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Heavy Metals Phytoremediation Management via Organs of Aquatic Plants of Anzali International Lagoon (Iran)

[1]Gholam Reza Hoseinizadeh, [2]Ebrahim Azarpour, [3]Mohammad Karim Motamed, [1]Hamid Ziaeidoustan, [2]Maral Moraditochaee and [2]Hamid Reza Bozorgi

[1]Department of Agriculture, Lahijan Branch, Islamic Azad University, Lahijan, Iran
[2]Young Researchers Club, Lahijan Branch, Islamic Azad University, Lahijan, Iran
[3]Department of Rural Development, Guilan University, Agricultural College, Iran

Abstract: Experiment was conducted to see the long - term effects of heavy metals as environmental pollutants that has been increseased day by day so it has been clear that phytoremediation may be a satisfactory and suitable method to measure amount of heavy metals and their bio availability. Measurement of pollutant amount is rational due to complications of determining biological effects in a habitat. Aquatic plants due to existence in ecosystem are useful indicators for heavy metal pollution. Wet digestion method was employed for extraction of metals in samples by and through a solution containing HNO_3 and HCl. Atomic Adsorption Spectrophotometry was employed for measurement of the heavy metals. In order to study was performed to analysis of heavy metals accumulation in aquatic plants during 2007from 7 stations of Anzali international lagoon by factorial statistical format based on randomized complete block design. Experimental factors were heavy metals (M_1= Cu, M_2= Cr, M_3= Cd, M_4= Zn and M_5= Pb) and organs of aquatic plants (P_1= leaf, p_2= stem and P_3= root). The aquatic plants studied were P_1= *Typha Iatifolia*, P_2= *Trapa natans* and P_3= *Hydrocotyle vulgaris*. Results indicate that the kind of organs of three aquatic plants and the kind of heavy metal with 99% probability had significant effect on pollutant accumulation. highest heavy metals pollutant accumulation of *Typha Iatifolia* (34.18 ppm), *Trapa natans* (36.20 ppm) and *Hydrocotyle vulgaris* (34.30 ppm) were observed in treatment O_1M_4.

Key words: Anzali lagoon · Phytoremediation · Translocation Factor · Heavy Metals · Aquatic Plants

INTRODUCTION

Anzali international lagoon is among valuable lagoons of southwest Caspian Sea. Which has especial importance due to specific ecological, economical, social conditions and diversity on one hand, Anzali lagoon receives water of 19 rivers and on the other hand it transmits this water through two outflows (Figure 1). These rivers by passing through forest, urban and rural regions carry all kinds of minerals, organics, sedimentary materials, industrial area of Anzali lagoon catchments basin (374000 hectare) and average annual discharge of input ponds (218 kilometer) and given the long period of time of arresting input river's water to this pond as well as high diversity and number of plant and animal communities it can be explained that Anzali lagoon plays a positive role to decrease the burden of organics, minerals and finally to adjust physical and chemical properties of water entering to Caspian sea through its outflow [1]. The pollution with petroleum, heavy metals, xenobiotics, organic compounds and other contaminants is a emergent environmental concern that harms both terrestrial and aquatic ecosystems. Heavy metal pollution

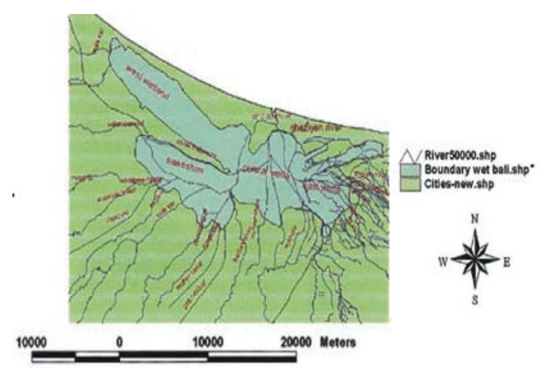

Fig. 1: Map of Anzali international lagoon

Corresponding Author: Ebrahim Azarpour,Young Researchers Club, Lahijan Branch, Islamic Azad University, Lahijan, Iran.

is mainly due to the result of human activities such as agriculture, mining, construction and industrial processes [2]. Soil and water pollution by toxic heavy metals can readily enter bio-chemical cycles and so major efforts should be made to prevent or minimize their distribution and damage. Bioremidation as a cleanup method and through the exploitation of the activities of microorganisms would degrade or attenuate such contaminants. Phytoremediation as one of the developed and implemented technologies of bioremediation is another option for cleaning up environmental pollution which, focuses on tile use of living green plants (trees, grasses and aquatic plants) for the removal of contaminants and metals from soil [3]. The specific mechanisms involved ill phytoremediation include: enhanced rhizosphere activity and subsequence biodegradation, phytodegradation, phytoextraction, phytovolatilization and hydraulic pumping. All plants, terrestrial and aquatic, have the ability to acquire and accumulate metal ions such as Pb, Cu, Cr, Zn, which are essential for plant growth and development. Some plants can also accumulate nonessential toxic metal ions. Consequently, the concept has emerged that plants can be used to remove toxic metals from soil and water thereby contributing to the remediation of polluted sites. Some aquatic plants have been investigated for their potential to improve wastewater quality because of their ability to grow in water polluted by heavy metals [4]. Aquatic plants play an important role in maintaining the purification capability of water and the entire aquatic ecosystem [5]. The present work evaluated the potential of five green marine macroalgae (*Cladophora fasicularis, Ulva lactuca, Chaetomorpha* sp, *Caulerpa sertularioides* and *Valoniopsis pachynema*) for the removal of Cd, Hg and Pb from aqueous solutions (Okha Port, india). The results obtained in this study indicated the highest adsorption ability of *Chaetomorpha* sp. for Cd and Pb while maximum Hg sequestration was observed in *C. sertularioides* [6]. Anderson *et al*. [7] performed heavy metals absorption in sediments of an artificial wetland located in sacramento during 1994-1998 period. Sediment sampling and analysis indicated that concentration of As, Zn, Ni, Cu and Cr have increased by time, But concentration of Ag, Hg, pb and cd didn't significantly increase in sediments law *et al*. [8]. Studied sediment pollutant in Mai po wetland in Hong Kong. Samples were collected from 6 satiation along the pond in February and Zn, Ni, Cu and Cd parameters were measured. Using data statistical analysis including variance analysis indicated that in beginning and in the end of this pond amount of total N and Cu have been accumulated more than other parts. In addition total P concentration has greatest amount in the end of the wetland and Zn concentration has greatest amount in the beginning the wetland. Totally, amount of pollutants was high in the entrance of industrial waste waters. Continuous examination of pollutant amounts in the number of species and defining its effects requires understanding wide range of physical and chemical to ecological factors such as defining influence of interaction of the species to other ecosystem components, defining rates of pollutant transition in various levels, measuring digestion percent which describes resistance percentage in species in various levels [9]. In the field pollutant, aquatic plants have been used for the removal of heavy metals from wastewater and constructed wetland [10, 11, 12]. The aim of the study was performed to study heavy metals accumulation in aquatic plants in 2007 from 7 stations of Anzali international lagoon by organs of aquatic plants.

MATERIALS AND METHODS

In southern coast of Caspian sea in 37 20' to 37 30' North latitude and 49 15' to 49 40' eastern longitude, one of most important lagoon of the world with approximate area of 218 kilometer is located which due to vicinity to Anzali is called this name. In order to study was performed to study heavy metals accumulation in three aquatic plants (P_1= *Typha Iatifolia*, P_2= *Trapa natans* and P_3= *Hydrocotyle vulgaris*) in 2007 from 7 stations of Anzali lagoon by factorial statistical format based on randomized complete block design. Experimental factors were heavy metals (M_1= Cu, M_2= Cr, M_3= Cd, M_4= Zn and M_5= Pb) and organs of hygrophyte (P_1= leave, P_2= stem and P_3= root). After defining studying regions, Sampling stations were determined on the map. Then points defined on the map were marked in the pond by using global positioning system (GPS). Wet digestion method was employed for extraction of metals in samples by and through a solution containing HNO_3 and HCL [13]. Atomic Adsorption Spectrophotometry (Shimadzu AA-680/680) was employed for measurement of the heavy metals. Firstly, preliminary analysis was performed to provide standards and concentration limit for each element and required standards were prepared for each element [14]. Translocation factor was calculated with bottom Equation [15].

$$\text{Translocation factor} = \frac{\text{Density of Heavy metal in shoot}}{\text{Density of Heavy metal in root}}$$

The data was analyzed using MSTATC software. Also, the figures were drawn by EXCEL software. The Duncan's multiple range test (DMRT) was used to compare the means at 5% of significant.

RESULTS

Results of Experiment showed that 7 stations of Anzali lagoon had significant effect on pollutant accumulation. Results of data variance analysis were indicated that the kind of organs of three aquatic plants and the kind of heavy metal with 99% probability had significant effect on pollutant accumulation (Table 1). Among the organs of aquatic plants (O_1= leave, O_2= stem and O_3= root) lowest heavy metals pollutant accumulation were observed in leave and root tissues and highest heavy metals pollutant accumulation were observed in stem (Table 2). Among of heavy metals of three aquatic plants, lowest heavy metal pollutant accumulation was observed as a Cd and highest heavy metal pollutant accumulation was observed as a Zn (Table 2). With attention to variance a nalysis table (Table 1), the interaction effects of kind of organs of three aquatic plants vand kind of heavy metals on heavy metals pollutant accumulation had a significant difference in 1% probability level. The mean comparison of interaction effects (table 2) show that, the highest pollutant accumulation of *Typha Iatifolia* (34.18 ppm), *Trapa natans* (36.20 ppm) and *Hydrocotyle vulgaris* (34.30 ppm) were observed in treatment O_1M_4 (Stem organ and Zn heavy metal) (Figure 2, 3 and 4). Among of aquatic plants, lowest Translocation factor was observed in *Typha Iatifolia* (0.86) and highest Translocation factor was observed observed in *Hydrocotyle vulgaris* (1.11) (Figure 5). Among of heavy metals of three aquatic plants, lowest Translocation factor was observed in Cu (0.81) and highest Translocation factor was observed in Pb (1.13) (Figure 6). In the field pollutant, aquatic plants have been used for the removal of heavy metals from wastewater and constructed lagoon [10, 11, 12]. Since *Hydrocotyle vulgaris* than *Typha Iatifolia* and *Trapa natans* more amounts heavy metals to air biomass itself transfer. Seem that this plant than other plants studied with had less limited in metal inside transfer than root and shoot. As mentioned in this study, further research is required to find the direction of pollutant sources. Results of this study may be used in continuous care on heavy metals in aquatic plants of Anzali international lagoon.

Table 1: Analysis of variance on Accumulation Heavy Metals by organs of aquatic plants

S.O.V	df	*Trapa natans*	*Typha Iatifolia*	*Hydrocotyle vulgaris*
Replication	6	32.925**	74.774**	63.734**
Heavy metals	4	1676.659**	1522.595**	2500.375**
Organs of hygrophyte	2	1035.841**	1045.974**	577.976**
Heavy metals×organs of hygrophyte	8	147.549**	269.021**	61.307**
Error	84	10.71	15.022	15.322
C.V		28	42	34

** and * respectively significant at 1% and 5%

Table 2: Comparison of Mean on Accumulation Heavy Metals by organs of aquatic plants

Treatment	*Trapa natans*	*Typha Iatifolia*	*Hydrocotyle vulgaris*
Heavy metals			
Cu	13.359B	7.873B	10.284B
Cr	8.471C	5.209C	8.632BC
Cd	0.705D	0.569D	0.949D
Zn	25.096A	23.242A	29.918A
Pb	9.165C	8.330B	7.499C
Organs of hygrophyte			
Leaf	8.031B	4.708C	9.331B
Stem	17.637A	15.185A	16.142A
Root	8.408B	7.24B	8.896B

Within each column, means followed by the same letter do not differ significantly at P<0.05

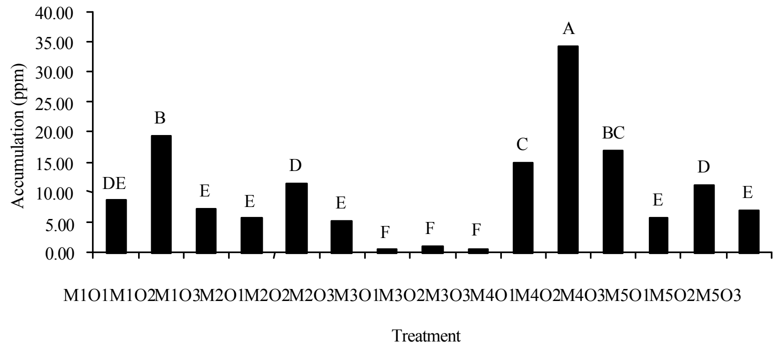

Fig 2: Heavy metals pollutant accumulation of *Typha Iatifolia*

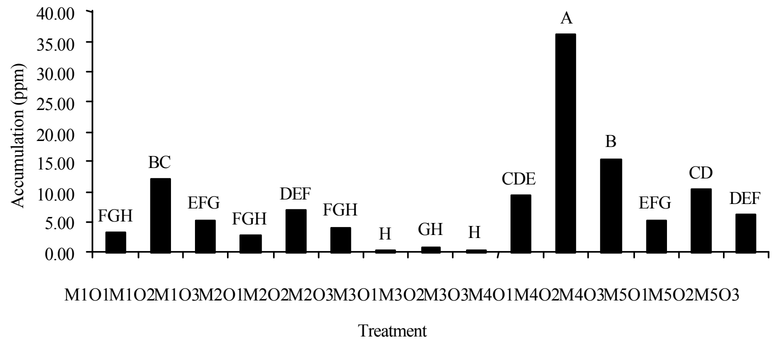

Fig. 3: Heavy metals pollutant accumulation of *Trapa natans*

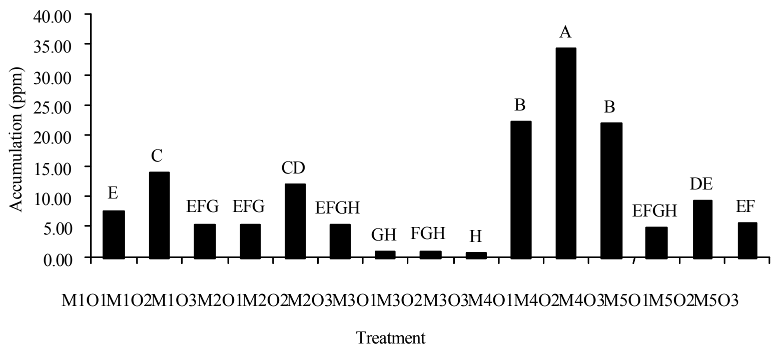

Fig. 4: Heavy metals pollutant accumulation of *Hydrocotyle vulgaris*

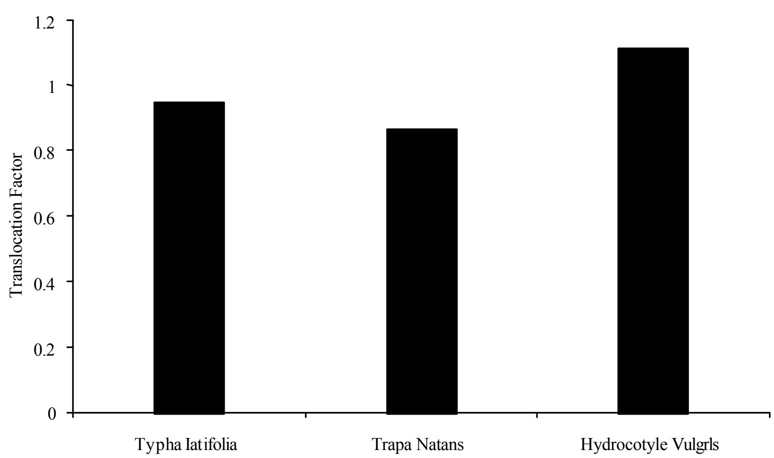

Fig. 5: Translocation factor of aquatic plants

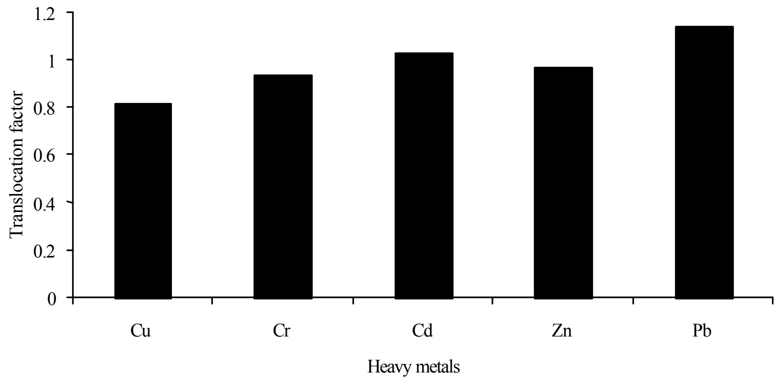

Fig. 6: Translocation factor of Heavy metals

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