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Phytoremediation of the Sludge Contaminated with Chromium by Aquatic Plants in Dezful

Shahram Goudarzi[1], Ali Afrous[2]

1. Department of Soil Sciences, Dezful Branch, Islamic Azad University, Dezful, Iran.
2. Department of Water Engineering, Dezful Branch, Islamic Azad University, Dezful, Iran.

ABSTRACT

The existence of heavy metals in the environment has always affected the health of human beings, plants and animals. These metals are the elements that are not easily degradable via chemical and microbial processes. However, they are very likely to accumulate in the soil, aquatic environment and in the plant organs. In the present research, the absorption of the heavy metal of Chromium from the enriched sludge to this metal in the 150 ml/kg concentration level sludge was studied by three species of aquatic plants of Phragmites australis, Typha latifolia and Bulrush scirpus during a two-month interval with three replications. The results of this research showed that after 60 days, the highest amount of absorption in the underground organs was observed in Phragmites australis with the amount of 378/6 mg/kg dry matter and after that the highest amount of absorption belonged to Typha latifolia and Bulrush scirpus amounting to 212/3 and 98/8 respectively. TF factor in these three plants was calculated as 0/16, 0/23 and 0/21 respectively; this shows the relatively high ability of these three plant species studied in phytoremediation in various environments contaminated with Chromium.

***Key words**: Sewage Sludge, Aquatic Plants and Chromium*

INTRODUCTION

The accumulation of heavy metals such as Chromium via various plant species such as Phragmites Australis, Typha Latifolia and Bulrush Scirpus have been studied in different researches. Although these plants may not have been considered as the accumulators having high abilities, they are capable of saving many of these metals due to their quick growth, deep roots and tall aerial organs. Manios *et al*, [1] studied the effect of the ingoing concentration of heavy metals in sewage sludge on the absorption of these metals by the land and aerial organs of the aquatic plant species of *Typha latifolia*. The heavy metals studied in this research included Cadmium, Copper, Zinc, Nickel and Lead. The cultivation areas irrigated with the water enriched with the above-mentioned metal every two weeks, and after 10 weeks, samples were made of the plant organs. The results of the research showed that this plant species has high ability in absorbing the studied metals, and the accumulation of these metals in the underground organs was more than their accumulation in the aerial organs. The results of the research done by Maine *et al.* [2] on the elimination of the metals and the existing nutrients in the sewage of steel industry with artificial canebrake in Argentina showed that the artificial canebrake system made of Thypha and Panicum Alphantasius could eliminate the Chromium from the system area by 86%. Bragato *et al.* [3] studied the quality improvement of Po River in Italy using the cultivation of Phragmites Australis. The research was done regarding the ability of eliminating Copper, Zinc, Nickel and Chromium in an artificial canebrake system inside the sediments and preventing the entrance of these contaminants into the river. In this research, the highest amount of metal accumulation was observed first in Rhizomes, then in roots and after that in the stalks and leaves of the plant. Song and Lee [4] assessed the application of the sewage sludge on the plant and also the soil from the viewpoint of economic and environment in South Korea. In this research, the amount of accumulation of four metals of Copper, Chromium, Cadmium and Lead existing in the sewage sludge was studied in the organs of three aquatic plant species. In this research, using the aquatic plant species was evaluated positive from the viewpoint of environment. The accumulation of heavy metals such as Copper, Cadmium, Nickel, Mercury, Arsenic and Chromium in the plant organs such as Phragmites Australis, Typha Latifolia and Scirpus Bulrush was studied by many researchers such as Bragato et al. [8], Vymazal et al. [5] and Afrous et al. [6]. Regarding the decrease of concentration of heavy metals such as Copper, Varun et al. [7] studied the role of aquatic plant of Typha latifolia as the green stabilizer of industrial sewage sludge in Firozabad, India. In this research done in five sites and with different

concentrations of heavy metals, the concentration of metals in the underground and aerial organs and leaves of Typha Latifolia was measured. The results showed a significant difference in the concentration in the underground organs compared to the aerial organs.
Many researchers have been done on the chemical aspects and the contaminations resulted from using sludge in the agricultural lands and also the effect of sludge on the physical properties of soil in Iran and across the world. However, a few researches have been done in Iran regarding the purification of sewage sludge by cheap environmentally friendly methods. One of these methods is to use fruitless plants in absorbing the contaminating materials of sludge especially the heavy metals.

MATERIALS AND METHODS

The present research was done at the venue of Agriculture Faculty of Islamic Azad University of Dezful, in field condition. The young plant samples of three aquatic plants of *Phragmites australis*, *Typha latifolia* and *Bulrush scirpus* were gathered from the irrigation channels and open drainages of Senjer, Dezful in April-May, 2011in order to be planted in pot cultivation areas having 40cm diameter and 75cm height. The plant samples were kept in the cultivation pots for 10 days in order to be adapted to the cultivation area. The bed of pot cultivation areas was filled with the sewage sludge till 30cm height, and in 150mg/kg level, the sludge was concentrated. This research was replicated three times and during two months, and with 10-day intervals, a complete plant sample was exploited and after being divided into the aerial and underground organs, first was dried in the laboratory and then in the oven with 65˚C for 48 hours and in the end they were grinded. After that, the powder of the grinded plants was digested via the wet method and the concentration of the heavy metal was measured by the atomic absorption machine. The research was done completely randomly, SPSS version 13 was used for the statistical analyses and Duncan test was used for comparing the averages.

RESULTS AND DISCUSSIONS

The diagram 1 shows the comparison of average of the plant species effect on the absorption amount of Chromium (mg/kg dry matter) in the aerial and underground organs of the studied plants after 60 days. As the results show, the plant species of *Phragmites australis* with the average of 378/6 mg/kg dry matter showed the highest amount of absorption in the underground organs. There was a significant difference between the observed amount in this plant and that of two other plant species. In a research, Mundi et al. (2010) showed that the plant species of Phragmites Australis is capable of absorbing Chromium for 13 months for 6000 mg/kg dry matter in the underground organs in the artificial canebrake system via the horizontal current.

Table 1- comparison of average of the plant species effect in absorbing (mg/kg in dry matter) Chromium from the cultivation area (%5 level or P≤0.05)

Plant Species	Underground Organs	Aerial Organs
Phragmites australis	378.6 a	61.7 a
Typha latifolia	212.3b	49.9 a
Bulrush scirpus	98.8 c	21.1 b

TF coefficient is one of the parameters that show the translocation ratio; that is, the absorption amount of each element in the aerial organs compared to the underground organs. The plants first absorb the heavy metals in the underground organs and after storing those in the organs gradually transfer them to the aerial organs. This issue is important due to this reason that the plants can continue this to the extent that the concentration of the heavy metal in the aerial organs reaches the level of toxicity in the plant. When the translocation to the aerial organs reaches the minimum, the aerial organs of the aquatic plants can be cut and the re-growth in the direction of more absorption of the metals can be allowed. Table 2 shows the TF coefficient in the three plant species under study.

Table 2- TF coefficient in 3 plant species under study

Plant Species	TF factor
Phragmites australis	0.16 b
Typha latifolia	0.23 a
Bulrush scirpus	0.21 a

As the table 2 shows, the three plant species has a relatively high TF coefficient. However, no significant difference was seen between the two plant species of Typha Latifolia and Bulrush Scirpus. This high coefficient shows more translocation of the metal from the underground organs than the aerial organs. The reason why the TF is less in the *Phragmites australis* is due to more height of this plant species compared to two other species.

CONCLUSION

All three plant species studied in this research had a suitable capability in absorbing and decreasing the heavy metal of Chromium from the sludge contaminated with this metal in the cultivation area. The obtained result showed that regarding the purification of the soil or the sludge contaminated with the heavy metals, researches can be done on the local plants of different regions. However, further researches are necessary to be done from the view point of time, age, temperature and other effective elements.

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