, coir pith, rice husk and tea waste) showed a very good reduction of pollution parameters.

pH
pH of the municipal sewage sample showed little alteration with treatments after 48 and 72 hours. In the 96 hours duration treatment, maximum reduction in pH was achieved by coir pith (7.74-7.27) followed by rice husk (7.74-7.30), tea waste (7.74-7.32) and coconut shell treatments (7.74-7.59) respectively.

EC
Among the different treatments 96 hours treatment showed better reduction rate. Maximum reduction of EC was observed in coconut shell (2.70 mmhos/cm) and coir pith (3.30 mmhos/cm) treatments. In rice husk and tea waste treatments the reduction performance was the same (3.39 to 3.34 mmhos/cm).

Total solids
Though significant reduction in the level of total solids was observed in all the treatments 96 hours duration treatment showed better effect. Among these coir pith, rice husk and tea waste treatments performed equally well in reducing the TS level from 8000.00mgl^{-1} to 600.00 mgl^{-1}. The next in order was observed in coconut shell treatment (8000.00mgl^{-1} to 666.67mgl^{-1}).

Total dissolved solids
Among the three treatments 96 hours treatment showed better effect. Maximum and equally well reduction was observed in rice husk and tea waste (5333.33 mgl^{-1} to 333.33 mgl^{-1}) followed by coconut shell and coir pith treatments (5333.33 mgl^{-1} to 400.00 mgl^{-1}).

Biological oxygen demand
Different hours of treatment with various materials showed BOD reduction. BOD removal was better achieved during 96 hours treatment. The coconut shell reduced the BOD of municipal sewage water from the initial level of 123.33 mgl^{-1} to 40.00 mgl^{-1}. Coir pith, rice husk and tea waste treatments performed equally well in reducing BOD level upto 43.33 mgl^{-1}.

Chemical oxygen demand
Better impact on COD removal was in 96 hours treatment with various materials. Maximum and equally well reduction in COD level was observed in coconut shell and rice husk (277.33 mgl^{-1} to 50.67 mgl^{-1}) followed coir pith and tea waste treatments (58.67 mgl^{-1}).

The relationship between BOD –COD during treatments
Analysis of correlation co-efficient indicated a low degree of positive correlation between BOD and COD in all the treatments except chemical treatment which exhibited a negative correlation between BOD and COD.

Sulphate
Among the treatments 96 hours treatment showed better reduction effect on sulphate. Maximum and equally well reduction in sulphate level was observed in coconut shell (20.00 mgl^{-1}), coir pith (21.67 mgl^{-1}) and tea waste (28.33 mgl^{-1}). Minimum reduction was noticed in rice husk (40.00 mgl^{-1} to 33.33 mgl^{-1} respectively).

Phosphate
The 96 hours treatment showed phosphate reduction with better effect. Minimum reduction was observed in coir pith, coconut shell, tea waste and rice husk treatments from (9.47 mgl^{-1} to 8.00 mgl^{-1}, 8.10 mgl^{-1}, 8.23 mgl^{-1} and 8.40 mgl^{-1} respectively).

Table 1: Variation Between Treatment Group in Reduction of Pollution Load in 48 Hours

Treatment	pH	EC	TS	TDS	BOD	COD	Sulphate	Phosphate
R-Raw municipal sewage water	7.74	3.39	8000.00	5333.33	123.33	277.33	40.00	9.47
T_1– Coconut shell	7.69	3.25	800.00	400.00	63.33	61.33	33.33	8.30
T_2- Coir pith	7.68	3.37	800.00	533.33	60.00	69.33	30.00	8.37
T_3- Rice husk	7.70	3.37	800.00	466.67	43.33	61.33	38.33	8.53
T_4 – Tea waste	7.70	3.37	933.33	600.00	53.33	69.33	35.00	8.43
SEd	0.01	0.03	674.77	801.49	3.90	6.13	2.11	0.08
CD (0.05)	0.01	0.07	1447.40	1719.21	8.38	13.15	4.53	0.17
CD (0.01)	0.02	0.09	2008.83	2386.07	11.60	18.25	6.29	0.24
F-ratio	5113.29**	323.316**	27.92**	9.325**	114.76**	360.53**	69.60**	1187.03**

Table 2: Variation Between Treatment Group in Reduction of Pollution Load in 72 Hours

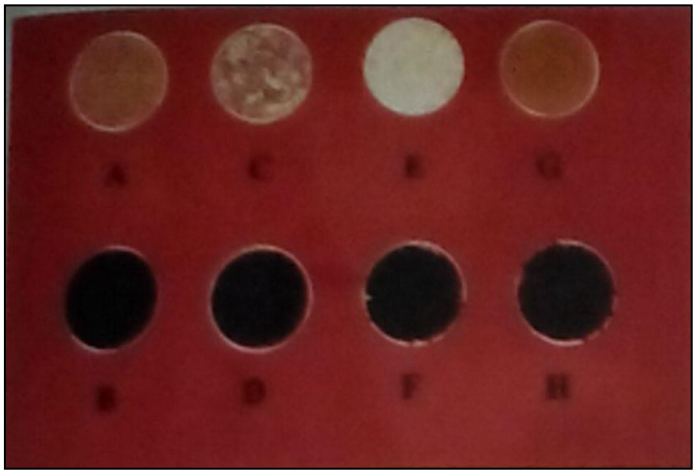
Treatment	pH	EC	TS	TDS	BOD	COD	Sulphate	Phosphate
R-Raw municipal sewage water	7.74	3.39	8000.00	5333.33	123.33	277.33	40.00	9.47
T_1– Coconut shell	7.65	3.17	800.00	466.667	40.00	53.33	20.00	8.23
T_2- Coir pith	7.53	3.34	600.00	400.000	50.00	61.33	26.67	8.20
T_3- Rice husk	7.57	3.35	600.00	333.333	43.33	53.33	36.67	8.47
T_4 – Tea waste	7.60	3.35	600.00	333.333	43.33	61.33	28.33	8.33
SEd	0.01	0.03	674.77	801.49	3.90	6.13	2.11	0.08
CD (0.05)	0.01	0.07	1447.40	1719.21	8.38	13.15	4.53	0.17
CD (0.01)	0.02	0.09	2008.83	2386.07	11.60	18.25	6.29	0.24
F-ratio	5113.29**	323.316**	27.92**	9.325**	114.76**	360.53**	69.60**	1187.03**

Table 3: Variation between treatment group in reduction of pollution load in 96 Hours

Treatment	pH	EC	TS	TDS	BOD	COD	Sulphate	Phosphate
R-Raw municipal sewage water	7.74	3.39	8000.00	5333.33	123.33	277.33	40.00	9.47
T_1– Coconut shell	7.59	2.70	666.67	400.00	40.00	50.67	20.00	8.10
T_2- Coir	7.27	3.30	600.00	400.00	43.33	58.67	21.67	8.00

Pith T_3- Rice husk	7.30	3.34	600.00	333.33	43.33	50.67	33.33	8.40
T_4 – Tea	7.32	3.34	600.00	333.33	43.33	58.67	28.33	8.23
waste								
SEd	0.01	0.03	674.77	801.49	3.90	6.13	2.11	0.08
CD (0.05)	0.01	0.07	1447.40	1719.21	8.38	13.15	4.53	0.17
CD (0.01)	0.02	0.09	2008.83	2386.07	11.60	18.25	6.29	0.24
F-ratio	5113.29**	323.316**	27.92**	9.325**	114.76**	360.53**	69.60**	1187.03**

All values are in mgl-1 except pH and EC in mmhos/cm.
SEd – Standard deviation CD – Critical Difference ** Significant at 1% level.



A: Raw coconut shell B: Activated coconut shell
C: Raw coir pith D: Activated coir pith
E: Raw rice husk F: Activated rice husk
G: Raw tea waste H: Activated tea waste

Fig 2: Adsorbents used for Treatment

Treatment of Vellalore municipal sewage water by using adsorbents

The activated carbons are effective in the reduction of several pollution parameters (TS, TDS and COD). Use of these adsorbents may be recommended for the treatment of municipal sewage wastes as they are cheaper, easily disposable by burning at high temperature and can be used as source of energy. According to the increase in the duration of treatment, proportionate decrease of pollution load was observed in 48, 72 and 96 hours treatment.

In the present study, a significant reduction in pH, TS, TDS, COD was achieved in the treatment of the water through activated carbons during 48, 72 and 96 hours. This falls in line with the work of Kadirvel (1993) [9] who recorded complete removal of colour, BOD and COD from the dyeing waste water by using carbonized coir pith.

In the present work, the coir pith, rice husk and tea waste were found to be effective in the removal of TS upto 92.5 per cent in 96 hours. Sharma *et al*. (1997) [5] found activated carbon derived from coconut shell was effective in the adsorption of phenol from synthetic waste water.

TDS removal was achieved to the maximum of 93.75 per cent by the adsorption process of rice husk and tea waste at 96 hours treatment. COD removal to the maximum of 81.73 per cent was effectively carried out by carbonized coconut shell and rice husk at 96 hours treatment duration.

Prabhu and Thangavelu (1995) [10] who reported considerable reduction of TDS, TSS, BOD and COD by using carbonized rice husk. Murthy *et al*. (1997) reported a reduction in COD level in electroplating industry effluent on treatment with activated coconut shell and tea waste. Patnaik *et al*. (1995) [12] conducted batch experiment on removal of COD from textile mill by using fly ash as adsorbents. Kadirvel (1993) [9] who recorded complete removal of BOD and COD from the dyeing waste water by using carbonized coir pith. Pohan Lemeyonouin Aliou Guillaume *et al*., (2018) [13] reported a good removal efficiency of Titanium Oxide Clay as adsorbent and photocatalysts for wastewater treatment.

Table 4: Pollution load removal efficiency in percentage by adsorbents and impact of time duration

Percentage efficiency of activated carbon treatment												
Coconut shell				**Coir pith**			**Rice husk**			**Tea waste**		
Parameter	**48hr**	**72hrs**	**96hrs**	**48hrs**	**72hrs**	**96hrs**	**48hrs**	**72hrs**	**96hrs**	**48hrs**	**72hrs**	**96hrs**
pH	0.65↓	1.16↓	1.94↓	0.78↓	2.71↓	6.07↓	0.52↓	2.20↓	5.68↓	0.52↓	1.81↓	5.43↓
EC	4.13↓	6.49↓	20.35↓	0.59↓	1.47↓	2.65↓	0.59↓	1.18↓	1.47↓	0.59↓	1.18↓	1.47↓
TS	90.00↓	90.00↓	91.67↓	90.00↓	92.50↓	92.50↓	90.00↓	92.5↓	92.50↓	88.33↓	92.5↓	92.5↓
TDS	92.50↓	91.25↓	92.50↓	90.00↓	92.50↓	92.50↓	91.25↓	93.75↓	93.75↓	88.75↓	93.75↓	93.75↓
BOD	48.65↓	67.57↓	67.57↓	51.35↓	59.46↓	64.87↓	64.87↓	64.87↓	64.87↓	56.76↓	64.87↓	64.87↓
COD	77.89↓	80.77↓	81.73↓	75.00↓	77.89↓	78.84↓	77.89↓	80.77↓	81.73↓	75.00↓	77.89↓	78.84↓
Sulphate	16.68↓	50.00↓	25.00↓	25.00↓	33.33↓	45.83↓	4.18↓	8.33↓	16.68↓	12.50↓	29.18↓	29.18↓
Phosphate	12.35↓	13.09↓	14.47↓	11.62↓	13.41↓	15.52↓	9.93↓	10.56↓	11.30↓	10.98↓	12.04↓	13.09↓

All the values are in percentage ↑ denotes increase
↓ denotes decrease

4. Conclusion

The study showed the potential of adsorbents like coconut shell, coir pith, rice husk and tea waste in the treatment of municipal sewage water collected from Vellalore.

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