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Absorption competency of Duck weed and Water lettuce towards Cd and Ni in Electroplating waste water

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Abstract – *The huge concentrations of the heavy metals present in Electroplating industry waste water enters food chain by getting accumulated in various living components. The traditional methods that are currently in usage involves lot of processes and highly non-economical. Phytoremediation emerged as a cost effective, efficient and green technology to remediate these heavy metals. In this study two free floating aquatic plants Water lettuce and Duck weed are investigated for their potential to absorb heavy metals from electroplating industry waste water. These plants are grown in waste water samples for the period of 20 days and Heavy metal concentration in the water sample is analyzed for every 4 days until 20 days. Finally the comparison is made between these two plants for removal of Cd and Ni from waste water. The Duck weed plants showed better absorption towards Cd and Ni than Water lettuce plants. The removal efficiency varied from 70-80 percentage by both the plant species.*

Key Words: Bio-absorption process, Atomic Absorption Spectrophotometer (AAS), Phytoremediation, Water lettuce, Duck weed, Heavy metal Toxicity, Cadmium(Cd), Nickel(Ni).

1.INTRODUCTION

The rapid growth in industrial sector made a safe waste water disposal as major environmental issue. Due to discharge of untreated waste water into natural ecosystem, the surrounding environment is polluted. Electroplating technique is employed in metal finishing industries which give rise to waste water with lot of hazardous components and heavy metals (L. Suseela et al.,2021). There are many heavy metals which exhibit different characteristics, some of them are categorized as precedence pollutants which are highly toxic in nature and engages into the food chain through plants and animals (Uzma Majeed et al.,2014). These heavy metals adversely affect the soil environment by altering the soil composition, granular size and microbial activity. They cause chlorosis, stunted growth, yield decrement, metabolic disorders in plants with depression, insomnia, fatigue, sensory damage, irritability and gastric disorders in various animals and humans. Aquatic ecosystem balance is severely impacted by these heavy metals which leads to biomagnification and bio-accumulation in different aquatic species (Vinod Kumar et al.,2019). Hence treatment of waste water is considered as good practice to overcome scarcity of water and reduce the damage to environment. But the conventional methods that are being used are costly and ineffective. The use of easy, economical and efficient technique to remediate heavy metals from waste water is necessary.

1.1 Phytoremediation

It is a green technology, where the toxic heavy metals are converted into non-toxic or less toxic form by various plant species (Shahabaldin Rezania et al.,2016). It includes various mechanisms such as Rhizofiltration, Phytoextraction, Phytodegradation, Rhizodegradation, Phytostabilization, Phytovolatilization, Hydraulic control etc., (Monika Yadav et al.,2021). Bio-absorption is a mechanism where the heavy metals and other pollutants are absorbed by plants roots, tissues and shoot areas. The plants that are used for this process should be able to uptake large amount of both inorganic and organic pollutants with fast growing ability and should show less toxicity (Rasha H Mahmoud et al., 2017). Hence choosing of plants plays a very important role in this technique.

1.2 Free-Floating Aquatic plants

Free Floating aquatic plants possess better capability to eliminate heavy metal from waste water as they are fast growing with high absorbing potential. Active transport of pollutants occurs via roots to shoot system. Passive transport occurs during direct contact of plant parts with polluted water (Shafaqat Ali et al.,2020). Water lettuce (*Pistia stratiotes L*) and Duck weed (*Lemna minor L*) are the most commonly seen aquatic weeds which absorb heavy metals at a faster rate and exhibit less metal toxicity (Sangeeta Anand et al., 2016). Water lettuce consists of pale green leaves with 3-4 inch wide and 2-3 inches long and also with whitish hairy lower part. It has leaves floating on water and a well-developed root system hanging beneath the water. Duck weed plants are tiny with 0.5 to 1 inch overall height and 1-2 cm light green leaves. These plants propagate vegetatively and can be easily harvested if the absorbed heavy metals are to be extracted (Dana A. Mohammed Barznji, 2015).

2. MATERIALS AND METHODOLOGY

2.1 Collection of Waste water sample from Electroplating industry

A CETP located at 12.8421^{0}N, 77.6796^{0}E coordinates near Electronic city, Bengaluru, which receives waste water from surrounding Electroplating industries was approached and waste water sample was collected from its inlet tank .

2.2 Collection of free Floating aquatic plants

The plant samples (Duck weed and Water lettuce) were collected from a lake situated at 12.7769^{0}N, 77.6608^{0}E coordinates near Hennagara village, Bengaluru. These plants were washed in tap water to remove dust and dirt particles and then grown in tap water for 7 days and 50% diluted electroplating industry waste water for other 7 days to acclimate them to waste water. After 14 days healthy plants are selected for further process.

2.3 Experimental process

The collected waste water sample was filled in 10 different 1 litre capacity plastic containers in which the Water lettuce and Duck weed plants are grown. Initially about 10 grams of plants species are introduced in each container and allowed to grow. Plants uses all the nutrients in the waste water and develop day by day. The water samples were analyzed at 4, 8, 12, 16, 20 days for Cd and Ni concentrations. 1 container with water lettuce plants and 1 with Duck weed plants are used during every analysis. After 20th day the absorption efficiency of both the plants are compared.

Fig -1: Experimental setup

2.4 Analytical procedure

The two heavy metals Cd and Ni were analyzed in Atomic Absorption Spectrophotometer (AAS) model AA-6880 through "WizAArd" software. Cadmium is analyzed at 228.8nm and Nickel at 232.0nm wavelengths. Slit width is adjusted as per the requirements for different elements.

3. RESULT AND DISCUSSION

3.1 Cd and Ni reduction over 20 days by Water lettuce and Duck weed plants

The initial Cd and Ni concentrations in the waste water sample was found to be 7.80 mg/L and 11.0 mg/L respectively. After 20 days the concentration of Cd was reduced to 2.06 mg/L and 1.49 mg/L by Water lettuce and Duck weed plants respectively. Water lettuce plants reduced Ni content to 2.98 mg/L and Duck weed plants reduced it to 2.53 mg/L.

3.2 Bio-Absorption efficiency of Water lettuce and Duck weed plants

The Duck weed plants showed better absorption efficiency for both Cd and Ni elements over Water lettuce plants. Duck weed plants absorbed about 80.89% of Cd and 77.00% of Ni. The absorption efficiency of Water lettuce plants was found to be 73.50% and 72.90% towards Cd and Ni respectively. The results obtained during the analysis on 4, 8, 12, 16, 20 days are shown in the below tables and charts.

Table -1: Variation in heavy metal concentration due to Water lettuce plants

Sl.No	Time interval (days)	Parameters	
		Cd (mg/L)	Ni (mg/L)
1.	0	7.80	11.00
2.	4	6.70	9.48
3.	8	5.57	7.92
4.	12	4.42	6.39
5.	16	3.26	4.79
6.	20	2.06	2.98

Table -2: Changes in heavy metal concentration due to Duck weed plants effect

Sl.No	Time interval (days)	Parameters	
		Cd (mg/L)	Ni (mg/L)
1.	0	7.80	11.00
2.	4	6.60	9.40
3.	8	5.35	7.73
4.	12	4.07	6.05
5.	16	2.79	4.35
6.	20	1.49	2.53

Table -3: Absorption potential of Water lettuce plants

Sl.No	Time interval (days)	Absorption efficiency (%)	
		Cd	Ni
1.	4	14.10	13.80
2.	8	28.58	28.00
3.	12	43.33	41.90
4.	16	58.20	56.45
5.	20	73.50	72.90

Table -4: Absorption potential of Duck weed plants

Sl.No	Time interval (days)	Absorption efficiency (%)	
		Cd	Ni
1.	4	15.38	14.54
2.	8	31.41	29.72
3.	12	47.82	45.00
4.	16	64.23	60.45
5.	20	80.89	77.00

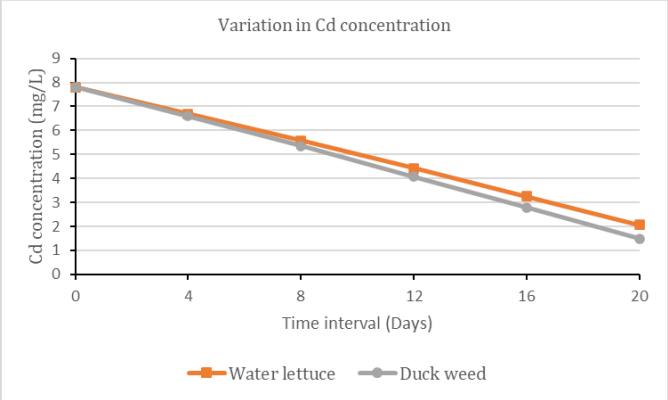

Chart -1: Cd concentration versus Time interval

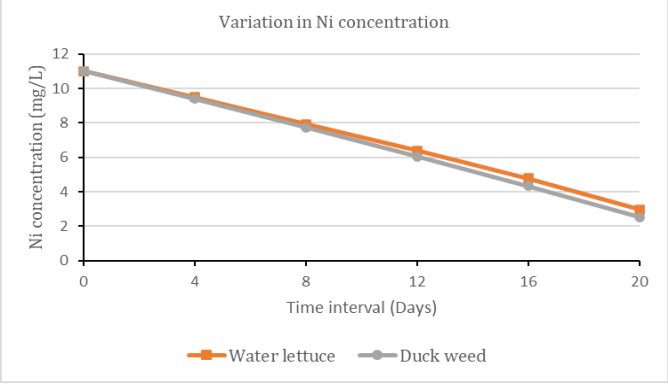

Chart -2: Ni concentration versus Time interval

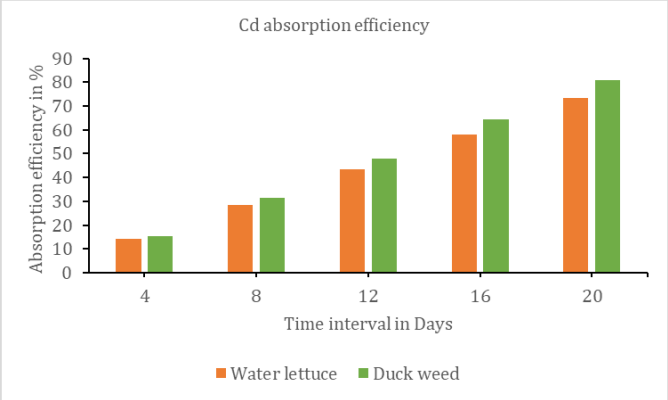

Chart -3: Cd absorption efficiency verses Time

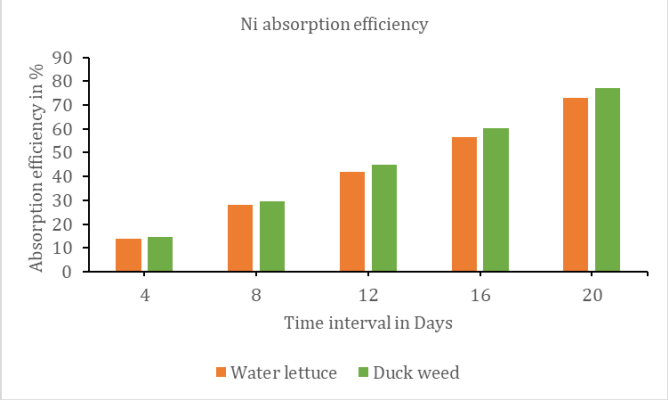

Chart -4: Ni absorption efficiency versus Time

4. CONCLUSION

A clear-cut idea about heavy metal toxicity and cost effective with easily approachable method for heavy metal reduction is obtained by this study. Both the Duck weed and Water lettuce plants showed best absorption on 20th day. The concentration of the heavy metals are highly reduced by Duck weed plants when compared to Water lettuce plants. The absorbed heavy metals can be easily extracted by harvesting the plant parts with very less efforts. This method can be easily adopted in various industries which could not afford for costly conventional treatment methods.

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