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"Water Hyacinth - A potential Phytoremediator and Biofertilizer"

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Abstract- *Phytoremediation a biological treatment method for different domestic and industrial waste water that utilizes plants and microbiological processes to eliminate potential harmful contaminants in wastewater. Different plants have been employed in the methodology based on their ability of contaminant removal from the wastewater. The current paper is focused to treat Sewage and Dairy wastewater by the process of phytoremediation with the application of effective hydrophyte Water Hyacinth, which was isolated from the lakes of Davangere District, Southern part of India. Phytoremediation was carried out in Laboratory scale by cultivating Water Hyacinth for 27 days in both wastewaters in two separate acrolytic containers. Analysis was made for every 9 days interval to check the reduction in different parameters. Results showed that Water Hyacinth was effective in treatment of both wastewaters with 40%, 60% and 72% of significant reduction in Dissolved solids, Suspended solids and turbidity, 65 % and 64 % of COD and BOD reduction, Nutrient absorption for both wastewaters with Water Hyacinth was found to be 51% and 53% .Cultivated and harvested plant was utilized for compost, tested on Cicer arietinium plant and positive growth response were observed than chemical and controlled compost.*

Keywords: **Phytoremediation, Sewage, Dairy Waste Water, Water Hyacinth, Compost**

1. INTRODUCTION

Rapid Urbanization and industrialization have created major environmental alterations and nuisance deforming the developing society in a serious manner. Control of pollution and environmental engineering management are the two developing concerns of Human daily routine (Moyo et al. 2013). Water is a Universal solvent which has the inherent capability of diluting the pollutants which enters the system (Nilanjana 2005). Industrial and Municipal Wastewater produced from human activities need to be treated before discharging in to the water bodies. (Moyo et al. 2013). Food, water, fuels, minerals and different types of raw materials is an essential to maintain a sustained life but it is reaching a unsustainable level due to the unwanted wastewater discharged back to the environment. Environment is considered as an unlimited source and also unlimited sink for wastewater which serves also as the reason for environment deterioration (Ajayi et al. 2012). Conventional wastewater treatment method includes filtration, Ion exchange columns, adsorption, and electrochemical removal etc., are not economical and badly affects the aquatic systems. Recently, removal of potential harmful pollutants from wastewater is phytoremediation technique which is a simple, cost effective and a self-sustaining low land alternative among Conventional wastewater treatment methods (Bhokari *et al.* 2016). A plant represents the first compartment of the terrestrial food chain and it is also the major component of the natural ecosystem and agro system (Smical et al. 2008).Last two decades have witnessed for huge development in phytotechnology that involves plants for potential harmful pollutants removal by the application of hyper accumulating plants that is capable of accumulating, translocating, and concentrate large quantity of potential harmful metals in their above-root tissues(Bhokari et al. 2016).

Phytoremediation is the technique that uses the concept of plant-based systems and processes of microbiology in order to eliminate contaminants in aquatic systems. Plant absorbs certain contaminants and nutrients from soils or water and stores in their body and ultimately disposes. Remediation of waste water through plants uses specific arrangement for plants, constructed artificial wetlands, floating systems of plants etc., Different unit operations of wastewater treatment plants like sedimentation, filtration, adsorption are adopted to remove wastewater constituents from soil as well as wastewater. Phytoremediation involves different methods for the treatment of wastewater by Rhizofiltration, phytostabilization, phytoextraction, phytotransformation or phytodegradation. Choosing of appropriate phytoremediating plant which suits the method and capable for uptaking huge quantity of organic as well as inorganic contaminants. The plant should get adjusted to the wastewater so that it grows well in that wastewater and should have the capacity to produce a huge biomass by making use of nutrients that are available in the wastewater and controlled in quantitavely propagated dispersion. Uptaking of organic, inorganic nutrients and pollutants storage vary from plant to plant and varies from species to species with a genus. Economic profit of green technology is measured using activity of photosynthesis and plant growth in wastewater (Gupta et al. 2012). Phytoremediation process that utilizes the plant are classified as Aquatic plant species, Hydrophytes and Macrophytes used to take out the contaminants from the wastewater keeping an intention of cleaning the environment. Floating plants such as Hyacinth, Water Lettuce, Duckweed, including other species from this family Cattalis and Common Reed can be used. The plants are best selected due to their high Biomass production, and their capacity to absorb nutrients from the soil and water. The technique is very useful during the Nutrients removal process (Marecik et al. 2013).

The phytoremediating plants can also be used as Biocompost that can be applied to obtain effective and successful results by increasing the plant growth. Biocompost is the important necessity in agriculture which may be either organic or chemical which in return increases the soil quality and crop yield. Organic manure is nowadays drawing its attention because of its increased organic efficiency in terms of physical, chemical characteristics of the soil. (Vidya et al.,2014). By the above data the current work was designed to treat waste water by Water Hyacinth in lab scale with generation of compost.

2. MATERIALS AND METHODS

2.1 Waste water Sample collection

Domestic sewage was collected from a point of Davangere District, Southern part of India. Grab sampling also called as catch sampling was followed for the collection of sample at a specific time. Sample was collected at a single point where water was not stagnant. Dairy waste water was collected from Bhathi Dairy, Davangere, Shimoga Milk union limited, Southern part of India. Raw wastewater was collected from the point before aeration process which had a foul odour due to the presence of organic matter.

2.2 Characterization of wastewater

The untreated domestic sewage and Dairy Waste water were analyzed for Chemical (COD),(BOD), Nitrate(as NO_3), Phosphate (PO_3) and other physical parameters. The Concentration determines organic load and nutrients, the quality of water. Both water samples were optimized for cultivation of water plants.

2.3 Hydrophytes and its Lab Scale Cultivation for Phytoremediation

Davangere lies in the center of Karnataka between the latitudes 13°5' and 14°50' N longitudes 75°30' and 76°30' E. Davangere district having 7 lakes with many hydrophytes, among them potential phytoremidiating plant was isolated. Eicchornia Crassipes (Water hyacinth) was collected from Bhathi lake and was washed with tap water to remove the soil particles attached to the roots and fresh weight of Water Hyacinth was taken.

Lab scale cultivation of Water Hyacinth was made in acrolytic containers for 10 liters volume of wastewater. Fresh plant weighing 250 grams was inoculated in both optimized Sewage and Dairy Waste Water with pH 7 at room temperature for 27 days and was harvested and used for compost preparation. Treated water was analyzed for its reduction efficiency with regular interval of 9 days for 27 days cultivation.

2.4 Hydrophytes as compost

Harvested plants was washed and weighed, about 250grams each was cut into pieces and dried well in the shade for 15 days and mixed with soil with 1:1 and applied as compost. Pots experiment was carried to determine the effect of compost on commercial plant Cicer artienium. Pots were taken and equally divided for Hyacinth compost, Control and Chemical fertilizer. Each pots were sown with ten *Cicer artienium* seeds treated with 150gms of Water Hyacinth and 10 grams of urea. Seeds were allowed to germinate and was watered daily. Plant after 30 DAS (Days after sowing) were analyzed for Root length, Shoot length, number of leaves and branches to determine compost efficiency.

3. RESULT AND DISCUSSION

Domestic and Dairy wastewater was treated by Water Hyacinth by harvesting it for complete 27 days and treated wastewater was analyzed for 9 days interval to determine the reduction in pH, TDS, TSS, COD, BOD including nitrate and phosphate. Table 1 shows the reduction in pollutants of domestic wastewater using Water Hyacinth for 9, 18, and 27 days respectively.

3.1 Treatment of Domestic wastewater using Water Hyacinth

After cultivation Results showed the gradual increase in pH of Sewage with Water Hyacinth which was alkaline before the treatment itself. pH of the Sewage was increased from 7 to 9 with both Water Hyacinth as shown in Table 1. Turbidity was reduced to 2.81NTU with Water Hyacinth. 70.8mg/L and 15.6mg/L of higher reduction of TDS and TSS were found as shown in Table 1. 87.1% removal of BOD was found with Water Hyacinth for 27 days of treatment. The COD removal was 55%, 57.94% and 70% for 9, 18, and 27 days respectively. Water Hyacinth is capable of absorbing nutrients from the waste water. Result shows nitrate and phosphate content in water was reduced to 8mg/L and 3.5mg/L respectively as shown in Table 1.

Table -1: Remediation of Domestic wastewater using Water Hyacinth.

Sl. no	Parameter	Units	Raw	Remediation Period		
				9	18	27
1	Ph	-	7.65	8.77	9.38	9.77
2	Turbidity	NTU	8.93	3.3	3.26	2.81
3	EC	µs/cm	419.8	359.8	210	91.8
4	TDS	mg/L	240.3	210.2	130	70.8
5	TSS	mg/L	220	160.2	70.6	15.6
6	BOD	mg/L	428.57	171.42	148	128.57
7	COD	mg/L	1000	450	420.6	300.2
8	Nitrate	mg/L	16.3	11.6	9.1	8.0
9	Phosphate	mg/L	8.2	5.1	4.0	3.5

3.2 Treatment of Dairy wastewater using Water Hyacinth

Remediation of various parameters in Dairy Waste Water using Water Hyacinth for 27 days of treatment is shown in Table 2. Water Hyacinth have brought the pH of the water to neutral and within 9 days of treatment water was converted to alkaline state. Dairy waste water was more turbid initially but on treatment Water Hyacinth reduced turbidity to 2.81NTU. With 27 days of treatment electrical conductivity was highly reduced and was found to be 106.7mg/L. Dairy waste water will be having more dissolved solids and after treatment was reduced to 64.05mg/L with Water Hyacinth. 65.20mg/L reduction was obtained for total suspended solids with Water Hyacinth. COD was removed at a very high efficiency and also with BOD. Water Hyacinth proved to be a good nutrient remover from waste water. Water Hyacinth showed the good performance in Phosphate and nitrate removal. 3.15mg/L of final value for phosphate was obtained with Water Hyacinth.

Table -2: Remediation of Dairy wastewater using Water Hyacinth.

Sl. No	Parameter	Units	Raw	Remediation period		
				9	18	27
1	pH	-	6.06	6.82	7.15	7.47
2	Turbidity	NTU	53.7	20.31	17.7	2.81
3	EC	µs/cm	1084	836.65	592.5	106.7
4	TDS	mg/L	646.52	510.69	360.65	64.05
5	TSS	mg/L	304.9	260.18	135.43	65.20

6	BOD	mg/L	1333	738.60	409.21	342.22
7	COD	mg/L	2270	1063.02	621.54	416.02
8	Nitrate	mg/L	651	342.14	284.67	133.48
9	Phosphate	mg/L	225	160.20	119.24	3.15

3.3 Comparison of Water Hyacinth in remediating Domestic and Dairy Wastewater efficiency

Table 3 and chart 1 shows the remediation efficiency of Water Hyacinth in remediation of Sewage and Dairy Waste water. Results shows pH , Turbidity, BOD and COD are reduced up to 21.65%, 65.68%, 65.15% and 61% with Water hyacinth. Water Hyacinth was efficient in treating Domestic wastewater.

Table -3: Remediation efficiencies of Water Hyacinth for Domestic and Dairy Waste water

Sl. no	Parameters	Units	% of reduction in Dairy wastewater	% of reduction in Domestic wastewater
1	pH	-	17.88	21.65
2	Turbidity	NTU	74.68	65.68
3	EC	mg/L	52.76	46.23
4	TDS	mg/L	45.47	42.98
5	TSS	mg/L	49.61	62.66
6	BOD	mg/L	62.74	65.15
7	COD	mg/L	69.14	61
8	Nitrate	mg/L	61.07	41.3
9	Phosphate	mg/L	58.20	48.76

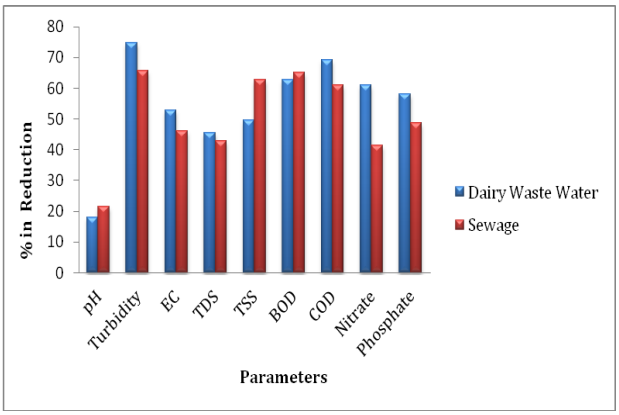

Chart -1: Remediation efficiencies of Water Hyacinth for Domestic and Dairy wastewater

Water Hyacinth gets adopted and grows well in polluted water is identified as one of the reason for this reduction. Results shows that all the Parameters are removed efficiently by Water Hyacinth. Dairy wastewater was treated by Water Hyacinth with higher reduction efficiency than Domestic wastewater. Turbidity was reduced by 74.68% with Water Hyacinth. Reduction in BOD, COD, Nitrate, Phosphate, including Suspended solids was 62.74%, 69.14%, 61.07%, 58.20% and 49.61% with Water Hyacinth for Dairy wastewater.

Water Hyacinth cultivated in both the wastewater for treatment depletes carbon dioxide in water because of the photosynthetic activity resulting in the increase of dissolved oxygen and aerobic condition is created that results in the reduction BOD and COD in wastewater. The roots of aquatic plants can retain both coarse and fine particulate organic materials present in water bodies supporting their growth. This was mainly achieved through the electrical charges associated with the root hairs, reacts with the opposite charges on colloidal particles observed reduction of total dissolved solids from effluent samples treated by the aquatic macrophytes in the present study could be attributed to this reason (Reddy 1981).

3.4 Growth Study of Cicer Arietinum Using Hydrophyte Compost

Water Hyacinth used for the treatment of Domestic Waste water and Dairy Waste Water were further used as fertilizers for growing the plant for about 30 days. Growth study results shows that Root and Shoot Length of the plant grown in a pot using Water Hyacinth as a fertilizer is good when compared to other pots. Overall growth of the plant was good with Water Hyacinth.

Table -4: Growth study on Cicer arietinum Plant using Fertilizer at 30 Days of sowing

Manure	Root Length (in cm)	Shoot Length (in cm)	No. of leaves	No. of branches
Control	5	12.5	60	7
Water Hyacinth	11.4	18	81	7
Urea	5	15	59	7

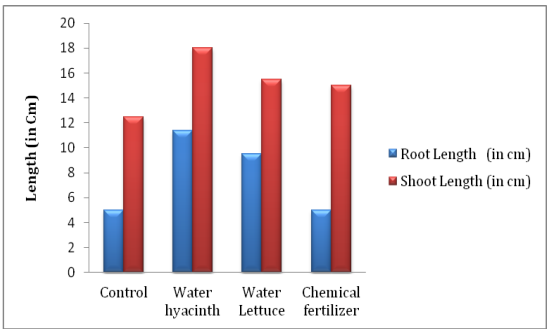

Chart -2: Root and shoot length of *Cicer Arietinum* plant using Compost

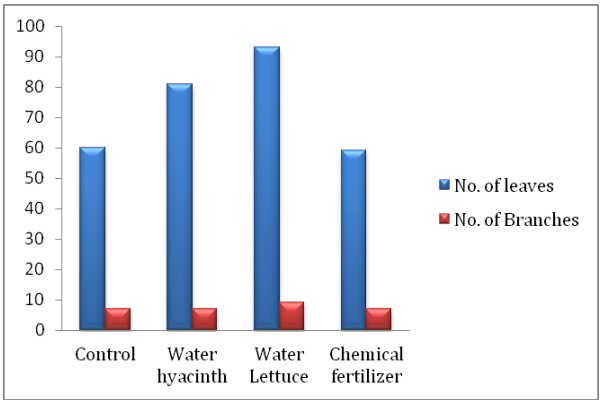

Chart -3: Number of leaves and Branches of *Cicer arietinum* plant using Compost

3.5 Effect of Water Hyacinth Compost on Cicer arietinium

Application of water hyacinth manure had significant influence on the growth attributes and yield of the Cicer arietinium plant when compared to control. Increased yield was obtained with the use of Water Hyacinth as compost.

Contaminants are uptaken and stored in the root tissues of water hyacinth and due to this process they are called as Bio accumulators. Contaminants are absorbed by the roots along with the water and Carboxyl group present in the root structure help them to undergo Cation exchange in cell membrane and this process may be the reason behind the absorption of pollutants from wastewater. Good environment is provided by Hyacinth for the growth of bacteria and hence they feed on nutrients producing inorganic compound for their survival resulting in the formation of compost. (Rizwana M. et al. 2014).

4.CONCLUSIONS

Phytoremediation popularly known as Green technology due to its low cost and also because of its easy managing criteria replaces Conventional methods of treating industrial and municipal effluents (Gupta et al. 2012). The phytoremediation is very effective and eco-friendly technology and proved as most successful method in the treatment of Wastewaters (Reddy et al. 2015). Water Hyacinth is the most common floating leaved plant on water.

Result provides a conclusion that Water Hyacinth emerges as a better phytoremediator in treating both waste waters. Dairy wastewater was also treated by Water Hyacinth with higher reduction efficiency than Sewage. Turbidity was reduced to a lower value by Water Hyacinth. Overall reduction in BOD, COD, Nitrate, Phosphate, including Suspended solids were found good with Dairy wastewater. But, Water Hyacinth again proves to be the best one in reduction of different parameters.

Water Hyacinth has a good remediating property due to its excellent root system and due to this, a good absorption of coarse and fine organic particulate matters can be found and results in growth of the plant leading to a huge biomass (Dipu et al. 2010).

Phytoremediation is a process where the plants are used directly for the removal and reduction of the contaminant from the wastewater by using processes of natural metabolism and hydraulic actions. These properties are exhibited by the water hyacinth and hence it exhibits a higher potential in the treatment of wastewater efficiently (Ajayi et al. 2012).

Present study revealed that application of water hyacinth manure had significant influence on the growth attributes and yield of the Cicer arietinium plant when compared to control. There was a significant increase in the percentage of biomass, root and shoot length when compared to control. All parameters had higher values as compared to control, Chemical fertilizer and Water

Lettuce pots. The study of water hyacinth as Compost revealed that incorporation of water hyacinth into soil crop system increases the performance of the plant.

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