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Bioaccumulation Of Heavy Metals Using Hydrophytes

Madhavi M. Motankar, Ankita Chattopadhyay, Chrisene Lucinda Oliveira
Denaisy Rumina Barretto, Joella Rosel Leitao, Laxmi Kumari Malla
Department of Biotechnology
Parvatibai Chowgule College of Arts and Science Autonomous
Gogol, Margao Goa

ABSTRACT:
Hydrophytes play a pivotal role in remediating contaminated water bodies. In the recent years, there has been an increase in heavy metal pollution. The heavy metals enter the water in various ways and adversely affect the flora and fauna. In the present study, Eichhornia crassipes, Salvinia molesta and Azolla pinnata have been tested for removal of Cu, Fe, Pb, Mn, Ni and Zn from metal solutions. These plants have high multiplication rate, wide tolerance to diverse environments and are globally distributed which makes them an ideal choice for bioaccumulation. Examination of water from the two nearby mining areas showed high amount of Fe, Mn, Cu and Ni in Sanvordem and that of Zn and Pb in Rassaim water samples. The heavy metal uptake capacity of these hydrophytes was analyzed from water samples collected from two nearby mining areas namely, Sanvordem and Rassaim Yard, Lotoulim in Goa. Bioaccumulation capacity of plants was studied experimentally in 10 and 21 days by using Atomic Absorption Spectrophotometer (Varian). Present investigation results shows that Eichhornia crassipes can accumulate Fe, Zn, Mn and Ni in larger quantities followed by Salvinia molesta and Azolla pinnata from Sanvordem and Rassaim Yard whereas the highest efficiency in Cu and Pb accumulation was seen in Azolla pinnata, thus phyto-remediation holds a great potential.

KEYWORDS: Heavy metals; Bioaccumulation; Atomic Absorption Spectrophotometer; Hydrophytes; Eichhornia crassipes; Azolla pinata; Salvinia molesta

1. INTRODUCTION:

Heavy metal pollution has become a serious environmental problem nowadays and most conventional remediation approaches do not provide acceptable solutions. Presence of heavy metals even in trace amounts is detrimental to flora and fauna (Das et al. 2008). Phyto-remediation is simple and cost effective technology that uses plants for removal of heavy metals from polluted waters and can be used for environmental cleanup. Hydrophytes such as Eichhornia crassipes, Salvinia molesta and Azolla pinnata have high multiplication rate, wide tolerance to diverse environments, globally distributed and produces large amount of biomass which make them potential candidates for use in phytoremediation as they can accumulate high amount of heavy metals. In such a way, they reflect the toxicity of the water environment, and may serve as a tool for the bio monitoring of contaminated waters (Cardwell et al. 2002; Zurayk et al. 2001).

2. MATERIALS AND METHODS:

The present study was done to investigate the bioaccumulation ability of the above mentioned hydrophytes using stock solutions and water samples from polluted mining areas, Sarvordem site and Rassaim yard at Loutolim, Goa. These water samples were analyzed for various physic-chemical parameters. The hydrophytes, Eichhornia crassipes, Salvinia molesta and Azolla pinnata were collected and acclimatized in troughs for a week in distilled water. After acclimatization, the hydrophytes were transferred into metal ion solutions of Copper ($CuSO_4.5H_2O$), Iron ($FeSO_4$), Nickel ($NiCl_2.6H_2O$), Zinc ($ZnSO_4$), Lead ($Pb\ CH_3(COO)_2$) and Manganese ($MnSO_4$) at 5 mg/L concentration and also placed in water samples collected from nearby mining areas. They were kept for 10 and 21 days with daily measurement of the water level to check the absorption capacity and everyday aged tap water was added to maintain the same level. On the 15^{th} day a pinch of EDTA was added in all the samples as it acts as a chelating agent. The plants were checked for morphological changes daily and finally the plants were sun dried and kept in the hot air oven at 85^{0} C for 2 hours and the concentration of metal accumulation was checked using AA240FS (VARIAN).(Begum, Bioaccumulation of Trace metals by aquatic plants, 2010; Kaladevi, 2014).

3. RESULTS & DISCUSSION:

Our present study on bioaccumulation of heavy metals using hydrophytes and the various analysis reveals, as evident from **Table 1**, water samples collected from Sanvordem and Rassaim yard was found to be unfit for drinking & is of poor quality.The hydrophytes studied from the water samples showed morphological changes such as yellowing and browning of leaves after few days due to the accumulation of heavy metals and the survival efficiency in Eichhornia crassipes was found to be high followed by Salvinia molesta and Azolla pinnata. Water sample from Sanvordem site was found to have a very high concentration of heavy metals like Iron, Manganese, Copper and Nickel whereas water sample from Rassaim yard was found to have a heavy metal concentration of Lead and Zinc comparatively by AAS analysis from Eichhornia crassipes has the maximum potential in accumulating Iron, Manganese, Zinc, Nickel from the nearby mining sites like Sanvordem and Rassaim followed by Salvinia molesta and Azolla pinnata. The highest efficiency in accumulation of copper and lead was seen by Azolla pinnata from Sanvordem and Rassaim as compared to Eichhornia crassipes and Salvinia molesta. Bioccumulation of manganese from the two study sites was found to be higher in concentration in Salvinia molesta followed by the other two hydrophytes**.** The study reveals that when the plants were placed in stock solutions, Eichhornia crassipes had the highest capacity of uptaking Iron whereas Salvinia molesta has the potential of uptaking Iron and Manganese. However, Azolla pinnata had a good capacity of uptaking Nickel. The potential for heavy metal uptake by Eichhornia crassipes was found to be more as compared to Salvinia molesta and Azolla pinnata, which may be due to its enormous root system and physiological makeup.

4. CONCLUSION:

The present investigation and study indicates that the hydrophytes, Eichhornia crassipes,Salvinia molesta and Azolla pinnata can be used as potential indicators of heavy metal pollution in water, thereby aid in assessing and enhancing the health of the environment as by AAS analysis, Eichhornia crassipes has proved to be more effective than Salvinia molesta and Azolla pinnata in the accumulation of Iron, Zinc and Manganese when comparing both the sites namely Sanvordem and Rassaim Yard. However, Azolla pinnata showed better copper and lead accumulation followed by Eichhornia crassipes and Salvinia molesta in the two sites. Future work on this area of study could focus on: identifying the different species of hydrophytes which can efficiently uptake large amount of heavy metals.

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CONFLICTS OF INTEREST:

The authors declare no conflict of interest.

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Figure 1: Mining area in Sanmvordem, Goa

Figure 2: Mining area in Rassaim, Lotoulim Goa

Figure 3 : Samples dried in a hot air oven

Figure 4 : Acid digestion of powdered samples.

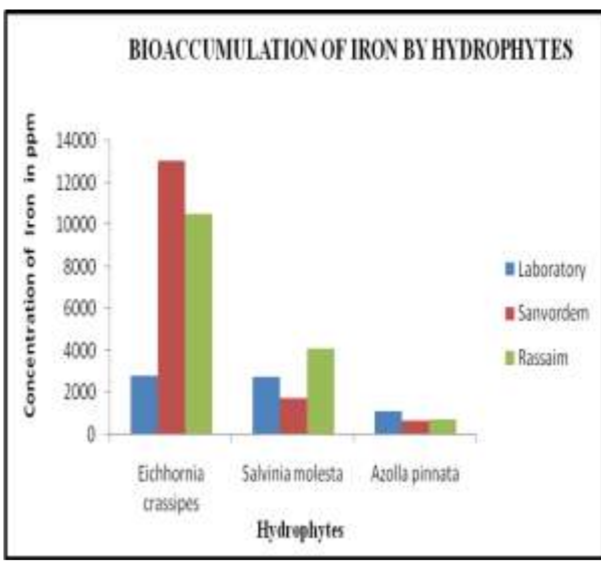
Table 1: Parameters tested in both collected water samples from Sanvordem & Rassaim

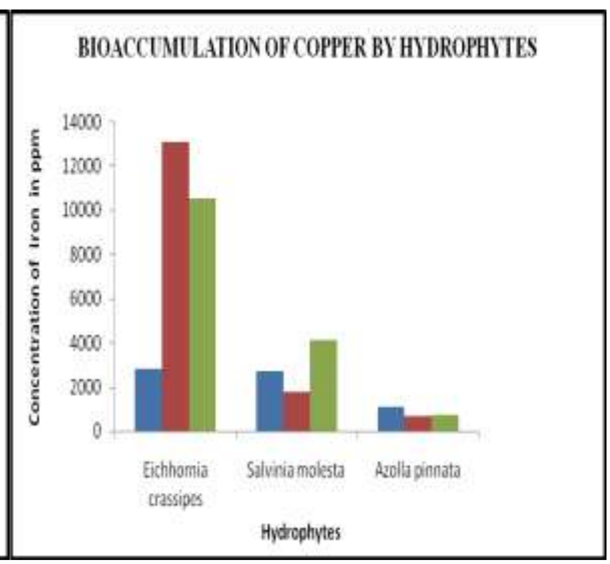
Sr. No.	Parameters	Standard readings	Standards from Agency	Sample 1 Sanvordem	Sample 2 Rassaim
1.	pH	7.0 – 8.5	U.S. EPA/WHO	6.41	6.18
2.	Turbidity (NTU)	25 – 50	WHO	1.2	0.4
3.	TDS (mg/L)	500	U.S.EPA/WHO	1000	114000
4.	D.O (mg/L)	1 - 3	APHA	6.43	6.036
5.	B.O.D (mg/L)	5**	ICMR	2.41	2.82
6.	Nitrates (mg/L)	45	WHO	32.22	28.16
7.	C.O.D (mg/L)	10*	WHO	22.4	26.6

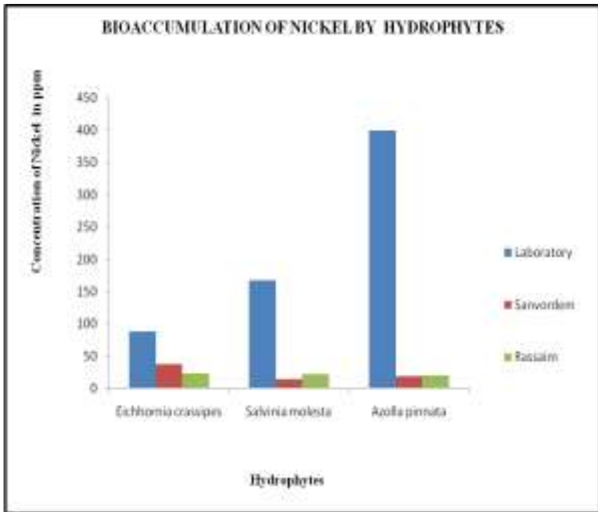
Source: *(Choudhary et al., 2011) ** (Singh and Kamal, 2014)

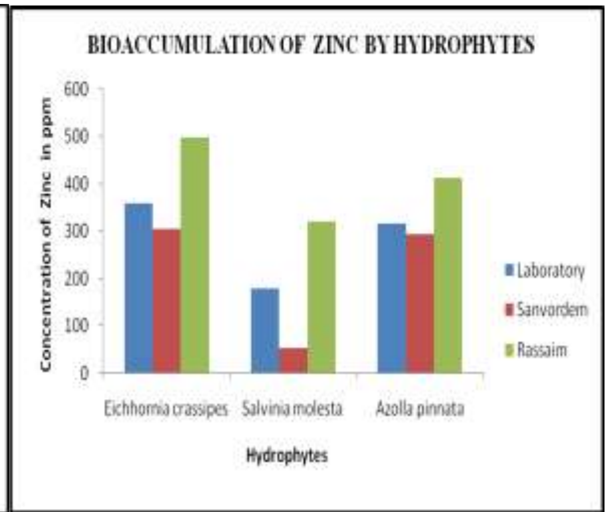
Table 2: Concentration of the heavy metals in the Hydrophytes found using AAS

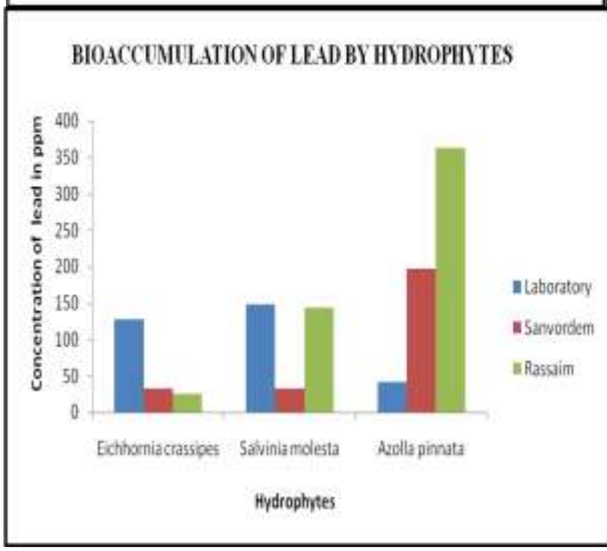
Metals	**Samples**	**Concentration of Heavy metals in ppm**		
		E. crassipes	**S. molesta**	**A. pinnata**
Iron	Laboratory	2811.25	2728	1100.625
	Sanvordem	13054.35	1747.1	692.2
	Rassaim	10497.95	4087.45	737.65
Copper	Laboratory	101.80	139.70	206.25
	Sanvordem	38.60	35.30	106.40
	Rassaim	25.85	68.40	82.45
Nickel	Laboratory	87.95	166.95	399.35
	Sanvordem	37.50	14.20	18.40
	Rassaim	23.60	21.50	19.35
Zinc	Laboratory	358.05	178.63	315.55
	Sanvordem	305.545	52.895	292.15
	Rassaim	497.61	320.55	413.83
Lead	Laboratory	126.75	148.30	41.35
	Sanvordem	32.35	31.95	197.75
	Rassaim	25.62	143.85	362.4
Manganese	Laboratory	1875.5	657.55	155.00
	Sanvordem	531.00	849.50	59.50
	Rassaim	302.85	501.40	46.8

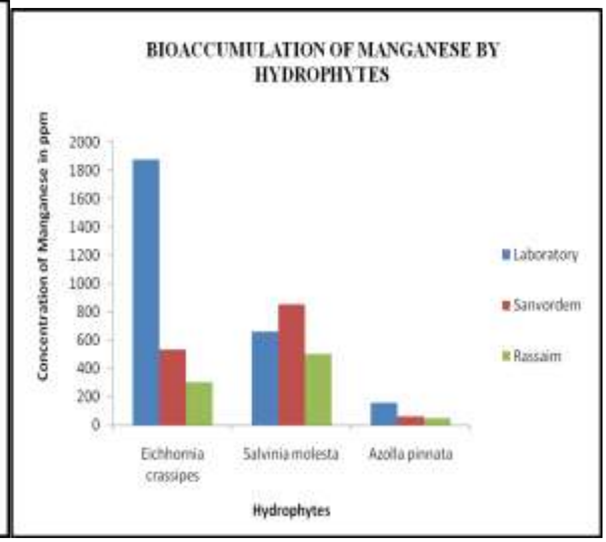




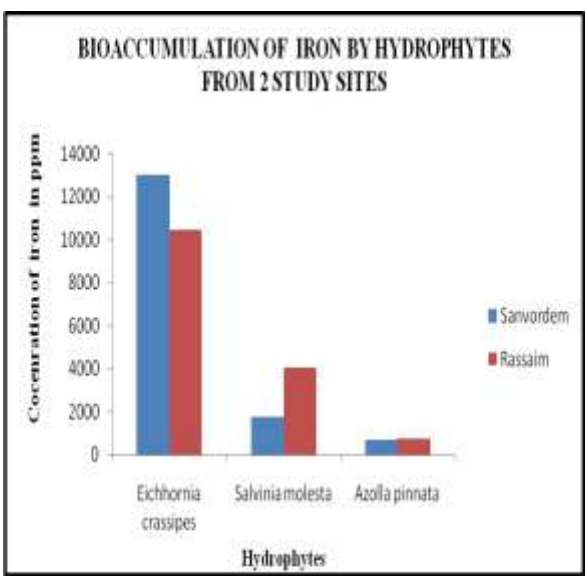


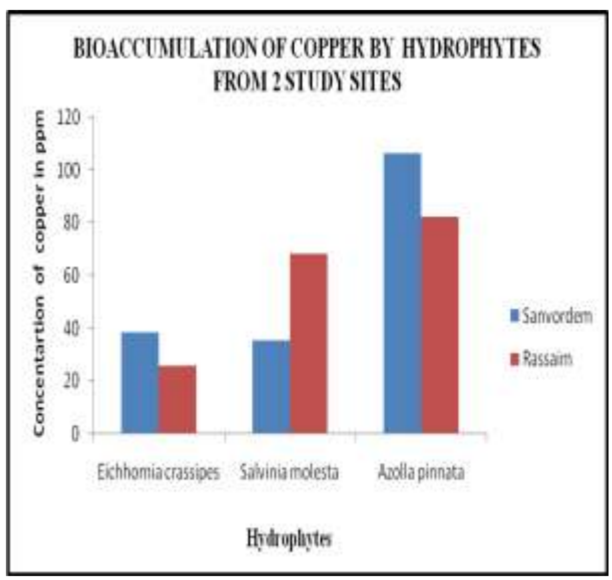


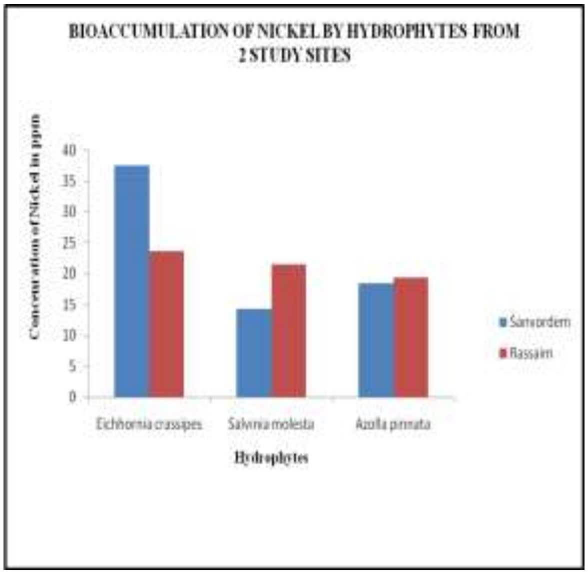


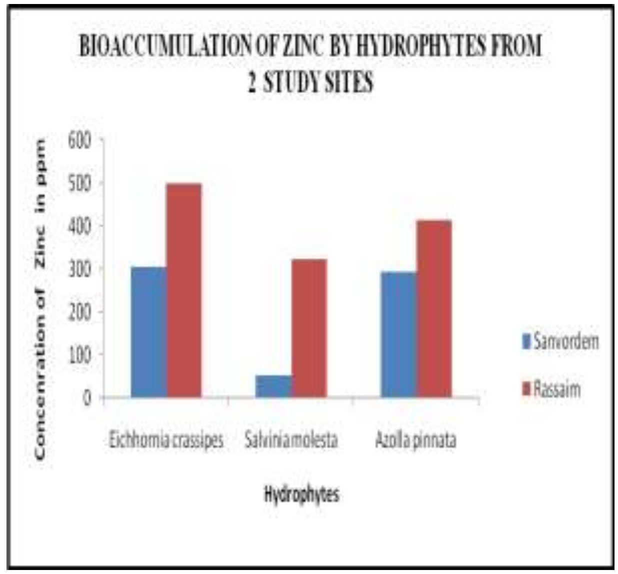


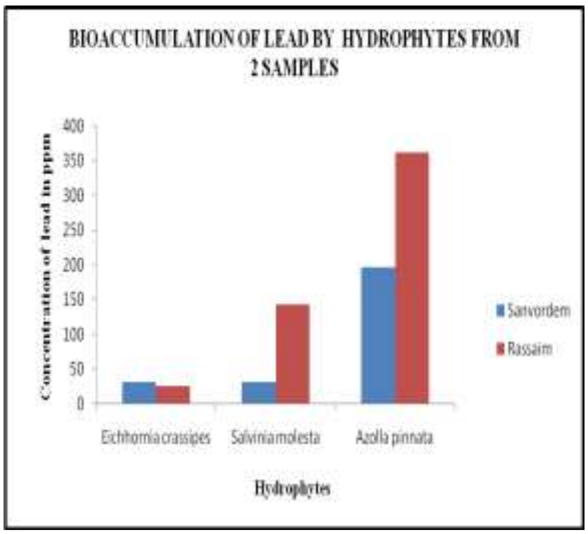
GRAPHICAL REPRESENTATIONS OF HEAVY METAL UPTAKE BY HYDROPHYTES FROM WATER SAMPLES

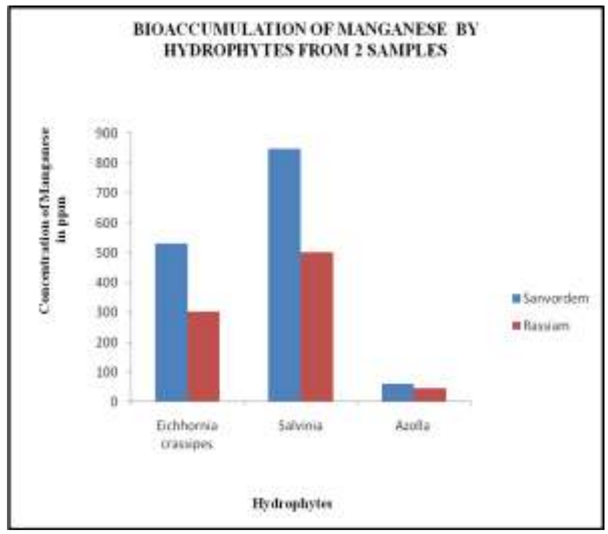












GRAPHICAL REPRESENTATIONS SHOWING BIOACCUMULATION OF HEAVY METALS FROM TWO WATER SAMPLES COLLECTED FROM NEARBY MINING AREAS