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Treatment of Fertilizer Waste Water by Using Carica Papaya

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Abstract: Eutrophication is one of the most problematic water pollution, caused by the high level of nutrients in water, mainly phosphorous, nitrogen and potassium, which is due to the fertilizers runoff from the agricultural and fertilizer industry areas, as well as the untreated disposal of domestic and industrial wastewater into the environments. Besides, consuming high concentration of phosphorous, nitrogen and potassium from drinking water can lead to various types of health diseases. Considering the bad effects of phosphorous, nitrogen and potassium pollution to human and environment, scientists and researchers had done numerous studies and discovered many useful techniques to remove the pollutants from water sources and wastewater effectively.This project work is intended to study the biomaterials application effect as adsorbents for minimizing the effect of nutrients contamination on fertilizer effluents. The carica papaya leaf, seed and trunk are selected as adsorbent materials.

Keywords: Sedimentation, Carica Papaya Adsorbents, Nutrients

1. Introduction

The human population has been increased since the development of science and technology in this modern era, which brings about greater demand for food all around the world. Therefore, more and more industrial and agricultural activities were carried out to sustain the needs of the increasing communities. Despite advances in the science, engineering and legal frameworks, most of the wastewater resulted from the fast movement of humans towards urbanization, industrialization, and agricultural activities in the world are released into environment without treatment. The improper disposal of wastewater from the factories will pollute the water sources and disturb the aquatic life. Besides, the domestic wastes comes from human and animal excretion, food bodies and household garbage also contributes to water pollution and hormonal imbalance in human beings when consume the polluted water.

Water is an essential multipurpose substance that is being used every day by human, for drinking, bathing, washing and many more. It is of fundamental important for life as many mechanism of metabolism and synthesis needs water to be functioned well, for example water is required in the transport of nutrients inside the cells and interactions with the extracellular environment. The excessive exploitation of water bodies caused by uncontrolled industrial and agricultural activities will result in water scarcity. Moreover, water resources are limited and only a small fraction of the freshwater can be consumed as drinking water. Hence, it is important to take good care of our groundwater, rivers, lakes and streams to ensure clean water for our daily consumption and usage.

The impacts of water pollutants on the human health and the environment depend greatly on the physiochemical characteristics and the quantity of pollutants discharged. There are two types of water pollution, the point source pollution and non-point source pollution. When comparing both types of pollution, the point source pollution is known to have fixed sources of pollutants which are emitted in large amount, while the non-point pollution consists of mobile sources of contaminants which are discharged in low quantity. The pollution from the point sources is often detected and treated easily. Meanwhile, the emission of the pollutants from the non-point sources is difficult to be traced and controlled.

For instance, the discharge of untreated municipal wastewater from factories and the domestic wastes comes from human and animal excretion, food bodies and household garbage are point sources of nitrogen, potassium and phosphorous respectively. The dissolving of nitrogen oxides produced from internal combustion engines and furnaces is another example of point source pollution. In contrast, the agricultural activity is one of the main sources of non-point source pollution (diffuse pollution). Typical examples of diffuse pollution include the use of fertilizer in agriculture, pesticides from a wide range of land uses, contaminants from roads, and atmospheric deposition of contaminants arising from industry. Diffuse pollution occurs when potentially-polluting substances like phosphates and nitrates leach into surface waters and groundwater as a result of rainfall, soil infiltration and surface runoff.

1.2 Adsorbents

In fertilizer waste water treatment, carica papaya seed, leaf and trunk are the adsorbents used for the experimental work.Adsorption is a mass transfer process whichinvolves the accumulation of substances at the

interface of two phases, such as liquid - liquid, gas-liquid, gas-solid, or liquid-solid interface. The substance being adsorbed is the "adsorbate" and the adsorbing material is termed the "adsorbent". The driving forces for adsorption process are surface affinity, chemical reactivity, pH, surface area for adsorption per unit volume and reduction in surface tension.

1.4 Carica Papaya

- Plant species – C.papaya
- Family- Caricaceae
- Common Name- Papaya

Raw papaya pulp contains 88% water, 11% carbohydrates, and negligible fat and protein. In a 100 gram amount, papaya fruit provides 43 kilocalories and is a significant source of vitamin C (75% of the daily value) and a moderate source of folate (10% daily value), but otherwise has low content of nutrients.

2. Methodology

2.1 Materials

The materials used in this study were purchased from nearby village (Kunnamkulam). The carica papaya leafs,seeds and trunk were used for preparation of adsorbents.

2.1.1 Fertilizer Waste Water Sample

The fertilizer waste water sample for the testing was collected from kripa bone industries, located at chalakudy. The collection of water sample was used within the period of 2-3 weeks. The samples were collected, and the initial characteristics were recorded.

Figure 1: Fertilizer Waste Water Sample

2.1.2 Filtration With Paddy Straw For Treating Fertilizer Waste Water Sample

A simple rectangular filtration tank is manufactured with the following dimensions.Length = 30cm, width = 25cm, height = 45cm. The filter consists of different layers of filter materials like paddy straw, sand and coarse aggregates. The fertilizer waste water was collected in a bucket from chalakudy. Filter unit is made up of glass material with a dimension of 45x30x25 cm is used for filtration process. Inside of this filter, layers of materials were filled. The bottom most layer filled with coarse aggregate, which passes through 10mm IS sieve and retain on 20mm IS sieve at a depth of 150 mm. The layer above the coarse aggregate, sand is filled. In this project sand passing through 2.36mm IS sieve is used. The depth of sand bed is 60mm.

Layer of wire mesh was placed in between the sand and coarse aggregate. In the top most layer, paddy straw should be placed at a depth about 150mm. each pieces of paddy straw ranging from 4-5cm length is used. The performance of the filtration unit is analyzed to study the percentage removal of BOD, COD, TDS etc.

Figure 2: Filtration Set Up

2.2 Methods

2.2.1 Preparation of Carica Papaya Adsorbents

Carica papaya leafs, trunk and seeds were collected from nearby village. Then the material is washed several times with water for removing dust and other impurities from it. Then the washed papaya leafs, trunk and seeds were dried in oven at 80^{o}c and then crushed in to powder form.

2.2.2 Adsorption Using Carica Papaya Adsorbents

The removal rate of various parameters was tested using carica papaya leaf in the column apparatus with different heights such as 20cm, 30cm, and 40cm. At first, the fertilizer waste water sample is allowed to pass through the adsorption column which is filled with carica papaya leaf as adsorbent. The amount of water after adsorption is collected in the collection tank. The collected water is then analysed. Then the same procedure is repeated by using carica papaya seed, trunkand also its combination of all these 3 adsorbents in the column apparatus.

Figure 3: Adsorption Using Carica Papaya Leaf

2.2.3 Adsorption Using Combination Of All Adsorbents

The removal rate of various parameters was tested using combination of carica papaya seed, carica papaya trunk and carica papaya leaf in the column apparatus with different heights such as 20cm,30cm,40cm. At first the fertilizer waste water is allowed to pass through the adsorption column which is filled with combination of all adsorbent. The amount of fertilizer waste water after adsorption is collected in the collection tank. The collected water is then analysed.

3. Results and Discussions

3.1 Parameters Before And After Filtration

The fertilizer wastewater characteristics were tested before the commencement of the project and the initial characteristics like pH, BOD, COD, total suspended solids, total dissolved solids, alkalinity, chlorides, Dissolved oxygen, nitrogen, Phosphorous, iron, Potassium, colour, turbidity etc. were tested and were compared with the irrigation water limit. The limits were not satisfactory but the water can be easily purified through simple methods of purification. Later the fertilizer waste water after being passed through the three sets of processes; sedimentation, filtration and adsorption column, by using low cost carica papaya adsorbents such as papaya seed, papaya trunk and papaya leaf. The parameters before and after filtration were shown in the table 1.

Table 1: Parameters Before And After Filtration

Parameters	Value Of Parameters Before Filtration	Value Of Parameters After Filtration	Permissible Limit (Irrigation)
pH	8.8	8.7	6.5-8.5
TSS	530 (Mg/l)	430 (Mg/l)	<100
COD	164 (Mg/L)	160 (Mg/l)	<150
BOD	564.5 (Mg/L)	365 (Mg/l)	<100
TURBIDITY	66 (NTU)	55 (NTU)	<10
TDS	2665 (Mg/L)	887(Mg/L)	<2000
COLOUR	20 (Hazens)	18 (Hazens)	<25
IRON	0.88 (Mg/L)	0.88	<1
K	32.8 (Mg/L)	32.8	<30
P	41.3 (Mg/L)	41.3	<2
N	38.4 (Mg/L)	38.4	<30

3.2 Carica Papaya Leaf As Adsorbent (Varying Adsorbent Height)

The fertilizer waste water is being treated with carica papaya leaf as adsorbent. The test were conducted at three different heights such as 20cm, 30cm and 40cm. The changes of parameters were analysed and are shown in table 2. The best results were achieved at the height of 40cm, so the optimum height obtained is 40cm while using carica papaya leaf as adsorbent.

Table 2 : Carica Papaya Leaf As Adsorbent

Sl. No	Parameters	Adsorbent Height 20CM	Adsorbent Height 30CM	Adsorbent Height 40CM
1	pH	8.7	8.44	6.5
2	TSS(Mg/L)	192	179	148
3	COD (Mg/L)	175	167	144
4	BOD (Mg/L)	85	67	32
5	TURBIDITY (Mg/L)	51	42	26
6	TDS (Mg/L)	356	220	199
7	COLOUR (Hazens)	20	17	10
8	IRON (Mg/L)	0.85	0.85	0.52
9	K (Mg/L)	25	16	13.9
10	P (Mg/L)	15	14	13
11	N (Mg/L)	30	18	12

3.3Carica Papaya Seed As Adsorbent (Varying Adsorbent Height)

The fertilizer waste water is being treated with carica papaya seed as adsorbent. The test were conducted at three different heights such as 20cm, 30cm and 40cm. The changes of parameters were analysed and are shown in table 3. The best results were achieved at the height of 40cm, so the optimum height obtained is 40cm while using carica papaya seed as adsorbent.

Table3: Carica Papaya SeedAs Adsorbent

Sl.No	Parameters	Adsorbent Height 20CM	Adsorbent Height 30CM	Adsorbent Height 40CM
1	pH	8.6	8.3	6.7
2	TSS (Mg/L)	162	137	115
3	COD (Mg/L)	193	145	112
4	BOD (Mg/L)	81	43	26
5	TURBIDITY (Mg/L)	48	34	22
6	TDS (Mg/L)	310	270	210
7	COLOUR (Hazens)	19	14	8
8	IRON (Mg/L)	0.78	0.57	0.32
9	K (Mg/L)	25	18	11
10	P (Mg/L)	30	22	12
11	N (Mg/L)	20	21	17

3.4 Carica Papaya Trunk As Adsorbent (Varying Adsorbent Height)

The fertilizer waste water is being treated with carica papaya trunk as adsorbent. The test were conducted at three different heights such as 20cm, 30cm and 40cm. The changes of parameters were analysed and are shown in table 4. The best results were achieved at the height of 40cm, so the optimum height obtained is 40cm while using carica papaya trunk as adsorbent.

Table4: Carica Papaya Trunk As Adsorbent

Sl.No	Parameters	Adsorbent Height 20CM	Adsorbent Height 30CM	Adsorbent Height 40CM
1	pH	8.5	8.2	7
2	TSS (Mg/L)	160	135	114
3	COD (Mg/L)	190	140	120
4	BOD (Mg/L)	81	40	25
5	TURBIDITY (Mg/L)	44	33	20
6	TDS (Mg/L)	212	260	200
7	COLOUR (Hazens)	19	13	18
8	IRON (Mg/L)	0.67	0.34	0.32
9	K (Mg/L)	20	16	10
10	P (Mg/L)	25	22	13
11	N (Mg/L)	20	13	17

3.5 Combination Of All Adsorbent (Varying Adsorbent Height)

The fertilizer waste water is being treated with combination of carica papaya seed, trunk and leaf as adsorbent. The test were conducted at three different heights such as 20cm, 30cm and 40cm. The changes of parameters were analysed and are shown in table 5. The best results were achieved at the height of 40cm, so the optimum height obtained is 40cm while using combination of carica papaya seed, trunk and leaf as adsorbent.

Table5: Combination Of All Adsorbent

Sl.No	Parameters	Adsorbent Height 20CM	Adsorbent Height 30CM	Adsorbent Height 40CM
1	pH	8.4	8	6.6
2	TSS (Mg/L)	149	120	103
3	COD (Mg/L)	171	125	100
4	BOD (Mg/L)	47	39	21
5	TURBIDITY (Mg/L)	37	29	18
6	TDS (Mg/L)	210	178	150
7	COLOUR (Hazens)	18	12	7
8	IRON (Mg/L)	0.69	0.34	0.22
9	K (Mg/L)	16	15.7	9
10	P (Mg/L)	14	12	11
11	N (Mg/L)	19	12	8

3.6 Optimum Time

The carica papaya leaf, carica papaya seed, carica papaya trunk and the combination of all were used as adsorbents at different heights such as 20cm, 30cm, 40cm. From this we have got the better results by using the combination of all adsorbents in 40cm height.

Table6: Results Obtained In Various Time

Sl.No	Parameters	(Adsorbent Height 40 CM) Time = 20 min	(Adsorbent Height 40 CM) Time = 30 min	(Adsorbent Height 40 CM) Time = 40 min
1	pH	5.8	5.9	6.5
2	TSS (Mg/L)	198	154	102
3	COD (Mg/L)	125	123	121
4	BOD (Mg/L)	29	26	24
5	TURBIDITY (Mg/L)	31	24	16
6	TDS (Mg/L)	140	122	109
7	COLOUR (Hazens)	9	8	6
8	IRON (Mg/L)	0.41	0.4	0.23
9	K (Mg/L)	7.4	4.1	2.3
10	P (Mg/L)	7.1	4.3	2.2
11	N (Mg/L)	17	15	14

3.7 Efficiency of Adsorbents

To determine the efficiency of natural adsorbents used such as carica papaya leaf, carica papaya seed, and carica papaya trunk the optimum height, and optimum time can be maintained. Optimum height is 40cm, and optimum time is 40min. The reduction in turbidity is 70.9%, reduction in BOD is 93.42%, reduction in COD is 25%, reduction in total suspended solids is 76.41% and reduction in total dissolved is 87.71%, iron is 57.95%, nitrogen content is 63.54%, total phosphorous is 94.65%, potassium content is 92.98% and colour is 66.6%.is attained.

Table7: Efficiency Of Adsorbents

Sl. No	Parameters	Removal Efficiency (%) (ADSORBENT HEIGHT)	Removal Efficiency (%) (OPTIMUM TIME)
1	TSS (Mg/L)	80.56	75.75
2	COD (Mg/L)	26.82	26.21
3	BOD (Mg/L)	96.27	95.74
4	TURBIDITY (Mg/L)	72.72	75.75
5	TDS (Mg/L)	94.37	95.90
6	COLOUR (Hazens)	65	70
7	IRON (Mg/L)	75	73.86
8	K (Mg/L)	72.56	92.98
9	P (Mg/L)	73.36	94.67
10	N (Mg/L)	79.16	63.54

From this we can conclude that the natural adsorbents used are efficient in removing BOD, TDS, TSS, Total Potassium content, Phosphorus content.

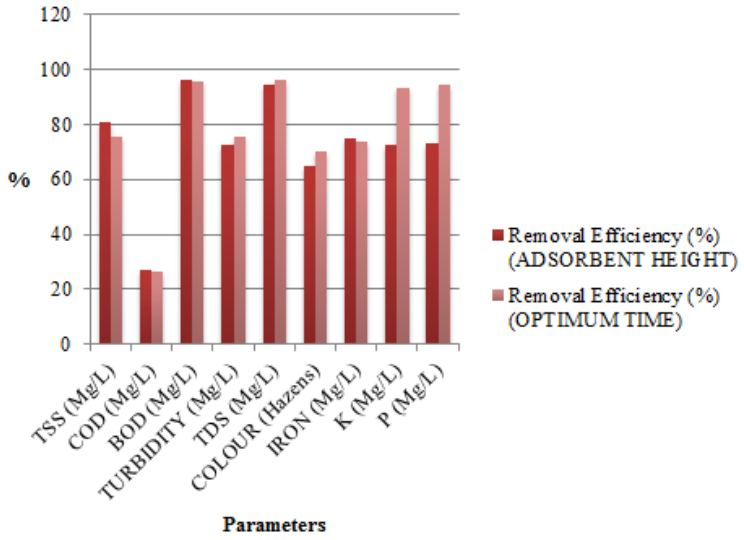

Figure 4: Efficiency Of Adsorbent

4. Conclusions

The various characteristics of fertilizer wastewater were observed to be changed after the treatment with natural adsorbents. The TSS and phosphorous of the waste water sample were already only slightly above the safe limits. After the final treatment the values became much better. The outstanding removal efficiency is obtained by using the combination of all adsorbents. Also there is a significant reduction in BOD level. The turbidity removal efficiency is found to be greater than 75%.The iron content was decreased considerably with an removal efficiency of above 74%.From this we can conclude that the natural adsorbents plays an important role in the nutrient removal and fertilizer waste water treatment in the experiment. The pH value changed closer to normal pH. Thus the water can be reused as irrigational water without any further treatment. The nitrogen, phosphorus, and potassium in the waste water sample tested, clearly revealed that the treated water can be used for the irrigational purposes and achieved a removal efficiency greater than 70%. The colour of the treated water only shows little variation compared to the original waste water. From the experiment, it is observed that the water after treatment is fit for irrigation purposes, gardening, washing, cleaning and various other domestic purposes. Here the natural adsorbents prove to be more effective in water treatment. The results proved that the low cost adsorbents such as carica papaya leaf, carica papaya seed and trunk can be fruitfully used for the

removal of nutrients too. The present project also revealed that the adsorption increases with increase in retention time and is dependent on the height of the adsorbent used in the adsorption column. Thus adsorption using low cost adsorbents like carica papaya leaf, carica papaya seed and trunk opens a new door to the existing water scarcity problem in Kerala. The outcome of fertilizer waste water treatment using natural adsorbents is an answer to the existing problem of water scarcity. Overall the project is found to be like take and put in use type.

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