ISSN: 2395-7852

International Journal of Advanced Research in Arts, Science, Engineering & Management

Volume 10, Issue 3, May 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 6.551

+91 9940572462 +91 9940572462 ijarasem@gmail.com www.ijarasem.com

International Journal of Advanced Research in Arts, Science, Engineering & Management (IJARASEM)

| ISSN: 2395-7852 | www.ijarasem.com | Impact Factor: 6.551 |Bimonthly, Peer Reviewed & Referred Journal|

| Volume 10, Issue 3, May 2023 |

Application and Characteristics of Aquatic Plants in Wastewater Treatment

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ABSTRACT: Increasing urbanization, industrialization and over population are the factors mainly responsible for adding hazardous components in lake water, which mainly constitutes heavy metals and chemicals etc. Water bodies are the main targets for disposing the pollutants directly or indirectly. In this review paper illustrating the role of plants to assist the treatment of wastewater. The prevailing purification technologies used to remove the contaminants are too costly and sometimes non-ecofriendly also. Therefore, the research is oriented towards low cost and eco-friendly technology for waste water purification, which will be beneficial for community. The review paper discusses the potential of different process and utilization of terrestrial and submerged aquatic plants (Hydrilla) in purifying water and wastewater from different sources. Present study was conducted by off-site experiment, where Hydrilla verticillata Casp was cultured in a tub for subsequent seven days over one year. Second one of the tub was used as control. The quality of domestic wastewater was assessed before and after the experiment by analyzing physicochemical parameters.The results of the present experiment revealed the significant improvement in the quality of municipal wastewater, as indicated by the decrease in values of most physicochemical parameters studied. That showed efficiency and potentiality of aquatic plant for the purpose.

KEYWORDS: Wastewater Treatment, Submerged Aquatic Plants, Lake Water, Constructed Wetlands, Hydrilla

I. INTRODUCTION

The growing environmental pollution needs for decontaminating waste water result in the study of characterization of waste water, especially domestic sewage. In the past, domestic waste water treatment was mainly confined to organic carbon removal. Recently, increasing pollution in the waste water leads to developing and implementing new treatment techniques to control nitrogen and other priority pollutants.

Globally, most developing countries are geographically located in those parts of the world that are or will face water scarcity in the near future. In addition, existing water sources are contaminated as untreated sewage and industrial effluents are discharged into surface waters, resulting in deterioration of water quality. Constructed Wetland (CW) wastewater treatment is one of the suitable treatment systems used in many parts of the world. Wetlands are defined as land where a body of water is near the earth's surface long enough each year to maintain saturated soil conditions along with associated vegetation. Bogs, marshes, and bogs are examples of naturally occurring wetlands.

Natural wetlands are ecosystems that are either permanently or temporarily saturated in water, providing a natural habitat for biotic organisms and supporting conditions that promote the development of wetland soils. The structure of a natural wetland is shaped due to its surrounding abiotic conditions and these may be classified as: marshes, swamps, forested wetlands, bogs, and wet meadows, as well as coastal wetlands such as mangroves. The ability of wetlands to retain large volumes of water, which they release slowly, makes them significant for combatting extreme weather conditions such as flood control and drought mitigation, that occur more frequently as a result of climate change. Additionally, wetlands contribute to water purification, water regulation, biodiversity, aesthetics and recreation. Within the natural wetlands many biological activities occur, therefore these are known to be as “biological supermarkets”. Natural wetlands endowed shelter to many species by providing huge quantity of food for their survival. The life cycle in the natural wetland ecosystem shows similarity as in other ecosystems. For example, in wetlands, bacteria degrade the dead decay matter of plants and animals into organic form as they do in other ecosystems.

II. LITERATURE REVIEW

Table 2.1: Historical developments of wetland treatment technology

Types	Flow	Year	Location	Application	References
Free water surface	Horizontal	1952-1970s	Plon, Germany	Removal of Phenols and dairy wastewater treatment with bulrush plants	Seidel, 1966
		1980s	California	Urban storm water treatment	Chan et al., 1982
		1990-2000	USA Norway China Canada	For the treatment of Landfill leachate, industrial, stormwater and mine drainage	Vymazal, 1998
		2000 onwards	Canada USA Argentina Kenya, Greece Australia Spain UK, Sweden, Zambia New Zealand	For the treatment of Landfill leachate, pulp and paper, mine drainage, swine, dairy, domestic and industrial wastewater	Hadad et al., 2006
	Horizontal	1960s	Germany	Various type of wastewater	Seidel, 1966
		1970s	Germany	Treatment of municipal sewage	Kickuth, 1978
		1980s	Germany, Australia	Treatment of municipal sewage and piggery effluent	Kickuth, 1981 Finlayson et al, 1987
		1990s	Worldwide, UK, USA, Australia, Slovenia, Germany China New Zealand Denmark Canada, Switzerland, Norway	For the treatment of municipal/ domestic, industrial, agricultural, run off and Landfill leachate wastewater	Robinson et al., 1999
		2000 onwards	UK, USA India Italy, Spain, Portugal, Kenya, Canada, Slovenia, Mexico Australia South Africa Lithuania	For the treatment of municipal/ domestic, industrial, agricultural, run off and Landfill leachate wastewater	Bresciani et al., 2007

			Thailand, Germany France Taiwan, Poland		
	Vertical	1965	Germany	CW with vertical flow was used as pretreatment units before wastewater treatment in horizontal flow bed	Seidel, 1965
		1990s	Germany, Netherlands	For the treatment of municipal/ domestic, special organics, herbicides, dairy,and cheese dairy wastewater	Kern and Idler, 1999
		2000 onwards	Portugal, Canada, Australia Germany France Pakistan	For the treatment of municipal/ domestic, special organics, leachate, and refinery wastewater	Aslam et al., 2007
	French - Hybrid	1979	France	The use of this system, developed by the CEMAGREF (now IRSTEA) in the early 1980's Used for treatment of raw sewage	Liénard, 1987
Subsurface	Hybrid	1965-1975	Krefeld, Germany		Seidel, 1965
		1990-2000	UK Nepal	Sewage wastewater, hospital	Burka and Lawrence, 1990; Laber et al., 1999

III. METHODOLOGY

3.1 MATERIALS AND METHODS

3.1.1 Materials Required

1. Hydrilla Aquatic plants
2. Wastewater Sample collect from Futala Lake, Nagpur
3. Tube
4. PVC Pipe
5. Valve

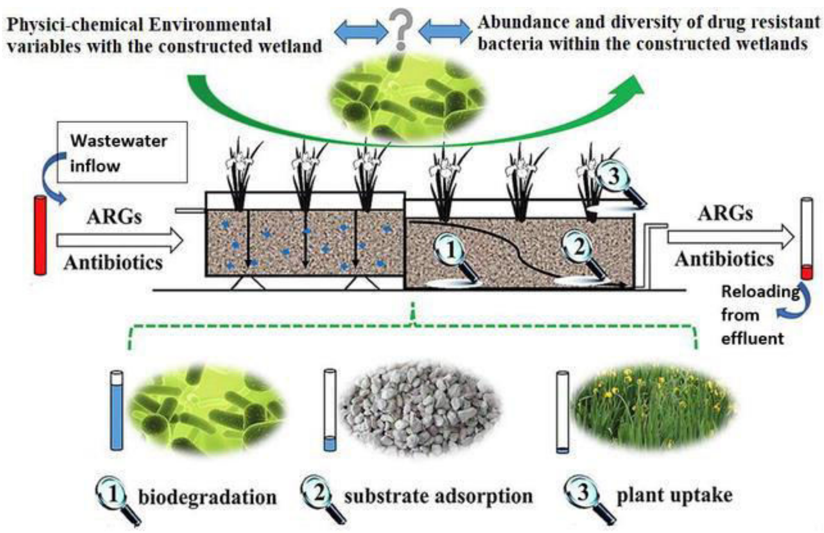
[Fig.3.1: Collection of Hydrilla Aquatic plants]

3.1.2 Experimental technique

Experimental aquatic plant (Hydrilla verticillata Casp.) is a submerged aquatic plant, native of Africa, Australia and parts of Asia, which can quickly overcome other plant species because of the ability to grow with less light and more efficiently take-up nutrients from aquatic system.

[Fig.3.2: Wastewater Sample and Hydrilla plants]

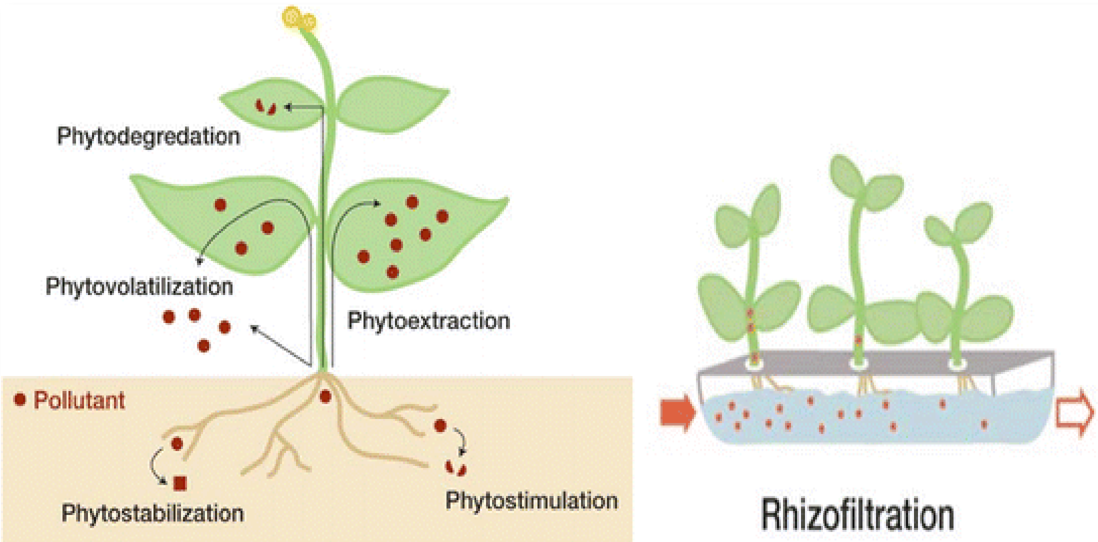
Remediation of nutrients from lake water (wastewater) was studied by using a Hydrilla verticillata Casp. A fixed amount of 100gms of this aquatic plant was cultured in a plastic tub of 0.173 m diameter, six inches deep and 20 Liter capacities containing domestic wastewater, for a week interval.



[Fig.3.3: Constructed Wetland Process]

3.1.3 Rhizofiltration Technique

A rhizofiltration system planted with Hydrilla was constructed with the sample of Futala lake Nagpur, Maharashtra, and evaluated for its efficiency in removing physical, chemical parameters and enteric pathogens from wastewater.The utilisation of wetlands for remediation of polluted soils and waters via rhizofiltration, phytostabilisation and phytoextraction has been increasing steadily over the past decades. The use of wetlands for quality improvement of wastewater, referred to as rhizofiltration, is the best known and most researched application of constructed wetlands.Rhizofiltration is the process of absorption of contaminants present in the rhizosphere into the root system of plants. This remediation process is used to decontaminate aquatic ecosystems using aquatic or land plants. During the utilization of this process, plants are grown on the contaminated site (in situ) or in an ex situ environment. Contaminants are absorbed through plant roots until saturation is reached, and finally, the plants are harvested with their roots. As the accumulation of contaminants occurs in the roots without any translocation to the shoots, there is an extremely low chance of atmospheric contamination.



[Fig.3.4: Rhizofiltration Technique]

IV. RESULTS

4.1 PHYSICO-CHEMICAL EXAMINATION OF FUTALA LAKE WATER

Macrophytes / aquatic plants grow normally in water bodies polluted by nutrients of varied sources and utilized the nutrients to produce large amount of biomass. The results of physico-chemical analysis of lake water before & after the remediation by using a submerged aquatic plant Hydrilla verticillata Casp shown in Table – 4.1).

Physical parameter Temperature plays an important role in change of various chemical parameters and physiological process of aquatic plant. pH Value was recorded around 7.0 before culture but after the culture (ending of the experiment) little increase was noticed due to reaction of aquatic plant in water.

Turbidity and Salinity values were decreased after the culture during the entire study period.

Table 4.1: Physico-chemical characteristics of Lake water before & after the culture of "Hydrilla verticillata"

S.No.	Parameters	Unit	Initial Value	Final Value
1.	Temperature	Celcius	24.8	22.9
2.	pH	.	6.98	7.63
3.	Turbidity	NTU	18.1	10.1
4.	Salinity	‰ (permil).	0.553	0.469
5.	Electrical Conductivity	Mmhos	835.10	720.30
6.	Total Oxygen Demand	Ppm	538.10	468.90
7.	Total Alkalinity	mgCaCo/L	260	155
8.	Chloride	mg/L	108.45	103.10
9.	Dissolved Oxygen	mg/L	2.6	7.5
10.	Oxygen Saturation	%	33.3	82
11.	Chemical Oxygen Demand	mg/L	144	100.8
12.	Total Hardness	mg/L	335.62	256.08
13.	Calcium Hardness	mg/L	184.14	140.58
14.	Calcium	mg/L	73.80	56.34
15.	Magnesium	mg/L	36.46	27.68
16.	Ammonical -N	mg/L	12.89	6.74
17.	Nitirite-N	mg/L	0.362	0.242
18.	Nitrate-N	mg/L	57.04	29.11
19.	Total Phosphate	mg/L	1.657	1.154
20.	Organic Phosphate	Mg/L	0.795	0.593

A minor variation was observed in chloride contents due to its non-utilization by the aquatic plant. In domestic wastewater Dissolved oxygen and Percentage oxygen saturation values were increased significantly, after the experiment, as Hydrilla verticillata Casp played a vital role in oxygen transfer in to water system. Nitrogen contents were examined as Ammonical, Nitrite and Nitrate form. As Nitrate nitrogen is the stable product of oxidation.

4.2 PERCENTAGE CHANGES IN PHYSICO-CHEMICAL PARAMETERS

Physical changes:

Temperature minimized 9.89 percentage and pH shifted above of 6.58 %. Reduction in Turbidity, Salinity noticed 37.00 and 17.42 %. Due to ionic absorbing tendency of Hydrilla verticillata Casp in experiment, Electrical conductivity and Total dissolved solids were deducted in 15.66 and 15.80 % relatively.

Chemical changes:

34.50 % Reduction was found for Total alkalinity. Remarkable utility of Carbon dioxide in photosynthetic activity Total and Free carbon dioxide reduced in 51.56 and 36.91 %. Because of significant release of oxygen in water by Hydrilla verticillata Casp Dissolved oxygen values increased to 140.1 % and Oxygen saturation 113.0 %. Little change in

Chloride (4.38%) was found. Chemical oxygen demand decline average of 36.14 %. Total hardness, Calcium hardness, Calcium, Magnesium values were reduced by percentage of 28.71, 24.96, 24.39 and 37.16 individually. More than 39.00 % reduction rate was noticed for Nitrogenous and Phosphorous compounds like Ammonical – N (39.45 %), Nitrite – N (47.59 %), Nitrate – N (50.35 %) and Total ortho phosphate (52.58%), Acid hydrolysable phosphate (42.85 %) and 44.69 % for Total phosphate. Organic phosphate reduction value in percentage was 36.41 after the experimentation in lake water with Hydrilla verticillata Casp.

V.CONCLUSION

It is noted that CWs are now being increasingly used for environmental pollution control. Constructed wetlands were implemented in a wide range of applications, such as water quality improvement of polluted surface water bodies, wastewater on-site treatment and reuse in rural areas, campuses, recreational areas and green architectures, management of aquaculture water and wastewater, tertiary treatment, and miscellaneous applications. Water monitoring results obtained from several demonstrations show that CWs could achieve acceptable wastewater treatment performances in removing major pollutants, including suspended solids, organic matters, nutrients, and indicating microorganisms, from wastewater influent. The results indicate that if constructed wetlands are appropriately designed and operated, they could be used for secondary and tertiary wastewater treatment under local conditions, successfully. Hence constructed wetlands can be used in the treatment train to upgrade the existing malfunctioning wastewater treatment plants, especially in developing countries. During hydraulic retention study, it was found that the BOD, COD was best removed in planted wetland than unplanted wetland. It is because of the oxygen diffusion from roots of the plants and the nutrient uptake and insulation of the bed surface. It is also found that the increases in the detention period of the wastewater the removal rate also increases.

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