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Heavy Metal Concentration in Soil and Plant Species (*Phragmites australis, Trapa natans*) from Anzali Wetland (Iran)

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Abstract: This study was designed to assess total contents of 3 toxic metals Pb, Cr, Cd in the sediments and native plant samples (*Phragmites australis, Trapa natans*) collected from anzali wethland, Iran. The concentration and accumulation of metals from media in terms of Biological Concentration Factor (BCF). Wet digestion method was employed for extraction of metals in samples and Atomic Adsorption Spectrophotometry was employed for the measurement of heavy metals. Measurement of pollutant amount is rational due to complications of determining biological effects in a habitat. Hydrophytes due to existence in ecosystem are useful indicators for heavy metal pollution. Total metal concentrations of Pb, Cr, Cd in sediment varied between 0.84-12.38 µg/g and for water varied between 0.03-0.07 mg/l. Accumulation of Pb was highest in plants. Among two species, *Trapa natans* showed greatest bioaccumulation factor in anzali wetland.

Key words: Anzali wethland · Biological Concentration Factor · *Phragmites australis* · *Trapa natans* · Spectrophotometry

INTRODUCTION

The accumulation of heavy metal contaminants in the environment has become a concern due to the health risks to humans and animals. Heavy metals are elements that cannot be degraded by microbial or chemical process and tend to accumulate in soils and aquatic sediments. Today transfer of toxic elements from media to plants in industrial areas is of great concern. To our knowledge there has not been any study that has identified heavy metal accumulator or tolerant plant species from contaminated media. The use of aquatic plants in water quality assessment has been a common practice for years in-situ biomonitors. They have also been used frequently to remove suspended solids, nutrients, heavy metals, toxic organics and bacteria from acid mine drainage, agricultural, landfill and urban storm-water runoff [1]. The export of dead plant material that may be highly enriched in metals is a concern. Because plants also take up and process metals, these toxic contaminants may be released above surface through similar processes, thereby increasing their bioavailability in contaminated sites [2]. Metal accumulation by plants is affected by many factors. In general, variations in plant species, the growth stage of the plants and element characteristics control absorption, accumulation and translocation of metals. Furthermore, physiological adaptations also control toxic metal accumulations by sequestering metals in the roots [3]. Thus, for persistent materials such as metals, wetlands may be sources as well as sinks for contaminants.

If metals are accumulated in aboveground tissues, they may pass on the contaminants to herbivores unless contaminated shoots are harvested. Since plant species can differ in rates of metal uptake, allocation and excretion, metal dynamics in salt marshes may be influenced by the composition of plant communities [4]. Anzali wetland receives water of 19 rivers and its sediments are generally considered a sink for metals and,

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in the anoxic zone, may contain very high concentrations of metals in a reduced state. As such, the bioavailability of the metals is low compared to terrestrial systems with oxidized soils.

It is often stated that wetlands serve as sinks for pollutants, reducing contamination of surrounding ecosystems. While sediments, which tend to be anoxic and reduced, act as sinks, the marsh can become a source of metal contaminants through the activities of the plant species. Plants can oxidize the sediments making the metals more bioavailable. Metals can be taken up by roots, transported upward to above-ground tissues, from which they can be excreted. Decaying litter can accumulate more metals, which may leach or may become available to detritus feeders. Using wetlands for water purification may serve only to delay the process of releasing toxicants to the water. As levels of pollutants increase, the ability of a wetland system to incorporate wastes can be impaired and the wetland can become a source of toxicity. Several studies have shown that plants can automatically acquire characteristic resistance against toxicants including heavy metals, depending upon various ecophysiological factors in time and space [5-7].

MATERIALS AND METHODS

Anzali wetland is located in the southwestern region of the Caspian Sea coast, at 37°28'N, 49°25'W. Tow plant species viz., *Phragmites australis* and *Trapa natans* were collected in 3 site from anzali wetland (Table 1).

For Metal analysis Wet digestion method was employed for extraction of metals in Plant and sediment samples and through a solution containing HNO and HCL, Atomic Adsorption Spectrophotometry (Shimadzu AA-680/680) was employed for measurement of the heavy metals. to tolerate and accumulate heavy metals may be useful for phytostabilization. bioconcentration factors can be used to estimate a plant's potential for phytoremediation purpose. A plant's ability to accumulate metals from media can be estimated using the BCF, which is defined as the ratio of metal concentration in the roots to that in media (sediment/water) [8].

RESULTS

Metal concentrations in plants vary with plant species [9, 10]. Under normal growing conditions, plants can potentially accumulate some metal ions in order of magnitude greater than the surrounding medium [11]. The average metal content of contaminated sediment in

Table 1: The mean of Heavy metals (Pb, Cr, Cd) in plant samples, sediment sampels (µg/gdry wight) and water samples (mg/l) collected from Anzali wetland (Guilan)

	Abkenar wetland		
Plant	Pb	Cd	Cr
Phragmites australis	0.57±0.01	0.99±0.01	0.32±0.008
Trapa natans	1.03±0.012	0.89±0.047	0.67±0.004
Sediment	10.06	0.84	3.68
Water	0.04	0.04	0.03
	Hendekhale wetland		
	Pb	Cd	Cr
Phragmites australis	4.12±0.02	1.02±0.02	0.58±0.016
Trapa natans	13.62±0.02	3.31±0.012	7.87±0.01
Sediment	11.97	1.58	4.95
Water	0.06	0.05	0.05
	Siyahkeshim wetland		
	Pb	Cd	Cr
Phragmites australis	9.53±0.01	2.11±0.01	4.62±0.02
Trapa natans	2.43±0.015	1.45±0.026	1.22±0.015
Sediment	12.38	1.08	6.91
Water	0.07	0.05	0.07

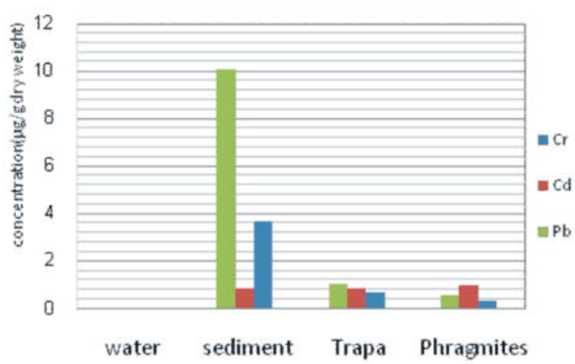

Fig. 1: Metal concentrations of cd, pb and cr of plants collected from abkenar part in anzali wetland comperation water and sediment metals

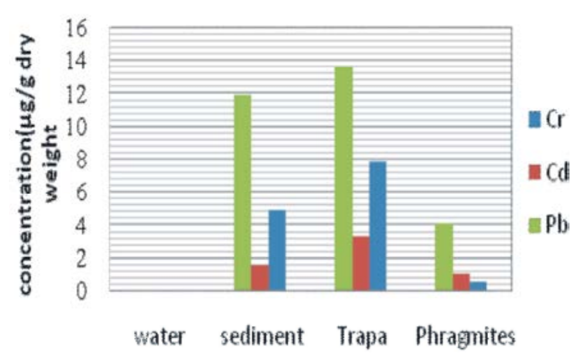

Fig. 2: Metal concentrations of Cd, Pb and Cr of plants collected from Hendekhale part in anzali wetland comperation water and sediment metals

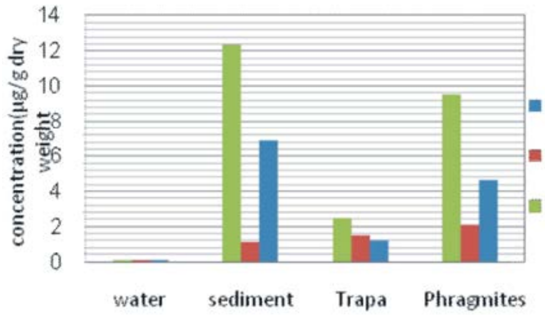

Fig. 3: Metal concentrations of Cd, Pb and Cr of plants collected from Siyahkeshim part in anzali wetland comperation water and sediment metals

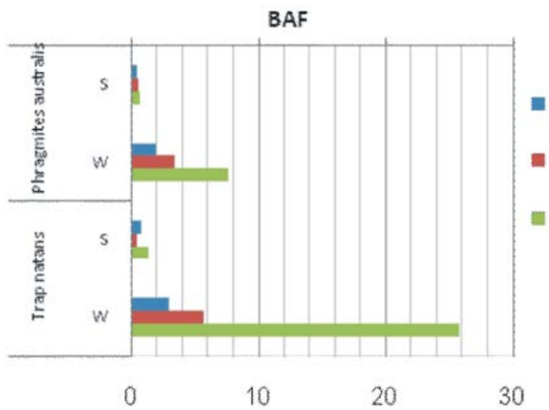

Fig. 4: Bioaccumulation factor of Phragmites australis and Trapa natans in anzali wetland(S:sediment and W:water)

Abkenar was found in the order of Pb (10.06) > Cr (3.68) > Cd (0.84), for Hendekhale Pb (12.97 > Cr (7.87) > Cd (1.02) and Siyahkeshim wetland Pb (12.38 > Cr (6.91) > Cd (1.08) that the average metal content of contaminated sediment was Pb (11.47 > Cr (5.18) > Cd (1.16) (µg/g). Among heavy metals of aquatic plants, highest heavy metal pollutant accumulation was observed as a Pb (Table 1). Also among plant species, the mean concentration of each metal for *Trapa natans* was found in the order of Pb (5.69> Cr(3.25) > Cd (1.88) µg g^{-1} d.w and for *Phragmites australis* maximum concentration was found as 9.53 µg g^{-1} d.w for Pb and minimum concentration 0.32 µg g^{-1} d.w for Cr (Table 1).

DISSCUSSION

The present study shows that some plants can colonize a wide range of metal concentrations. Indeed it is well known that plants can modify metal solubility [12], notably through exudates release and/or modification of soil microbial activity. In the field pollutant, aquatic plants have been used for the removal of heavy metals from wastewater [13].

In this study, the absorption of these elements in plants is variable in, but plants shows that the accumulation of metals followed this order: Pb > Cr > Cd > indicating that the metal release in the media correlates with their absorption by the plants. Cadmium is a toxic element for plants [14, 15] and few species can tolerate their high concentrations in the media. The contents of this element in the studied plants vary between two species. Also Chromium is a toxic metal for plants; in this study Cr concentration was higher than cadmium in studied plants. Results show that, the highest pollutant accumulation of *Trapa natans* was observed (Pb heavy metal). Studies revealed that BCF < 1 are inadequate to the phytoextraction [16]. Species show values of BCFw greater than one, have the potential to be used for the phytoextraction [17], but species show values of BCFs lower than one. Clearly, plant species should be selected as candidates for phytoremediation based on both the tissue concentration of the pollutant and the total biomass produced. Thus, the total amount of a metal accumulated in the harvested parts is the critical factor in assessing the efficiency of a given plant species for the phytoremediation of contaminated sites.

In the selection of plant species for phytoremediation of contaminated sites the main consideration is the amount of the pollutant that accumulated in the shoots. However, for phytoremediation of pollutants, consideration of the amount of pollutant accumulated by roots may be an important factor as well in selecting a plant species candidate. Our results have identified some encouraging prospects for using wetland plants to remediate polluted waters on a practical basis. Wetland managers concerned with the retention of metals in marsh sediments should consider the benefits of *Trapa natans* and *P. australis* in sequestering metals before automatically pursuing traditional restoration efforts. 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 wetland.

CONCLUSIONS

Trapa natans have good potential for the practical remediation of Pb contaminated water and a good candidate for remediation of wastewater contaminated with Pb. The development of practical technologies for phytoremediation with these plant species will require some additional investigations, such as plant uptake efficiency, mechanism, optimal combinations of plant species for specific circumstances and proper post-harvest treatment processing.

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