PHYTOREMEDIATION: ASSESSED BY ZINC & COPPER REMEDIATION BY COMBINING PISTIA STRATIOTES AND WATER HYACINTH.

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ABSTRACT: Metals including copper, zinc, lead, cadmium, etc can cause significant damage to the environment & human health as a result of their mobilities and solubilities. Pytoremediation process is best and prudent technique than the other physical, thermal and chemical methodologies. This technology involves efficient use of aquatic plants to remove, detoxify or immobilize heavy metals. Phytoremediation is a technology to clean the environment from heavy metals contamination & various toxins. The objectives of this study are to treat copper (Cu) and Zinc (Zn) contaminated wastewater by using phytoremediation technology and to determine the appropriate proportion of the both plants i.e. Water Hyacinth & Pistia Stratiotes to be a good accumulator. The results from the present study shows that Eichhornia crassipes (water hyacinth) has a very high accumulation capacity for copper (Cu) & also other physiochemical parameters (pH, T.S.S, T.D.S, & C.O.D) were removed efficiently from industrial wastewater. Pistia Stratiotes removes great amount of Zinc (Zn) compared to Water Hyacinth. Therefore, the treatment of subsurface flow constructed wetland system can be recommended for the small scale treatment facility for removal of heavy metals from various industrial effluents as an prudent, non disruptive & eco-friendly low cost treatment system.

***KEY WORDS*: Industrial effluent, Water Hyacinth, Pistia Stratiotes, Small scale, Constructed wetland.**

I. INTRODUCTION:

Water is the most essential normal asset on this planet henceforth assumes a critical part in the World Economy. It is getting to be scarcer and its accessibility is a noteworthy social and prudent concern. Water contamination is the adverse change of the fresh water which prompts ecological corruption, general medical issues and numerous more unsafe impacts. Water contamination because of substantial metal is more dangerous as overwhelming metals are non biodegradable and in this manner they collect in region any place water logging or holding of water happens. Overwhelming metals are by and large characterized as metals with generally high densities, nuclear weights, or nuclear numbers. Overwhelming metals enters through different sources as anthrapogenically or normally in the emanating of different industries like electroplating, mining, pesticide fabricating and so forth contains immense measure of substantial metals. The gushing with heavy metal contamination causes and delivers a wide range of unfriendly wellbeing impacts to the living creatures, for example, interruption, cancer-causing nature, and chlor-skin inflammation to the endocrine framework and insect estrogen impacts in the two disintegrates and particulate structures. For the most part, overwhelming metals are expelled by ion exchange, chemical precipitation, electro dialysis, coagulation, clarification, reverse osmosis, ultra and nano filtration and so forth, these procedure are exorbitant and proficiency of few isn't up to the mark (Akpor and Muchie, 2010). This strategy produces expansive volumetric ooze and builds the cost for transfer.

Phytoremediation is characterized as the utilization of green plants to expel substantial metals and contaminants from the waste water (Comis,1996). Thus, Pytoremediation process is best and prudent technique than the other physical, thermal and chemical methodologies. The word phytoremediation originates from Greek word phyto which implies plant and Latin word remediation which intends to expel, which alludes to a differing gathering of plants based innovations that utilization either normally happening, or hereditarily designed plant to clean contaminants. Phytoremediation is the used to wipe out toxins from the modern waste water by utilizing aquatic plants. The guideline of phytoremediation process is to tidy up sullied water by developing amphibian plants which has an ability to assimilate toxins by breaking it, or debasing, it can likewise settle metal contaminants by going about as channels or traps. This innovation had been utilized as a part of industrial and domestic wastewater treatment in expelling of supplements, organic chemicals, pesticides, oils, explosives, heavy metals and sewage pollutants. Phytoremediation incorporates a few procedures like, phytoextraction, phytodegradation, phytofiltration, rhizofiltration, phytostabilization and phytovolatilization. Contaminant take-up is mostly caused by underlying roots of plants. Leaves and roots function as a good accumulators. Roots give wide surface region to retain the contaminants. Plants used for the procedure gathers the wastewater, gainful supplements and additionally the non helpful or unsafe contaminants from effluent in leaves and roots. Plants for the most part handle the contaminants without influencing the encompassing condition.

Phytoremediation process will be done by developing the plants in designed artificial wetland with subsurface stream framework. This treatment is most effective with constructed wetland technology. The developed wetlands are ease, straightforward, low cost, environmentally non-disruptive, marsh prerequisites and eco-friendly innovation for water cleaning (Yulinah et al. 2008). Good aesthetic properties and effective treatment capabilities make subsurface flow wetlands an appropriate choice for small-scale or individual treatment for removal of heavy metals & other contaminants from industrial wastewater (Hiley, 1995; Knight, 1993; Knight et al., 1993; Steiner and Combs, 1993). In these frameworks wastewater from the tank enters a couple of creeps underneath the plants and the water level is kept up by the outpouring. Here, Subsurface flow System are outlined with a goal of optional or propelled levels of treatment expelling the heavy metals from industrial waste water. The subsurface flow keeps away from mosquito reproducing conditions, & decreases questionable smells. This system has been called "root-zone" & supports the emergent vegetation. Small-scale constructed wetlands for wastewater treatment are a relatively new & efficient technology. Aquatic plants retains components through roots and shoots which takes-up a significant part of the metal done by plant tissue happens by assimilation to anionic sites in the cell wall of the plant and metals do not really enter the living plants.
Above studies indicated that because of crisp water shortage, water contamination from different industrial exercises having varied ill impacts ought to be avoided and ought to have some treatment facility. This waste water contains many contaminants like pesticides, heavy metals, and other physiochemical parameters which is important to treat them proficiently. There can be numerous strategies for treatment of Industrial waste water, yet these procedures are expensive, most are not compelling, and creates expansive volumetric sludge. In this way, Phytoremediation is one of the technique which can be utilized to dispense with such contaminants by minimal effort, straightforward, naturally non-troublesome, and eco-friendly procedure for waste water cleaning. It can be utilized for pre treatment of industrial gushing with the goal that vitality used by general treatment decreases and effectiveness of the treatment plant increments.

II. EXPRIMENTAL PLANTS:

Eichhornia crassipes (water hyacinth) is an individual from pickerelweed family (Pontederiaceae). It is a free floating aquatic plant. Recreates amid Spring season, and develops all through Spring and Summer months. Locally accessible as Jal Kumbhi in close by lakes. It has been effectively utilized as a part of wastewater treatment frameworks to enhance the water quality by decreasing the levels of heavy metals and natural supplements too. Here, the gushing is debased by the two substantial metals, they are Zinc (Zn) and copper (Cu). Plants amass more zinc and copper from it since they are smaller scale supplements. Copper (Cu) is a part of an electron transporter which is known as "plastocyanin" i.e, dynamic amid photosynthesis. Zinc (Zn) is a segment of compounds like carboxypeptidase, carbonic-anhydrogenase, soluble phosphate, and glutamic dehydrogenase. The component is fundamental for starch and phosphorus digestion and union of RNA.

Figure 1: Water Hyacinth.

Pistia Stratiotes is likewise an amphibian plant in Arum family, Araceae. It is regularly known as the water cabbage, water lettuce or shellflower. The word Pistia is gotten from Greek word "Pistos" which signifies "water". Its development from the debased water is primarily because of its retention limit and in this way it is generally utilized for the treatment of modern wastewaters in view of its higher profitability rate (Dhote and Dixit 2009). Requires full sun to part shade for good development. Bloom time: June to September (best develops: Spring to Autumn) and its locally accessible as Jal Shrunkhla. Greenish yellow to rich white leaves with short roots and child plants developed rapidly along the edges.

Figure 2: Pistia Stratiotes.

The plants are aquatic macrophytes, utilized here are WATER HYACINTH and PISTIA STRATIOTES, are a standout amongst the most usually utilized plants in constructed wetlands in view of its quick development rate and expansive take-up of supplements and contaminants.

III. MATERIALS AND METHODS:

The exploration was led to treat the industrial wastewater at lab scale basis in an artificial constructed wetland, defiled with heavy metals like, zinc and copper and certain other physiochemical parameters like TSS (total suspended solids), TDS (total dissolved solids), COD (chemical oxygen demand), and pH.

The examination was completed in a rectangular tub under the atmospheric condition in open environment with Subsurface flow system. The plants were collected and purchased from nearby Plants nursery. The plants were thoroughly washed several times with tap water & 2 times with the distilled water. The excess amount of water was removed by putting them onto the filter paper and then the plants were weighted as per the requirements as shown in Table no 3.1. Plants were then placed in the plastic tub of dimensions 54*38*15 centimeters size. The plants i.e., Water Hyacinth and Pistia Stratiotes were sprouted in the rectangular tub.

Table: 3.1. Various proportions of both the plants taken to conduct the experiment:

SUBSURFACE FLOW SYSTEM.			
Proportions of plants taken, in % & wet weight (kg).	Number of test runs conducted:	Water Hyacinth plant:	Pistia Stratiotes plant:
	1	50% (1kg)	50% (1kg)
	2	100 (2kg)	0 (0kg)
	3	0 (0kg)	100 (2kg)

Table 1: Various proportions of both the plants taken to conduct the experiment.

Figure 3: Weighing of Water Hyacinth.

Figure 4: Weighing of Pistia Stratiotes.

Copper, zinc and other contaminants were analyzed before the experiment and also the physiochemical analysis & study of present raw industrial wastewater was carried out. This effluent was filled in the bucket container of amount around 8 liters which was passed through a PVC pipe of 0.5inch breadth having the flow control valve @flow rate of 1 liters/hour for each analysis directed for every proportion of plants.

The wastewater depth was kept up and retention time of 15 minutes was given to the plants and likewise for the roots development and efficient treatment of wastewater through the Phytoremediation procedure.

Figure 5: Experimental set-up of the treatment system.

For the collection of treated wastewater, another container measured of 1 liter was kept which was the outlet of the treated waste water.

The test runs of effluent were done and sampling of treated waste water was done at each time intervals of 1.3 hours. Now, to check the potential removal efficiency of the plants, the waste water sampled after each 1.3 hours of intervals were analyzed for its each parameter. This analysis was done for each test runs, & for each ratio of plants taken vice-versa of the same industrial raw waste water.

At that point, the outcomes were noted down contrasting the expulsion productivity at each time interims. Different examination tests (contrasts) were performed between influent v/s treated wastewater and likewise the graphical introductions were made demonstrating the decrease in measures of heavy metals and also in physiochemical parameters.

The examination was completed in the rectangular tub, at flow rate of 1litre/hour with the retention time of 15 minutes. 8 liters of wastewater was passed through the phytoremediation system having an outlet chamber for collecting the treated wastewater. The treated water was examined and graphically representation showing reduction efficiency of various trials.

IV. RESULTS AND DISCUSSIONS:

Our results demonstrated significant difference among the both plant species in this treatment of industrial waste water with high amount of heavy metals & certain physiochemical parameters.

The reduction in Zinc concentration is less by using Water Hyacinth plant, compared to Pistia Stratiotes. Pistia Stratiotes removes Zinc, pH & TSS efficiently. While, Water Hyacinth is efficient in removal of TDS, pH, Copper, & COD.

1.) Reduction efficiency achieved by using 50% Water Hyacinth (1kg) & 50% Pistia Stratiotes (1kg) at various Time intervals:

Time (hours)	pH (%)	T.S.S (%)	T.D.S (%)	ZINC (%)	COPPER(%)	C.O.D (%)
1.3	6.25	10.78	7.79	19.00	32.06	21.33
2.6	6.93	25.09	16.31	37.30	54.73	38.14
3.9	12.98	36.27	24.35	51.20	76.08	49.89
5.2	16.99	42.99	31.12	64.33	86.90	58.38
6.5	18.75	46.52	32.04	74.06	87.66	60.28
7.8	21.87	49.73	32.93	83.33	88.42	61.21

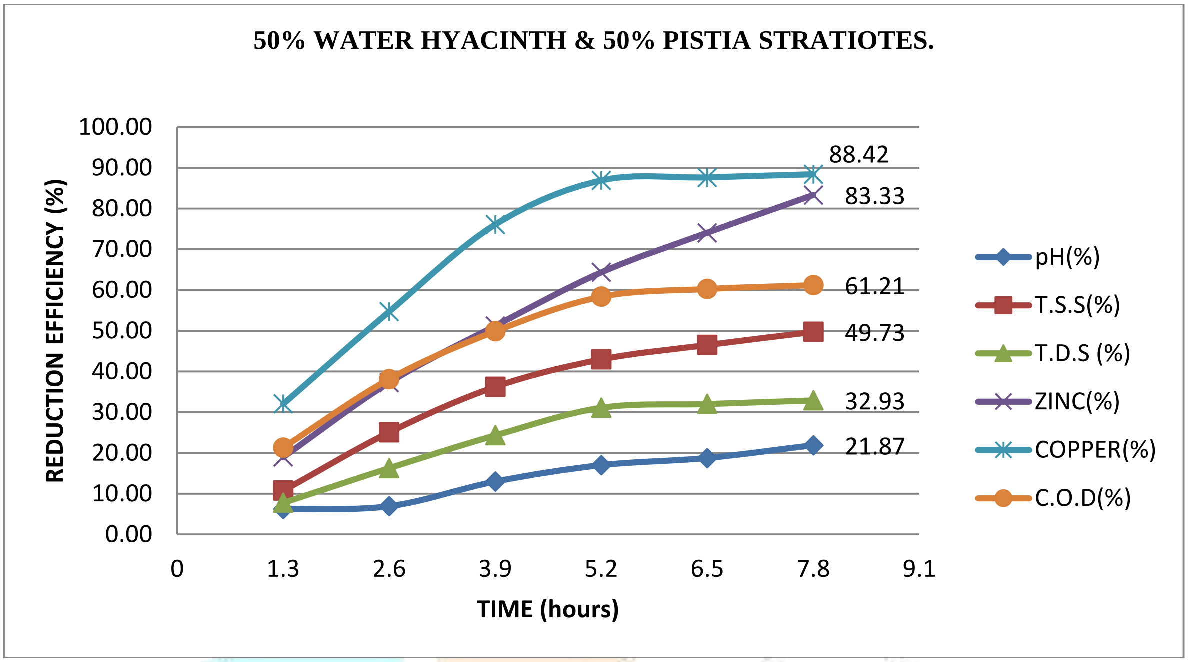

Figure 6: 50% Water Hyacinth & Pistia Stratiotes both plants.

2.) Reduction efficiency achieved by using 100% Pistia Stratiotes (2kg) at various Time intervals:

Time (hours)	pH (%)	T.S.S (%)	T.D.S (%)	ZINC (%)	COPPER(%)	C.O.D (%)
1.3	3.61	2.94	17.00	29.67	27.17	18.51
2.6	5.66	13.64	32.34	54.27	46.52	29.18
3.9	9.08	25.59	45.15	71.15	74.40	39.66
5.2	11.52	27.85	50.17	79.23	78.86	49.75
6.5	12.11	29.10	52.22	84.40	88.26	51.03
7.8	12.30	29.81	56.17	86.87	88.53	56.30

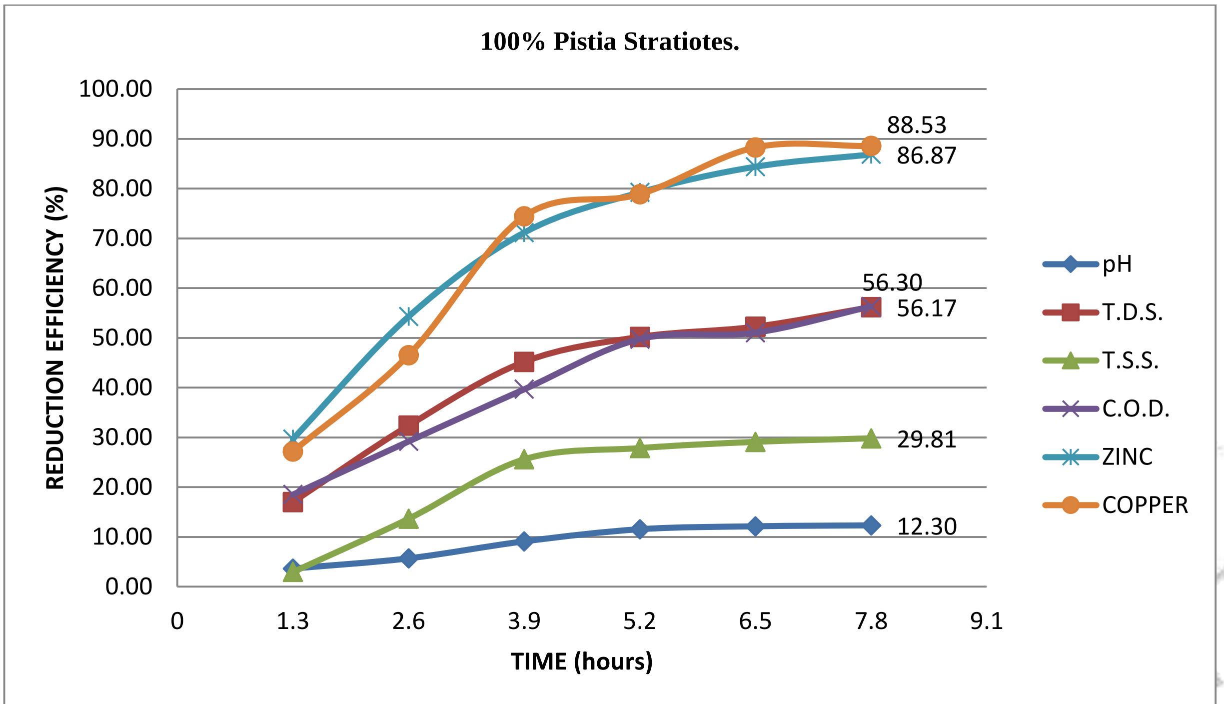

Figure 7: 100% Pistia Stratiotes.

3.) Reduction efficiency achieved by using 100% Water Hyacinth (2kg) at various Time intervals:

Time (hours)	pH (%)	T.S.S (%)	T.D.S (%)	ZINC (%)	COPPER(%)	C.O.D (%)
1.3	8.79	17.60	22.91	23.30	41.47	26.12
2.6	14.65	37.75	43.96	44.83	72.28	41.02
3.9	19.53	54.41	49.27	64.60	89.24	55.01
5.2	21.78	58.24	56.42	81.89	96.36	66.05
6.5	22.46	71.57	61.46	83.65	97.83	75.38
7.8	22.75	87.75	68.44	84.33	98.15	77.14

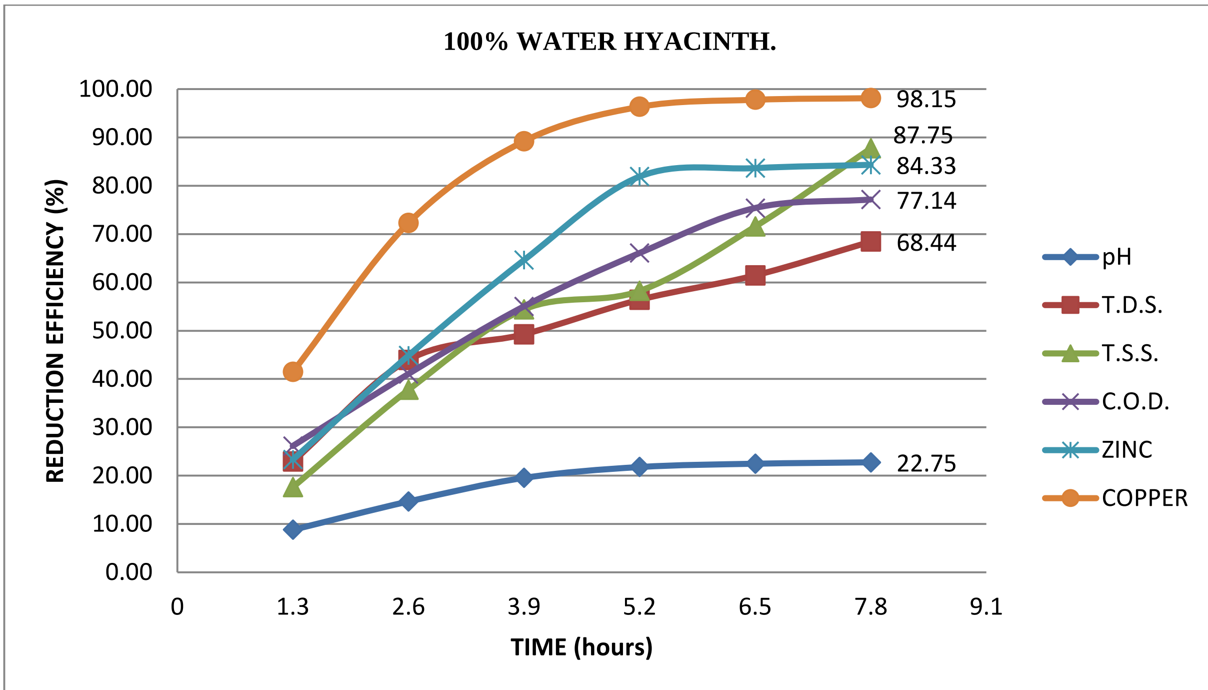

Figure 8: 100% Pistia Stratiotes.

Here, the graphical presentations shows, Reduction efficiency in (%) v/s Time in (hours) of present heavy metals (Zn, & Cu) and other physiochemical parameters by using various proportions of both Water Hyacinth & Pistia Stratiotes plants. The sampling of treated wastewater was done per 1.3 hours i.e. after each 72 minutes. The removal efficiency for Copper is measured 98.16% & Zinc is reduced to 86.87% efficiently by 100% Pistia Stratiotes. The removal efficiency for Copper is measured 98.16% & Zinc is reduced to 84.33% efficiently by 100% Water Hyacinth.

V. CONCLUSION:

Results from the present study shows that Eichhornia crassipes (water hyacinth) has very high accumulation capacity for copper (Cu) 98.51% & also other physiochemical parameters (pH, T.S.S, T.D.S, & C.O.D) from industrial wastewater. Pistia Stratiotes (water lettuce) has high accumulation of Zinc (Zn) 86.87%. When both the plants were equally taken in the experiment, the removal efficiency of each parameter were efficiently achieved 83.33% & 88.42 respectively.

Based on these results the blend of utilizing both the plants is favored which can exceedingly builds the expulsion productivity of heavy metals from the industrial effluent. These plants can be used on large scale for removal of heavy metals. It can be proposed that Eichhornia crassipes & Pistia Stratiotes can act as powerful agents of heavy metals removal from industrial wastewater. Since this specie grow abundantly in wetlands covering almost the entire water surface, the ability to absorb copper & zinc and certain physiochemical parameters.

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